<u>GEORGIA DOT RESEARCH PROJECT 11-12</u>
FINAL REPORT

TRAINING AND CERTIFICATION FOR CONSTRUCTION INSPECTORS

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16. Abstract:

Construction inspectors are an important asset to the success of a Department of Transportation; they provide quality control for state- and federally funded transportation infrastructure projects. A majority of departments of transportation in the United States are experiencing an increase in the quantity and scope of transportation infrastructure projects while simultaneously experiencing a decrease in the number of experienced construction inspectors. To offset this trend, the objectives of this research are: (1) to provide recommendations for best construction inspection practices for transportation infrastructure and (2) to create a delivery system for construction inspector training and certification materials. Transportation infrastructure inspection methods are limited to highway, roadway, and bridge infrastructure of construction projects in the United States. Selection metrics were used to evaluate findings of a review of various departments of transportation. Self-paced and web-based training and certification modules were created based on the standards and specifications of the Georgia Department of Transportation. Recommendations for best practices for transportation infrastructure inspection are presented, along with a unique and cost-effective training and certification method for construction inspectors.

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GDOT Research Project No. 11-12

Final Report

TRAINING AND CERTIFICATION FOR CONSTRUCTION INSPECTORS

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Georgia Department of Transportation

In cooperation with

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EXECUTIVE SUMMARY

Construction inspectors for state Department of Transportations have proven to be a vital asset for assessing and managing highway transportation infrastructure construction projects. These inspectors contribute to the overall quality of the project, maintaining the budget, and completing the project on schedule. Their ability to learn, retain, and disseminate knowledge and experience is important to enable knowledge transfer between seasoned inspectors and new hires. Furthermore, construction inspectors serve as an "in field" representative for citizens of their state.

As the population of the traveling public continues to grow and state highway budgets decrease, construction inspectors are tasked to maintain quality with less funding on highway infrastructure projects. Georgia ranked fifth in the number of vehicle miles traveled (VMT) of its citizens. The objective of this research is to provide recommendations for best practices of transportation infrastructure inspection and to create a delivery system of a training course for construction inspectors of the Georgia Department of Transportation (GDOT). The research scope was limited to existing best practices for construction inspectors of Department of Transportations across the United States.

A review of existing construction inspector guidelines was conducted across various state and other local government entities in the United States. Based on metrics obtained from the review, the research team selected best practices for construction inspectors based on their performance among other practices. Metrics used to evaluate included cost of inspection, time of inspection, overall quality of inspection, consistency and repeatability of inspection, and use of automation and technology. These metrics and corresponding best practices were reviewed multiple times by experienced GDOT construction inspectors. Feedback provided by these inspectors was incorporated into the research deliverables in an attempt to improve probability of implementation by GDOT. The best practices for each of the selected 16 construction inspection sections are shown in Appendix A of this report.

These best practices were also integrated into a self-paced and web-based instructional tool for GDOT construction inspectors. The research team investigated four types of adult education including live instructor, traveling instructor, webinar, and self-paced/web-based system. Based on the lowest cost, time required, and most productive learning environment, the self-paced and web-based platform was selected as the dissemination method for GDOT construction inspector training. The created training modules included 1) general provisions, 2) auxiliary items, 3) construction erosion control, 4) earthwork, 5) bases and subbases, 6) pavements, 7) bridges, 8) minor drainage structures, and 9) incidental items. A bank of test questions was also created that evaluates the quantity and quality of knowledge gained by the construction inspector after completing a training module.

Results of the research indicate that high quality construction best practices can be assembled and potentially improve current GDOT inspector practices. Key knowledge from these best practices can be presented in a web-based and self-paced instructional tool to increase the potential for learning for new construction inspector employees. Experienced construction inspectors can be evaluated through an examination in the software to determine their level of competence in various areas of construction inspection. Research deliverables of this project provide a set of best practices for construction inspection of transportation infrastructure as well as an enhanced method of disseminating learned knowledge.

1. INTRODUCTION

The ability of construction inspectors to learn, retain, and disseminate knowledge and experience is vital because inspectors are the field representatives of the department of transportation (DOT), as well as representatives for citizens of the state. Construction inspectors provide quality control for transportation infrastructure construction projects. Many of the DOTs across the United States are experiencing growth in both the number and size of transportation infrastructure projects while simultaneously witnessing a declining number of construction project staff needed to inspect such projects (FHWA 2010).

The Georgia Department of Transportation (GDOT) is attempting to capture the accumulated knowledge of seasoned construction inspectors before their retirement to transfer that knowledge to new employees. Similar to the national trends, GDOT construction inspectors are being required to perform more inspections with limited resources, which allows for minimum time and funding for creating and conducting training and certification courses for new construction inspector hires. The goals of this research are: (1) to provide recommendations for best practices of transportation infrastructure inspection and (2) to create a renewed delivery system of training courses and modules for GDOT's construction inspectors. Construction inspection methods and training strategies were reviewed, and the information was used to accomplish those research goals.

Other state DOTs have implemented unique strategies for training their construction inspectors. For example, the South Carolina Department of Transportation has outsourced their training and certification to Clemson University (Amirkhanian and Vaughan 2001). The Florida Department of Transportation implements many certification classes created by the National Highway Institute (NHI; Pielstick 2002). In this current effort, researchers reviewed existing components of strategies for training and certification from other DOTs for potential implementation. Based on this collective body of existing methods, the research team presents self-paced and web-based training and certification modules for construction inspectors, and recommendations for construction inspection best practices.

2. LITERATURE REVIEW

For a majority of state-funded transportation infrastructure projects, construction inspectors represent the interests of the state government and, ultimately, the citizens of the state. These inspectors have a great responsibility to ensure construction methods, environmental issues, budget management, public safety, structural integrity, traffic planning, and other issues are compliant to their state's requirements. Skilled construction inspectors are an important asset to the success of a Department of Transportation.

2.1 Construction Inspection of Transportation Infrastructure

Lack of adequate funding for transportation infrastructure construction inspection personnel presents a problem for many DOTs. These government entities must deliver the same quality construction inspections on more transportation infrastructure projects with a decreased inspection staff. Construction inspection personnel with constrained time and resources may be forced to prioritize critical inspection tasks and possibly eliminate noncritical inspection activities. This could decrease the overall quality of construction inspection and potentially decrease the quality of the transportation infrastructure.

Construction inspectors employed by the Missouri Department of Transportation are currently required to perform four times the workload of inspectors in 1978 (FHWA 2010). To cope with their own increased number of projects, the Florida Department of Transportation has outsourced approximately 60 percent of its construction inspection to private companies. The Texas Department of Transportation is attempting to distribute the burden on construction inspectors by transferring the responsibility of tracking and reporting materials on hand from the Texas Department of Transportation to contractors (FHWA 2010). Over half of the state DOTs have implemented warranty contracts in an attempt to reduce the number of site inspections required (Bayraktar 2004). Surveyed contractors, however, were reluctant about this project delivery method due to the associated risk of warranty contracts. Some DOTs are using technologies such as the Global Positioning System (GPS) and Geographic Information Systems (GIS) to increase quality and reduce inspection time (Sobanjo 2006). Many other strategies have been implemented by various DOTs to counteract the impacts of this problem.

2.2 Construction Inspector Training

Transportation infrastructure construction inspectors are vital components of the construction process because they provide the final quality check for contractors constructing state projects. Developing skilled construction inspectors through proper training is essential to enhance or maintain the quality of a construction project. By maintaining an effective training program, knowledge gained by experienced construction inspectors can be transferred to new employees.

Several methods for construction inspector training are used by departments of transportation across the United States. Many states, such as Pennsylvania, California, Washington, Virginia, Iowa, and Utah, have created training and certification courses for construction inspectors (AASHTO 2011; VDOT 2011; Anderson 2003). Those and other states require inspectors to be certified through their training and certification courses, and through required federal training for specific construction activities.

Other methods for training include using available resources from federal government organizations and other third party sources. The National Highway Institute has created several training courses for bridge inspection (NHI 2011a), bridge rehabilitation (NHI 2011b), geotechnical inspection (NHI 2011c), and earthwork inspection (NHI 2011d). Other organizations have certification programs, such as the American Concrete Institute (ACI) certification program for concrete transportation construction inspection (ACI 2011). The American Segmental Bridge Institute and the Florida Department of Transportation have created training and certification programs for grouting inspection (Pielstick 2002). Since the South Carolina Department of Transportation mandates contractors hire and train their own inspectors, that department has delegated its inspector certification courses to other entities, such as Clemson University (Amirkhanian and Vaughan 2001).

2.3 Georgia Department of Transportation

With one of the largest networks of roadways in the United States, Georgia is working to meet the increasing demands on training resources for construction inspectors. Current training and certification will not be sufficient as experienced inspectors retire.

2.3.1 Georgia Roadway Demands

In 2009, the Georgia Department of Transportation maintained 121,631 roadway miles, including Interstates, freeways, expressways, arterials, collectors, and local roadways, and it ranked ninth in the country for number of roadway miles (GDOT 2011a; US Census Bureau 2012). In a preliminary study, the Federal Highway Administration (FHWA 2010) found that Georgia experienced 1.9 million total vehicle miles traveled (VMT) in 2010. The VMT estimates the number of miles traveled in a state per year and is calculated by multiplying the average annual daily traffic (AADT) for a given state by the number of lane miles in that particular state. The VMT value for Georgia ranked fifth among all states in the 2010 study, a ranking the state also held in 2009 (FHWA 2010).

GDOT is required to provide construction inspectors for new transportation infrastructure projects and rehabilitation ventures, placing a strain on existing and future resources. GDOT is divided into seven districts and 41 area field offices. Currently, each field office hosts a field engineer and 10 to 15 construction inspectors, who inspect transportation infrastructure projects in their jurisdiction.

2.3.2 GDOT Construction Inspector Training

At this time, GDOT offers a self-study program for construction inspectors for training. These training courses are offered through the Engineering Skills Development (ESD) program and provide opportunities for construction inspectors to obtain training and certification for various construction inspection activities. Inspectors independently progress through courses by a voluntary, “self-paced” system (GDOT 2011a). Available course topics range from basic plan reading to inspection of bridges and structures. Each course presents important inspection information and a variety of exercises for validation.

Another training program offered by GDOT is for worksite erosion control supervisors (WECS) (GDOT 2011b). The WECS is responsible for ensuring that a project remains compliant with the required erosion control measures. This training and certification program requires the supervisor to score more than 70 points to qualify for certification, and it must be renewed every 3 years. Because the WECS and state certification are separated, GDOT inspectors are required to obtain the Georgia Soil and Water Conservation Commission (GSWCC) certification for level 1A training (GDOT 2011b). That training and certification module covers duties of a WECS, the definitions and implications of erosion and sedimentation, and special provisions, such as environmental considerations. It also covers water quality and sampling, maintenance, fencing, monitoring, and other areas. Other courses include bridge inspection, pavement management, supervisory roles and responsibilities, computer training, and flagger certification (GDOT 2011c). In addition to these programs, to prepare for future loss of experience in the field, GDOT needs an exhaustive review of best inspection practices across the country and an innovative delivery system of training courses and modules for construction inspectors.

3. OBJECTIVE AND SCOPE

The purpose of this research is to improve construction inspection practices of GDOT employees on transportation infrastructure projects. The following two primary objectives are necessary to accomplish that purpose:

1. Provide recommendations for best construction inspection practices for transportation infrastructure projects
2. Create a delivery system for construction inspector training and certification materials

This research is focused on best practices of US construction inspection for typical construction activities related solely to highway, roadway, and bridge infrastructure.

4. METHODOLOGY AND RESULTS

The methodology framework is divided into two sections: (1) construction inspector best practices (see Appendix A), and (2) training and certification for construction inspectors (see Appendix B). For each section, a prototype was created and reviewed by a technical expert committee comprised of 10 GDOT inspectors with sizable experience in a particular area of transportation infrastructure construction. Feedback received from these reviews improved the quality and accessibility of the research deliverables by complying with the needs of GDOT inspectors.

4.1 Construction Inspector Best Practices

The research team conducted a review of existing construction inspection practices employed by DOTs across the United States to identify best inspection practices for highway and roadway infrastructure. Construction inspection practices from the following states were included in the review effort: Alabama, Arkansas, California, Florida, Georgia, Kentucky, Mississippi, North Carolina, New York, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Construction inspection manuals from these states were reviewed either because of their complex transportation infrastructure systems and/or the state's close proximity to Georgia. The following sections of the manuals were identified and used to segment the construction inspection practices: (1) asphalt pavement, (2) base course, (3) pavement markings, (4) earthwork, (5) portland cement concrete (PCC) paving, (6) culverts, (7) erosion control, (8) clearing and grubbing, (9) traffic control, (10) Advanced Traffic Management System (ATMS), (11) drainage, (12) surface treatments, (13) curbs and gutters, (14) utility relocation, (15) bridges, and (16) roadside and overhead signs.

A multi-dimensional chart with inspection activities, methods implemented for each activity, and the evaluated states was created to visualize the inspection method used for a specific activity for a specific state. Inspection methods for a specific construction activity from various states were compared and evaluated based on the following metrics:

- Cost of inspection
- Time of inspection
- Overall quality of inspection
- Consistency and repeatability of inspection
- Use of automation and technology

By comparing each inspection method based on the presented metrics, a best practice was either identified as a single existing inspection method or a combination of reviewed inspection methods. The research team organized the identified best construction inspection practices into 16 construction inspection sections for highway and roadway infrastructure. Self-pa

4.2 Construction Inspector Training and Certification

The research team also conducted a review of existing methods of training and certification for construction inspectors. After reviewing how various DOTs train and certify their construction inspectors, the researchers examined other strategies for training for both the private and public sector, including: colleges and universities, large and small construction firms, corporate training methods, innovative or new teaching/certification methods, and adult education classes (e.g., General Education Development [GED]). Laws and regulations of Georgia associated with construction personnel training and certification were also reviewed. The following construction inspector training and certification methods were identified as potential candidates for implementation by GDOT:

Live instructor:	An instructor periodically trains and certifies construction inspectors at the GDOT central office
Traveling instructor:	An instructor periodically travels to each district office of GDOT to train and certify construction inspectors
Webinar:	An instructor broadcasts a live presentation from the GDOT central office to all GDOT district and field offices
Self-paced/web-based:	Self-guided tutorials allow construction inspectors to complete on-line training

To evaluate each training and certification method, the following metrics were used: cost of training, time required for training, overall quality, implementation strategy, and ease of updating information. For example, approximate traveling expenses for each live instructor course taught at the central office are $2466, and cumulative travel time totals approximately 89 hours. These values were calculated based on GDOT's fuel index and average highway speeds between the area offices and the central office located in Atlanta, Georgia (GDOT 2013). A full-size pickup truck typically allocated to GDOT construction inspectors was used to calculate the fuel consumption rate. Each GDOT district office hosts between four to seven area offices. The total travel distance and time for each field office to the respective area offices and for each area office to the district office was calculated for one construction inspector. The travel distance and travel times used for comparison of the training methods are shown in Table 1.

Table 1: Travel Distance and Time for One Construction Inspector

	Travel Distance (miles)		**Travel Time (minutes)**	
Area Office	**Area Offices to District Office**	**Area Offices to Central Office**	**Area Offices to District Office**	**Area Offices to Central Office**
Gainesville	185	397	224	463
Tennille	289	899	368	950
Thomaston	301	641	397	656
Tifton	390	1416	451	1417
Jesup	283	1395	359	1411
Cartersville	181	338	221	373
Chamblee	75	52	118	80
Total	1704	5138	2138	5350

Based on its research and calculations, the research team selected the self-paced and web-based training and certification for construction inspectors for implementation. This training format scored highest with regard to the previously discussed metrics, and it will allow construction inspectors and supervisors to schedule training time around actual construction operations. Construction inspectors will be able to progress at various speeds through the training modules depending on their current level of understanding and individual learning pace.

Standards and specifications for GDOT construction infrastructure projects for highways and roadways were used for the foundational material for the self-paced and web-based training and certification modules. The modules were segmented into the following sections, which mimic the sections of GDOT's Standard Specifications Manual: (1) general provisions, (2) auxiliary items, (3) construction erosion control, (4) earthwork, (5) bases and subbases, (6) pavements, (7) bridges, (8) minor drainage structures, and (9) incidental items. A sample of the instructional section is shown in Figure 1.

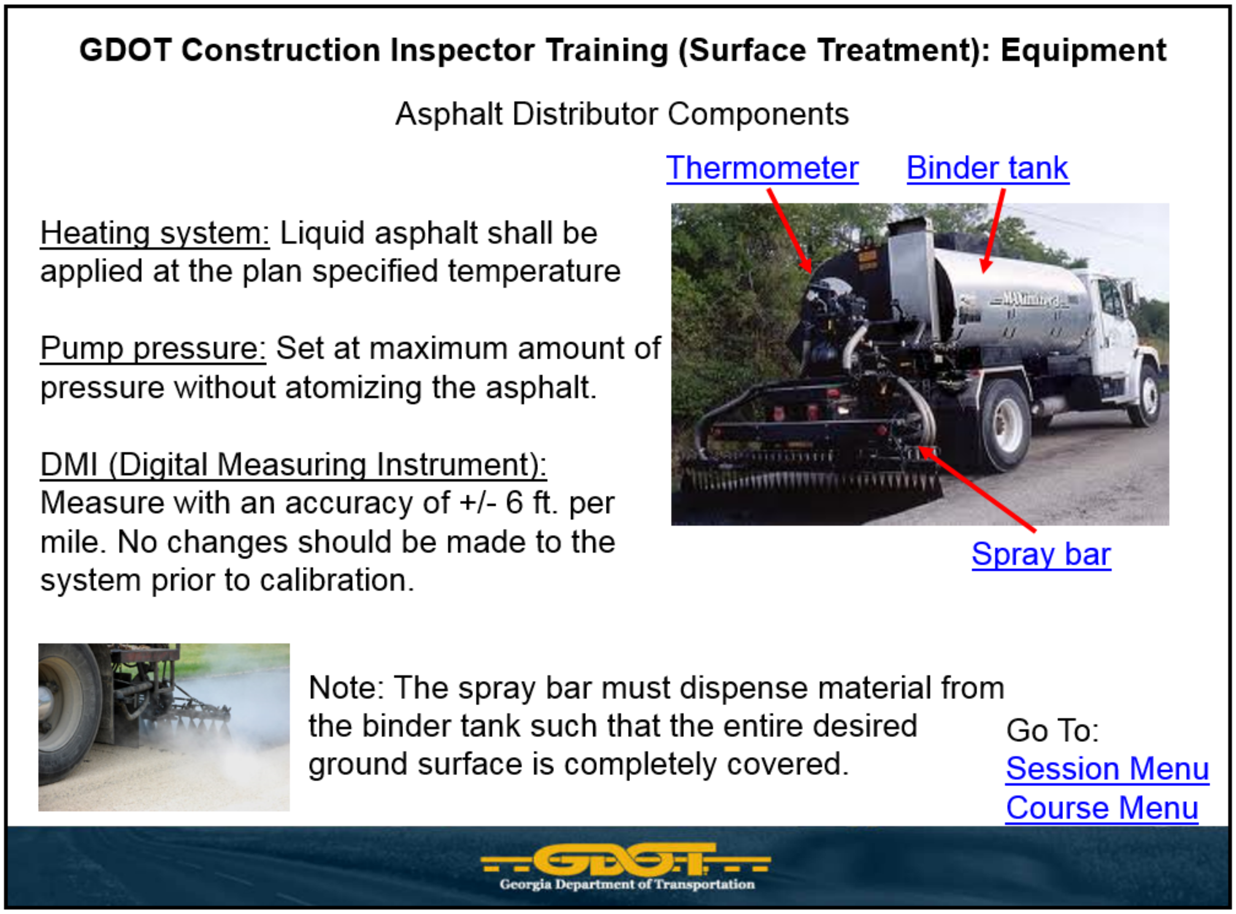
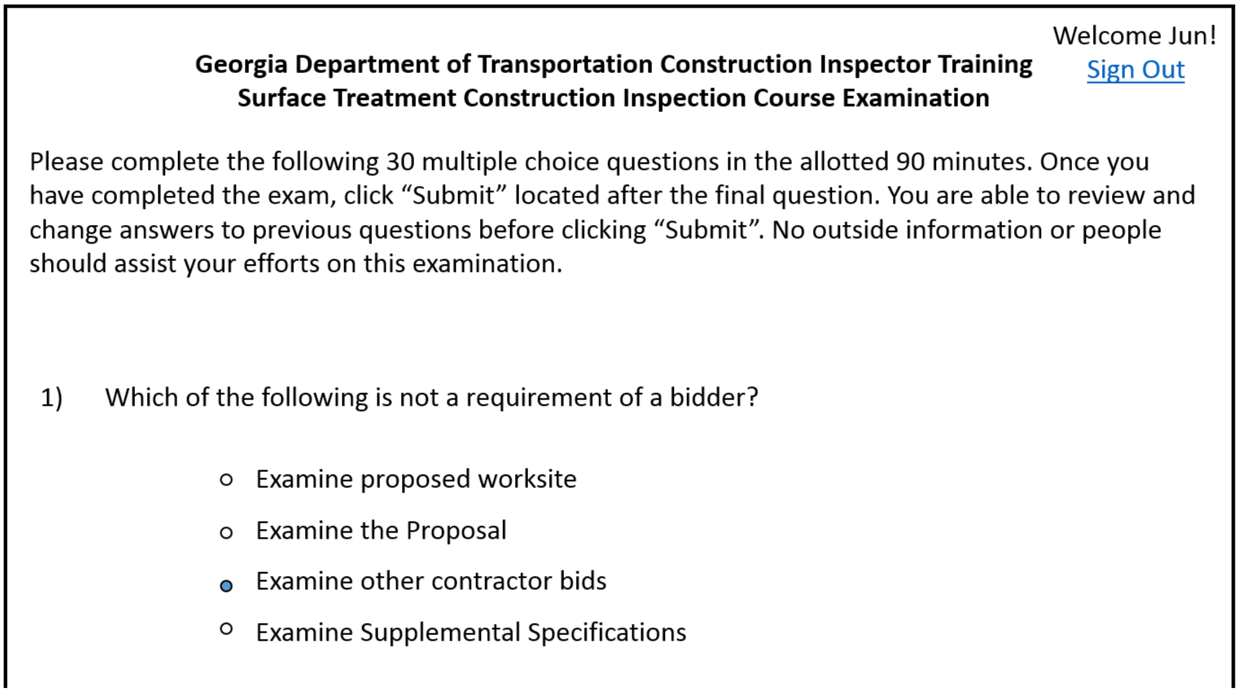


Figure 1: Training Module Sample for Surface Treatment Equipment

Each section includes an instructional module that presents the standards and specifications (provided in Appendix B) and concludes with a certification exam (provided in Appendix C). Inspectors must answer at least 70 percent of the 45 randomly generated questions correctly to obtain certification in each of the sections. A certificate of training completion is presented to each inspector who achieves a passing score on the exam. Figure 2 shows a sample question from the surface treatment certification exam.



Welcome Jun!
Sign Out

Georgia Department of Transportation Construction Inspector Training
Surface Treatment Construction Inspection Course Examination

Please complete the following 30 multiple choice questions in the allotted 90 minutes. Once you have completed the exam, click “Submit” located after the final question. You are able to review and change answers to previous questions before clicking “Submit”. No outside information or people should assist your efforts on this examination.

1) Which of the following is not a requirement of a bidder?

- Examine proposed worksite
- Examine the Proposal
- Examine other contractor bids
- Examine Supplemental Specifications

Figure 2: Construction Inspector Certification Exam Sample Question

After completing the certification exam, the construction inspector receives an examination score and details of each question answered incorrectly, as shown in Figure 3. In addition, the inspector becomes aware of areas that may require more study and is allowed to re-try the certification exam.

13. For the binder application, the pump speed shall be increased to meet the correct....

- a) temperature
- b) pressure
- c) humidity
- ✕ d) volume

14. Under what circumstances would patching to the existing roadway surface not be performed?

- a) If a change order is made to include patching
- b) If the inspector feels patching is needed after visual inspection of the existing surface
- c) If a contract modification is made to include patching
- ✕ d) When a line item exists for patching in the original contract

15. Written approval of using a paver not on the approved equipment list should be submitted no later than __ days after work begins.

- a) 10
- b) 15
- c) 30
- ✕ d) 60

FAILED Your score is 0. Retake the exam.

Figure 3: Evaluation and Score of Section Exam

5. CONCLUSION

Construction inspectors provide quality control for transportation infrastructure construction projects. These inspectors are a vital asset because they act as the state's representative on the construction site for the department of transportation. Many DOTs are inspecting more and increasingly complex transportation infrastructure projects, while experiencing a decrease in the number of experienced construction inspectors (FHWA 2011).

GDOT desires to capture best inspection practices and provide training for its new construction inspectors. Best construction inspection practices were investigated and recommended for highway, roadway, and bridge infrastructure construction projects. A self-paced collection of instructional modules and certification exams was created based on the current standards and specifications for transportation infrastructure construction projects (highway, roadway, and bridge infrastructure) employed by GDOT. By assembling the best construction inspection practices, GDOT can compare its existing inspection practices and potentially implement new procedures.

The created training materials provide each inspector with a tool containing valuable inspection information that is accessible and easy to understand. These self-paced, web-based courses provide construction inspectors an opportunity to learn about inspection practices in a minimal-stress environment.

In this project, researchers were unable to address some metrics required to properly implement the training module, such as security settings, frequency of updating training per inspector, and strategy for updating construction inspection practices in the training materials.

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APPENDIX A: CONSTRUCTION INSPECTOR BEST PRACTICES

A-1 Asphalt Paving Construction Inspector Best Practices

A-1-1 Preconstruction – Duties of the Inspector

Inspecting

Inspecting includes reviewing the Project plans, preparing field books, and acquiring a working knowledge of the specifications that apply to the Project.

Observing

Observing is performed continually to ensure compliance with the specifications. Thorough checking and diligent observation will result in good inspection. The following are typical items to be observed:

- Roadway preparation
- Handling of mix
- Equipment:
  - Type and features
  - Operation of equipment
- Traffic control
- Safety

Sampling

Sampling and testing of materials is a very important part of construction work. Payment for many items of work is based on the compliance of tests performed on material that has been sampled. Most Project sampling is performed by Contractor personnel, as directed and witnessed by the Inspector or Plant Monitor. Project sampling work will be performed by the Office of Materials personnel. ***The Inspector should inform the Office of Materials when that material will be available for sampling so it can be tested in a timely manner.***

Documenting and Reporting

Complete documentation of all phases of the work is necessary. Records of the paving plan and job mix formula must be kept to document payment to the Contractor. Some items for the Inspector to keep in mind are the following:

- Keep complete, neat, accurate, and up-to-date records and reports.
- Submit Daily Work reports to the SiteManager software on time.
- Include lineal, quantitative, and unit count measurements to support pay quantities.
- Complete the Inspector Diary. (There is never too much information in the diary. Information found in a diary is useful in the future to recreate events.)

- Inspect traffic control devices daily.
- Inform other Inspectors and/or Supervisor of any irregularities.

Other Inspection Duties

- Check the Contractor's equipment:
  - Type, size, and features
  - Operation
  - Maintenance
  - Safety
- Check the material certification.
- Check dimensions:
  - Width
  - Depth
  - Length
- Check quantities.
- Check traffic control installation.
- Check temperatures:
  - Onsite mix
- Check mix uniformity:
  - Temperature (based on the job mix formula)
  - Segregation
  - Aggregate clumps
  - Tack coat on the aggregate

Pre-paving Meeting

The purpose of the pre-paving meeting is to have a discussion with all parties involved. This discussion will evolve into a job-specific paving plan.

The following people should be in attendance at the pre-paving meeting:

- Project Engineer
- Superintendent
- Paving Foreman
- Construction Inspector(s)
- Bituminous Construction Engineer
- Plant Q/A or Q/C
- Office of Materials Testing Technician

Items to be discussed in the pre-paving meeting are as in the following subsections.

Maintenance and Protection of Traffic Safety

- Who will be handling maintenance and protection of traffic safety (M&PT)? Prime/Sub? Have lane closures been submitted by the Contractor and traffic interruption reports submitted to the Traffic Management Center?
- Any nighttime paving planned?

- The Contractor should submit a traffic control plan to the Project Engineer.
- A supply of “Uneven Lane” and “Do Not Pass” signs should be on hand in case they are needed for an overnight drop-off or other short-term drop-off (i.e., 1 or 2 days maximum). Refer to Section 150 of the Contract Special Provisions for further information.
- How and by whom will overhead hazards be marked out? Ensure they will be marked out prior to any paving work—preferably not painted on the road, so the marks will not be paved over.
- Any Utility Owner within the vicinity of the Project is notified and informed of the scope of work so utilities in conflict can be relocated or adjusted prior to paving operations.
- Any property within the Project limits that might be damaged due to vibratory rollers (antique shops, historic buildings, high water table, or rock foundations) is identified in preconstruction and should be monitored accordingly. This operation is performed in coordination with the Geotechnical branch of the Office of Materials (OM).
- According to Subsection 400.2.01 of the GDOT Standard Specifications, only the approved releasing agent is permitted for use during paving.

<u>Materials</u>

- Where will tack coat come from? How will it be placed? Remember that tack coat must be applied between all hot mix asphalt (HMA) lifts (excluding the surface of permeable base material). Is Subcontractor approved? This is not a service item.
- What plant will supply the asphalt? Will there be a backup plant? Who? What is the plant delivery rate? Are there any special arrangements for nighttime paving? Note the delivery temperature must be a maximum of 165°C or as recommended by the asphalt binder manufacturer. (This information should be included in the paving plan and job mix formula.)
- Have the appropriate mix designs been submitted to and reviewed by the Bituminous Materials Engineer? Delivery ticket and mix code discussion.

<u>Equipment</u>

- All trucks will be covered by solid tarps that will hang over the sides and back of the body and be securely fastened. The Construction Inspector is responsible for monitoring this. If a truck arrives uncovered, the Project Engineer will reject it.
- All haul trucks will be cleaned prior to loading. Any haul trucks found to have foreign material in the body will not be allowed back on the Project until the body has been cleaned to the satisfaction of the Project Engineer. The inside surface of the truck body may be lightly coated with an approved asphalt release agent. Approved asphalt release agents can be found in the Department’s Qualified Products List (QPL). Fuel oil is not an approved release agent.
- Where will trucks and paver clean out?
- What make and model paver will be used? When will the paver be on-site? What will be used for grade and depth control? String line? Ski? Marked fills on pavement? Is there a straightedge with the paver?
- What rollers will be used? Are they on the approved list?

- Who will be operating the rollers? If trainees, how much experience do they have? Who will be training them?
- Will there be a spare roller on site? What will it be? How far away is it?
- Arrange time for inspection staff to view and approve equipment.

Paving

Discuss chain of command, lines of communication, and giving and receiving instructions.

- What are the anticipated paving hours? Do these times conflict with any time or lane restrictions in the plans or Contract?
- Equipment removal—generally what time should the last load come to get equipment off road to be in compliance?
- What about the weather? Temperature? Rain? When and by whom will the decision be made to go or stop?
- Review sequences and widths (paving vs. lane) on plans; problem areas should be walked through in the field. Does planned paving and lane width impact striping?
- If paving is over 16-ft wide, encourage the Contractor to add a screed extension for this width paving.
- Discuss compaction patterns and equipment to be used to determine patterns. Compaction should always progress from the low side to the high side. A discussion of the tender zone and its associated problems should be conducted. Once a rolling pattern is established, it is important that it be maintained and monitored to ensure consistent density. Compaction testing is performed by both the GDOT technicians with the OM and the QA/QC representative from the asphalt plant. They also provide the rolling pattern and monitor alongside the Bituminous Construction Engineer.
- How will longitudinal joints be constructed? How will they be compacted? According to Special Provision 150 of the Standard Specifications, longitudinal joints are allowed up to a maximum thickness. For transverse joints, the Contractor is required to construct paper joints at the end of each day for a smooth tie-in. Refer to the corresponding section in the Standard Specifications for further information.
- What will be used to cut the tapers back? Remember that at the end of each paving day, there should be a smooth transition from the paving course to the existing pavement. Discuss signing requirements.
- What pavement markings are required to be replaced daily (rpm, temporary tape, paint, etc.)? How and by whom will they be replaced?
- Discuss short-term markings. When placing temporary tape on top course, be sure to offset them from the permanent locations. One application of short-term paint can be overlaid by permanent marking.
- When will drainage structures and utility boxes be raised? Who will do this? How will the basins be raised (i.e., lifting rings or bricked up)?

Timing

The pre-paving meeting should be held 1 to 2 weeks in advance of scheduled paving to leave enough time to make changes if necessary.

A-1-2 Equipment

Asphalt Distributor

Asphalt distributors are used to apply prime or tack coats on a surface in preparation for paving. They are available in either truck-mounted or trailer models and are considered the most important piece of equipment on any asphalt surface treatment Project. The distributor consists of an insulated tank with a heating system, a spray bar, and a unique control system, as follows:

- *Heating System*:
  - Is capable of heating and maintaining the asphalt at a specified temperature
  - Includes a temperature gauge
- *Circulation System*:
  - Has a pump to circulate the asphalt from the tank to the application equipment and back
  - Includes a pressure gauge
- *Application Equipment*:
  - Has a spray bar for applying bituminous material uniformly on variable widths of surface up to 15 ft
  - Includes pressure gauges, accurate volume-measuring devices or a calibrated tank, and a thermometer
  - Has a power unit for the pump and a spray bar that is adjustable laterally and vertically
  - Uses a method to continuously circulate the bituminous material through the tank and spray bar
  - Requires hand spray for small areas
- *Tachometer*

Haul Truck

Haul trucks should be inspected for the following requirements:

- Must have tight bodies with no holes or cracks (except a small temperature-check hole)
- Must be clean and free of foreign material, cold mix or diesel fuel (If the bed needs lubrication, releasing agent—not diesel fuel—should be used.)
- Should be equipped with a cover tarp

If “end-dump” trucks are used, they must be capable of loading the mix directly into the paver without disrupting the paver’s operation and should have these features:

- Tailgate chains to control the flow of the mix
- A sufficiently long apron to reach the hopper of the paver

Pavers

<u>Paver Tractor Unit</u>

- *Engine*:
  - Must be a self-propelled paver with sufficient power to receive loads of mix
- *Rubber Tires*:
  - Must be properly inflated

- *Tracks*:
    - Must be snug to avoid bumping
- *Hopper*:
    - Must be clean and free of cold mix, foreign material, or other contaminants, and have folding sides to empty mix onto the feeders

<u>Paver Screed Unit</u>

- *Screed Pull-Arms*:
    - Must be attached to the tractor unit and pull the screed so that it floats over the mix being laid
- *Mat Thickness Controls*:
    - Must be equipped with automatic screed controls
- *Vibrator Screed*:
    - When used, vibrators must be in good operating condition along the full width of the screed
    - Pre-strike-off unit must be in good condition
- *Tamper Screed*:
    - Has a tamper bar along the front edge of the screed plate. Ensure that the tamper bar:
        - Is straight
        - Clears the front of the screed plate by 0.015–0.020 in. to avoid deficiencies in the surface texture of the mat
        - Extends about 1/64 in. (about the thickness of a fingernail) below the bottom of the screed plate at the bottom of the tamper bar's stroke
        - Is not excessively worn to the extent that its horizontal face is no longer flat

Rollers

<u>Requirements</u>

All rollers must have the following features:

- Self-propelled
- Capable of compacting mix without excessive crushing of aggregates
- Equipped with wheel-moistening systems to prevent mix from sticking. The Inspector should:
    - Ensure use of an approved material
    - Not permit use of diesel fuel or other solvent
- Capable of smooth operation:
    - At slow, steady speeds
    - Without any "backlash" in reversing

Ensure that rollers are operated in accordance with the manufacturer's recommendations

Types of Rollers

Different types of rollers may be used within certain limitations as summarized below:

- *Steel-Wheeled Rollers*: Used for initial (breakdown roller), intermediate, or final (finish roller) compaction
  - Must be of a tandem type
  - Must have smooth wheels
  - Must have an operating weight of at least 8 tons
- *Vibratory, Steel-Wheeled Rollers*: May only be used if:
  - Nominal mat thickness is more than 1 in.
  - Surface temperature of the mat is at least 180°F
- *Pneumatic-Tire Rollers*: Generally used for intermediate compaction
  - Must be of an oscillating-type
  - Must have at least seven pneumatic tires of equal size and diameter spaced for full coverage
  - Must have tires capable of being inflated to 90 psi of air pressure
  - Must be capable of an operating weight of not less than 5000 lb per tire
  - Must be equipped with skirts to maintain the temperature of the tires during compaction

A-1-3 Surface Preparation

Surface Defects

The first step in surface preparation is to address the failed areas of the pavement.

- Cut back localized distress (potholes) in concrete or HMA pavement to sound pavement.
- Ensure the repair area is cleaned, tack coated, patched with HMA, and compacted.
- Repair fatigue or subbase-related distress by isolated reconstruction. Accomplish this by:
  - Undercutting the area
  - Replacing with suitable subbase material and HMA

Wheel Rut Shim

Wheel ruts can be prevalent in existing pavement from the travel pattern of vehicles. These wheel ruts should be leveled using asphalt paving material before the asphalt layers are placed.

The Inspector must be involved in identifying wheel ruts and preparing for shimming:

- Have a representative of the Department determine the beginning and ending point for wheel path rut shimming in each lane.
- Prior to shimming the wheel ruts, ensure the pavement is cleaned and tack coated.

Truing and Leveling

Some pavements have irregularities that must be corrected before the paving courses can be properly placed. This is done using a truing and leveling course. The truing and leveling course should be placed to accomplish the following:

- Remove surface irregularities

- Fill and patch holes
- Correct variations in banked pavement.
- Establish pavement crowns

Cold Milling

When the condition of the existing pavement has deteriorated to a point where joint/crack filling and/or surface distress repair cannot be performed effectively, or when changes in cross slope are needed, cold milling may be necessary.

- Use milling machines to accurately mill to the required depth of cut and cross slope to within one inch.
- Check the depth of cut and cross slope so the HMA quantities are not overrun.
- Check that the specified depth of milling is usually at the interface of existing pavement layers.

Pavement Cleaning

Once the numerous repairs are made to the existing pavement, the surface must be cleaned before the tack coat is placed. The tack coat will adhere better to a clean surface**. *Cleaning must be performed by mechanical sweepers or other methods approved by the Engineer*.**

Pavement Termination

During paving operations, the areas where the new paving meets the existing pavement must be terminated properly to provide a smooth transition. These areas usually include the start and end of a Project and major intersecting side roads.

- Accomplish a smooth termination by providing an adequate transition length to take the new pavement elevation to the existing pavement elevation.
- Ensure the joint where the new pavement meets the existing pavement is a sawn, keyed in, vertical joint.

Driveway Rebates

Residential and commercial driveways must be terminated properly to provide a smooth transition.

- Accomplish a smooth transition by providing an adequate transition length to blend the new driveway with the existing driveway.
- Ensure the joint where the new driveway meets the existing driveway is a sawn, keyed in, vertical joint.

A-1-4 Tack Coat

Before Construction

- *Contract Plans and Specifications*:
  - Pay particular attention to the type and grade of bituminous material specified and its application rate and temperature requirements.

- *Material Considerations*:
  - Retain and check the Certificates of Compliance and delivery tickets to ensure that the type and grade of bituminous material conform to the specified requirements.

During Construction

- *Application Rate*:
  - Ensure the application is uniform and continuous at the specified rate.
- *Corrections*:
  - Correct skipped or deficient areas.
  - Correct (e.g., by squeegee, blotter material, sanding) excess material (e.g., overlaps, puddling).
- *Material Control*:
  - In general, check that no more material than that needed for the day's operation is applied.
  - Correct overspray and smearing of curbs, gutters, and barriers, which are unacceptable.
  - Consult the Project Engineer if penetration appears to be an issue.
- *Blotter Material*:
  - Where traffic must be maintained on the treated lane and the material does not adequately penetrate the surface, ensure blotter material is spread to absorb the excess bituminous material.

A-1-5 Prime Coat

Besides the following best practices, refer to Section 412 of the GDOT Standard Specifications.

Preparation

The key points to watch for in inspecting the preparations for prime coat operations are the following:

- Ensure the approved traffic control plan is properly established and maintained.
- Check that weather conditions are adequate, including:
  - An ambient air temperature in the shade of at least 70°F
  - A slightly damp base surface with no standing water or rain (use a water truck to dampen the base in dry weather)
  - Conditions approved by the Engineer, who is authorized at any time to stop prime coat applications due to adverse weather conditions
- Inspect the base before application of the prime for:
  - Proper line and grade
  - Firm, uniform base with no spots of unstable material or other defects

Application of Bituminous Material

Bituminous material refers to tack coat and prime. Besides the following, see Section 412 of the Standard Specifications and Section 413 of the Special Provisions.

The primary inspection points in applying the bituminous material for bituminous material are:

- Proper preparation and operation of the distributor (as previously discussed)
- Proper temperature of the material, depending on the type and grade being applied
- Compliance with the application rate specified in the GDOT Standard Specifications, particularly avoiding:
    - too much material, which can cause bleeding, or
    - too little material, which can cause raveling

The most effective application rate for bituminous materials is suggested in the GDOT Standard Specifications.

Curing

The prime coat must be allowed to cure until the priming material has fully penetrated into the aggregate base. In curing the prime coat, ensure the following:

- Apply blotter sand (manually or mechanically) at intersections and driveways where traffic must cross.
- Keep all other traffic (vehicles and equipment) off the primed surface.
- Watch closely for excessively rich or lean spots (3 min/12 ft^2). To correct rich or lean spots do the following:
    - For smaller spots:
        - Hand-hose small lean spots.
        - Apply blotter sand to small rich spots.
    - For larger areas:
        - Respray large lean areas.
        - Blade to at least 1-in. deep, blade-mix, and re-compact large rich areas.

Rolling

It is not always necessary to roll the primed base after curing, but when rolling is done, follow these guidelines:

- Use pneumatic rollers.
- Watch closely for:
    - Any loosening of larger aggregates
    - Any materials sticking to the roller's wheels:
        - Remove any loose, excessive amounts of blotter sand after rolling.
        - Do not allow traffic on the surface until authorized by the Project Engineer.
- Whether or not the prime coat is rolled, maintain it until the next course is placed or until final acceptance.
- In the event traffic has caused holes or breaks in the surface, ensure such holes or breaks are satisfactorily repaired by the Contractor.

Mix Acceptance

Weight Tickets

The Inspector is responsible for assuring that the weight tickets, supplied by the asphalt plant and/or Contractor, are collected and that essential information is recorded on them. These tickets, along with other documentation, are used to determine how much the Contractor is paid. Simply expressed, ***the weight tickets are invoices for the amount and type of material delivered to the Project site***.

Number each ticket consecutively for each item on each Project. This numbering system is required by the Department's *Construction Manual* and SOP-15—Certified Public Weigher.

Temperature Check

It is necessary for the Inspector to periodically check the temperature of the mix to ensure it is within 20°F of the approved job mix formula. ***It is not necessary to check the temperature of every truck.***

- For each temperature check, record it on the asphalt ticket for the truck checked.

Mix Deficiencies

The proper temperature, mix of materials, and moisture are essential for an acceptable prime coat. As Inspector, it is necessary to recognize and take appropriate action to correct the following deficiencies.

- *Incorrect Temperature of the Mix*:
  - *Overheated Mix*: A batch of mix that has been overheated is usually indicated by blue smoke rising from it.
    - Check the temperature immediately.
  - *Cold Mix*: A generally stiff appearance or improper coating of the larger aggregate particles often indicates a cold mixture.
    - Check the temperature.
- *Too Much or Too Little Liquid Asphalt*:
  - *Too Much Asphalt*: When loads have been arriving at the roadway with the mix peaked or rounded at the top and then a load appears in which the material lays flat (slumped) and has a shiny (soupy) appearance, it may contain too much asphalt.
  - *Too Little Asphalt*: Identify a load with this flaw by its lean, granular appearance; improper coating of aggregate; and lack of shiny, black luster.
- *Excess Coarse Aggregate*: This could be mistaken for mix with too much asphalt. Detect it by its poor workability and coarse appearance on the road.
- *Excess Fine Aggregate*: The mix will have a lean, dull brown appearance much like mix with too little asphalt. Detect it by the difference in texture from a properly graded mixture.
- *Contamination*: Such things as spilled gasoline, kerosene or oil, rags or paper, trash, or dirt can also contaminate mix.
  - If the contamination is not too bad, it can be removed (shoveled out); but immediately reject any load that is badly contaminated.

- *Excess Moisture*: A mix with excess moisture may have a soupy appearance like a mix with too much asphalt. As the mix is dumped into the paver, steam will rise. It may also be bubbling and popping as if it were boiling.
- *Non-Uniform Mix*: A mix that is not uniformly mixed will have spots of lean, brown, dull-appearing material mixed with areas of a rich, shiny appearance.
- *Segregation*: Segregation in hot mix means that the fine aggregates clump together and the coarse aggregates clump together. Therefore, the aggregates are not spread evenly throughout the mix. Improper handling of the mix can cause segregation.
    - If the segregation is severe, reject the mix.

A-1-6 Mix Placement

The Inspector must closely monitor the placement of the mix in terms of the following parameters.

Paver's Speed

The paver should move at a slow-enough speed to avoid pulling or tearing the mat. The actual speed will vary with the equipment being used and the thickness of the mat being placed, but faster speeds generally increase the possibility of defects in the mat.

- Ensure the Contractor balances the paver's production rate with that of the plant and with the number of haul trucks being used.

Handwork Behind the Paver

Handwork behind the paver is highly undesirable because it is difficult to get the hand-spread mix to fully bond with the rest of the mat and still have a smooth, uniform surface. So, ***allow handwork only for small, minor irregularities***. If an excessive amount of handwork is being done, it is usually an indication of defects in the adjustment of the paver or in the mix itself.

When handwork is done, it must be done properly as in these steps:

- Take mix directly from the hopper of the paver—not from a separate pile that may be cooler.
- Lightly fan the mix over the defect.
- Immediately rake the mix into the mat so it will bond.

Temperature of the Mix Prior to Compaction

The resulting quality of asphalt pavement can be greatly impacted by the temperature of the mix before compaction. If the temperature is lower than acceptable limits, the compaction effort may adversely affected.

- Spot-check the temperature of the mat just prior to compaction at random locations and times.
- For each temperature check, record the temperature, location, and time.

Laydown Thickness of the Mat

The laydown thickness of the mat must be periodically checked. This is usually done by the Contractor's personnel by the following procedure:

1. Set the collar of the probe to the desired laydown thickness. (Remember: "laydown" thickness = "plan" thickness + 20–25%)
2. Insert the probe straight into the mat until the tip touches bottom.
3. Check the collar position:
   a. Just touching mat = okay
   b. Above mat = too thin
   c. Sinking into mat before touching bottom = too thick
4. Repeat Steps 1 and 2 at several spots (at least right, left, and center) for each check.
5. Record the station number location and results in the diary.

Notify the Contractor that adjustments may be needed only if the mat is consistently too high or too low.

Mat thickness checks are used to monitor the general status of the thickness of the mat. The Inspector should remember the following guidelines:

- Individual checks are not sufficiently accurate to warrant immediate adjustment.
- Over-adjustment of the thickness controls can create more significant problems in the surface of the mat. It is important that the Inspector give the automatic controls adequate time and distance to reflect the adjustment to thickness and/or grade.
- Any adjustments should be based on the calculated spread rates.

Pavement Cross Slope

In some circumstances it is necessary to periodically check the cross slope of the mat as it is laid. When overlaying an existing pavement, the cross slope of the old surface is usually reliable enough that cross-slope checks are not needed very frequently. However, on new pavement construction, cross-slope checks should be made frequently enough to find and correct any deviations before they become serious problems.

Use a straightedge with a spirit or bubble level attached to the end and a ruler to measure the cross slope of the mat. For each check, follow these steps:

1. Place the straightedge across the pavement.
2. Hold the end of the straightedge so that it is level.
3. Measure the vertical distance from the end of the straightedge to the pavement.

Using a 10-ft straightedge as in the steps above, a 0.02 ft/ft cross slope should result in a 0.2-ft measurement at the end.

Spread Rate Calculation

The Inspector must periodically check the quantity of mix actually being used in relation to the volume of the mat constructed. This spread rate calculation ***must be made at least every half-day of paving*** to keep track of the mix quantities and make any necessary adjustments. The spread rate is equal to total asphalt tonnage divided by the square yard measure of the mat.

Use this basic calculation procedure:

- Determine the planned mix quantity for the area paved:
  - (length) × (width) = area (in yd^2)
  - (area) × (plan thickness) = planned ft^3
  - (planned ft^3) × (tons/ft^3) = planned mix quantity (tons), where (tons/ft^3) is the bulk density from the mix design
- Determine the actual mix quantity:
  - From the scale house OR
  - By totaling all weight tickets
- Compare the planned and actual mix quantities of mix:
  - If they are the same → okay, thickness is as planned
  - If actual is more than planned → mat is thicker than planned
  - If actual is less than planned → mat is thinner than planned
- Repeat the calculations at least each half-day and maintain a record of the accumulative planned and actual quantities of mix used.

If the difference between the planned and actual quantities is significant, some adjustment in the mat thickness may be needed—to avoid paying for more pavement than needed or ending up with a pavement that is not structurally adequate.

Mat Thickness

Occasionally, adjustments may be needed to the thickness of the mat, but adjustments should not be made too quickly or too frequently. Adjustment problems are particularly critical when the screed is operated by manual mat thickness controls because the paver takes about 15–18 ft to fully make the change from a small adjustment to the manual controls of only ¼-turn. Too often, the laborer operating the manual controls tends to make “waves” in the pavement by over-manipulating the controls.

To avoid such over-manipulation, pavers must have automatic screed controls. Most automatic control systems allow the paver to be operated in these modes:

- Fully automatic mode (both sides automatic)
- Semi-automatic mode (one side automatic and one side manual)
- Manual mode (both sides manual)

However, the semi-automatic and manual modes must be avoided—***unless authorized for special circumstances by the Project Engineer***. Fully automatic screed controls practically eliminate the problems of over-manipulating the mat thickness, but when an adjustment is needed during automatic operation the operator should:

- adjust the sensor control screw (best choice) or
- use the grade control knob on the command panel (usually more difficult).

Never adjust the manual controls during automatic operation.

Quality of the Mat Surface

The Inspector must check the general quality of the surface of the mat behind the paver. The surface should be smooth and uniform across the full width of the mat—including any extensions. There should not be any of the following defects:

- Streaks, gouges, or holes
- Slick or rocky spots
- Spots of coarse or fine aggregates (rock or sand "pockets") or spots that are rich or lean with asphalt

If such defects occur, notify the Contractor so the source of the problem can be determined and corrected.

Considerations for Paving in Urban Areas

The Inspector should also see that special care is taken when paving in urban areas, including the following considerations:

- Higher volumes of traffic in traffic control, particularly in providing for:
  - adequate flow of traffic (full closures are usually not feasible) and
  - access to homes and businesses
- Protection of adjacent structures and property
- Placement of mix around manholes, drainage inlets, etc.
- The relationship of the pavement with the curb and gutter:
  - Ensure the last compacted asphalt course is flush with the gutter after compaction.
  - Ensure chip seal coats are above the gutter after compaction.

A-1-7 Joint Construction

Longitudinal Joints

Longitudinal joints are necessary during progressive asphalt paving operations. These joints much be constructed properly to ensure the quality and structural integrity of the asphalt pavement remains.

- Plan the paving operation so the longitudinal paving joints line up with the edges of the proposed travel lanes.
- When paving multiple courses, stagger the longitudinal paving joints of each course at least 12 in. to avoid a single vertical joint the depth of the pavement.

Transverse Joints

Transverse joints are prevalent in large quantity asphalt paving projects. These joints can greatly impact the structural integrity in the section that contains the joint. All construction practices should be followed in order to minimize the impact of this joint on the asphalt pavement's strength.

- Plan paving operations to minimize the number of transverse joints.
  - Stagger transverse joints in adjacent lanes by a minimum of 2 ft.

- Construct transverse joints between the end of the previous day's paving and the start of a new day's paving.
  - At the end of the day's paving, choose a location for the joint where the mat is at the desired thickness.
- For transverse joints, have the Contractor construct a "paper joint."
- Before the material is compacted at the joint, check it with a straightedge.
  - Place the straightedge in a few locations on the uncompacted material so it extends over the existing pavement.
  - Check that the straightedge is parallel to the existing pavement and at a distance above the existing pavement equal to the amount the mat will compact.
  - If it is not parallel, make corrections by adding material, or removing, raking, and leveling the uncompacted material. When done properly, the joint will not feel like a bump in the pavement when it is driven over.
- If possible, compact the joint in the transverse direction. Place boards of the proper thickness at the longitudinal edge of the pavement so the roller does not damage the edge.
- When it is not possible to roll the joint in the transverse direction because of guardrail or traffic conditions, roll the joint in the longitudinal direction similar to routine compaction of the mat.

A-1-8 Rolling

Rolling should begin as soon as the mat will carry the roller without displacing the mix. Inspectors should be aware of the following recommendations related to rolling:

- When overlaying an existing surface, do not start out laying the full laydown thickness of the overlay. The new pavement would cause a bad bump in the pavement.
- When the transverse joint occurs, roll the joint first.
- When both a longitudinal and a transverse joint occur, begin by rolling a few feet of the longitudinal joint, and then return to the transverse joint and roll it.
- The more passes the pneumatic roller must make for complete coverage of a lane, the more the paths need to overlap. ***Ensure the roller is in motion before any attempt is made to change paths, and it is turned very gently.***
- Ensure the pneumatic roller operator is careful not to reverse exactly where the breakdown roller reversed nor to roll over mix that has not been compacted by a steel-wheeled roller.
- Ensure the pneumatic roller makes only as many passes as are necessary to achieve a smooth surface. Too much rolling can cause alligator cracking and reduce density.
- Occasionally, a mix may not be able to support the rollers without displacement. Such mix is said to be tender. If allowing the mix to cool somewhat does not help, try adjusting the mix.

A few rolling rules can aid in avoiding problems:

- Operate the roller slowly enough to prevent displacement of the mix.
- Change the speed of a roller gradually. It should never be "gunned" or "braked" sharply.
- Change the direction of a roller gradually. A roller should never make sharp turns.

- Watch for any mix piling up in front of the roller wheel.
- Watch for mix shifting from one place to another.
- Watch for sinking of the roller into the mix.

A-1-9 Finished Pavement Inspection

All roads are subject to testing for conformity to acceptable standards as established by the GDOT Standard Specifications and Special Provisions. Among these specifications are those for the crown (transverse slope of the surface), the smoothness of the pavement surface, and the width of the road.

- Ensure the crown is the same as shown on the plans. There are several methods of checking crown; one of the most common ways is using a slope template. Construct a slope template out of wood to measure this slope.
- Conduct testing for surface course tolerance by the Laser Profiler method. Perform this testing only on surface courses and only on the mainline of the roadway and on ramps more than ½ mile in length.
- The proper width of the lane is shown on the plans. Check the width as follows:
    - Use a 50- or 100-foot metallic measuring tape.
    - Select several places at random to measure.
    - Measure the distance from the centerline to the top of the edge.
    - Measure the complete width of the roadway from outside edge to outside edge.
    - If the distance from one side to the other of a two-lane pavement differs from the plan width, tell the Contractor, who should correct it.
- To have roadway density checked, take five samples of the compacted mat as follows:
    - Select the points from which the samples are to be taken. The testing technician (not the Inspector) is in charge of this. The technician uses either a saw or a water-cooled diamond drill to remove the sample.
    - Cut the sample to the full depth of the lift.
    - Make sure the sample is sawed out slowly and carefully to prevent any change in the density, and measure the thickness of the sample.
    - After the sample is removed, the Contractor is responsible for filling in the hole with new mix from one of the haul trucks.
    - Tamp or roll the mix in the hole. It is the Inspector's responsibility to see that this is done.

A-1-10 Final Documents

With computers being added to the workplace, the Department is constantly changing and, thus, improving recordkeeping for both the Construction Office and Office of Materials and Research (OM&R) personnel. With the implementation of the "SiteManager" software program, the Department will have engaged in the latest of available technological support for all recordkeeping and Contractor payments.

Recordkeeping is a necessary and increasingly important part of the Inspector's job. Due to the constant changes in both the Construction Office and the OM&R, In recordkeeping, Inspectors should reference all current guidelines, memorandums, and manuals and Contractor payment for further information and/or instruction. Depending on the construction activity, Inspectors can consult the Standard Specifications to find metrics and information that should be recorded for project recordkeeping.

A-2 Base Course Construction Inspector Best Practices

A-2-1 Preconstruction

Reviewing Requirements

The Inspector should prepare for placement of the base course by being proactive in understanding the various requirements and the specific conditions, as follows:

- Review the contract, plans, and specifications (see Sections 300, 302, 317 of the GDOT Standard Specifications) to determine the extent and scope of base construction.
- Note any potential problem areas and areas prone to problems from weather changes. Wet areas tend to have more problems than dry areas.
- Monitor the jobsite and weather changes during construction to avoid possible deficiencies in the subbase. Note all events in the Contract log/diary.

Identifying Deficiencies and Failures

Deficiencies in density, or failures, are structural weaknesses in the roadbed. They are caused by either excessive moisture or improper compaction procedures. Failures would probably show up during compaction of the roadbed. (The roadbed would yield under the heavy load of equipment).

The Inspector should do the following:

- Visually inspect the subgrade carefully for potential failures that did not show up during compaction. Notice that failure is in the roadbed, which will result in a failure in the base and surface course.
- Report severe deficiencies and failures to the Project Manager for further evaluation.

Identifying Surface Irregularities

The Inspector will usually have to measure or survey to find surface irregularities (high spots, low spots, and corduroy effect) in the subgrade. Such a deficiency can prevent a base course from conforming to specifications. A summary of the Standard Specifications on this topic is: “Deficiencies in the subgrade such as high spots, low spots, corduroy effects, improper elevation, improper grade, and improper cross slope can throw a base course out of tolerance, or can even lead directly to a failure. Ensure that proper grading methods are used to avoid potential problems and set consequent installation to the highest standard. Once the subgrade is covered, it is difficult to identify and fix problems; particular attention needs to be paid while the subgrade is exposed.”

Repairing Roadbeds

The Project Manager and the Area Engineer decide how roadbeds will be repaired. The Inspector has the following duties:

- Find out what methods and materials will be used for these repairs, and see that the Contractor uses these methods and materials in accordance with the specifications.
- Document the location of the defect, the date, and the corrective action taken.

- Ensure defects in the roadbed repaired by either reworking or recompacting small areas, such as soft spots, or by removing and reworking larger areas (one or more stations).
    - The repaired area must meet the same density requirements as the rest of the roadbed.
    - Repair all defects in the roadbed before the base course is placed!

Avoiding Ruts

The Inspector should ensure ruts are limited by monitoring the following areas:

- Watch for heavy or overloaded roadway equipment that could cause ruts and depressions in the roadbed.
- Without holding up the movement of material, make sure the drivers do not continually ride through the same set of tracks. The drivers should move around rather than use just one lane for travel.
- If it rains, keep haul trucks and other equipment off the subgrade until it dries.

Timing

Keep subgrade preparation ahead of the base course so that construction will not be held up.

- The Contractor should have 1500 ft of subgrade completed before beginning the base course.

A-2-2 Premixing

Use premixing ***only*** when the existing soil fails specification.

- The Inspector coordinates efforts with the lab and the Contractor to bring the soil into tolerance with lab testing.
- The Contractor must provide a plan for approval from the Area Engineer to provide for reparations.

Two methods of premixing that are recommended are the mixing table and the pugmill plant for mixing.

Mixing Table

The first method of premixing materials is the mixing table, which is used only to mix components of raw materials. ***Premixing the soil in place must be approved by the Area Engineer.*** Due to costs, mixing usually is done in place.

The following are steps for proper premixing using a mixing table:

- Have the Contractor clear a flat area of trees and debris and smooth it off for use as the mixing table.
    - The size of the cleared area depends on the amount of material to be mixed.
    - It is usually located near the roadway.

- After the area is cleared, have the Contractor haul in some of the same material that he/she will be mixing and spread it over the mixing table in a layer.
    - o To prevent contamination of base material by the native soil, ensure the motor grader operator exercises care not to penetrate this working surface.
- After the area has been cleared and the working surface compacted, have the Contractor haul the correct amount of each component of the material to the mixing table.
    - o Ensure the lab has sampled, tested, and approved each component before it is hauled.
- Inspect materials used to construct the base course both before and after mixing to ensure they meet specifications. Non-specification material could cause failures in the base course.

Pugmill Plant for Mixing

The pugmill plant is a second method of mixing materials (Figure A-1).

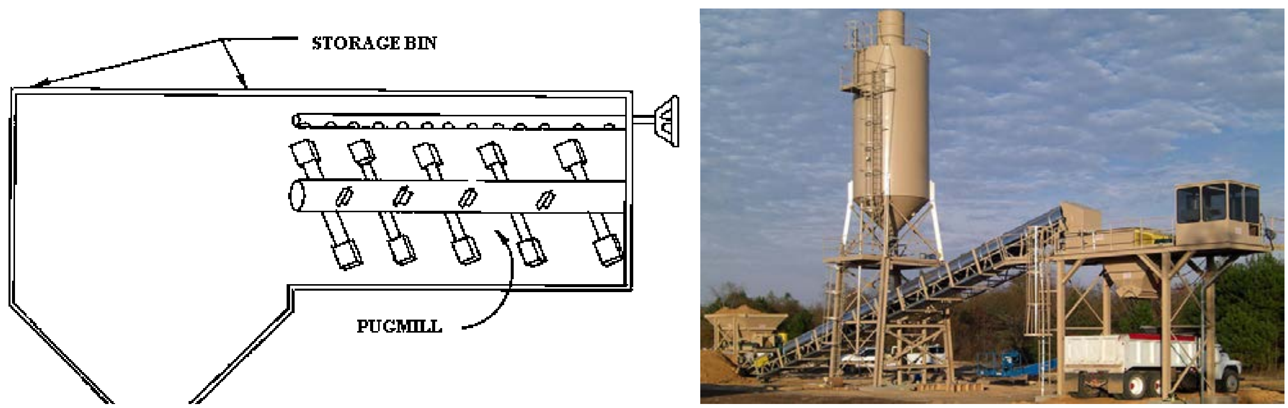


Figure A-1: Pugmill Plant

The pugmill plant functions as follows:

- The shafts of paddles do the actual pulverizing and mixing.
- The spray bar is used to add moisture to the pugmilled mixture.
- The valve on the right regulates the amount of water sprayed through each bar.
- After mixing, the mixture moves into the pugmill storage bin. The discharge gates on the storage bin are closed until the bin is filled.
- The gates open to release the mixture into a haul truck.

If base course materials have been premixed, the mixtures should have been sampled and tested by the OM&R before delivery. However, if they have not been tested or are individually shipped they may still need to be sampled and tested to determine if they meet specification requirements.

Cement or Lime

<u>Transport Seal</u>

The cement or lime must be carried in a sealed transport. The following rules apply regarding the seals:

- The seals are put on when the transport is loaded, and they are broken only after the transport arrives at the roadway.
- The Inspector is required to keep these seals as part of the Project records, and should be present when the seals are broken.
- ***The Inspector must reject any shipment having broken or missing seals!***

To record the transport, document the information below in the order given:

- Inclusive stations
- Linear feet
- Pounds of cement
- Actual spread rate
- Truck number
- Seal numbers (indicated on the Certificates of Delivery)
- Lab number
- Date and the Inspector's initials (in the last two columns)

<u>Verification Sample</u>

Cement and lime are usually pretested and approved; however, the OM&R will be required to take one verification sample per Project—the sample representing only one tanker.

- ***Take the sample from a pile on the roadway and not the tube coming from the back of the truck.***

<u>Restrictions for Cement</u>

The following is a list of "do not's" concerning cement for base courses:

- Do not mix different brands of cement together.
- Do not mix different types of the same brand together.
- Do not use different brands, or different types of the same brand, alternately.
- Do not use cement salvaged from discarded bags.

<u>Requirements for Asphaltic Concrete</u>

Asphalt concrete is a commonly used paving material for highways in Georgia. The term "asphalt concrete" specifically describes the asphalt material used to pave a particular highway.

The Inspector plays a critical role in monitoring the materials. The following is a list of requirements related to asphaltic concrete:

- Have asphaltic concrete delivered to the job site in haul trucks.
- Ensure the mixture is hot—it should be no cooler than 20°F below the minimum allowable temperature of the mixture when discharged from the mixer at the plant.

- Ensure asphaltic concrete base material is sampled and tested in accordance with GDOT's Sampling, Testing, and Inspection Manual.

General Inspection

For general inspection, the Inspector is responsible for the following items:

- *Subgrade*:
  - Ensure that the subgrade is checked.
- *Irregular Surface on Each Lift*:
  - As each lift is being placed and compacted, make sure that the top surface of the lift is fairly irregular or rough before placing the next lift.
    - This applies for all base courses except asphaltic concrete base course; its irregular surface will provide the necessary friction to bond that lift to the lift placed on top of it.
  - Use one-course construction only on soil cement. The surface should not be too smooth because the lift placed on top of it will slide, forming a plane of slippage. This shifting causes a base course to be unstable and to be off crown. It can also cause cracks/breakage in a lift leading to failure in the pavement (see Figure A-2).
- *Time for Inspection*:
  - Allow 1 day's run of the roadbed to be finished to give time to inspect it. This is desirable so the operations can run smoother. There should be a balance, however, because having too much of the subgrade finished can mean allowing time for traffic to damage it before the base course is placed.

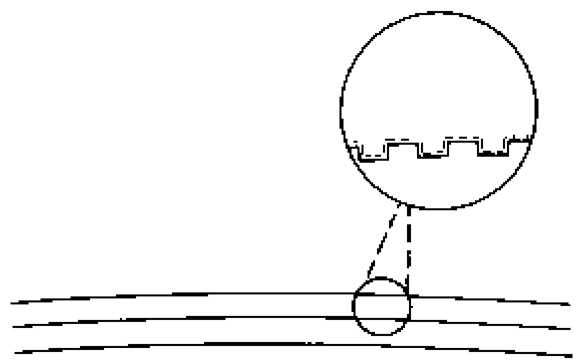


Figure A-2: Rough/Unstable Surface

- *Questions to Address*:
  - Were lab reports, soil surveys, etc., reviewed, and do they correlate with job conditions?
  - Has the subgrade been string lined and the results recorded?
  - Has the subgrade been inspected and corrected for any deficiencies?
  - Is all of the construction equipment properly adjusted and in good working condition?

A-2-3 Prime Coat

Surface Condition

The surface condition refers to the existing asphalt surface before a new layer of asphalt material is placed.

- Check that the surface of the base is at optimum moisture and is free of any loose foreign material.

- If any loose material exists, sweep the base course with a rotary broom; however, the Inspector must ensure that the Contractor does not begin sweeping until the surface is dry.

Asphalt Distributor

The asphalt distributor is a piece of construction equipment that emits liquid asphalt material for preparing an existing pavement surface for rehabilitation.

- Check that the asphalt distributor (Figure A-3) is in good working condition and has the following:
  - Tachometer
  - Bitumeter
  - Prime temperature not less than 40°F
  - Pneumatic tires wide enough to avoid breaking the bond of forming ruts in the base surface
  - Its own calibration chart (Check the calibration number on the chart and be sure that the distributor has the same number stamped on it. The chart will indicate where the stamp is located on the distributor, how to measure the distributor tank, and how to convert the measurements to gallons.)

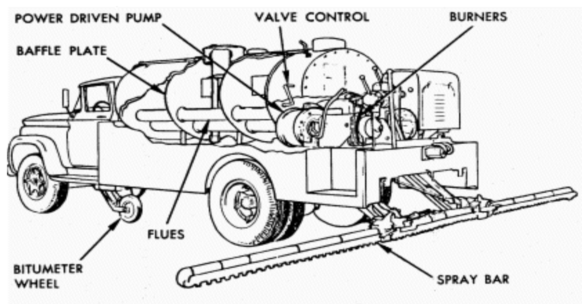


Figure A-3: Distributor

- Ensure that the distributor spray bar nozzles meet their own requirements:
  - The distance between the centers of the openings of the outside nozzles must be equal to the width of the application required within a tolerance of 2 in.
  - The nozzles should be parallel to each other and at an angle of approximately 15 degrees to the spray bar.
  - The spray bar nozzles must be clean, unclogged, and adjusted properly.
    - Non-uniform nozzle openings and clogged nozzles will produce an un-uniform prime coat with streaks of thickly and thinly covered or bare pavement.
    - Often the Contractor will "blow out" the spray bars to be sure that all nozzles are open and adjusted properly.
  - The nozzles should be clean and open before making the initial application of prime.

Application

Application refers to the placing of asphalt material on an existing pavement surface.

- Clean off any bituminous material sprayed on such surfaces immediately.
  - The exception is when the concrete surfaces are to be subsequently covered by a bituminous wearing course, in which case the surface does not need to be protected from the priming.
- Check that the actual prime coat application rate falls between 0.15 gal/yd^2 and 0.3 gal/yd^2.

- Do not apply prime to the entire width of the base course because shoulders of 3–10 ft wide will be placed on each side of the surface course.
  - The width of the prime application will be the width of the surface course plus 6 in. on each side.
- Record the actual number of gallons used in the prime coat application.
- Shoot prime at any temperature from 80°F to180°F, depending on the type.
  - Prime heated over 60°F expands, and more gallons must be used to cover the same area of base.
  - The distributor will have to spread the prime at a slower rate for the base course to be properly covered.
- Ensure that the Contractor cleans and dresses the slopes and ditches as much as possible before the surface course is placed. This process includes the following:
  - Notify the Contractor of any areas that need repairs.
  - Check the condition of the base course and prime coat regularly.
  - Make a record of all areas where prime is stripped off or where defects are evident in the base course.
  - Document any corrective action taken.
- Repair areas where raveling has occurred by removing loose material and applying asphaltic material (hot mix) that is rolled in uniformly with the tandem or pneumatic roller such that depressions (low spots) are repaired.

The Inspector is responsible for seeing that the base course is properly maintained until the surfacing is placed.

A-2-4 Graded Aggregate Base Course

The graded aggregate base course is made up of coarse and fine aggregate. The mixture of aggregate components is measured and calculated. Sections 814, 815, and 816 of the GDOT Standard Specifications provide information for mixing the various components.

The Inspector should take note of the following regarding this course:

- Ensure a raw aggregate mixture is either an artificial mixture or a pit-run mixture.
  - For an artificial mixture, the soil should be 35% and the aggregate 65%.
  - The raw aggregate materials must have particles of specified sizes and a certain proportion of each size particle.
- For a higher plasticity material, possibly make several passes with a single-pass mixer for appropriate pulverization.
- When multiple cutting passes are made, inspect to ensure that 6-in. overlap runs the entire length of the cutting pass.
- The paddles and tines of the cutting box should create fluff (mixture coming out from the mixer). The Inspector should look for:
  - the uniformity of the fluff,
  - the depth of the fluff, and
  - the bottom of the fluff down to the subgrade (dig a narrow trench).

It should be uniform. If there are streaks and clods in the fluff after several cutting passes, or if the depth of the cut is too shallow, then the paddles or tines probably need to be replaced.

- Ensure the cutting box on the mixer is equipped with a spray bar to add moisture when required.
- Make depth measurements by digging at least 3 holes across the roadway.
- Make width measurements as follows at the same locations as depth checks at the actual width cut and mixed:
  - Find the outside edge of the base course by digging into the material on each edge and locating the hub that was set for horizontal alignment.
  - Use a metallic tape to measure the width from outside edge to outside edge.
- Pulverized material is acceptable if 100% of the material passes the 1½-in. screen and 80% of the material by total weight exclusive of gravel or stone will pass a No. 4 screen. Have the Office of Materials and Research perform this test.
- The actual moisture content should be 90–120% of the specified optimum moisture content at the time of compaction.
  - Use the method of testing for moisture content found in the Sampling, Testing, and Inspection Manual; this testing is done by the OM&R.
  - The OM&R also conducts the proctor test to find dry densities at certain moisture contents. Take one proctor mold per 1500 ft per two lanes.
- To control the thickness of pugmilled material, take measurements before spreading it on the subgrade.
  - The Inspector should use a straightedge to take these measurements or a string line stretched between points of known elevation to the prepared subgrade.
- The Inspector should ensure the construction crew immediately begins spreading the mixture, as all compaction must be completed within 2 hours after initial mixing of cement with base course materials.
- For both pugmilled and mixed-in-place materials, complete compaction within 2 hours after the initial mixing of cement with the base course materials.
  - Typically, use the steel-wheeled and vibratory steel-wheeled roller to begin compaction.
  - Three to six coverages are usually enough if the moisture content and weight of the roller are sufficient.
- After final rolling, have the OM&R take density tests and document the results.
  - Compact stabilized bases to at least 98% of maximum density. (This differs from untreated aggregate base courses that must be compacted to 100% of maximum density.)

Stabilized Base Course Finishing

Once the Contractor’s personnel think the base course is to plan grade and crown, the Inspector will need to check it.

- If the base course, other than soil cement or cement-stabilized aggregate, is not within tolerance, the Contractor must rework the materials.

Stabilized Base Course Curing

Stabilized base course should be protected against rapid drying for a 7-day curing period. Accomplish this protection by applying an approved grade of prime to the completed base.

- Apply the curing compound to the section at a minimum rate of 0.15–0.30 gal/yd^2.
- Keep traffic and equipment off of the base during the curing period unless specifically permitted.

Stabilized Base Course Construction Joints

A construction joint should be cut at the beginning of each day's operation, or at approach slabs or the edge of an existing roadway slab.

- In the case of cutting into existing soil cement, the Contractor should cut back (usually with a motor grader) approximately 2 ft or more into the existing material to form the construction joint.
- In the case of joining an existing concrete slab (when cutting in place), the Contractor should move the material away from the slab by means of a motor grader, mix it, and then blade it back into place.

A-2-5 Asphaltic Concrete Base Courses

The Inspector should keep an eye out for mixture deficiencies that may lead to rejection of a truckload of asphaltic concrete. Some of these deficiencies and their appearances are:

- *Overheated Mix*: Blue smoke rising from the mix
- *Cold Mixture*: Stiff appearance or improper coating of larger aggregate particles
- *Excess Asphalt Cement in Mixture*: Material lays flat and has extremely shiny appearance; soupy
- *Too Little Asphalt Cement in Mixture*: Granular appearance or improper coating of aggregate
- *Excess Coarse Aggregate*: Coarse and rough textured appearance
- *Excess Fine Aggregate*: Lean, dull brown with fine-textured appearance
- *Excess Moisture*: Steam rising from mix as it is being dumped into paver; may be bubbling as if boiling and may look soupy
- *Segregation*: Fine aggregates lumped together, and coarse aggregates lumped together

Compaction

Compaction of asphaltic concrete is achieved by rolling. Three stages of rolling have traditionally been employed:

- Breakdown rolling
- Intermediate rolling
- Finish rolling

The first two stages achieve the compaction, and the final stage is actually for smoothing the surface of the mat. All rollers used must be:

- self-propelled,

- in good condition, and
- capable of maintaining the pace of the paver.

Employ the following procedures for compaction:

- *Breakdown Rolling*: The first stage of compaction should be completed as follows:
  - On the first lane, work the roller from the outside of the mat toward the centerline of the roadway. The roller should actually overhang the edge of the mix by 2–3 in.
  - Make one pass in one direction.
  - Follow the first pass with a return pass on the same coverage.
  - On the third pass, overlap the previous pass by 6 in.
  - Make the fourth pass over the same material as pass three.
  - Continue this pattern until the entire width has been rolled.
  - Ensure the final passes overhang the edge of the mat by 2–3 in.
- *Staggered Stopping*: Stagger the places where the roller stops on its passes. This is done to avoid a dip across the entire width of the mat.
  - Roll diagonally on pass seven to iron out the dips caused by reversal of the roller on each pass.
- *Intermediate Rolling*: Perform intermediate rolling to obtain maximum density. Follow a different rolling pattern to complete this stage of compaction:
  - Start with the pneumatic roller from the outside edge and work in.
  - Keep the roller about 6 in. away from the centerline if only one lane is in place. When both lanes are down, overlap the joint at least 6 in.
  - Take from 7 to 17 passes with the pneumatic roller to cover a lane, but do not over-roll the mix. (Vibratory rolling generally requires fewer passes than static rolling).
  - Overlap the previous pass on each pass, but do not make two passes in the exact path as was done in breakdown rolling.
- *Finish Rolling*: Finish rolling is necessary to obtain surface smoothness. The procedure includes the following:
  - Carry out finish rolling when the mix is still workable enough.
  - Use a rolling pattern similar to that of the intermediate rolling.
  - When vibratory rollers are used instead of tandem rollers, switch the roller to a static mode for finish rolling.

Samples and Testing

The linear feet of asphaltic base course laid each day is subdivided into five sections of equal length, and one sample is taken from each section. Samples must meet the following parameters:

- Each sample should have a diameter of approximately 4 in.
- The average of the five tests must be a minimum of 97.5% of the control strip density.
- The control strip density must equal or exceed 94% of the voidless mix density when the mix is tested by AASHTO: T-245 (Marshall Specimens).

Tack Application

Upon completion, an asphaltic concrete base course should be coated with tack, which is also a bituminous material. The following are some rules concerning the application of tack:

- Never apply tack to a dirty, wet, or frozen surface.
- Apply emulsified asphalt tack only when the temperature is above 40°F.
- Note that any time asphalt concrete can be placed in accordance with Table 400.05B of the GDOT Standard Specifications, asphalt cement tack may also be applied.
- At 60°F, convert the measurement of gal/yd^2 to gal/liter.

Transverse Joint Inspection

At the end of the day's operations, the Inspector will need to examine the construction of the transverse joint at which the next day's operations will begin. The Asphalt Paving Inspection course provided by GDOT gives a more detailed description of the procedure, but the basic procedure is as follows:

- Lay Kraft paper along all the top and face of the vertical joint.
- Run out the remainder of the mix from the paver over the piece of Kraft paper in front of the vertical face of the joint.
- Taper the mix to the subgrade and compact.
- At the start of the base course construction the next day, inspect the following:
  - Remove the paper and tapered mix; a butt joint at 90 degrees with the pavement surface should be left.
  - Make sure that the surface of the mat is smooth and parallel to the surface.
- Once the joint has passed inspection, coat the edge of the mat and the joint face with tack.
- Place the screed of the paver above the compacted mix to a height that will compact even with the previous day's work.
- Begin spreading.

A-2-6 Shoulder Construction

Shoulder Construction Types

Depending on the Project plans and specifications, construct the shoulder bases at the same time as the base course or after the base course has been completed.

- *Monolithic Construction*: When the shoulders and the base course are constructed at the same time and form one unit.
- *Separate Construction*: When the shoulders are constructed after the base course has been completed. The construction follows this general procedure:
  - Usually, premix the shoulder material that is placed and deposit it with a shoulder spreader off the edge of the base course.
    - The shoulder spreader operates by running on top of the base course depositing shoulder material off the edge.
  - Compact the shoulder material and finish it to conform to the plan typical section.
  - Shape, compact, and fine-blade the shoulder material after placement.
    - Also, if required, protect the shoulders with the specified asphaltic material.

Base Course Construction

Base course construction is the foundation for roadway installation. It is vital to providing excellent highways for the travelling public, and great effort must be taken to ensure that the foundation meets the highest standard. This will minimize future deficiencies and failures that arise from poor construction and shoddy materials. ***Good inspection practices are instrumental in keeping Georgia at the top of the nation's best roadways list.***

A-3 Pavement Markings Construction Inspector Best Practices

A-3-1 Introduction

The key to high-quality pavement markings lies in proper installation. To assure high-quality installation, proper inspection procedures are essential. The intent of this chapter is to provide Inspectors with necessary guidance in the field inspection of pavement markings before, during, and after application. The objective is to achieve quality control and quality assurance of pavement markings so that the desired service lives are achieved.

Pavement markings are required to separate lanes of travel and should be used along all edges of pavement. The following general guidelines are provided for designing and installing pavement markings for highways:

- All pavement markings installed on asphalt within the public right-of-way (ROW) must be in compliance with the Contract plans and specifications (see Sections 150, 653 through 655, 657, and 659 of the GDOT Standard Specifications).
- Lane lines are generally 5 in. (white).
- Stop lines should be 24 in. (white).
- Deceleration lanes and left-turn lanes should have turn arrows (TP 2) spaced every 100 ft.
- Deceleration lanes do not require “Right Lane Must Turn Right” signs or “ONLY” pavement markings unless they are through-lane drops or trap lanes.
- New construction should install 5-in. white edge lines, including at new curb and gutter.
- Raised pavement markers (RPMs) should be installed for all new construction on roadways with existing RPMs (see Figure A-4).
- Crosswalks should use the current Georgia DOT standard.

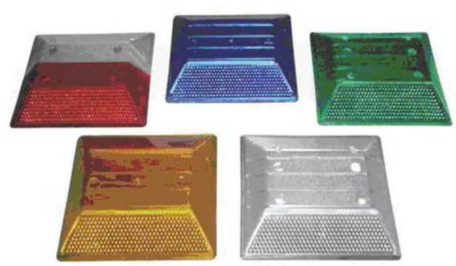


Figure A-4: Example of Raised Pavement Markers

A-3-2 Preconstruction Meeting

For contracts involving pavement markings, specific marking items should be discussed at the meeting in an attempt to eliminate confusion and disputes during construction. At minimum, these items should include:

- Marking materials that will be used
- Estimated dates when striping will occur
- Minimum marking thicknesses
- Estimated striping quantities
- Retroreflectivity requirements (according to the Contract specifications)

A-3-3 During Construction

Raised Pavement Markers

The Contractor must furnish and place raised pavement markers according to the plans or as directed by the Engineer. The Inspector should perform the following:

- Ensure use of markers that conform to plan shapes, dimensions, and tolerances, and are on the Qualified Products List.
- Follow Standard Specifications Section 868: Bituminous Adhesive for Raised Pavement Markers, Section 886: Epoxy Resin Adhesives, and Section 919: Raised Pavement Marker Materials.
- Before beginning construction, clean marker replacement equipment and ensure that it is mechanically sound.

Containers and Stirring Devices

The Inspector should make sure that containers and stirring devices are cleaned (e.g., paddles, propellers for drills, etc.) before hand-mixing epoxy.

Automatic Mixing Device

- *Cleaning*: Ensure that the mixing head to the automatic epoxy mixing equipment is cleaned after stopping work for any extended period of time. The length of downtime allowed depends on the pot life of the adhesive system being used.
- *Mixing Ratio*: Make sure that an automatic mixing device delivers separate components to the mixing head in a one-to-one ratio by volume.
- *Sample Valves*: Ensure that the lines feeding the mixing head are equipped with suitable valves to allow samples to be taken for checking the ratio of each component.

Bituminous Adhesive Equipment

The Inspector should ensure that equipment for melting, stirring, and dispensing bituminous adhesive is cleaned and maintained according to the bituminous adhesive manufacturer's requirements.

Epoxy and Bituminous Adhesive

Cement the markers to pavement surfaces with a Type I-R epoxy or Type I-S epoxy (see Section 886), or with a bituminous adhesive (see Section 868). Space the markers according to the plans.

- *Type I-R Epoxy*: Ensure the use of Type I-R epoxy when the pavement temperature is above 50°F (10°C) or traffic conditions require a rapid-setting system.
- *Type I-S Epoxy*: Ensure the use of Type I-S epoxy when the pavement temperature is above 60°F (15°C) and traffic conditions permit a slower setting system.
- *Bituminous Adhesive*: Ensure the use of bituminous adhesive when the pavement temperature is above 40°F (4°C) or traffic conditions require a rapid-setting material.

Handling and Applying Adhesives

Obtain an epoxy adhesive furnished as two separate components. Combine and use the components as follows:

- Immediately before use, make sure the individual components are thoroughly stirred with separate paddles. Reject material permanently increasing in viscosity or showing settling of pigments, filler, or thixotropic additives that cannot be readily re-dispersed.
- After stirring or agitating the two separate components, ensure they are mixed in a one-to-one ratio and blend thoroughly until obtaining a uniform color without streaks.
- At the time of mixing, ensure that the temperature of both components is 60–80°F (15–27°C).
    - If necessary, heat components using indirect heat to avoid locally overheating and decomposing the material.
    - Do not heat adhesive above 120°F (49°C).
- Place markers between the start of mixing the epoxy system and the termination of the pot life.
    - The Engineer will designate the allowable pot life based on environmental factors.
    - Never use a partially set mixed system that does not readily extrude around the perimeter of the marker when pressed to the roadway.
- When using an approved fast-setting epoxy system, mix the separate components with a two-component–type automatic mixing and extrusion apparatus, and place markers immediately.
- Use bituminous adhesive furnished in approximately 30-lb (14 kg) cubes.
    - Heat the cubes in an oil-jacketed melting pot.
    - Maintain the bituminous adhesive at the manufacturer-recommended temperature during placement of the markers.
    - Discard bituminous adhesive heated above 450°F (232°C).

Placement of Markers

- *Surface Cleaning*: Prior to placement, clean the surface as follows:
    - Make sure that the pavement is cleaned of dirt, curing compound, grease, oil, paint, moisture, loose or unsound layers, or other material that would impair the bond between the adhesive and the roadway.
    - Use either sandblasting or grinding equipment to clean the pavement.
        - Remove the dust before placing the marker.
    - Provide suitable traps for cleaning equipment air lines to prevent oil or moisture from being re-deposited on the road surface.
- *Placement Limits*: Place markers as follows:
    - Do not place markers over joints in rigid pavement.
    - Do not place markers when pavement temperature is below 40°F (4°C).
    - When possible, wait 60 to 90 days before placing markers using epoxy adhesive on newly constructed asphaltic concrete pavements.

- *Marker Placement Using Epoxy Adhesives*: Place markers using epoxy adhesives as follows:
    - Place enough adhesive on the cleaned pavement or the bottom of the marker to completely cover the contact area of the marker.
    - Press the marker firmly to the pavement.
    - Allow a slight bead of epoxy adhesive to extrude from under the marker edges.
    - Remove adhesive on the face of the marker or adhesive that obscures the marker.
        - Do not use thinners or solvents to clean epoxy adhesives from the markers.
- *Marker Placement Using Bituminous Adhesives*: Place markers using bituminous adhesives as follows:
    - Place enough bituminous adhesive on the cleaned pavement or the bottom of the marker to completely cover the contact area of the marker.
    - Press the marker firmly to the pavement.
    - Allow a slight bead of adhesive to extrude from under the marker edges.
    - Remove adhesive on the face of the marker or adhesive that obscures the marker.
    - Place the marker before the bituminous adhesive cools and then fails to extrude around the perimeter of the marker when pressed to the roadway.

Thermoplastic Traffic Stripe Application

This work includes furnishing and applying thermoplastic reflectorized pavement marking compound (Figure A-5). The Inspector should ensure that markings conform to plan details and locations, these Specifications, and the *Manual on Uniform Traffic Control Devices* (MUTCD).

Figure A-5: Thermoplastic Traffic Stripe

A thermoplastic traffic stripe consists of solid or broken (skip) lines, words, and symbols according to plan color, type, and location.

- *Thermoplastic Marking Compound*: A compound extruded or mechanically sprayed on the pavement that cools to pavement temperature. When combined with glass spheres, it produces a reflectorized pavement marking.
- *Short Lines*: Crosswalks, stop bars, arrows, symbols, and crosshatching.
    - Extrude short lines rather than spraying them on.
    - Unless otherwise specified, spray all other lines.

Refer to GDOT Standard Specifications Section 653 for more material information.

<u>Deterioration</u>

Use thermoplastic material that has the following characteristics related to deterioration:

- Does not deteriorate upon contact with:
    - Pavement materials
    - Petroleum droppings from traffic
    - Chemicals, such as sodium chloride or calcium chloride, used to prevent formation of ice on roadways or streets

- Does not scorch, discolor, or deteriorate if kept at the manufacturer's recommended application temperature, or at least 375°F (190°C), for up to 4 hours
- Has a temperature versus viscosity characteristic that remains constant from batch to batch through four reheatings

Fumes

Use material that in the plastic state does not give off fumes that are toxic or harmful to persons or property.

Physical Requirements

Confirm the color of thermoplastic as follows:

- White thermoplastic material contains at least 8% by weight titanium dioxide that meets the requirements of ASTM D 476, Type II, Rutile. The white thermoplastic material must be pure white and free from dirt or tint.
- The material, when compared to the magnesium oxide standard, uses a standard color spectrophotometer according to ASTM D 4960 (see Table A-1).
- Yellow material matches Federal Test Standard Number 595, Color 13538.

Table A-1: Magnesium Oxide Standard Using a Standard Color Spectrophotometer According to ASTM D 4960

Scale	Definition	Magnesium Oxide Standard	Sample
Rd	Reflectance	100	75min
a	Redness-Greenness	0	-5 to + 5
b	Yellowness-Blueness	0	-10 to +10

Color Retention

Use a thermoplastic stripe tested for color retention as follows:

- Use specimens prepared from samples submitted by the Department Inspector to test according to ASTM D 620.
- Use an ultraviolet light source as specified in the test procedure, or use a 275-watt sunlamp with a built-in reflector.
- Ensure that after 100 hours of exposure to the light source, the test specimens show no color change when compared to an unexposed specimen.

Physical Requirements of Glass Spheres

Ensure that the compound has been manufactured with glass spheres in the proportion specified in the GDOT Standard Specifications Subsection 653.2.B.4—Reflectorization. The glass spheres contained in the material must meet the following requirements:

- *Index of Refraction*: Determine the index of refraction of the premixed glass spheres by the liquid immersion method at 77°F (25°C).
- *Roundness*: Ensure that the minimum percentages of premixed glass spheres are true spheres according to Table A-2.

Table A-2: Percent of Pre-mixed Glass Spheres that are True Spheres (When Tested with ASTM D 1155)

Minimum Index of Refraction	Percent of Overall Beads	Percent of Beads retained on any sieve
1.65	At least 75%	At least 70%
1.5	At least 70%	At least 60%

- *Imperfections*: Ensure that no more than 5% of the spheres show air inclusions, bubbles, lap lines, chill wrinkles, or other imperfections when viewed through a 60-power microscope in the refractive index liquid.
- *Foreign Matter*: Ensure that the quantity of foreign matter does not exceed 1%.
- *Gradation*: Have the beads tested using ASTM D 1214 to ensure they have the gradations in Table A-3.

Table A-3: Percent Glass Spheres Passing U.S. Sieve Standard Sieve Size

U.S. Sieve Standard Sieve Size	Percent Passing
No. 16 (1.18 mm)	100
No. 30 (600 µm*)	60 to 90
No. 50 (600 µm)	15 to 40
No. 80 (200 µm)	0 to 10
No. 100 (150 µm)	0 to 5
*µ: micrometer	

- *Chemical Resistance*: Use material manufactured with glass spheres that withstand immersion in water and acids without corroding or etching, and withstand sulfides without darkening or decomposing.
  - Have the chemical resistance tested by placing a 3–5 g sample in each of three glass beakers or porcelain dishes and immersing as follows:
    - Cover the first with distilled water.
    - Cover the second with a 3N solution of sulfuric acid.
    - Cover the third with a solution of 50% sodium sulfide, 48% distilled water, and 2% Aerosol 1B or similar wetting agent.
  - Ensure that after 1 hour no darkening, hazing, or other evidence of instability is evident when examined microscopically.
  - Ensure that these spheres meet the requirements of GDOT Standard Specification Subsection 652.2.

Spray Application Machine

Ensure that each spray application machine is equipped with the following parts and components:

- Parts that continuously mix and agitate the material
- Truck-mounted units for lane, edge, and centerlines that operate at a minimum of 5 mph (8 kph) while installing striping
- Conveying parts between the main material reservoir and the shaping die or gun that prevent accumulation and clogging
- Parts that contact the material that are easily accessible and exposable for cleaning and maintenance
- Mixing and conveying parts, including the shaping die or gun, that maintain the material at the plastic temperature with heat transfer oil or electrical element–controlled heat. ***Do not use an external source of direct heat.***
- Parts that provide continuously uniform stripe dimensions
- An applicator that cleanly and squarely cuts off stripe ends and applies skip lines. ***Do not use pans, aprons, or similar appliances that the die overruns.***
- Parts that produce varying widths of traffic markings
- An applicator that is mobile and maneuverable enough to follow straight lines and make normal curves in a true arc

Automatic Bead Dispenser

The automatic bead dispenser is a construction machine that emits glass beads onto a paint stripe to improve visibility on the highway.

Apply glass spheres to the surface of the completed stripe using a dispenser attached to the striping machine to automatically dispense the beads instantaneously upon the installed line.

- Synchronize the glass sphere dispenser cutoff with the automatic cutoff of the thermoplastic material.

Special Kettles

Special kettles are construction machines used to create and maintain thermoplastic material used for highway pavement striping.

Use special kettles for melting and heating the thermoplastic material. Kettles equipped with automatic thermostatic control devices provide positive temperature control and prevent overheating.

- Ensure that the applicator and kettles are equipped and arranged according to the requirements of the National Fire Underwriters.

Hand Equipment

Use hand equipment for Projects with small quantities of lane lines, edge lines, and centerlines, or for conditions that require the equipment.

- Use hand equipment approved by the Engineer.

- Ensure that hand equipment can hold 150 lb (68 kg) of molten material and is maneuverable to install crosswalks; arrows; legends; and lane, edge, and centerlines.

Auxiliary Vehicles

Supply the necessary auxiliary vehicles for the operation.

General Application

The Inspector is involved in verifying proper preparation and existence of suitable conditions prior to application of the thermoplastic traffic stripe.

- Thoroughly clean pavement areas to be striped.
    - Use hand brooms, rotary brooms, air blasts, scrapers, or other approved methods that leave the pavement surface clean and undamaged.
    - Take care to remove all vegetation and road film from the striping area.
- Mechanically wire brush or abrasive clean all new portland cement concrete pavement surfaces to remove all laitance and curing compound before striping.
- Lay the stripe with continuous uniform dimensions. Apply the type of stripe at each location according to the plans, using one of the following methods:
    - Spray Techniques: Use extrusion methods wherein one side of the shaping die is the pavement and the other three sides are contained by or are part of the suitable equipment to heat and control the flow of material.
    - Temperature: Apply the thermoplastic traffic stripe only when the pavement temperature in the shade is above 40°F (4°C).
        - To ensure optimum adhesion, install the thermoplastic material in a melted state at the manufacturer's recommended temperature, but not at less than 375°F (190°C).
    - Moisture: Do not apply the thermoplastic traffic stripe when the surface is moist. When directed by the Engineer, perform a moisture test on the portland cement concrete pavement surface as follows:
        - Place approximately 1 yd^2 (1 m^2) of roofing felt on the pavement surface.
        - Pour approximately ½ gallon (2 L) of molten thermoplastic onto the roofing felt.
        - After 2 minutes, lift the roofing felt and inspect to see if moisture is present on the pavement surface or underside of the roofing felt.
        - If moisture is present, do not proceed with the striping operation until the surface has dried sufficiently to be moisture free.

Binder-Sealer

To obtain optimum adhesion, apply a binder-sealer material before installing the thermoplastic in each of the following cases:

- Extruded thermoplastic
- Sprayed thermoplastic where directed by the Engineer
- Old asphaltic concrete pavements with exposed aggregates
- Portland cement concrete pavements as directed by the Engineer

Ensure that the binder-sealer material forms a continuous film that mechanically adheres to the pavement and dries rapidly. Use a binder-sealer currently in use and recommended by the thermoplastic material manufacturer according to QPL 46.

To ensure optimum adhesion:

- Apply a two-part epoxy binder-sealer on all portland cement concrete pavements for either sprayed or extruded thermoplastic material.
- Apply the epoxy binder-sealer immediately in advance of, but concurrent with, the application of the thermoplastic material.
- Apply in a continuous film over the pavement surface.

Bonding to Old Stripe

The old stripe may be renewed by overlaying with new material.

- Ensure the new material bonds to the old line without splitting or cracking.

Offset from Construction Joints

Offset longitudinal lines at least 2 in. (50 mm) from construction joints of portland cement concrete pavements.

Crosswalks, Stop Bars, and Symbols

Make crosswalks, stop bars, and symbols at least $^3/_{32}$ in. (2.4 mm) thick at the edges and no more than $^3/_{16}$ in. (4.8 mm) thick at the center.

Film Thickness

Maintain the following minimum average film thicknesses on all open-graded asphalt concrete friction courses:

- 0.120 in. (3.0 mm)* for lane lines
- 0.090 in. (2.3 mm)* for edge lines
- 0.150 in. (3.8 mm)* for gore area lines

Maintain the following minimum average film thicknesses on all other pavement types:

- 0.090 in. (2.3 mm)* for lane lines
- 0.060 in. (1.5 mm)* for edge lines
- 0.120 in. (3.0 mm)* for gore area lines

  * see Table A-4

Table A-4: Average Film Thickness (terms of *lb* used and *total linear feet* or *meters*)

(For 5 in. wide stripe)	
*Average Film Thickness (in) =	$\frac{lb\ used}{total\ linear\ feet} \times 0.236$
(For 125 mm. wide stripe)	
*Average Film Thickness (mm) =	$\frac{lb\ used}{total\ linear\ meters} \times 4.0$
(For 10 in. wide stripe)	
*Average Film Thickness (in) =	$\frac{lb\ used}{total\ linear\ feet} \times 0.118$
(For 250 mm. wide stripe)	
*Average Film Thickness (mm) =	$\frac{lb\ used}{total\ linear\ meters} \times 2.0$

Glass Spheres

Apply the glass sphere top-coating with a pressure-type gun specifically designed for applying glass spheres that will embed at least one-half of the sphere's diameter into the thermoplastic immediately after the material has been applied to the pavement.

- Apply glass spheres (Figure A-6) to the installed stripe surface at a minimum rate of 14 lb of spheres to each 100 ft^2 (700 g/m^2) of thermoplastic material.

Figure A-6: Glass Spheres

Painting Traffic Stripe

This work includes furnishing and applying reflectorized traffic line paint according to the plans and these Specifications. This item also includes applying words and symbols according to plan details, Specifications, and the current *Manual on Uniform Traffic Control Devices*.

Painted Stripes: Solid or broken (skip) lines. The location and color are designated on the plans.

Skip Traffic Stripes: Painted segments between unpainted gaps as specified on the plans. The location and color are designated on the plans.

Ensure that the materials for painting traffic stripe, words, and symbols conform to Table A-5.

Table A-5: Material Requirements for Traffic Stripe, Wording, and Symbols

Material	Section
Traffic Line Lane 5A and 5B	870.2.02.A.2 and 870.2.02.A.3
Glass Beads used on Luminous Traffic Lanes	AASHTO M 247 Type 1*

*In addition, meet the following requirements for glass beads:

- Maximum quantity of angular particles is less than 1% by weight
- Maximum quantity of particles with milkiness, scoring, or scratching is less than 2% by weight

- Glass beads do not impart any noticeable hue to the paint film
- Glass beads conforming to the following alternate gradation may be used provided all other requirements of AASHTO M 247 and this Specification are met

Traveling Traffic Stripe Painter

Use a traffic stripe painter that can travel at a predetermined speed both uphill and downhill, applying paint uniformly. Ensure that the painter feeds paint under pressure through nozzles spraying directly onto the pavement. Use a paint machine equipped with the following:

- Three adjacent spray nozzles capable of simultaneously applying separate stripes, either solid or skip, in any pattern
- Nozzles equipped with the following:
    - Cutoff valves for automatically applying broken or skip lines
    - A mechanical bead dispenser that operates simultaneously with the spray nozzle to uniformly distribute beads at the specified rate
    - Line-guides consisting of metallic shrouds or air blasts
- Tanks with mechanical agitators
- Small, portable applicators or other special equipment as needed

Hand Painting Equipment

Use brushes, templates, and guides when hand painting.

Cleaning Equipment

Use brushes, brooms, scrapers, grinders, high-pressure water jets, or air blasters to remove dirt, dust, grease, oil, and other foreign matter from painting surfaces without damaging the underlying pavement.

Preparation

Clean equipment, paint, and pavement surfaces have a direct impact on the quality of the finished product.

- Before starting each day’s work, thoroughly clean paint machine tanks, connections, and spray nozzles, using the appropriate solvent.
- Thoroughly mix traffic stripe paint in the shipping container before putting it into machine tanks.
- Before painting, thoroughly clean pavement surfaces of dust, dirt, grease, oil, and all other foreign matter.

Alignment

Ensure that the traffic stripe is the specified length, width, and placement.

- On sections where no previously applied markings are present, ensure accurate stripe location by establishing control points at spaced intervals. The Engineer will approve control points.

Application

The Inspector must monitor the striping process, ensuring the following requirements are met.

- Apply traffic stripe paint by machine. If areas or markings are not adaptable to machine application, use hand equipment.
    - Application Rate: All work will be subject to application rate checks for both paint and beads. Apply a 5-in. (125 mm) wide traffic stripe at the following minimum rates:
        - *Solid Traffic Stripe Paint*: At least 25 gal/mile (58.8 L/km)
        - *Skip Traffic Stripe Paint*: At least 6.3 gal/mile (14.8 L/km)
    - Thickness: Maintain a 15 mils (0.38 mm) minimum wet film thickness for all painted areas.
- Do not apply paint to areas of pavement when the following conditions exist:
    - The surface is moist or covered with foreign matter
    - Air temperature in the shade is below 40°F (5°C)
    - Wind causes dust to land on prepared areas or blows paint and beads around during application
- Apply a layer of glass beads immediately after laying the paint.
    - Apply beads at a minimum rate of 6 lb/gallon (700 g/L) of paint.

Protective Measures

Protect both the traffic and the newly applied paint as follows:

- *Traffic*: Control and protect traffic with warning and directional signs during painting.
    - Set up warning signs before beginning each operation and place signs well ahead of the painting equipment.
    - When necessary, use a pilot car to protect both the traffic and the painting operation.
- *Fresh Paint*: Protect the freshly painted stripe using cones or drums.
    - Repair stripe damage or pavement smudges caused by traffic according to GDOT Standard Specification Subsection 652.3.06.

Appearance and Tolerance of Variance

Continually deviating from stated dimensions is cause for stopping the work and removing the nonconforming stripe (see Section 656). Adhere to the following measurements:

- *Width*:
    - Do not lay stripe less than the specified width.
    - Do not lay stripe more than ½ in. (13 mm) over the specified width.
- *Length*:
    - Ensure that the 10-ft (3 m) painted skip stripe and the 30-ft (10 m) gap between painted segments vary no more than ±1 ft (300 mm) each.
- *Alignment*:
    - Ensure that the stripe does not deviate from the intended alignment by more than 1 in. (25 m) on tangents or curves of 1 degree or less.

- Ensure that the stripe does not deviate by more than 2 in. (50 mm) on curves exceeding 1 degree.

Quality Assurance

The Inspector should ensure that stripes and segments of stripes are clean-cut and uniform. Markings that do not appear uniform or satisfactory, either during the day or night, or do not meet Specifications, will be corrected at the Contractor’s expense. Work will be subject to application rate checks for both paint and beads. The following will be accepted:

- Sections of painted stripe, words, and symbols that have dried so that paint will not be picked up or marred by vehicle tires.
- Sections placed according to the plans and Specifications

The Contractor will be relieved of responsibility for maintenance on accepted sections.

Correction of Alignment

When correcting a deviation that exceeds the permissible tolerance in alignment, do the following:

- Remove the affected portion of the stripe, plus an additional 25 ft (8 m) in each direction.
- Paint a new stripe according to these Specifications.
- Remove the stripe according to GDOT Standard Specification Section 656.

Removal of Excess Paint

Remove misted, dripped, or spattered paint to the Engineer’s satisfaction.

- Do not damage the underlying pavement during removal.

Refer to the applicable portions of GDOT Standard Specification Section 656.

A-4 Earthwork Construction Inspector Best Practices

A-4-1 Introduction

This area focuses on the duties of DOT Inspectors as it relates to their authority, responsibility, and inspection practice related to earthwork.

Inspectors employed by the Department are authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used.

Inspectors will *not* be authorized to:

- Alter or waive the provisions of the Contract
- Issue instructions contrary to the plans and specifications
- Act as foreman for the Contractor

Inspectors must:

- Clearly communicate expectations to the Contractor concerning inspection of the Contractor’s activities
- Maintain a cooperative attitude toward the Contractor’s prosecution of the work, but be assertive in their efforts and insist on conformance with the Contract, plans, standards, and specifications
- Ensure conformity with Project specifications and contractual intent

Inspector: The authorized representative of the Engineer assigned to make a detailed inspection of any or all portions of the work and materials.

The following are requirements for cooperation between the Inspector and the Contractor:

- The Contractor will allow and provide reasonable access to all parts of the work by the Department’s representatives, and the Contractor must cooperate with the representatives making the inspection by providing such information and assistance as is necessary for a complete inspection.
    - In no circumstance should the safety of the Department’s representative be jeopardized when performing the inspection.
    - Having access to all parts of the work does not give the Engineer and/or Inspector the right to interfere with the Contractor’s operations. Occasionally, however, the Inspector may have to stop the work for a sufficient length of time to sample, test, or check measurements. This should be done as expeditiously as possible.
    - If the Contractor does not allow access to the work and does not cooperate with Department representatives in making the inspection, the provision of this article of the Specifications must be brought to the Contractor’s attention.
        - Continued failure to provide access and cooperation is grounds for suspending the work in accordance with Article 108-7 of the Specifications.
        - Except in cases of emergency, suspension on these grounds will not be invoked without first consulting with the Division Construction Engineer.
- If the Inspector has reasonable grounds to believe that any finished work is not of the quantity or quality required by the Contract, and if the Inspector has been delegated the

authority by the Engineer, he/she may require the Contractor to remove or uncover such portions of the finished work as may be suspected of being defective. When the suspect work is exposed, the Inspector must immediately investigate the conditions and take such samples and make such tests or visual observations as may be required to document whether the suspect work does conform to the requirements of the contract.

  - Cover the results of this investigation in every detail by appropriate entries in the Project diary.
  - In any event, restore the work in a manner such that the finished work does, in fact, comply with the requirements of the Contract.
  - During the course of removing, uncovering, and restoring the work, maintain cost records by the Contractor and the Inspector.
    - If it is determined the suspect work is not defective, payment will be made to the Contractor for all of the work involved in removing, uncovering, and restoring the work based upon the verified actual cost of performing the work.
    - If it is determined the suspect work is defective, no additional compensation will be allowed the Contractor for removing, uncovering, or restoring the work.

A-4-2 Excavation and Embankment

This area of inspection generally relates to the work that consists of excavating and constructing a graded roadbed and embankments, which will support the roadway surfaces. This area includes the excavation and preparation of roadbed areas; placement and compaction of materials; and construction of embankment, shoulder, and ditch areas. This part of construction accounts for a majority percentage of the Inspector's overall job and includes the following.

- Ensure proper environmental controls are in place.
- Ensure the area to be excavated per the plans, and limit disturbed areas to minimize erosion and siltation.
- Ensure the depth of fill embankment layers as per GDOT Standard Specifications Section 208.
- Verify the Contractor's effort in obtaining desired density and moisture content as defined in the GDOT Standard Specifications and the Manual of Instructions—Materials Division.
- Ensure cut and fill slopes are constructed on the specified ratio. Ensure slopes intercept the ditch line or shoulder line at the correct location. Refer to GDOT Standard Specifications Subsection 149.3.05.
- Ensure the subgrade and typical section are within specified tolerances.
- Confer with the Contractor about the area to be graded using the Contractor's sequence of operations.
- Discuss environmental concerns, stripping and disposition of topsoil, limiting of disturbed areas, and balance points, which are outlined in the plans and specifications of the specific project.
- Sketch and calculate topsoil excavation in areas with less than 5 ft of fill and ditches and entrances not shown on cross sections.

- Before placement of borrow, ensure material has been tested and approved according to the requirements stated in Sections 206.2 and 208.2 of the GDOT Standard Specifications.
- Check and document that erosion and siltation control devices are placed as work progresses.
- Perform tests to determine earth or rock fill embankment to ensure placement of material in lift depths defined in the GDOT Standard Specifications Sections 208 and 212.
- Perform and document checks of line and grade, slope ratio, and slope texture.
- Perform density tests and line and grade checks ***before*** beginning subbase or base operations (also stabilization treatment or placement of select material).
- Ensure roadway excavation conforms to the lines, grades, and cross sections shown on the plans or established by the Engineer. Information can be found in Section 205 of the GDOT Standard Specifications.
- If artifacts of historical or archaeological significance are encountered, temporarily stop excavation operations until directed by the Engineer. See Subsection 107.13.A.

For more information, see Sections 204–206, 208, and 211–212 of the GDOT Standard Specifications.

A-4-3 Removal of Structure and Obstructions

Use the following guidelines when inspecting building demolition operations:

- *Buildings and Appurtenances*: Check that the Contractor removes buildings and appurtenances to the existing ground level, including any concrete slabs or floors resting upon the ground. Clarify through GDOT Standard Specifications Section 201 or the appropriate pay item.
- *Basements*: Visually inspect that the Contractor clears all debris and other obstructions from the basement so that only the foundation walls and basement floor remain. Before backfilling, check that the foundation walls and basement floor are shattered sufficiently to promote drainage. Clarify through GDOT Standard Specifications Section 201 or the appropriate pay item.
- *Backfilling and Compaction*: Backfill and compact all pits, trenches, holes, and basements that will not be eliminated during subsequent excavation operations. Use the guidelines in this document for Structure Excavation in Section A.4.4 below. Clarify through GDOT Standard Specifications Section 201 or the appropriate pay item.
    - *Inside the Roadway Prism*: Check that all backfill within the roadway prism is placed and compacted in accordance with the requirements of the Contract specifications.
    - *Outside the Roadway Prism*: Inspect the compaction of backfill outside the roadway prism to verify that it is compacted to obtain a minimum density equal to that of the surrounding ground. GDOT requires the same compaction throughout the placement process.
- *Underground Storage Tanks*: Remove underground storage tanks according to GDOT Standard Specifications Section 217, plan details, and as directed by the Engineer.

A-4-4 Structure Excavation

For structure excavation, inspect for adherence to these requirements:

- Use final locations and elevations of the structure as determined by the Engineer; the locations and elevations shown on the plans are approximate.
  - GDOT only approves final layout as presented by the Contractor through Section 149 of the Standard Specifications.
- Follow the minimum requirements for length and depth of excavation for each structure as determined by the Engineer.
  - Assume responsibility for the cost of installing necessary sheeting and bracing.
  - GDOT only approves final layout as presented by the Contractor through Section 149 of the Specifications.
- Excavate through rock or boulder formations to at least 1 ft (300 mm) below the bottom of the structure, except where the entire concrete or masonry structure rests on solid rock.
  - Refer to GDOT Standard Specifications Subsection 207.3.05.B.
- Backfill with Type I or Type II material to the proper subgrade elevation only as noted or approved by the Engineer.
  - Refer to GDOT Standard Specifications Subsection 207.3.05.C.
- As the embankment is constructed, excavate and place pipe on the new embankment.
  - Allow pipe to be placed incrementally on steep gradients.
- Cut surfaces at structure trenches to prevent damage to the adjacent pavement when existing paved areas will be retained.
- Saw pavements deep enough to cause the edges to break in straight lines.
- Ensure that the width, depth, and vertical walls of an excavated imperfect trench conform to plan details and dimensions within 2 in. (50 mm). The inspector should check at a minimum of every 10 minutes of paving as stated in the GDOT Standard Specification Subsection 207.3.05.B.
- Dispose of surplus and unsuitable materials after the approval of GDOT.
- Consider excavated material as unclassified excavation according to Section 205, except that the Department will not pay for excavation for minor structures. Excavation to place drainage structures is covered in the pay item for the item being installed (e.g., pipe culvert, box, etc.).
- Include the cost of fulfilling these requirements in the price bid for the pipe.
- Obtain backfill materials that meet the Specifications from sources approved by the Engineer.
  - *Type I Backfill Material*: Compact to 95% of the theoretical dry density.
  - *Type II Backfill Material*: Compact to a satisfactory uniform density as directed by the Engineer.
- Do not place rock more than 4 in. (100 mm) in diameter within 2 ft (600 mm) of any drainage structure.

- For backfill behind retaining walls, use a pervious material that meets the requirements of Case I or Case II as follows:
    - Case I refers to backfills for retaining walls that support roadbeds and parking areas.
        - Ensure that the backfill conforms to GDOT Standard Specifications Section 208.
        - Do not place rock more than 4 in. (100 mm) in diameter within 2 ft (600 mm) of the retaining wall or finished surface.
    - Case II refers to backfills for retaining walls that do not support roadbeds or parking areas.
        - Ensure that the backfill conforms to the requirements of Case I above, except compact the backfill to the density of the adjacent soil.
        - GDOT has actual requirements for all backfill not as surrounding adjacent soil.
- Replace pavement removed at structure trenches in kind where adjacent pavements will be retained.
    - An equal or better material may be used when approved by the Engineer.
    - Backfill and maintain a smooth riding surface until repaving is complete.
    - Refer to GDOT Standard Specifications Subsection 207.3.05.D.
- Remove and properly dispose of materials placed as surcharge for consolidation or other purposes. The following is also stated in the GDOT Standard Specifications Subsection 205.3.05.G.
    - Waste the material removed or use it for other purposes as specified on the plans or in the special provisions.
    - Provide other areas for disposal if adequate areas are not available for disposing of excess surcharge within the right-of-way.
- For more information, see Section 207 of the GDOT Standard Specifications.

A-5 Portland Cement Concrete (PCC) Paving Construction

A-5-1 Introduction

Definition

Concrete Pavement: Rigid concrete layer of the pavement structure, which consists of a mixture of Portland cement, fine and coarse aggregate, and water. Additives may be used to entrain air in the concrete or to retard set. Fly ash may be used to replace part of the Portland cement. The pavement may be reinforced with steel fabric or bars.

Overview of the Chapter

The following areas related to concrete pavement are covered in this chapter:

- *Types of Concrete Plants*: There are two basic types of concrete plants, either of which may furnish concrete for a paving Project:
    - *Central Mix Plants*: Plants that proportion and mix the concrete
    - *Dry Batch Plants*: Plants that only proportion the ingredients of the concrete; the concrete is mixed in trucks.
- *Subgrade and Subbase Quality*: The concrete pavement is supported by the subgrade and subbase. GDOT Specifications Section 300: General Specifications for Base and Subbase Courses covers these two subjects. The quality of the subgrade and subbase is very important in concrete paving, and selected parts of their construction are covered in this chapter.
- *Placing and Finishing Concrete Pavements*: There are two basic methods included in this chapter:
    - *Side-form Paving*: Paving in which stationary forms are used. The forms are built to the line and grade of the finished pavement, and the paving equipment rides on the forms.
    - *Slipform Paving*: Paving that typically uses string lines for line and grade. The paving units are equipped with sensors that run along the string lines. Concrete is contained by short side-forms built into the paving equipment.

Summary of Steps for Placing Concrete Pavement

The following is a summary of the steps for placing concrete pavement:

- Before the concrete is placed:
    - Prepare the subgrade.
    - Construct the subbase.
    - Set forms or string lines, depending on the type of paving operation.
    - Put steel dowels in position at joints.
    - Mix the concrete at a central plant or in a truck mixer.
- While the concrete is being placed:
    - Form the joints.
    - Place steel reinforcement, if it is required.

- After the concrete is placed and its surface is finished, cure and protect it from damage while it gains strength.
- Before the highway is opened to traffic, seal the joints.

A-5-2 Inspection Duties and Responsibilities

Quality control is vital in every construction Project. It is the Inspector's responsibility to ensure that concrete pavement is constructed according to plans and specifications. An Inspector must understand that the roles the Inspector and the Contractor play are distinctly different.

It is the Inspector's job to see that the construction operations are producing results that meet specifications. The Inspector must identify variations and bring these to the attention of the Contractor and the Engineer. ***The Inspector does not have the authority to approve changes in the specifications.***

Communications and Qualifications

Preconstruction Meeting

One of the most important steps in establishing communications is the preconstruction meeting. These meetings are held before the beginning of any major construction Project.

At the preconstruction meeting:

- The Inspector becomes acquainted with the Contractor's key personnel.
- The attendees:
  - discuss the plans and specifications for the Project and the traffic control techniques, and
  - define the lines of authority.

Inspector Influence

The Inspector helps GDOT and the Contractor by understanding the Project from the Contractor's point of view. The Inspector does not permit reduced quality in order to increase the Contractor's productivity. ***An Inspector influences the construction process to obtain the best possible results.*** If an Inspector has a suggestion for changing a procedure to improve the quality and efficiency of the work, he/she does not hesitate. This benefits both GDOT and the Contractor.

The Inspector's task includes the following:

- Offer assistance while being careful not to supervise construction.
- Avoid giving the impression that the Inspector controls the work.
- Never issue a direct order to the Contractor's workers or assume supervision of the work.
- Judge the quality of work that is performed by methods that meet specifications. Failure to do this can cause legal problems later.

Inspector Attitude

An Inspector's qualifications are expected to exceed those of the ordinary construction worker. The Inspector's attitude is especially important.

- The Inspector must be honest and conduct him/herself in a fair, straightforward manner.
- When under stress, the Inspector must still be able to maintain personal composure and make good decisions. He/she must have keen common sense for making competent decisions.
- The Inspector must be frank and sincere in relationships with people, and be a skilled diplomat able to handle tough situations without arousing hostility.
- Above all, the Inspector must be observant and be capable of keeping neat, concise, and accurate records.

Inspector Skills and Experience

Technical study and/or construction experience is necessary to perform well as an Inspector. The Inspector must:

- Be able to perform accurate mathematical calculations
- Be able to read and understand plans, specifications, and other Contract documents
- Be able to understand the basic engineering principles of roadway design
- Be familiar with the characteristics of construction materials
- Know the principles of material testing
- Know how to interpret the test results

A Paving Inspector must have:

- A thorough working knowledge of concrete plants
- A broad general knowledge of concrete materials, concrete production and construction procedures, and paving equipment operation
- Practical experiences with concrete mix productions, roadway construction, and concrete laboratory testing.

If all the qualifications of an Inspector could be reduced to three, they would be: (1) technical knowledge, (2) common sense, and (3) observational skills.

- *Technical Knowledge*: The Inspector should be familiar with the construction materials and concrete paving procedures. Self-motivated education is a necessary goal. The more knowledgeable the Inspector is, the better prepared he/she is to perform Inspector duties. Materials that might be of interest to the new Inspector or the Inspector-in-training include:
    - DOT Design Manual
    - DOT Construction Manual
    - GDOT PCC Pavement Manual
    - GDOT Standard Specifications (see Section 430 of the Standard Specifications)

- *Observational Skills*: It is important for an Inspector to look carefully at everything going on. “Seeing” means thinking carefully about what the eyes observe. The Inspector should consider these tips for improving observation:
    - Maintain a position to oversee what is going on.
    - Do not form timeline-dependent practices that make the Inspector’s actions predictable.
    - Rely on instinct; when something looks wrong, it probably is.
    - Stop and look for a while to see if a problem is being created, then take appropriate action.

Records

Another critical function the Inspector performs is to keep accurate records and complete required reports daily. Records and reports are necessary to determine that Contract requirements have been met.

Records and reports should be:

- Kept current
- Submitted on schedule
- Kept neat and legible
- Kept in accordance with SiteManager, the materials lab, and the construction manual

GDOT Inspection Team

The team should be organized as far in advance of the actual paving as practicable. The Chief Inspector should make all members of the paving team aware of their specific duties and make certain they are familiar with the Contract specifications.

The Chief Inspector is responsible for these areas:

- Performance and quality of the work
- Inspection service
- Inspection personnel assigned to the Project

Because of the many operations being performed during the paving phase of the work and the time limitations imposed on them, complete cooperation between the members of the paving team and the Chief Inspector is required.

Concrete Inspector

The Concrete Inspector is responsible for the placing and finishing of the concrete. To satisfactorily cover each detail of the work, the Inspector will be very busy at times. If conditions warrant, the Concrete Inspector will be required to spend a major portion of time with the paving operations. The Concrete Inspector may delegate the immediate responsibility for the inspection and control of certain operations.

If air-entraining admixtures are used, the Inspector must ascertain that the approved measuring device is in satisfactory working order and that a suitable supply of the admixture is on hand or is readily available. The Concrete Inspector must arrange for the Inspector ahead of the paving equipment to check the fine grade with a subgrade template and to true up the form alignment, if necessary.

The Concrete Inspector is responsible to make the following checks:

- Ensure cement that has a temperature higher than 160°F (71°C) is not used in the concrete.
- Make sure the temperature of cement at the plant is measured and recorded at least four times daily.
- Verify that concrete delivered in place is at least 60°F (15°C) and does not exceed 90°F (32°C).

Paving Inspector

The Paving Inspector must check the following conditions.

- Set forms, if used, at the correct line and grade.
- Lay out the transverse and dummy joint locations properly for a suitable distance ahead.
- Ensure the reinforcement, when placed, is not bent and is lapped the required distance.
- Receive the batch or delivery tickets properly.
- Place the lower course and mat reinforcement properly.
- Place the top course of concrete within the allowable 45-minute interval.

This Inspector also is responsible for these tests and reports:

- Field test the concrete for air content and slump.
- Cast test cylinders.
- Complete daily paving reports, which should show these data:
    - Roadway stations for the beginning and end of the placement
    - Quantity of the items involved
    - Results of the field control tests

Finishing Inspector

The Finishing Inspector must perform the following tasks:

- Check all lutes and straightedges for trueness and all edging tools for size and wear.
- Straightedge the pavement along three points for the full length of each slab.
    - Learn to use a straightedge in a manner that does not disturb the pavement surface.
    - Have irregularities corrected.
- Critically review the finishing of all joints and insist that the surface texturing operation be performed at the proper time, so that the desired surface finish and texture are attained.
- Determine when the concrete cure operation should begin.
- Identify each starting point by doing the following:
    - Make up a brass tag showing the station and date of the beginning of the day's work.
    - Place this tag on the outside edge of the lane within the edged area of the first joint.
- Immediately after the forms are removed from the previous day's run, check that:

    - All honeycomb is suitably patched
    - The ends of the expansion joints are open to their full depth
- When that form work is complete, check that the sides of the pavement are properly covered with the cure cover material.
- Use the finishing work as the final control; its results will be reflected in the appearance, durability, and riding qualities of the pavement.
    - Ensure the finishing operation keeps pace with the placing operation.
    - Obtain a satisfactory surface by having competent workers who are able to perform their duties before initial set takes place.

A-5-3 Before Construction

Contract plans provide information related to roadway pavements:

- *Cross Sections*: Show the location, depth, width, and class of pavement to be constructed and the finished pavement line and grade by station.

Plan Sheets: Provide a visual representation of the roadway and the width of the roadway at specific stations.

Plan Review

Prior to construction, the Inspector should conduct a complete review of the plans and specifications to be familiar with the requirements of the Project. The sequence of priority concerning specifications is:

- Special Provisions (see Sections 446 and 800)
- Plan Notes
- Supplemental Specifications
- GDOT Standard Specifications (each section is mentioned as applicable in this manual)

As listed here, each has priority only over the others that it is listed above. Thus, special provisions govern over the plan notes, supplemental specifications, and the GDOT Standard Specifications. Plan notes govern over supplemental specifications and the Standard Specifications, but not the special provisions. Finally, supplemental specifications only govern over the GDOT Standard Specifications.

Proposal Review

The Inspector should review the proposal for a set of plans for the following items:

- Special Provisions
- Supplemental Specifications
- Agreement to Sell Material
- Haul Road Agreement
- Utility Adjustment Plans

In addition to the plans and proposal, the Inspector should review the following items:

- Right-of-Way Agreements
- Temporary Easement Agreements

Materials

For materials on the jobsite during the operation, the Inspector should perform these tasks:

- Check the documents for acceptability before the material is incorporated in the work.
    - The material specifications for fine and coarse aggregates are governed by Sections 800 and 801 of the GDOT Standard Specifications.
- Observe the breaking operation for extensive disturbance of the underlying subgrade or base material.
    - Such disturbance may require unnecessary reworking of the subgrade.

Cement Material

The materials specifications for Portland cement are defined in Section 830 of the GDOT Standard Specifications.

The Inspector is responsible for the following items regarding the cement materials:

- Verify that the Contractor is using an approved source. The materials lab generally requires pretesting and source approval.
- Check that the cement material the Contractor may stockpile at the job site during the operation is kept dry and free of contamination and that material from different sources is stored separately.
- Maintain records on the length of time the Contractor stores cement on the job site.

The Inspector should promptly remove material failing such tests from the job site so that it will not be incorporated in the work.

Mix Water

Water from public treatment systems is generally acceptable for use in Portland cement concrete mixes. However, the Inspector should require that water from other sources is:

- Pretested and approved in accordance with project specifications.
- Frequently monitored for compliance

Types of Reinforcing Steel

The Inspector should verify that reinforcing steel is stored on blocks, dunnage, etc. above ground to prevent rusting due to standing water. Depending on the requirements of the Contract plans, the following types of reinforcing steel may be used in the PCC pavement:

- *Deformed and Epoxy-Coated Rebar*: The testing and acceptance criteria for reinforcing bars are governed by Section 853 of the GDOT Standard Specifications. Special storage and handling are required to maintain the integrity of epoxy-coated rebar:
    - Check that the Contractor adequately covers epoxy-coated rebar that are stored at the job site. Prolonged exposure to sunlight can degrade the epoxy coating.
    - Periodically spot-check the material as it is unloaded and incorporated in the work. If mishandled, the epoxy coating can be damaged, which exposes the underlying steel.

        - If the damage is repairable within the provisions of the Contract, request that the Contractor repair the material before it is incorporated in the work.
        - If the damage exceeds specified limits, reject the material and have it promptly removed from the job site.
- *Welded-Wire Fabric*: The testing and acceptance criteria for welded-wire fabric are governed by Section 881 of the GDOT Standard Specifications.
    - Where welded-wire fabric is used for PCC pavement construction, ensure the use of sheet stock as the Division requires, not rolls.
    - If the Contract plans call for epoxy-coated fabric, check the material for damage and needed repairs.

<u>Chairs and Ties</u>

Chairs and ties are typically used to seat and secure the steel reinforcement within PCC pavements. The Inspector's duties include the following:

<u>Coated Dowel Bars</u>

Section 853 of the GDOT Standard Specifications governs the material specifications for coated dowel bars. The Inspector must verify the condition of coated dowel bars as follows:

- Check the bars upon delivery for any damage to the coating.
- Reject any material that does not meet specified requirements and have it removed from the job site.

<u>Curing Materials</u>

Materials that are typically used for curing PCC pavements (e.g., polyethylene coated burlap, burlap cloth, waterproof paper, liquid membrane, and white polyethylene sheeting) are defined in Section 832 of the GDOT Standard Specifications. The Inspector is responsible for the following:

- Upon delivery, check the material for any damage. Acceptance is based on visual inspection.

A-5-4 During Construction

Equipment

The Contractor should adjust and check all equipment after it has been placed on the forms or setup and prior to any placement of concrete. To ensure proper results, it is essential that the top of the forms and the wheels of the machines be kept free of mortar or concrete. All machines should have scrapers to prevent concrete buildup.

In addition, the Inspector should check the following items on the equipment:

- *Strike-off Plate*:
    - Check with a string line to make sure that it has the proper depth.
- *Spreader*:
    - Ensure the spreader is clean, with no concrete buildup.

    - If the machine has vibrators, check those for spacing and frequency.
    - Provide spare vibrators.
    - Check that vibrators can be raised and lowered.
- *Transverse Screeds*:
    - Check with a string line that the screeds are aligned properly.
    - Ensure the first screed is high enough to let some concrete pass under it to the second screed.
    - Check the slab behind the screeds to make sure the screeds are performing properly.
- *Longitudinal Float*:
    - Check with a string line.
    - As with all machinery, ensure there are scrapers on the wheels to prevent concrete buildup.
- *Carpet Drag*:
    - Make sure the carpet drag is wetted down (if necessary) before use.
    - Ensure it is cleaned at the end of the day to prevent buildup of concrete.
    - Ensure 2 ft of carpet is in contact with the pavement surface.
- *Tine Machine*:
    - Check that the tine machine will groove the slab at the proper spacing and the proper depth.
    - Check that the tines are not bent and are clean.
- *Nozzle Head on the Curing Machine*:
    - Ensure the nozzle head is open to give uniform spray.
    - Check that the curing machine is equipped so as to keep the curing compound agitated.
    - Provide a wind screen or break, if required.
- *Hoses and Connections*:
    - Check that hydraulic fluid will not leak onto the concrete.

On slipform paving jobs, the Inspector should also check the following:

- The width of the slipform paver and the width of the trail forms
- Vibrators, in the same way as the conventional paving equipment
- The pan float with a string line

Batching Plant and Equipment

The Inspector should inspect the following related to the batching plant and equipment:

- Ensure the batching plant includes bins, weighing hoppers, and scales.
- If cement is used in bulk, ensure that equipment includes a bin, hopper, and separate scale for cement.
- Ensure the Contractor provides adequate means for cement cut-off checks.
- Check that the weighing hoppers are properly sealed and vented to preclude dusting during operation.
- Check that the bulk cement storage bin or hopper is provided with adequate means for sampling the cement in storage.

Bins and Hoppers

The Inspector should verify that the batching plant provides the following:

- Bins with adequate separate compartments for fine aggregates, each size of coarse aggregate, and cement
- Compartments that discharge efficiently and freely into the weighing hopper
- Means of control so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision
- A port or other opening for removing an overload of any one of the several materials from the hopper
- Weighing hoppers constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales
- Partitions between compartments, both in bins and in hoppers, ample to prevent spilling under any working conditions

Mixer

Concrete may be mixed at the site of construction or at a central point, or wholly or in part in truck mixers. The following requirements apply related to mixers:

- *Manuafacturer's Plate*: Each mixer should have attached in a prominent place a manufacturer's plate showing:
  - Capacity of the drum, in terms of mixing and agitating capacity
  - Speed of rotation of the mixing drum or blades for both mixing and agitation
- *Mixing Capabilities*: Mixers must:
  - Be capable of combining the aggregates, cement, additives when specified, and water into a thoroughly mixed and uniform mass within the specified mixing period
  - Have a minimum capacity sufficient to comply with minimum production requirements
- *Water Measurement*: Mixers must be equipped with:
  - An approved device for accurately measuring water within a range of error of not more than 1%
  - An indicator showing the amount of water used in each batch, which is accurately calibrated and easily read
- *Batch Meter and Timing Device*: Central plant mixers and mixers at the site of construction must be equipped with:
  - An approved batch meter and timing device that will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period
    - Ensure this device is equipped with a bell or other suitable warning device that will give a clearly audible signal each time the lock is released.
    - In case of failure of the timing device, allow the mixer to be used for the balance of the day while it is being repaired, providing the Contractor furnishes a satisfactory means of determining the mixing time.
- *Pickup and Throw-over Blades in the Drums*: The pickup and throw-over blades in the drum(s) require:

    - Repair when the blade wear reaches the blade wear indicator or when holes are worn through the blades
    - Placement of the top of the blade wear indicator at 90% of the total height of the radial part of the blade
    - That the Contractor has available at the job site or central plant a copy of the manufacturer's design showing the dimensions and arrangements of blades
    - Blade wear indicators, which must be:
        - Made of ¼ inch. thick steel, 2 in. wide and 6 in. long

Located as shown in the Department of Transportation's "Division of Materials and Test," Circular D-9

Mixers at the Construction Site

In addition to the above requirements, mixers at the site of construction, unless otherwise stipulated, must be:

- Boom and bucket type
- Capable of discharging and distributing the mix without segregation on the prepared subgrade or subbase

<u>Truck Mixers and Truck Agitators</u>

Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete must meet all the applicable requirements above. The manufacturer's plate should indicate the following information:

- Various uses for which the equipment is designed
- Gross volume of the drum
- Minimum and maximum speed of rotation of the drum or blades for charging, mixing, and agitating

The Inspector should inspect as follows:

- Ensure trucks equipped for mixing have an approved device for recording the number of revolutions of the drum or blades.
- Require that mixers or agitators used to mix and transport paving concrete be of the hydraulic drum lift type or other especially designed types that will discharge low slump concrete ½ to 1½ in. (13 to 38 mm) at a satisfactory rate without segregation.
- For Projects that contain 10,000 yd^2 (m^2) or less of concrete paving, allow approved conventional or standard truck mixers or truck agitators for mixing and hauling concrete under GDOT Standard Specifications Section 604.

<u>Non-agitator Trucks</u>

The Inspector should inspect non-agitator trucks as follows:

- Ensure the bodies of non-agitator hauling equipment for concrete are:
    - Smooth, mortar-tight, metal containers
    - Capable of discharging the concrete at a satisfactorily controlled rate without segregation

- Ensure covers are provided for protection of the concrete.

For more information, see Section 440 of the GDOT Standard Specifications.

Forms

Straight Side Forms

The Inspector should check that straight side forms:

- Are made of metal having a thickness of not less than $\frac{7}{32}$ in. (5 mm) and are furnished in sections not less than 10 ft (3 m) in length
- Have a depth at least equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to not less than the depth of the forms
- Use flexible or curved forms:
  - of wood or metal of the proper radius for curves of 100-ft (30 m) radius or less
  - of a design acceptable to the Engineer
- Have adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment
- Extend the flange braces outward on the base not less than ⅔ the height of the form
- Do not vary the top face of the form from a true plane more than ⅛ in. within 10 ft (3 mm in 3 m), and do not vary the face of the form more than ¼ in. (6 mm)
- Contain provisions for locking the ends of abutting form sections together tightly, and for secure setting
- Have metal pins of the proper size and length to hold the forms rigidly and securely in place

Built-up Forms

As Inspector, do not permit use of built-up forms except where the total area of pavement of any specified thickness on the Project is less than 10,000 yd^2 (m^2). In addition, consider these guidelines:

- Ensure built-up forms have a minimum base width of 8 in. (200 mm).
- Remove forms with battered top surfaces, and bent, twisted, or broken forms from the work.
- Do not use repaired forms until inspected and approved by the Engineer.
- Provide and maintain the supply of forms in satisfactory condition not less than that required for a full day’s run.

For more information, see Section 500 of the GDOT Standard Specifications.

Vibrators

The key to paving is a consistent mix that is placed consistently. The Inspector can help achieve that end by adhering to these guidelines as relates to the use of vibrators:

- The Contractor provides a monitoring system as required in the GDOT Standard Specifications for checking vibrators. If the system shows that a vibrator is not operating, ***stop the paving operation until the condition is corrected.*** Document all work stoppages.

- Verify daily that the Contractor checks that vibrators are operating within specifications.
- Verify that vibrators for full-width and full-depth vibration of concrete paving slabs are:
    - Multiple spuds or other types approved by the Engineer
    - Attached to the spreader or the finishing machine, or mounted on a separate carriage
- Ensure the frequency of the vibrators is that recommended by the manufacturer, subject to approval of the Engineer.
- Verify that the Contractor furnishes the Engineer the manufacturer's recommendations for installing and operating vibrators.
- Discontinue vibrating whenever the forward motion of the paver is stopped.
- Keep the speed of the slipform paver as uniform as possible.
- Vary the speed of the paver with the rate of concrete delivered to minimize the possibility of the paver stopping on the fresh concrete.

Slipform and Screed

Mortar-paste buildup between the slipform and screed will cause tearing and/or raveling of the pavement.

- Keep the slipform and screed clean and free from hardened concrete during the paving operation
- Adjust the strike-off and extrusion plate to produce the required section.
- Check the screed for proper grade and cross-section profile.

Haul Trucks

The Inspector should check haul trucks daily to maintain satisfactory conditions and product:

- Keep all trucks in good mechanical condition.
- Ensure all trucks have backup warning devices.
- Verify the dump bed interior surface is smooth and water tight, with round corners.
- Check that the interior of the dump bed is free from excessive accumulation of hardened concrete and from obstruction or deterioration sufficient to interfere with the discharge of concrete.
- Spray the interior dump bed with a light coat of Form Release Oil at the beginning of each working day.
- Install safety chains on all tailgates to prevent the tailgates from opening and spilling concrete.

Longitudinal Floats

The Inspector should ensure the longitudinal float is of suitable design and in working order as follows:

- Ensure the mechanical longitudinal float is of a design approved by the Engineer.
- Check that the longitudinal float is in good working condition.

- Ensure the longitudinal float is so constructed as to provide for accurate adjustment to the required crown.

Finishing

If the work has progressed according to recommended best practices, the final surface should be of a satisfactory condition. The Inspector should monitor finishing as follows:

- After the screed has struck off the concrete, no additional finishing will be required, except the need to maintain line and grade.
- Ensure the surface is true to grade and cross section, and free from irregularities.

Hand Finishing

The Inspector should follow these guidelines for hand finishing:

- Use long-handled floats to smooth and fill in the open-textured surface areas.
- ***Keep hand finishing to a minimum.*** Take care not to overwork the concrete as this could result in a less durable surface.
- If the surface cannot be brought to the desired conditions without continual use of hand operations, adjust paving operations or consistency of materials to bring the surface back to specified tolerances.
- Do not permit spraying or splashing of additional water on the pavement to aid in finishing.
- Do not allow use of an evaporative aid.

Finishing Straightedge

The Contractor must use not fewer than two finishing straightedges, with handles at least 3 ft (1 m) longer than ⅛ the width of the slab. The Inspector should ensure the finishing straightedges are:

- Constructed of light metal
- Not less than 10 ft (3 m) long
- Maintained clean and straight

Straightedge Templates

The Contractor should provide not fewer than two straightedge templates for testing the completed surface. The Inspector should ensure the straightedge templates are:

- Of wood or metal
- Not less than 12 ft (3.6 m) long
- Maintained clean, straight, and free from warp

Water Supply Equipment

Water supply equipment includes pumps, or tanks mounted on trucks, of adequate capacity to furnish more than sufficient water to accommodate this construction and at the required and necessary pressure.

- Allow use of a pipe line appropriate to the requirements of the construction.

Small Tools

The Inspector should verify that small tools, such as edgers, trowels, hand floats, brushes, etc., are such as will produce the results required.

Special Equipment and Tools

The Inspector should inspect to ensure equipment and tools necessary for the Construction of special features as indicated on the plans are such as will produce the results required.

Transverse Grooving Equipment

The Inspector must ensure that mechanical transverse grooving equipment consists of one of the following:

- A steel tine comb with a minimum width of 6 ft (1.8 m)
- A vibrating beam roller
- Other approved devices

Concrete Saw

When sawed joints are elected or specified, the Inspector should ensure the requirements are met as follows:

- Check that the Contractor provides sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate.
- Require that the saws are equipped with water-cooled diamond edge blades.
- Ensure that saws used for sawing longitudinal joints are equipped with guides to assure proper alignment of the joints.
- Maintain an ample supply of saw blades at the site of the work at all times during sawing operations.
- Require the Contractor to provide adequate artificial lighting facilities for night sawing.
- Ensure that all of this equipment is on the job both before and continuously during concrete placement.

Burlap Drag

The burlap drag is a seamless strip of burlap, kept free of hardened concrete. For best results, the Inspector should consider these guidelines:

- Use at least 3 plies of wet burlap and drag parallel to the centerline without tearing.
- Complete the drag finish with one pass.

Texturing

To achieve the desired texturing, the Inspector should inspect for the following:

- Ensure transverse grooves are produced mechanically by means of a comb equipped with steel tines.
- Form the grooves using the grooving device in one pass over the full width, without overlap.
- Check tines for proper transverse grooves.

For more information, see Subsection 430.3.05.3.G.2 of the GDOT Standard Specifications.

Curing

The Contractor must commence curing as soon as finishing operations have been completed. The Inspector will require the following practices:

- Uniformly spray the entire exposed area, including sides and edges, with curing compound.
- Apply curing compounds with mechanical sprayers of the fully atomizing type.

Some check points for inspection are:

- Ensure the pavement surface is exempt from freestanding water.
- Employ the specified rate of application.
- Calibrate the spraying device to give the proper rate of application.
- Adjust nozzles on the spray device not to damage the pavement surface.
- Use hand spraying to supplement mechanical spraying, if necessary.
- Apply a second application of curing compound at the specified rate within 48 hours before placing PCC as a bond breaker.

For more information, see Subsection 430.3.05.3.I of the GDOT Standard Specifications.

A.5.5 Concrete Mixing

Mixing time begins when the component materials are placed in the mixer. Concrete that is mixed less than the established minimum is grounds for rejection. The Inspector should:

- Require adjustments, if needed, and make appropriate entries on the proper attachment to the Inspector’s Daily Report.
- Not allow the volumetric or speed capacity of the mixer to exceed the manufacturer’s recommendations in any case.

Truck-Mixer Operation

In truck-mixer operations, component materials are mixed for either a specified amount of time or a specified number of revolutions at normal mixing speed. The Inspector will:

- Check the speed of the drum blade rotation to ensure that it is within specified limits.
- Require close coordination between Project Inspectors at the plant and the paving site to ensure proper mixing.
- Check delivery tickets, evolution counters, and timing devices frequently to verify mixing time.

Other Mixing Operation

Mixing time generally should not be less than 75 seconds (i.e., 60 seconds plus 15 seconds for each additional cubic yard [cubic meter] of batch). However, a shorter mixing period can be established if the Contractor demonstrates the adequacy of the resultant mix.

- Typically control mixing time by a timing device and automatic discharge locking system. An audible warning device signals when the discharge lock is released.
- Using a stopwatch, check the mixing time from charge to discharge at least once a day during production to verify proper adjustment of the control system. In multiple drum-mixer operations, include the transfer time between drums.

Mix Property Checks and Adjustment

The certified PCC Inspector is responsible for overseeing testing to ensure mix properties are within tolerance of the Contract specifications, as follows:

- Unless otherwise directed, sample seven production batches. ***Each property tested should not exceed tolerance in more than one test batch.***
- Base the grounds for rejection on the type and magnitude of the infraction.

When conditions change (e.g., materials, batch size, mixing operation, hauling method), additional testing may be required.

It is good practice for the Project Inspector to review the PCC Mix Design Plan and become familiar with:

- Mix proportions
- Methods of determining batch quantities
- Yield
- Effective water and cement factor
- Procedures for adjusting mix proportions

During production, changing conditions will invariably require mix adjustments. The PCC Inspector will ***immediately*** notify the Project Engineer/Supervisor of any needed adjustments (e.g., changes in material source or proportions, introduction of admixtures) because Contract provisions may require the Contractor to submit a revised Mix Design Plan.

Field Laboratory Requirements

The Contractor is responsible for furnishing a field laboratory to maintain adequate control over the quality of materials and work on the Project. Sampling and testing will be defined in the Contractor's Quality Control Plan. The Inspector should perform the following checks:

- Prior to production, check that the Contractor locates the facility to permit reasonable observation of key operations and furnishes the facility in accordance with Contract specifications.
- During production, check that the facility is maintained in a clean and orderly condition for the most effective work.

Aggregate Gradation Checks

Verify that gradation and uniformity are checked at least once each production day and more frequently as conditions warrant (e.g., changes in aggregate source, use of multiple stockpiles).

- If gradation is outside the specified limits, halt production until corrected, in accordance with the provisions of the Contract.
- Note that changes in aggregate source will require a new mix design.

Strength Checks and Adjustment

The Inspector should make periodic checks of the quantity of cement used.

- Compare the actual quantity (i.e., the difference between total supply and quantity remaining) to the theoretical quantity determined from the PCC Mix Design Plan.
- Ensure that the compressive strength is monitored and that the cement factor is adjusted as needed in accordance with the provisions of the Contract.

*Consistency (Slump) Check*s

Consistency, or slump, is an indicator of concrete workability and must be carefully monitored and held within a narrow margin to assure proper placement and consolidation to the prescribed geometry. The Inspector should consider the following guidelines.

- Check that consistency is tested and monitored within the limits of the Contract specifications. The target value will depend on the method of paving.
    - Slipform paving generally requires a 2-in. (50 mm) consistency. ***Excessively wet or dry batches are grounds for rejection.***
    - For other paving methods, consistency should be within ¾ in. (20 mm) of the target value. ***If exceeded, require immediate adjustment. Failure to comply is grounds for rejection.***

It is generally unacceptable for the Contactor to introduce additional water at the paving site for the purpose of adjusting consistency. This adjustment should be made at the production site. However, water may be added to dry batches in truck mixers if the operation can be performed within 45 minutes of initial mixing. In such cases:

- Do not permit more than 1 gal/yd^3 (5 L/m^3) to be added.
- Ensure that the batch is remixed for at least 20 drum revolutions at normal mixing speed.

Air Entrainment Checks

The Inspector should ensure that the amount of entrained air is tested and monitored within the limits of the Contract specifications.

- Require adjustments and reject batches based on the provisions of the Contract.

Yield Checks and Adjustment

After consistency and air entrainment have been established for production, the Inspector must ensure that actual yield is verified and properly adjusted.

- Determine the actual yield from the average unit weight of specified samples.
- Compare it to the theoretical yield of the mix design. In general, mix adjustment is required if the difference is greater than ±2%.

For concrete mixing, also see Subsection 440.3.06 of the GDOT Standard Specifications.

Hauling Consideration

High-quality pavement construction requires that concrete be uniform from batch to batch. To achieve uniformity, the Inspector should do the following:

- Ensure the batching or mixing plant is in good operating condition.
- Exercise close control over the handling and batching of the materials used in the concrete.

Contractors use two basic methods to mix concrete: ready mix and central batch plant. Considerations for the central batch plant are discussed here.

Central Batch Plant

Many Projects utilize fully automatic central mix plants to produce the concrete. Manual operations are permitted when the automatic controls fail, but the problems must be resolved and automatic control restored before work may commence the next day.

Depending on the plant, batches up to 11 yd^3 are mixed at one time at a central location and then transported by either dump trucks, live bottom trucks, or agitator trucks. The Plant Inspector is responsible for checking the trucks for:

- Operational cleanliness
- Revolution counter compliance

Material Segregation Considerations

The Inspector should periodically verify that concrete is being discharged completely without segregation. To minimize the occurrence of segregation, look for the following:

- When possible, use bottom discharging trucks because the batch can be deposited directly onto the subgrade with little segregation.
- Where tilting body type trucks are used, ensure suitable baffles are in place to retard the rate of discharge and reduce segregation.

Haul Time Considerations

Concrete begins to set when water is introduced to the batch. If excessive time elapses before the concrete reaches the site, mix consistency may be compromised, making it difficult to place and finish. The Inspector must adhere to the following time requirements:

- *Non-Agitating Trucks*: Concrete that is hauled in non-agitating trucks must be placed within 30 minutes or less after water is introduced to the batch.
- *Agitating Trucks and Truck Mixers*: Where agitating trucks and truck mixers are used, the concrete must be placed within 60 minutes or less.

Batch Tickets

Time requirements must be met when concrete is being mixed or hauled by ready mix trucks. Haul tickets are used to control these requirements. The Plant Operator issues a "batch ticket" for each load leaving the plant.

- Check the W/C ratio shown on batch tickets against calculations to verify its accuracy at the start of a Project and occasionally thereafter.

Central batch plants have a capability to print computer tickets. These tickets include batch weights and time batched information, as follows:

- Truck number
- Total volume of load in cu. yds.*
- Actual weight of volume of each component of the mix*
- Revolutions
- Date and time batched*
- Mix ID*
- W/C ratio
- Admixtures
- Project number
- Plant inspector's name or initials

* Required on automatically generated tickets.

Form Setting

Following the semifinal grading of the subbase material, the Contractor establishes an offset longitudinal grade line parallel to the roadway base line, centerline, or lane lines. The Inspector should make the following inspection:

- Use the offset longitudinal grade line as a reference line to check the location of the actual form line.

Form Condition

When the forms are first spread out, the Chief Inspector assigns the Concrete Inspector to straightedge each individual form to ensure that each form is free of warps and bends. The Inspector should check the following:

- Ensure the top surface does not show a deviation from a straight line of more than ⅛ in. (3 mm) in 10 ft (3 m).
- Ensure the lateral deviation does not exceed ¼ in. (6 mm) per 10-ft (3 m) section of form.
- Check the form locks to ensure that the forms can be properly locked together when set.
- If the forms are bent, twisted, or have irregularities of any kind, order them removed from the work until the defects are corrected. ***Approval of the forms on another Project is no reason to accept them.***

- If necessary, mark the forms needing repair with paint.
- Check that forms are clean of all dirt, concrete particles, and rust.

See Subsection 439.3.05.A of the GDOT Standard Specifications, as well.

Bracing Pins

At least three bracing pins are used to anchor a section of form. The size and length of the pins are important, and the requirements vary with differing subsoil materials. The Inspector should make the following inspection:

- Ensure the pins are of sufficient size and length to hold the forms firmly in the required position.
    - If the forms show movement during the first placing of concrete, or through use of a fine grading machine, the size and length of the pins are one of the chief items of possible correction.

Wooden Forms

The Inspector should consider these guidelines for the wooden forms:

- A wooden form usually is made of well-seasoned lumber of adequate thickness and of a width equal to the depth of the pavement to be placed against it.
- Check that the form is thoroughly pinned and braced so that deviations in the line or grade of the completed pavement do not exceed the allowance of the specifications.

Sharp Curves

The Inspector must be alert to special needs on sharp curves.

- If a curve is so sharp that the use of standard steel forms will result in a series of chords, use wooden forms or acceptable metal forms.
    - Saw cuts are made at frequent intervals, when necessary, in wooden forms to obtain the true curvature.
- For a sharp curve, do ***not*** approve the use of standard steel forms and then depend on the finisher to edge a true line at peaks of the curve. It cannot be done satisfactorily.

Line and Grade

Before placing the forms, the alignment and grade of the lane, as indicated by the concrete stakes, are transferred to steel pins placed on the actual form line. As Inspector, accomplish this by following the steps below:

- Make offset measurements, and place the pins for line so that the outer face of a pin is on the edge of the lane.
- Transfer grades and mark the form grade on the pins with a sharp keel or scratch mark.

- Attach mason's line, free from knots, at grade elevation and stretch from pin to pin.
  - Check the line carefully by eye for any minor irregularities or kinks in either alignment or grade. The string line closely represents the top inside edge of the forms.
  - Usually make a slight lateral allowance for the longitudinal keyway.
- At points of intersection, change of pavement widths or other special joints, plan a special form layout so that no featheredge is left.
  - It generally is necessary to build the beginning of the flare or taper with the nearest adjacent lane.
  - This special construction should be planned to extend 12 in. (300 mm) or more outside the normal lane edge.
- When placing forms adjacent to a completed lane, use a grade line.
- Make elevation checks using the completed lane as a grade line, applying the pavement crown or super-elevation.

Form Placement

Forms are set only after the subbase is properly prepared, including the area under the forms. The Inspector must implement the following checks and practices:

- Ensure that forms rest firmly on a prepared surface throughout their entire length and width.
- Check placed forms for overall alignment.
  - Use the "eyeball" method. The forms should look straight and the tops should give a smooth surface.
  - If the surface of the forms seems out of tolerance, check it with a straightedge. Forms must be set correctly for smooth pavement.

REMEMBER: The top face cannot vary from a straight line by more than ⅛ in. in 10 ft.

- Excavate the form area by hand to pavement depth below the string, and place each section of form in its approximate position. When a few hundred feet (hundred meters) of forms have been placed, make final adjustment to the positions of the forms.
- Before any concrete is placed, ensure the forms are in proper alignment and grade for at least 500 ft (150 m) in advance of a single-lane-width paving operation.
  - The Chief Inspector may allow some deviation from this rule. However, the Inspector may ***never*** permit concrete to be mixed and placed if less than 350 ft (100 m) of forms are properly set in advance of the strike-off machine.
  - If less than 350 ft (100 m) are ready for pavement, the paving operation must be shut down until the form work is carried ahead at least the initial 500 ft (150 m).
  - The Chief Inspector must report deviations from the rule to the Project Engineer. The number of deviations should be kept to a minimum.
- When approaching or leaving horizontal or vertical curves, verify that sufficient forms are set ahead to make a satisfactory transition.
- Ensure the surfaces of all forms that come in contact with the concrete are thoroughly cleaned and lightly coated with oil.
- Remove and reset leaning forms or forms sprung into line.

When paving operations are in progress, the Concrete Inspector must be assured that the forms immediately in advance of the strike-off machine have not been forced out of line by the trucking equipment operating between or adjacent to the forms.

- If forms are forced out of line, make immediate adjustment to bring the forms back and hold them in their original positions.

Form Removal

The Inspector is responsible to ensure conditions are met prior to, during, and after form removal.

- Do not remove forms until concrete has set for at least 12 hours except for auxiliary forms used temporarily in widened areas.
- Remove forms without damaging the pavement.
- After the forms have been removed, cure the exposed sides by one of the methods discussed later in this manual.

See Subsection 439.3.05.3.E of the GDOT Standard Specifications, as well.

Longitudinal Joint Key

The longitudinal construction-joint key is placed in accordance with the standard paving details and must:

- Be securely held in position so that it will not move out of alignment if the concrete along the forms is spaded or vibrated
- Extend to within 6 in. (150 mm) of each transverse expansion joint

The Inspector should take particular care to see that the extremities of the key are supported in the proper alignment.

Refer to Subsection 439.3.05.3.H of the GDOT Standard Specifications, as well.

String Lines

<u>Slipform String Lines</u>

Slipform paving operations usually use equipment units that automatically sense line and grade from a string line. The Inspector should be familiar with typical usage and requirements.

- One string line usually is used for both fine grading and paving.
  - Set the line on one or both sides of the grade, depending on the design of the equipment.
- Regardless of the terrain over which the machine must track, it will maintain the grade indicated by the string line.
  - Ensure that the string line is as accurate as practicable.

Normal String-Line Setting

The location of the metal stakes that support the string line is oriented to the grade stakes. The Inspector should consider the following factors before any hubs are set, to determine the most feasible location for the string line:

- Other work that may be performed either between the string lines or along the shoulders
- The amount of material to be wasted near the string lines and the disposition to be made of the material
- Obstructions along either side of the roadway
- The limits of the machine sensor-arm supports
- The height of the string line above grade required for the paving equipment
- The percent of fall (cross slope) from the centerline of the roadway to the hubs or edge of pavement

Location of the string line may vary with each section of the roadway because of super-elevations, crowns, and offsets. Each section should be evaluated separately to determine the proper location or position of the line.

Hubs are set after considering the factors above. Setting hubs is one of the more critical phases of the paving operation, as the line and grade for all following work depends on them. Set the hubs as follows:

- Drive metal stakes into the ground, normally at 50-ft (15 m) intervals, along:
    - One side of the roadway if using a machine equipped with a cross-slope system
    - Both sides of the roadway if using a machine with sensors installed on both sides

  On ramps and super elevations, stakes may be set at 25-ft (7.5 m) intervals for greater accuracy.
- Locate the stake 12 in. (300 mm) to the rear of the hub.
    - Check that it is vertical and driven deep enough for good stability.
    - Ensure the slotted end of the string-line rod is directly over the center of the tack in the top of the hub and slightly above the intended string-line elevation.
    - Use a rule to measure the height of the road above the tack and a plumb bob to assure the rod end is over the tack. Figure A-7 shows a typical setup.
- Check the string line itself, after it is installed and tensioned, so that no sag between stakes is visible.
    - Check the string line with a rule for the exact height above the tack.
    - After the string line is adjusted to the exact height, check for a smooth alignment of the string line by sighting down the line.

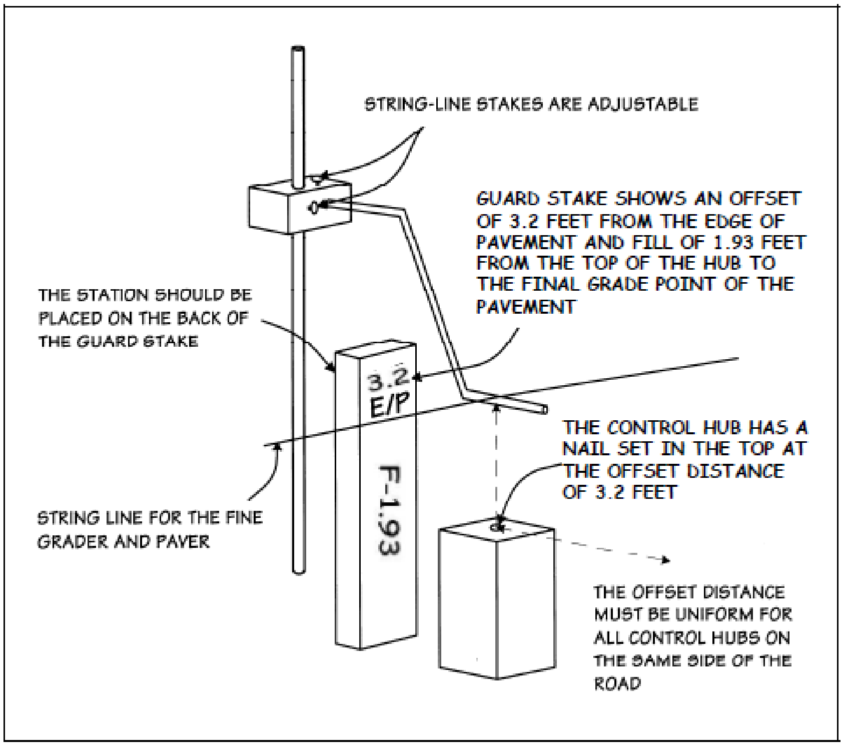


Figure A-7: String Line Setup

<u>String-Line Repairs</u>

A break in the string line can be repaired by tying the string line together with a square knot. The knot does not affect the accuracy of the machine but must be tied securely enough to permit re-tensioning of the string line. The Inspector should do the following:

- If the string line is repaired, moved, damaged, or partially dismantled for any reason, ***halt paving operations until the line can be reset and rechecked.***
- During actual grading or paving operations, maintain a constant watch over the string line to prevent interference of any kind from causing a deflection in the line. Examples of interference are:
  - personnel leaning against the line, lifting the line to crawl under, and hanging coats or tools on the line; or
  - equipment passing by nudging the stakes.

Subbase

The fine-grade elevation may be determined from accurately set forms or completed lanes of pavement. The Chief Inspector assigns the work to the Inspector ahead of the paving operation.

It is that Inspector’s responsibility to see that the subbase is ready to receive the concrete pavement.

- Check the grading with an approved template or scratch board as grading progresses. The bottom contour of the scratch board must conform precisely to the desired contour of the subbase.
    - Use a template furnished by the Contractor and designed to ride the forms; move it along as the fine-grading operation progresses.
        - Cut down areas where the points scratch the surface, and fill in and compact low areas.
        - Ensure there are at least two templates available for use.
        - When the templates are in use, check them at least twice daily.
    - Alternatively, check the grade with the use of string lines tied between each form.
- If the fine grading is done by a machine, adjust it to cut accurately to the required grade. ***The Inspector must check the fine grade as conscientiously as if the work was done by hand.***
    - Some fine-grading machines produce a lateral thrust that causes the forms to rock and the form pins to become loose. If this occurs”
        - Immediately correct the operation of the machine
        - More firmly fasten the forms, so that there is no further rocking of the forms
    - The current trend favors an adjustable blade unit that is mounted on a grader.
        - Work the grader between the forms.
        - Roll the blade unit along the top of the forms, and carry the surplus material along within the forms and usually remove it with a front-end loader.
        - Closely control the grade of the blade, and use only a minimum amount of hand labor to complete the shaping operation.
- Immediately after grading to the required elevation, roll the fine grade with an approved roller.
    - Draw the subgrade template over the completed area for a final check, and correct irregularities.
    - Ensure that the entire depth of the forms, including bottom edges, is fully exposed.
- When concrete is being placed, reshape and roll any irregularities in the subbase surface caused by trucking equipment working between forms, as needed.
    - If the trucking equipment ruts the subbase, it is an indication that the subbase is not in proper condition for the work.
- The Concrete Inspector must continually observe the condition of the fine-grade surface immediately ahead of the paving train and keep a close check on its elevation and state of compaction. The check must be by template, as described above.
    - See that the fine grade is thoroughly dampened well in advance of the paving train to prevent drawing excessive amounts of water from the fresh concrete.
    - Regulate the procedure of dampening the fine grade so that concrete is never placed within 100 ft (30 m) of the sprinkled fine grade.
    - Never place concrete on a subbase that contains frost.

A-5-6 Concrete Placement

Preparation for Concrete Placement

Having the proper conditions for concrete placement, and the structure and equipment in place is critical to the concrete placement process. The Inspector is responsible for verifying the following prior to pouring the concrete:

- Check the subbase.
- Check the vertical and horizontal alignment of the forms, if they are used.
  - Ensure the forms have full base support and are locked in place with the correct number of pinlocks.
  - Place the form pins at an adequate depth to prevent the forms from rocking.
  - Side lock the forms with keys so proper alignment will be maintained.
- Check the width of the slab (the inside of one form to the inside of the other form or the width of the slipform paver adjustable forming trails) if forms are used.
- Check the gradeline and cross slope of the base.
  - High areas must be cut down and low areas must be brought to the proper grade and properly compacted.
- Check for loose material and debris that the Contractor must remove from the base prior to concrete placement.
- Check the subgrade moistening so that it will not absorb water from the concrete and reduce the water–cement ratio.
- Moisten wood forms so they will not reduce the water–cement ratio.
- Treat the forms with a parting agent such as oil or lacquer to facilitate their removal.
- When dowel baskets are placed on the base before concrete placement, check them for position and alignment. The Contractor must make any necessary adjustments.
- When reinforcing steel is used, check that it is free of mud, oil, or other organic materials that may reduce bond.
- Maintain a sufficient amount of covering material at the job site to cover and protect the green concrete against rain. The covering should be:
  - in a bed roll and mounted on the curing machine or
  - located as near as possible to the curing machine.
- Keep backup equipment such as hand vibrators, floats, and straightedges on hand, ready for use.
- Check the current and upcoming weather conditions. Care must be exercised when placing concrete in very cold or very hot weather, and weather in which sudden rains are possible.

Cold Weather Concreting

When the ambient temperature is below or expected to drop below 40°F before the concrete attains 1500 psi, the Inspector should take the following precautions.

- Ensure the Contractor has a sufficient supply of insulating blankets, burlap mats, plastic sheeting, or other suitable blanketing material to help prevent the water in the concrete from freezing.
- Heat the water for mixing, not to exceed 160°F.

- Heat the stockpiles, if necessary, not to exceed 100°F.
- If forms are used, ensure they are heated.
- Never place the concrete on a frozen base or subgrade because the rate of hardening will be retarded, and uneven settlement below the concrete may occur when the subgrade thaws.
- Ensure the concrete temperature at the time of placement is between 50°F and 90°F (GDOT Specification 830). To meet this requirement, the Contractor may need to heat (or cool) the mixing water or aggregates. Warmer temperatures could create a flash set.

Hot Weather Concreting

In very hot weather water evaporates quickly from concrete, and the result may be shrinkage cracks in the pavement surface. In addition, when concrete is placed in layers, cold joints or discontinuities in the concrete can develop if one layer is allowed to harden before the next layer is placed.

Delay in placing concrete during hot weather contributes to a loss of slump and increase in the concrete temperature. This decreases the concrete's workability because the concrete has begun to take its initial set.

The following precautions should be taken when the concrete temperature is above 85°F:

- Transport and place concrete as quickly as possible. If placement is delayed, concrete will begin to take its initial set and will be unworkable.
- Ensure there are enough workers on the job site to handle and place the concrete immediately after delivery.
- If necessary, reduce the temperature of the concrete. Cooling the concrete components by the following means can do this:
    - Use cooler cement
    - Use ice in place of the mixing water
    - Sprinkle the coarse aggregate stockpile
- The maximum temperature of the concrete mix is 90°F.

<u>Formed Paving Method</u>

With this method, forms are used to contain the concrete and to act as a set of tracks for the paving equipment. The Inspector must check forms for alignment. If the face of the top of the forms is out of line, then crooked or rough pavement results. Although a variety of machines are used to place and finish the concrete, all must be equipped with these items (not necessarily in this order) (see Figure A-8):

- An auger or other comparable device to spread concrete across the pavement width
- Strike-off equipment
- Vibrators to consolidate the concrete
- A screed to shape the concrete to the cross section called for by the plans
- A float to give the surface a smooth finish

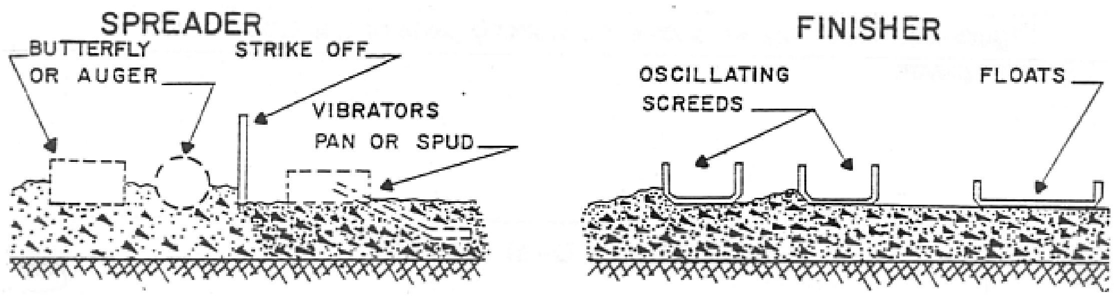


Figure A-8: Spreader and Finisher

Tie Bars

Tie bars are deformed reinforcing bars (see Figure A-9). They are placed across some longitudinal joints to hold the pavement together and to prevent faulting. The Inspector must inspect as follows:

- Check plan notes and standard plates for the size, length, and placement of the tie bars.
- At a minimum, verify the tie bar depth, location, and spacing at:
    - The start of paving each day
    - A frequency of every 250 ft during normal paving

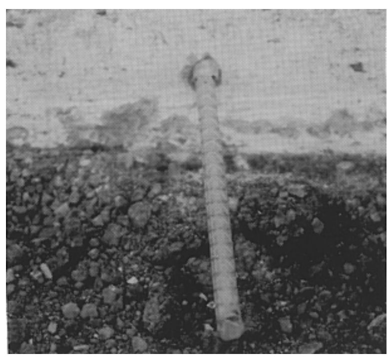


Figure A-9: Deformed Tie Bar

Nonreinforced pavement contains tie bars placed across the centerline (longitudinal) joint, and the following practices are recommended.

- Accomplish placement of tie bars wired to chairs prior to concrete placement.
- Do not allow the use of a jig to place tie bars in fresh concrete.
- Always check the location and depth of the tie bars periodically after concrete placement.
    - Either dig them out or check with a cover meter to verify location depth.
- Position reinforcement on approved supports in advance of concrete placement or inserted in the plastic concrete by an approved mechanical device.
- Place mechanically inserted tie bars prior to the final strike off of the paver.
- Do not allow any hand method.

Placement Unit

A placement unit mounted on the slipform paver consists of a small wheel that rides on one track of the paver and a hydraulic device to place the steel. The wheel measures the forward movement of the paver; at the predetermined intervals, an electronic impulse is sent to the placement unit, and tie bars are then hand fed into it.

- Care should be taken to prevent forcing a tie bar down onto a dowel basket or within 15 in. of a transverse joint.
- Verify the depth, spacing, and location of tie bars effectively from the back of the paver using a trowel or cover meter. Record the depth and spacing in the diary.
- Alternatively, drill and epoxy the tie bars in-place

A.5.7 Steel Bar Installation

Steel bars are installed using an epoxy resin adhesive to anchor them in the drilled holes. Basic requirements include these:

- Cut the steel bars to the specified length by sawing.
- Ensure they are free from burring or other deformations.
- Do not permit shearing.

Other requirements for the Inspector to adhere to are as follows:

- Ensure the diameter of the drilled holes in the existing concrete pavement for the steel bars is not less than ⅛ in. nor more than ⅜ in. greater than the overall diameter of the steel bar.
- Locate the holes drilled into the existing concrete pavement at mid-depth of the slab and ensure they are true and normal.
- Blow out the drilled holes with compressed air using a device that will reach to the back of the hole.
  - Remove all debris or loose material prior to epoxy injection.
  - If necessary, insert a long round wire brush prior to blowing to loosen the material inside the hole.
- Mix the epoxy resin as recommended by the manufacturer.
- Apply the epoxy resin by an injection method approved by the Engineer.
  - If an epoxy pump is utilized, it must:
    - Be capable of metering the components at the manufacturer’s designated rates
    - Be equipped with an automatic shut-off valve if either component is not being metered at the designated rate
  - Fill the drilled holes ⅓ to ½ full of epoxy, or as recommended by the manufacturer, prior to insertion of the steel bar.
  - Take care to prevent epoxy from running out of the horizontal holes prior to the steel bar insertion.
  - Rotate the steel bar during installation to eliminate voids and ensure complete bonding of the bar.
  - Do not allow insertions of the bars by the dipping method.

Pull Testing

The Contractor must load test 5% of the first 500 tie bars that are drilled and epoxied in place. The following requirements apply to testing of the tie bars:

- Do not allow further installation until the initial 5% testing has been completed and the Engineer has given approval to continue installation.
- Require testing for 0.5% of the bars installed after the initial 500.
- For each bar that fails to pass the minimum requirements, test two more bars selected by the Engineer.
- Reinstall and retest each bar that fails to meet the minimum load requirement.
- Ensure the equipment and method used for testing meets the requirements of GDOT Standard Specifications Section 853.
- Perform all tests within 72 hours of installation.
- Install and approve tie bars before placing concrete in the adjacent lane.

Continuously Reinforced Concrete Pavement Steel

Continuously Reinforced Concrete Pavement (CRCP) is a Portland cement pavement that has continuous longitudinal steel reinforcement. It has the following structure and characteristics:

- CRCP does not have intermediate transverse expansion or contraction joints.
- The pavement is allowed to crack in a random transverse cracking pattern and the cracks are held tightly together by the continuous steel reinforcement.
- The transverse cracks will most likely be spaced between 2 and 5 ft. The first 250–300 ft from a terminal anchor may not have any transverse cracks.
- The principal reinforcement in CRCP is the longitudinal reinforcing bars.
    - Transverse reinforcing bars are used to a lesser extent, depending on individual cases.
    - If transverse reinforcing bars are not carried through longitudinal joint locations, tie bars are required to hold the adjoining slabs together.
- Transverse construction joints are provided in CRCP at locations where construction progress is halted at the end of the day’s run or where production delays occur.
    - Although these joints are few in number on any one construction project, their potential for creating problems is high and they must be constructed in accordance with design details.
    - Experience has shown that special bar arrangements are needed at transverse construction joints to handle early stress concentrations and to replace load transfer capacity lost because of the smooth joint faces.

Design and Construction Quality Control

Attention to design and construction quality control of CRCP is critical. A lack of attention to design and construction details and quality construction practices can cause premature failures in CRCPs. The most critical aspect of the CRCP design is the placement of the reinforcing steel. If the reinforcing steel is not placed correctly, a premature failure in the CRCP is imminent.

- *Longitudinal Lap*:

    - Check the longitudinal lap of all splices to assure that the minimum lap of the reinforcing steel is maintained as shown in the plan details. The length of the lapped splices of the longitudinal reinforcing bars is critical to good performance.
    - Carefully observe and strictly enforce the minimum length requirements during construction. If adequate bond strength is not developed in lap splices, wide cracks and subsequent failures will develop.
- *Vertical Placement*: Typically, the reinforcing steel will not be high.
    - If the reinforcing steel is too high, the pavement will not be of sufficient depth and the Department may price adjust the Contractor for the thin pavement.
    - If the reinforcing steel is low, require the Contractor to shim the transverse reinforcing steel to correct the deficiency.
    - Periodically, check that the reinforcing steel is placed within the specified tolerance vertically. This is accomplished by:
        - pulling a string line transversely across the roadway at the grade of the new pavement and measuring down to the reinforcing steel.
    - Verify the depth of the reinforcing steel.
        - Ensure the materials lab has a cover meter available on the Project to periodically check the depth of the reinforcing steel behind the paver. This can be accomplished while the concrete is plastic or hardened.
        - Alternatively, verify the depth of the reinforcing steel by:
            - ✓ Digging down to the reinforcing steel while the concrete is still plastic
            - ✓ Measuring the depth

- *Other Considerations*: The Inspector should check for:
    - Steel spacing
    - Bent steel reinforcement
    - Broken welds on the chairs supporting the reinforcing steel
    - Bar alignment changes
    - Sufficient number of wire ties on the steel laps
    - Broken clips having wire ties holding the reinforcing steel
    - How the steel is lapped:
        - Verify the lap pattern with the plans to prevent failures in the CRCP.
        - Lap the outside longitudinal steel bars such that the approaching bar is placed to the inside as the paver approaches the lap.
            - ✓ The spreader or paver may catch the approaching bar as the spreader or paver moves forward if the reinforcing steel is not lapped in this fashion.

- *Trash Removal*:
    - Ensure foreign materials such as bits of wood, oily rags, cigarette butts, and soda cans are removed prior to placing concrete.
    - Check that the reinforcing steel is clean and free of any dirt before placement of the concrete.
- *Steel Misplacement*:
    - Watch the reinforcing steel during concrete placement with either the spreader or paver.

    - The plastic concrete being pushed ahead of either the spreader or paver puts a large amount of pressure against the reinforcing steel and can cause misplacement of the reinforcing steel.
    - Experience has shown that tying the steel too far ahead of the paver causes the reinforcing steel to bend due to the pressure from the paving operation.
- *Finishing, Texturing, Curing, and Longitudinal Sawing*:
  - Follow the same construction practices as with any other PCCP.
  - Monitor and measure the required items.
  - Ensure CRCP meets smoothness requirements as specified in the Contract.

CRCP as an Overlay

Some CRCP is an overlay of an existing pavement. The existing pavement can be either asphalt or concrete. The Inspector should be aware of the following inspection needs:

- If the existing pavement is asphalt:
  - Mill the roadway to proper profile and cross slope and overlay with CRCP.
- If the existing pavement is concrete:
  - Place an asphalt mat or gravel bond breaker over the existing concrete pavement to prevent the new pavement from bonding with the existing pavement.
  - Spray lime slurry on the asphalt overlay to minimize the amount of heat absorbed into the asphalt overlay and reduce the number of shrinkage cracks of the new CRCP that may be induced with the higher asphalt temperatures.
    - Reducing the heat on the reinforcing steel and the mat helps prevent the concrete from setting up unevenly.
  - During periods of extreme heat, if the shoes supporting the reinforcing steel sink into the asphalt overlay, place pieces of tin under the shoes. This reduces the depth the shoe will sink into the asphalt overlay and helps maintain the reinforcing steel at the proper height.

Leave-ins and Leave-outs

In some paving situations it becomes necessary to introduce a temporary gap in the mainline paving for a haul road crossing, an intersection where cross traffic must continue to flow, or for other reasons. These gaps in CRCP generally are referred to as “leave-ins” or “leave outs”:

- *Leave-in*: Gap pavement if paving in the gap area precedes the mainline construction
- *Leave-out*: Gap pavement if paving in the gap area follows the mainline construction

Of these two gap pavement alternatives, the leave-in is by far the more preferable. Experience has shown that if all details of leave-out construction are not handled in strict accordance with the plans, or if unexpected large ambient temperature drops occur before the leave-out concrete has hardened sufficiently, movement in the free ends of the hardened mainline concrete abutting the short stretch of freshly placed leave-out concrete will cause overstressing. This movement causes excessive cracking and permanent loss of bond between the concrete and steel in the leave-out area.

A-5-8 Spreading

Before any concrete is spread, all surfaces of subbase must be moistened. A dry granular subbase pulls water out of fresh concrete, reducing its strength. Asphalt-, lime- and cement-treated subbases should also be misted to keep them cool. This helps to reduce the possibility of a flash set. The surface of the subbase is usually moistened with water sprayed from a hand-held hose or a fine-misting water truck. Areas for the Inspector to monitor include the following:

- The Contractor should keep the misting process a few hundred feet ahead of the concrete placement operation.
- Do not allow puddles of water to be left on the subbase. The extra water is absorbed by the concrete and reduces its strength.
- Spread the concrete uniformly on the subbase with the spreader.
  - By spreading it across the roadway, only a small amount of moving is needed to put it in its final location. If it must be moved much distance, there is the possibility of some segregation occurring (380.3 H).
  - If concrete must be placed by hand, do so by shovel scoops and place where the concrete is needed. ***Do not throw concrete, as segregation may occur.***
- When slipform pavers are used, place the concrete:
  - in a windrow down the middle,
  - in a windrow on each side, or
  - spread evenly over the entire roadway.

  Any of these methods are acceptable, as long as the concrete does not become segregated.
- Urge the Contractor to place the concrete in an even spread.
  - Concrete placement and the spreader augers both affect the uniformity of the concrete in front of the paver.
  - Concrete placed in big piles with open areas between piles results in non-uniform amounts of concrete being pushed by the spreader or paver.
- Placement of the concrete on the roadway dictates how the augers are used.
  - If concrete is placed in the center, usually turn the augers outward.
  - If it is placed on the sides, usually turn the augers inward.
  - If it is spread across the entire roadway, turn the augers inward and outward for equal periods of time.
  - ***Run the augers so they do not push the concrete into big piles.*** Big piles of concrete result in both "surge" and "no surge" locations in the pavement, which can result in a rough pavement surface.
- Have the Contractor remove areas containing mostly rock or mortar.
  - Watch for these areas during spreading.
  - Do not allow the material removed from one area to be placed anywhere else in the pavement. ***It must be wasted***.
- Keep the conveyors used to place the concrete clean, so dried concrete does not build up. Chunks of dried concrete mixed with plastic concrete can cause weak areas in the pavement.
- Do not allow workers to walk in the freshly placed concrete with mud-coated boots or shoes.

- Do not allow vehicles to back into the freshly placed concrete.

Butterfly versus Screw Spreader

The concrete deposited on the subbase is spread to its final location by either a “butterfly” or a “screw” spreader.

Butterfly Spreader:	A huge paddle that moves back and forth across the roadway, levels off the concrete, and fills in any low areas. Some segregation occurs because the butterfly simply pushes the concrete around.
Screw Spreader:	A big auger that allows the concrete to be augured toward the outside or the center of the roadway.

Because it mixes the concrete as it is being moved, the screw spreader is preferred over the butterfly. However, the Inspector should be alert to damage to prepositioned tie bars and dowel baskets during the placement, spreading, and forming of the pavement by the paver.

Surge

Concrete being pushed ahead of the spreader should be held to a uniform height across the full width of the spreader.

- When piled high, the weight of the concrete causes boil up behind the strike-off plate (surge), increasing the depth of the pavement.
- When the spreader is pushing a small amount of concrete, there is almost no surge behind the strike-off.

Either situation is acceptable as long as it is constant. However, the Inspector should be attentive to possible issues:

- Avoid excessive material, which will throw the machine off-line.
- Do not overload the spreader to the point that concrete is spilling over the forms or the machine is rocking the forms.
    - This will cause either horizontal or vertical misalignment of the slab because the machine rides up or to one side. As a result, the slab may have to be cut down to obtain the correct grade.
    - Random areas of surge and no surge cause some surface roughness in cured concrete.

Paver Precautions

Overloading the paver will also result in a waste of materials, excess finishing work, and poor riding quality. With care, the Inspector can minimize those issues.

- Exercise care to maintain a constant and continuous movement of the slipform paver. Any starts and stops of the paver can cause the machine to ride up over the mix and result in bumps in the pavement and a poor riding surface.

- Keep the forward speed of the paver as uniform as possible, but vary it according to the speed of concrete placement. Random areas of surge and no surge cause some surface roughness in cured concrete.

A-5-9 Consolidation

Concrete must be consolidated to be strong and durable. Using vibrators is the easiest way to consolidate concrete. The three types of vibrators available for use are:

- Spud vibrators
- Internal (immersed) tube vibrators
- Pan (surface) vibrators

Consolidation is achieved when the surface is smooth and submerged coarse aggregate is barely visible on or immediately under the surface. Recommendations to achieve consolidation include the following:

- Adjust the vibrators so the mortar or cream on top of the finish comes together.
- Ensure vibrators do not come in contact with a joint assembly, the grade, or a side form.
- Avoid operating the vibrator longer than 10 seconds in any one location.
    - This could cause over-vibration and the coarse aggregate will settle to the bottom of the mix, causing segregation.
    - Excessive vibration will also leave vibrator trails in the concrete mix. Look at cores to verify consolidation.

<u>Spud Vibrators</u>

Spud vibrators are individual tubes with a “cam shaft” arrangement inside. As the cam shaft rotates, the tube vibrates. Porous concrete becomes consolidated and smoothed when the vibrators move through it. The Inspector should consider these recommendations:

- When spuds are used alone, check that they are close enough together so all the concrete shows visible vibration.
    - A maximum of 24-in. spaces between vibrators is recommended.
- Use a hand-operated spud vibrator along the form line to consolidate the concrete and eliminate honeycombing on the edge of the pavement if the paver vibrators do not affect the edges of the pavement.
    - If a strip of the slab appears stiffer than the rest of the vibrated slab, a vibrator is not functioning properly.

<u>Surface Vibrators</u>

A surface vibrator, more commonly found on hand-pour jobs, is a metal plate or “pan” with vibrator units mounted on the top. The Inspector should enforce the following best practices:

- Whenever a surface vibrator is used, make sure the entire pan is resting on the new concrete. If it is not, vibrations will be uneven: many in some places and none in other places.
- Do not use hand spud vibrators to consolidate the concrete prior to the use of a surface vibrator.

General Vibrator Requirements

The Inspector should consider the following requirements for vibrators on each Project.

- Do *not* apply vibration indirectly or through the reinforcement to sections or layers of concrete that have hardened to the degree that they are not plastic.
- Ensure the frequency of the surface vibrators is not less than 3500 impulses per minute.
- Ensure the frequency of the internal vibrators is not less than 7000 impulses per minute, unless modified by the Engineer.
- Do not operate vibrators in excess of this frequency to such a degree that:
  - flotation of aggregate particles is caused and is evident or visible either during or after placement, or
  - it causes an accumulation of laitance on the surface of the concrete.
- Provide a vibrating reed tachometer, hand type, with each paver.
  - The vibrating reed tachometer must have a range of at least 4000–10,000 VPM.
- For a Contract with a minimum of 50,000 yd^2 of pavement that is 12 ft or more wide, provide an electronic internal vibrator monitoring device.
  - The device must be capable of displaying the operating frequency of each internal vibrator, and must be visible to the paving operator.
  - The vibrator monitoring device must have a range of at least 4000–10,000 VPM.
- Do not use vibrators to level or spread the concrete, but only for purposes of consolidation.
- Ensure spud-type internal (immersed) vibrators, either hand operated or attached to spreaders or finishing machines, used next to forms have a frequency of not less than 3500 impulses per minute.
- Ensure spud or internal vibrators operate at a frequency of not less than 7000 impulses per minute, unless they are used next to forms. Pan vibrators should have at least 3500 impulses per minute.
- Perform visual inspection of the pavement surface behind the paver float to disclose a vibrator problem. Check the frequency of the vibrators by using a tachometer supplied by the Regional Materials Engineer.
- If the normal equipment does not provide uniform consolidation, use supplemental mechanical vibrators.
- Check all the vibrators before starting paving and again a few times during the Project.
- During paving, interlock the vibrators with the travel mechanism of the machine so vibration stops whenever the forward motion of the paver is stopped. Continued vibration when the paver is stopped will pull grout to the surface, making an area of segregated concrete.

Also check Subsection 430.3.05.G.1 of the GDOT Standard Specifications.

A-5-10 Strike-Off

Strike-off is the molding of concrete into the cross section called for by the plans (380.3 B 3). Before starting paving, inspect all strike-off plates on the paver. During the job, make inspections of these plates periodically.

- Set screeds and floats for the proper cross section. The method for checking is similar to checking the subbase. Stretch a string line between the ends and measure up from it at 1-ft intervals.
- Be alert for excessive wear of the center of the strike-off plate.
- Set the strike-off plate not to the exact cross section, but close. Too much variation will affect the amount of concrete the screeds work with.
- Set screeds and floats for the amount of concrete the screeds work with. Screeds and floats both need to be set for the exact cross section.

Some Projects have a plan note calling for crown removal on curves. If required, the Inspector should do the following:

- Have the Contractor make the adjustments needed to get a plane that will just touch the string line along its full length.
- Check the adjustment periodically during the job.
- Document the results in the diary.

The method of strike-off for a slipform paver varies slightly from form paving because it uses either the preset string line or the subgrade instead of forms to establish the finished surface. When using the subbase, the slipform paver is set for the planned pavement depth. As the paver moves along the subbase, the gradeline is transferred to the finished surface. The Inspector can check for the following:

- To achieve smooth pavement:
    - Ensure the subbase under the paver tracks is smooth.
    - Correct distortions in the subbase caused by batch trucks, other equipment, or disturbing forces to the shoulders.
    - Discuss the situation with the Project or Area Engineer.
- Because the slipform paver gets its elevation control from the subbase or string line, do not let too much concrete pile up in front of the paver. Pushing a roll of concrete load that is too large can cause the tracks to spin and dig into the subbase, leaving a bump in the pavement surface.

A-5-11 Joints

Transverse joint layout is the responsibility of the Contractor. Approximate locations of the transverse expansion and contraction joints can be determined well in advance of the paving operation. It is customary to plot the various joints on a set of construction plans. The Inspector should ensure the following requirements are met:

- At bridge structures, ramps, or pavement widening, perform necessary adjustment to the length of usually one or two pavement slabs.
    - The maximum desired length of a slab is 50 ft (15 m); the minimum length is 20 ft (6 m).
    - If it is necessary to adjust a slab length, consider the length of the fabric or mat reinforcement. The use of short lengths is discouraged.
- Make adequate provisions for expansion.
    - The maximum expansion-joint spacing should not exceed 1000 ft (300 m).

- If pressure relief joints are called for on the plans, the Contractor must construct the joints in accordance with the plan details.

Longitudinal Joint Arrangement

The longitudinal joint arrangement must conform to the details shown on the plan sheets or the orders of the Engineer.

- Note that the current trend in design is to show the specific locations of the longitudinal joints on a plan sheet, providing for lane continuity and delineation that best serve traffic needs.
- Comply with the starting and ending stations of all pavement widening unless it is apparent that a minor change satisfies other joint criteria better.

Transverse Joint Location

The following steps in locating joints for the first lane are essential to accurate joint location:

- Make the location of joints for the first lane by measurement along the forms with a tape.
- Obtain the transverse line of the joint by pulling a string across the forms and, with the use of a good square, find a point on the opposite form. ***Be sure the line is at right angles to the centerline or on a radial line if the joint is in a curve.***
- After locating the first joint, scribe a line at right angles to the pavement surface on the inside of the forms at the locations of the other joints.

If the joint is accurately located for the first lane constructed, the placing and aligning of joints in subsequent lanes is simplified. Any slight deviation in the line of the first joint probably will be amplified in the line of the adjacent joint.

Additional areas for the Inspector to watch carefully include the following:

- On dual-lane Projects, take care that the line of the joints in each lane is continuous.
- There may be changes in length of an original slab because of intersections, drainage structures, inside or outside lanes on horizontal curves, or dual lanes divided by a median area.
  - Distribute any adjustment in slab length among the slabs to ensure a satisfactory appearance.

Transverse Joint Construction

The transverse joints normally are expansion, contraction, or construction joints.

- *Expansion Joint Unit*: Consists of a horizontally mounted, capped, sliding dowel assembly that is attached to a compressible, yet rigid, piece of joint filler.
  - Vary the height of the joint filler with the depth of pavement.
  - Always locate the top surface ¾ in. (19 mm) below finish grade.
- *Contraction Joint Unit*: Consists of a horizontal sliding dowel assembly that is installed on the subgrade and extends approximately to mid-depth of the pavement.

    - Form a shallow vertical joint in the pavement surface to develop a plane of weakness over the center of the dowel assembly. The vertical joint may be formed in either of two ways:
        - Install a steel strip in a holding device prior to placing the concrete. Remove the strip following the finishing operation.
        - Saw cut a contraction-joint groove into the finished concrete to a depth indicated in the specifications or on the plans.

Transverse joints must be installed:

- Perpendicular to the pavement surface; if the concrete surfaces adjacent to the joint assembly are inclined, the pavement can slide upward as the slabs expand during long periods of hot weather
- Perpendicular to the centerline on tangents or radially on curves

Load-Transfer Assemblies

Omission or improper installation of load-transfer units may result in joint faulting, transverse or corner cracking of the ends of slabs, leakage, and pumping. The joint assembly must be installed so that the longitudinal axes of the load-transfer units are not only parallel to the surface of the concrete but also parallel to the longitudinal axis of the pavement. A relatively small deviation from the correct alignment may cause a very high localized stress in the concrete surrounding a load-transfer unit, particularly during extreme temperatures that cause relatively large movements of the concrete at the joints. The Inspector must follow these requirements:

- Do not allow installation of joint assemblies until after the final check on the subbase is completed.
- Place the expansion assembly in the proper location.
    - Make sure that the ends of the joint butt against the forms and coincide with the vertical line drawn on the forms.
    - Ensure the bottom of the joint, as well as the joint supports, rests on the subbase for the entire length.
- Prevent mortar from flowing around the ends or under the joint to help ensure a cleaner joint, less hampered movement under temperature changes, and freedom from localized stresses.
- Check all caps on load transfer units with expansion slip dowels for adequate expansion space.
- Recheck the line of the transverse joint with a square, and check the line of one or two load transfer units for right angles with the joint.
- After placing the metal protection cap on the joint:
    - Pull a string across the forms and check the depth of the joint below finished grade.
    - Pull a string slightly ahead of the joint and check the distance down to several of the load transfer units.
    - Repeat the operation in the back of the joint.
- After a joint is set and checked, do not allow the workers to walk on it or to disturb it in other ways.
- Tie down the transverse joint units with suitable pins or 60D nails.

- Ensure that the assemblies are not cocked or tipped and that the dowel component is parallel to the base and surface.
- Lubricate the caps on the ends of all expansion joint dowels.

Dummy Joints

Dummy transverse joints, or weakened plane joints, are constructed at the locations and according to the dimensions shown on the plans. The horizontal controls that apply to transverse expansion joints are applied to the locations and line of the dummy joints.

After the transverse screeding operation is complete, but prior to longitudinal screeding or luting, a groove is made in the soft concrete by a suitable device. The Inspector should:

- Ensure the line extends vertically downward from the surface to the depth shown on the plans and is true to line.
- Insist on a uniform depth throughout the length of the dummy joint, as well as a consistent depth for each joint.
- Not allow the workers to enlarge the groove when edging. The larger the opening, the greater are the chances of obtaining a rough-riding pavement.

Bulkheads

Bulkheads are constructed if the end of a day's run or shutdown for lunch occurs at a transverse expansion joint. Follow these steps to ensure proper construction of the bulkhead:

- Install a 2-in. (50 mm) wooden bulkhead, cut to proper depth and contour, and slotted to slip over the load-transfer units in back of the transverse joint.
- Securely stake the bulkhead to prevent misalignment of the joint.
- About 5 ft (1.5 m) beyond the joint, place a section of regular road form transversely across the road with its top at finished grade, for use as a second rail.
- Operate the lute at the end of the slab from the concrete and the top of this cross form to prevent a short wave in the end of the slab.

Construction Joints

Transverse construction joints are formed only in the case of breakdown causing a delay of more than 30 minutes in the concreting operations. These joints should meet the following requirements:

- Ensure the length of pavement laid up to the time of breakdown is not less than 10 ft (3 m) from the nearest joint. ***Shorter sections must be removed.***
- Construct transverse construction joints in the same manner as transverse expansion joints, except use a bulkhead of wood or steel, and do not require expansion material or load-transfer units.
- Place tie bars conforming to the requirements of longitudinal tie bars at intervals of 2½ ft (0.75 m) or less across all transverse construction joints.

Longitudinal Joint Construction

Longitudinal joints serve to delineate traffic lanes for the motorist. If improperly laid out, the joints can have an adverse effect on the planned flow of traffic. Thus, it is vitally important that the pavement layout and longitudinal joint details not deviate from the requirements of the construction plans.

- For single-lane construction, ensure the longitudinal joint between slabs is of the tongue-and-groove type, equipped with tie devices
- Check the keyway form for size, shape, and proper attachment to the pavement form. It should:
  - Be continuous on the inside lane form and properly installed on the outside lane form for abutting ramps and pavement widening
  - Extend to within 6 in. (150 mm) of each transverse joint
- If the joint keyway form is steel, require the Contractor to cut the end of the transverse expansion joint filler material to fit. However, before placement of the abutting lane, ensure a precut piece of suitable filler material is placed in the form cutout.
- Ensure the longitudinal joint support units are properly installed, firmly attached to the form, and properly oriented.
- Verify the normal spacing of the tie devices at 5 ft (1.5 m) center to center. Ten-ft (3 m) forms generally have holes spaced 2½ ft (0.75 m) on centers.
  - Establish the location of the first transverse joint closest to the point where the forms are being set so that:
    - The proper location for the tie device can be easily established
    - Succeeding longitudinal joint assemblies can be installed at the prescribed spacing
  - If lane length differences result from horizontal curvature or other reasons and the prescribed joint spacing and clearance cannot be satisfied, make additional holes in the forms, as necessary. The holes are usually needed at transverse joint units.
- If new lanes are constructed adjacent to existing roadways, special types of longitudinal joint assemblies are specified.
  - Grouted-in-place dowels and expansion shield bolts are frequently used.
  - For multilane pavement construction, the longitudinal joint support units may be:
    - installed prior to the placement of the lower course when the transverse baskets are set, or
    - placed by hand or by a mechanical placer after the lower course has been brought to grade.
  - The joint supports consist of steel tie bars and are 5 ft (1.5 m) on center.
- Usually finish longitudinal joints for single-lane construction by hand.
- For multilane construction, form the joints by means of an approved nonmetallic joint-forming insert or by saw cutting.

For additional information on joints, refer to Subsections 430.03.05.J and 430.03.05.K of the GDOT Standard Specifications.

A-5-12 Pavement Finishing

Hand Finishing

Hand finishing is acceptable in certain situations of asphalt paving. For example, smaller sections around a joint or near the end of a section should be hand finished. Other areas that are inaccessible by a steel drum roller can be hand finished.

- Ensure the number and ability of the finishers is adequate, and the workers are experienced and capable.
  - Make correction if there is an insufficient number of finishers or if they are not capable of satisfactorily completing the work as required.
- Ensure finishing operations keep pace with the placing of the concrete, and gear all other pavement operations accordingly.

Longitudinal Floats

The GDOT Standard Specifications provide for longitudinal floating as soon as possible after the concrete has been consolidated by the transverse screed. The GDOT Standard Specifications require the following practice:

- Mechanically operate the longitudinal float where possible.
- Where mechanical longitudinal floating cannot be done, provide and use a hand float.

There are four basic types of equipment currently in use:

- Longitudinal or bull float
- Flexplane type of drag float
- Lewis type of chevron float
- Tube float

<u>The Longitudinal Float</u>

The Inspector should control the finishing operations to ensure proper timing relative to the moisture content, as follows:

- Operate the longitudinal float, sometimes referred to as the bull float, within 100 ft (30 m) of the transverse screed.
- Allow the distance to vary based on weather that causes excessive drying or is excessively humid, or because of variations of the mix.
- In general, delay the operation until the surface has started to dry out slightly, so that some settlement has begun to take place.
- Do not delay the operation too long because the concrete will be too dry for the final finish work.

When properly operated, the screed should carry a small roll of concrete along all but about the rear 24 in. (600 mm) of its length. The roll is largest at the forward part of the screed and tapers off toward the rear half of the screed. If the concrete is of the desired consistency, it rolls rather than flows. The Inspector should note the size of the roll and take the necessary action:

- If the roll is small, (less than 1½ in. [40 mm] in diameter), lift the screed as it reaches the form, and pick up the roll of mortar for the return pass.

- If the roll grows larger than this, or if the material flows in front of the screed, waste it over the forms.

The forward speed of the longitudinal float should be regulated so that, if necessary, two complete passes can be made over each area. The operator must:

- Continuously observe the amount of mortar being carried by the screed.
- Distribute the material along the length of the screed and not allow it to roll off the rear to form a ridge.
- Force down any large aggregate that might tear the surface.

<u>The Flexplane Float</u>

The Flexplane float has transverse screeds to smooth and shape the surface, and a rear-mounted, pan-shaped float unit to provide for the longitudinal finish. The float should:

- Have a slight front-to-back tilt
- Exert a slight amount of pressure on the surface
- Have about a ⅛-in. (3 mm) crown at the center
- Be free of nicks and dents

The finished surface should be smooth and free of all finishing marks.

<u>The Chevron Float</u>

The chevron float is a V-shaped drag float that provides for transverse screeding, as well as longitudinal finishing.

- The float component:
  - Is suspended from the rear of the machine
  - Consists of two sections of a trussed 12 in. (300 mm) wide channel section, each about 12 ft (3.5 m) long, jointed at the front to form a "V"
- The flat surface of the channel:
  - Is placed in contact with the screeded surface
  - Smooths out all remaining marks when the forward travel of the machine drags it over the surface.

The amount of concrete carried by the two transverse screeds should be held to a maximum 5 in. (125 mm) diameter roll for the forward screed and a 2 in. (50 mm) roll for the rear screed. If the Inspector notes a buildup of concrete on the screeds, the following steps are required:

- Waste the material.
- Back the machine up to where it appears the surface is to grade (a string line pulled across the forms will help confirm this).
- Make another pass.
- Make a check to determine if a localized high spot was the reason for the screed buildup, or if the forward transverse screeding machines are leaving too much concrete.
  - If the concrete has a tendency to roll down at the forms, again check the surface with a string. The operator might have raised the screeds to cover up a high spot. This shows up as a dip along the longitudinal joint.

- Watch the action of the end pans. They are hinged and float easily.

The Tube Float

This type of finisher requires extremely good grade control and surface finishing by the screeds on the top course strike-off machine on the slipform paver.

As the finishing machine moves longitudinally, the tube smooths the wet concrete surface. Excess concrete is pushed ahead of the tube and, because of its diagonal orientation, eventually rolls to the edge of the lane. The Inspector should monitor according to these recommendations:

- Ensure two passes of the float usually for a satisfactory surface finish.
- If more passes are required, check the adjustment of the top course strike-off machine.
- As in normal concrete paving, avoid overworking the surface.
- Use the spray bar sparingly to keep the float from dragging.

The most important consideration with this machine is that the float or burlap drag should only be raised or lowered when the machine is in motion. Stopping the finisher prior to raising the float or drag results in a ridge of material that is extremely difficult to remove.

Luting

All small irregularities and the longitudinal screed trail must be removed immediately after the surface is consolidated. The GDOT Standard Specifications provide for the use of a manually operated smoothing lute or striking straightedge of approved type and dimensions to follow the longitudinal floating operation. The Inspector should note the following requirements:

- Ensure the lutes are equipped with either an aluminum or steel blade, 10 ft (3 m) long.
- Do ***not*** permit the use of paddle-type lutes to finish pavement.
- At the beginning of the day’s work, lap the lutes back at least 5 ft (1.5 m) on the preceding day’s pavement and then move slowly over the surface of the concrete from one side to the other.
- Make movements longitudinally by:
    - raising the lute completely above the surface and lifting it ahead not more than half its length, or
    - sliding it along the form the same distance.
- Use luting to eliminate all finishing machine marks and remove all small irregularities.
    - Ensure the lute barely scratches the surface, except where high spots occur.
    - For low areas, carry fresh concrete back, spread it in the low area, hand float it to the correct grade, and smooth it with the lute.
    - Carry the luting operation across all joints as if they were not present.
- At the end of the day’s run, exercise considerable care in luting the area over and adjacent to the final joint.

If the finishing machine operations are carried out correctly, the surface should be smooth enough that very little luting is required. Often a finisher has the tendency to do too much floating, and ***the Inspector should insist that only enough floating is performed to ensure a smooth texture of surface that will straightedge properly.***

As mentioned previously, the use of paddle-type lutes to finish the pavement surface should not be permitted. However, a float suitable for cutting excessive high spots or floating fresh concrete placed in low spots should be available.

Straightedging

After the luting has been completed, the Inspector must systematically check the surface for smoothness with a 10-ft (3 m) straightedge.

- Perform straightedging over the entire length of the slab and along three points in width while the concrete is still plastic.
- Use the type of straightedge common today, which consists of an aluminum blade that is:
  - Different in shape from the lute
  - 10 ft (3 m) long
  - Mounted on a long handle
- Check the straightedge frequently and, when not in use, place it where it cannot be injured. ***Never use the straightedge for luting or floating.***
- Take care that the straightedging is done at a stage when the surface is dry enough to prevent any settlement under the weight of the tool.
  - If the concrete is too soft, the blade of the straightedge will sink into the surface, thus reducing the possibility of detecting minor variations of ⅛ in. (3 mm) or slightly over.
  - If straightedging is delayed too long and the initial set takes place, the resulting delay in the final finishing operations often causes a bad section of surface finish and joint work. Be alert to this condition, particularly on a hot, dry day.
  - Do not permit water to be sprinkled on the surface of the concrete to facilitate finishing because it causes scaling.
- Have the Contractor perform the work by lowering the straightedge very carefully onto the concrete, so as not to mark the surface.
- Require adjustment for all variations in the contour of the pavement surface of more than ⅛ in. (3 mm), as shown by the straightedge.
- Where adjustments are required, ensure that all irregularities are removed and the surface is properly floated.
  - Typically, use the lute to remove high spots.
  - Bring low spots to grade by placing fresh concrete in the depression and having the lute worker strike off and smooth the surface.
  - Straightedge all corrected areas.
  - Pay particular attention to the transverse joints.
  - Straightedge diagonally as well as conventionally to detect any unevenness.
  - When starting a new pavement section, lap the tool back on the completed work at least one-half the blade length.
- After the curing mats or paper are removed from the pavement, the Chief Inspector should make immediate arrangements to have the cured surface straightedged.
  - Make this inspection without delay.
  - When irregularities exist that reveal inferior workmanship, take immediate corrective measures.

Tining

The surface texture is done by steel tines as soon as the concrete allows transverse grooves. The Inspector can ensure the Contractor performs the work as follows:

- Make the transverse grooves ⅛ to $^{3}/_{16}$ in. (3 to 6 mm) deep and ½ in. (12 mm) apart without tearing the surface or filling in the grooves.
- Place the grooves across the entire width of the pavement, perpendicular to the centerline.

Edging

After luting is complete and before edging the sides of the pavement, the Inspector should ensure that the Contractor carries out the following tasks:

- Run a trowel along the edges of the slab to free the concrete adjacent to the forms and expansion joints and to facilitate use of the edger.
- Work the edging tools along the edge of the lane, preparatory to the final tooling.

The Inspector should be aware of two common pitfalls related to edging work.

- If the concrete is too soft when the edging work is done, the rounded corners become refilled, causing an unsightly edge.
- If edging work is delayed until the concrete has hardened, the bond is disturbed and it is difficult to secure a good finish.

The Inspector must require that the Contractor uses good edging tools to help ensure edging uniformity throughout the job. Often the concrete finishers are loath to part with a worn edging tool, as such a tool offers little resistance and is easier to operate. The Inspector, therefore, should do the following:

- Make frequent checks of the tools to see that the required radius is not distorted or entirely worn out.
- Ensure that the Contractor has a sufficient supply of edging tools on hand so that immediate replacement of worn tools can be made when necessary.
- Insist on uniform edging work.
  - The radii must be true and the troweled surface uniform and in a plane with the slab surface.
  - Tipping the edging tool causes an objectionable burr or depression and must be avoided.
  - Likewise, a stone encountered in the edge area must not be traveled over with the flange of the edger. If a piece of stone in the concrete is encountered:
    - Do ***not*** remove and replace it with mortar scraped from the surface or form.
    - Rather, tamp it below the required grade and fill in the resulting depression with fresh concrete and smooth it.
- If it is necessary to hand-float the edges:
  - Make some correction of the preceding operation.
  - Check the machines and method used in the prior work.

- Of particular importance, secure a true edge on the lane that will act as a form for an adjacent lane, so the finishing machines will have a true surface to ride on.

Many of the current Contracts do not require that the longitudinal-joint recess be filled with joint seal when the pavement is constructed on a single-lane basis. Smooth-riding longitudinal joints can be realized only if the joint recess is in accordance with the plan dimensions and shape and the edges of the abutting lanes are correct.

A-5-13 Curing

In all cases in which curing requires the use of water, the curing will have prior right to all water supply or supplies. The Inspector must require that conditions for curing are properly maintained.

- Immediately suspend concreting operations when there is failure to provide a sufficient quantity of one of the curing materials, or lack of water to adequately take care of both curing and other requirements.
- Do ***not*** allow the concrete to be left exposed for more than ½ hour between stages of curing or during the curing period.

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete must be covered and cured in accordance with one of the methods discussed below.

<u>Cotton or Burlap Mats</u>

The Inspector will ensure that the surface of the pavement is entirely covered with mats as follows:

- Use mats of such length (or width) that, as laid, they will extend at least twice the thickness of the pavement beyond the edges of the slab.
- Place the mats so that the entire surface and both edges of the slab are completely covered.
- Prior to placing the mats, saturate them thoroughly with water.
- Place and weigh down the mats so as to cause them to remain in intimate contact with the surface covered.
- Maintain the covering fully wetted and in position for 72 hours after the concrete has been placed, unless otherwise specified.

<u>Waterproof Paper</u>

The Inspector will ensure that the top surface and sides of the pavement are entirely covered with waterproof paper as follows:

- Lap the units at least 18 in. (450 mm). Place and weigh down the paper so as to cause it to remain in intimate contact with the surface covered.
- Ensure the paper has such dimensions that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement, or is of pavement width with 3 ft (1 m) strips of paper provided for the edges.

- If laid longitudinally, cement together paper that is not manufactured in sizes that provide this width in such a manner that the joints do not open up or separate during the curing period.
- Unless otherwise specified, maintain the covering in place for 72 hours after placing the concrete.
- Thoroughly wet the surface of the pavement prior to placing the paper.

Impervious Membrane Method

The Inspector will ensure the entire surface of the pavement is sprayed uniformly with white pigmented curing compound either:

- immediately after the finishing of the surface and before the set of the concrete has taken place, or,
- if the pavement is cured initially with jute or cotton mats, then upon removal of the mats.

Note the following requirements for the application of an impervious membrane:

- Do ***not*** apply the curing compound during rainfall.
- Apply curing compound under pressure by mechanical sprayers at the rate recommended by the manufacturer.
    - Ensure the spraying equipment is of the fully atomizing type equipped with a tank agitator.
- At the time of use, ensure the compound is in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle.
- During application, stir the compound continuously by effective mechanical means.
- Allow hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms.
- Do ***not*** apply curing compound to the inside faces of joints to be sealed.
- Should the film become damaged from any cause within a 72-hour curing period, repair the damaged portions immediately with additional compound.
- Upon removal of side forms, immediately protect the sides of the slabs exposed by applying curing treatment equal to that provided for the surface.

White Polyethylene Sheeting

The Inspector will ensure the top surface and sides of the pavement are entirely covered with polyethylene sheeting as follows:

- Lap the units used at least 18 in. (450 mm).
- Place and weigh down the sheeting so as to cause it to remain in intimate contact with the surface covered.
- Ensure the sheeting as prepared for use has such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement.
- Thoroughly wet the surface of the pavement prior to placing the sheeting.
- Unless otherwise specified, maintain the covering in place for 72 hours after placing the concrete.

Curing in Cold Weather

When concrete is being placed and the air temperature may be expected to drop below 35°F (2°C), a sufficient supply of straw, hay, grass, or other suitable blanketing material must be provided along the work. The Inspector should see that the Contractor meets these requirements:

- Any time the temperature may be expected to reach the freezing point during the day or night, spread the provided material over the pavement to a sufficient depth to prevent freezing of the concrete.
- Take care not to mar the concrete surface.
- Maintain such protection not less than 5 days assuming the temperature remains below freezing.

The Department reserves the right to require the Contractor to core the concrete. The Contractor will be responsible for the quality and strength of concrete laid during cold weather, and any concrete injured by freezing action must be removed and replaced at the Contractor's expense.

Removing Forms

The Inspector should follow these guidelines for inspection related to form removal:

- Do not remove forms from freshly placed concrete until it has set for at least 12 hours.
- Instruct the workers who are assigned to remove the forms in the proper manner to avoid spalling the edges of the concrete.
- Do not permit metal wedges, lever fulcrums, or stake-pulling devices to have a bearing on the concrete when pulling forms or lifting pins.
- Do not allow the removed forms to be placed on the new concrete or the pins to be thrown carelessly about.
- After the side forms are removed, examine the ends of all joints to see that they are not bridged with grout.
    - If they are bridged, require that they are cleaned immediately.
- Ensure all honeycombed areas are pointed up.
- Do ***not*** allow (under any condition) the placement of shoulder material until there is positive assurance that the joints are open.
- Instruct the workers to replace the curing cover at the edges exposed by the removal of the forms.

Sawing Longitudinal Joints

Longitudinal joints must be constructed as shown in the plans and in conformance with the specifications, or as ordered by the Engineer. The joints may be constructed by the following methods.

- If pavement is constructed a single lane at a time:
    - Use tongue-and-groove type longitudinal joints between slabs.
    - Construct the joints by means of the devices shown on the plans.
    - Equip the joints with tie devices as shown on the plans.
- If multilane construction is used:

- Form the longitudinal joints by an approved nonmetallic joint-forming insert introduced into the plastic concrete by mechanical equipment.
  - Ensure the insert is sufficiently rigid to remain in good alignment
  - Confirm the size and shape of the insert provides a joint of the specified configuration.
- Alternatively, construct the longitudinal joint with an approved concrete saw.
  - Verify that the Contractor performs the saw-cutting operations at a time when excessive raveling or uncontrolled cracking does not occur.
  - As sawing operations progress, thoroughly clean the completed sawed joint until all dust or slurry is removed:
    - ✓ With air, if dry-cutting blades are used
    - ✓ With water, if wet-cutting blades are used
  - Perform sawing within 4 to 24 hours of placing the concrete pavement.

In all cases, the longitudinal-joint groove must be:

- Constructed perpendicular to the pavement surface
- True in alignment
- To the minimum depth and width specified or approved

For additional information, see Subsection 430.3.05.I of the GDOT Standard Specifications.

Sealing Joints

Before the pavement is opened to any traffic, public or Contractor, all joints must be sealed as required. This is the last operation prior to opening the roadway to traffic. The sealing of the transverse and longitudinal joints prevents surface water from seeping through the joints and accumulating in the subgrade where frost action and other disintegrating effects may result.

The Inspector should review the special provisions and plan notes to determine if the longitudinal joint is to be sealed. The current practice is not to seal the joint for single-lane construction.

- Prior to pouring any filler, sweep the joints clean, and chip and remove or sweep any adhesions of dried grout particles.
  - Clean the transverse joints for the full width of the expansion material, and ensure the top of the expansion material shows over its entire area.
    - The presence of any concrete in a transverse joint prevents free compression of the joint material and may cause spalling along the joint in hot weather.
  - Thoroughly clean these joints and all others of foreign material, including mortar, by scraping and blowing them out with compressed air.
  - Watch for small stones that become lodged. They promote spalling of edges.
- Ensure the joint seal material is of the type specified.
- Apply the joint seal material according to the following requirements:
  - Mix and heat the material in a suitable kettle, and make a careful check of the temperature as it is being heated.
    - Take particular care in heating the material to avoid burning. The material usually is a rubber compound that is in a liquid or fluid state before heating.

Heating activates the setting agents and the material changes state when it cools to become a resilient solid. ***Heating too long or at too high a temperature may damage the material.***

- Usually apply the material under pressure with a mechanical applicator.
  - Fill the joint completely and neatly.
  - Avoid placing excess material.
  - Use the limits of flush to ⅛ in. (3 mm) below the surface.
  - Ensure that the workers engaged in this operation do not allow the joint seal to spatter or drip onto the adjacent pavement.

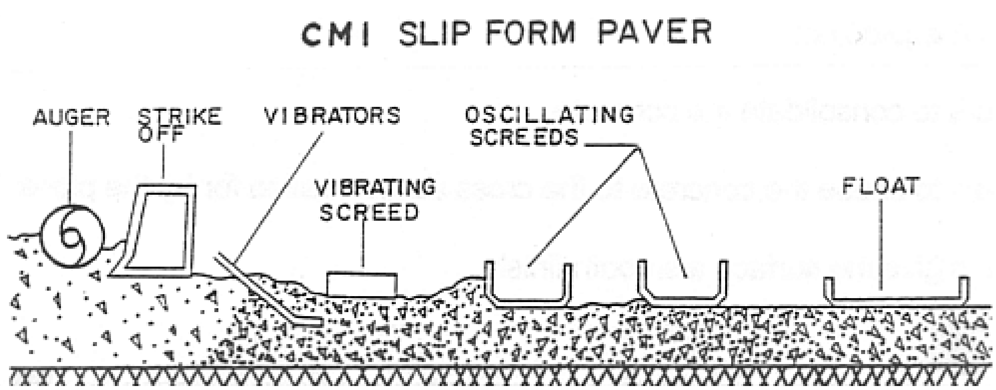
- Prior to the final acceptance of the pavement or before the suspension of work for the winter months, inspect the joints and reseal defective joints.

For additional information, refer to Subsection 430.03.05.M of the GDOT Standard Specifications.

A-5-14 Slipform Paving Period

Although slipform pavers vary in type and operation, and are often modified by the individual Contractor, every slipform paver must have the following (see Figure A-10):

- A method of spreading the concrete across the pavement width
- Strike-off equipment
- Vibrators to consolidate the concrete
- A screed to shape the pavement surface to the cross section called for by the plans
- A paver-mounted metal section that forms the pavement sides as the paver moves
- A float to give the surface a smooth finish



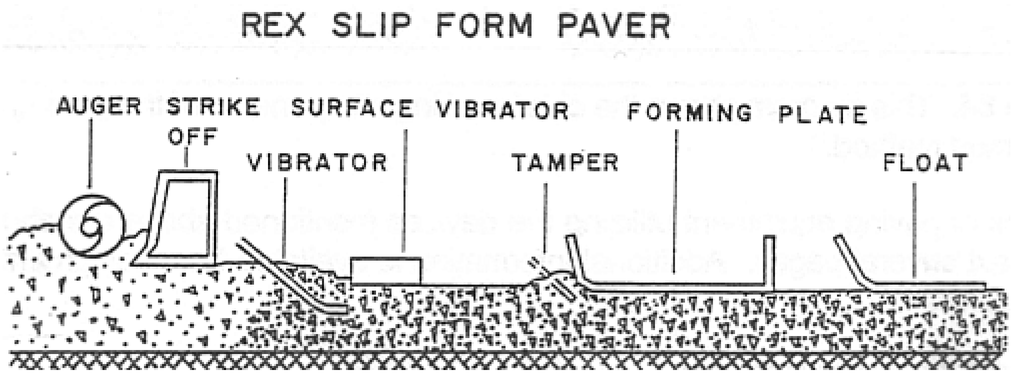


Figure A-10: Slipform Paver

- Electronic sensors that follow a fixed string line, which is used also for elevation control, to guide the forward movement of the slipform paver

Slipform Spreader Operation

The spreader places the concrete to the depth of the mat reinforcement, 2½ in. (65 mm) below finish grade if the concrete is placed in two layers. The placement width is approximately 6 to 12 in. (150 to 300 mm) less than the lane width. The remaining part of the slab is filled in by the paver when the top course is placed. Some important points for the Inspector to consider are as follows:

- Thoroughly moisten the subbase directly ahead of the spreader to prevent rapid loss of water from the concrete, to a depth of at least 1 in. (25 mm).
- Take care that the correct quantity of concrete is placed:
    - Too much will overload the following paver
    - Too little will result in having to halt the paving while material is added
- Remember that the interval between the spreader and paver is important; keep the distance as short as possible because the concrete will set in about 20 minutes.

<u>Reinforcing Mats</u>

The reinforcing mats are placed immediately behind the spreader. They are placed from a mesh cart or from previously distributed piles along the roadway. Requirements for placement and locking include the following:

- Ensure the mats are overlapped 14 in. (360 mm) in the direction of travel.
- Lock the sheets together to prevent dragging by the paver or depressor.
    - Perform locking by bending two or three wire ends around a transverse wire in the preceding mat.
    - If bar mat reinforcement is included, use C-clips to lock the mats together.
- Place the mats so that the transverse wires are up, to prevent depressor bars from breaking the wire welds.
- If placing the concrete in two layers, place the second course in a windrow on the center of the reinforcement.
    - Place the concrete so as not to shift the reinforcement laterally.

    - Use the windrow to help hold the mats in place when clipped together and lessen the possibility of them being dragged by the paver.

Slipform Paver Operations

The paver is the most important piece of equipment in a slipform paving train. It is directly responsible for the:

- riding quality,
- thickness, and
- cross section of the finished pavement.

Errors made by the paver are practically impossible to correct; therefore, constant inspection of the machine is an absolute necessity.

A-5-15 After Construction

Daily Reports and Tests

During the course of each day's paving operations, quality-control determinations are necessary to ensure that such things as air content, slump, and structural strength are satisfactory. The duties are performed by the Inspectors assigned to the paving operation.

- Check the air content and slump periodically during the day, especially in the morning when the operation begins and when the concrete changes.
- Cast eight cylinders for each concrete placement, four in the morning and four in the afternoon.
    - Should the operations suspend early, make every effort to cast the necessary cylinders.
    - Properly mark the cylinders and place them out of the way of operations so they will not be damaged.

  Remember, these cylinders are used to determine the strength of the pavement, and a satisfactory compressive strength must be obtained before the pavement can be opened to traffic. ***Should they fail, the quality of the pavement will be questioned, and more tests will be required.***

Flexural Strength Testing

Variations in air temperature, humidity, wind speed, and mix temperature can have a great effect on strength development of Rapid Strength Concrete (RSC). The goal of curing the beams for flexural testing is to have the strength of the beams match the strength of the pavement.

Remember that the field laboratory will contact the designated Inspector with the test results from the concrete flexural strength specimens.

- Do ***not*** use these flexural strength test results as the criteria for opening to traffic.
- Use the flexural strength test results to determine pay factors for the Contractor, as the Contractor may choose to open the lanes to traffic at less than specified strength to avoid penalties associated with delays.

A-5-16 Pavement Protection

The Contractor must protect the pavement and its appurtenances against both public traffic and traffic caused by employees and agents of the Contractor. The Inspector should ensure that the Contractor does the following:

- Include watchmen to direct traffic and the erection and maintenance of the warning signs, lights, pavement bridges or cross-overs, etc.
- Repair any damage to the pavement or replace the pavement at the Contractor's expense. prior to final acceptance

All concrete paving must be properly protected against the effects of rain before the concrete is sufficiently hardened; the Contractor is required to have available at all times materials for the protection of the edges and surface of the plastic concrete. Such protective materials will consist of:

- Standard metal forms or wood plank having:
    - A nominal thickness of not less than 2 in. (50 mm)
    - A nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges
- Covering material for the protection of the surface of the pavement, such as:
    - Burlap or cotton mats
    - Curing paper
    - Plastic sheeting material

When rain appears imminent, stop all paving operations and have all available personnel begin placing forms against the sides of the pavement and covering the surface of the plastic concrete with the protective covering.

Diamond Grinding

The Contractor uses diamond grinding to correct irregularities by removing a thin layer of hardened concrete, using closely spaced diamond saw blades. The grinding operation normally removes 4–6 mm per pass and results in a smooth, quiet, longitudinally grooved surface texture. This can be done for special situations in which typical grinding patterns are not able to remove the existing material. The Inspector should use the following guidelines for use of diamond grinding:

- Use ride quality measurements to determine when grinding is necessary.
    - After slabs are replaced, measure the surface variance and joint differential. Variances greater than 2.5 mm affect ride quality.
    - For slab replacements with a variance greater than 2.5 mm, require diamond grinding.
- Use diamond grinding to extend serviceability, improve ride and skid resistance, and reduce pavement noise. Diamond grinding has been used as a PCC pavement rehabilitation strategy for the following purposes:
    - Removal of transverse joint and crack faults (primary reason)
    - Removal of wheel path rutting caused by studded tires

    - Removal of permanent slab warping or curling at joints (in very dry climates where significant warping has occurred)
    - Texturing of polished concrete surface exhibiting inadequate friction
    - Improvement of transverse slope
    - Improvement of ride quality by removing faulting, surface roughness, and unevenness caused by slab replacement
    - Reduction of noise and provision of a safe, long-wearing surface texture
- Do ***not*** attempt to remove depressions that are deeper than 9 mm by diamond grinding.
    - Profile measurements along the Project in each lane are an excellent indicator of depressions and bumps.
    - The most effective approach for grinding is to grind the entire lane width, which requires several passes.
        - The reason for grinding the entire lane width is to avoid creating multiple longitudinal steps in the pavement.
- Do ***not*** allow use of adjacent slabs as guides and forms while performing slab replacements, which may result in steps or bumps where none existed.

Once diamond grinding is completed, roughness profile measurements are an excellent way to verify that the desired pavement profile has been achieved. Remember to replace any removed lane markers prior to re-opening to traffic.

A-5-17 Opening to Traffic

The Contractor must wait to open the pavement slab to traffic, other than joint-sawing vehicles, until the concrete is 14 days old, unless representative compressive tests show that the slab has a compressive strength of 2500 psi (15 MPa) (GDOT Standard Specifications Section 430).

- If the slabs have not reached their flexural strength prior to opening the lanes to traffic, consider that portion of the job remaining to be temporary.
- Require the Contractor to return the next shift and replace the temporary slabs.

A-5-18 Method of Measurement

Portland cement concrete pavement (plain) and Portland cement concrete pavement (reinforced) of the various thicknesses specified, will be measured by the square yard (m^2) in accordance with the provisions of GDOT Standard Specifications Section 109: Measurement and Payment.

- Measure additional concrete required for leveling on individual ramps, including acceleration and deceleration lanes, containing 4500 yd^3 or less.
    - Consider as an acceleration or deceleration lane where a ramp becomes a traffic lane without a tapered acceleration lane or a traffic lane becomes a ramp without a tapered deceleration lane, 300 ft of the lane, measured from the point of intersection with the adjoining lanes, and include it in the ramp.
    - Determine the number of cubic yards of additional concrete by deducting the theoretical quantity and any wasted concrete from the number of cubic yards actually used as determined from invoices or conversion from batch weights.
- Do not measure for payment additional concrete used for leveling on main line roadway or ramps that contain more than 4500 yd^3.

Tolerance in Pavement Thickness

The thickness of the pavement will be determined by average measurement of cores taken from each unit as set out below. For the purpose of determining the pavement thickness and for establishing an adjusted unit price for pavement that is deficient in thickness, units to be considered separately are defined, except as stipulated hereinafter, as follows:

- Pour widths will be 1000 ft (300 m) in length, starting at the end of the pavement bearing the smaller station number.
- The pour width will be considered as the width of a separately poured lane or lanes.
- Last units having a length between 500 ft (150 m) and 1000 ft (300 m) will be treated as separate units.
- Last units having a length not exceeding 500 ft (150 m) will be included in the last full unit.
- Units on interchange ramps will be considered separately from units on the main line.
- One core will be taken at random by the Department in each unit.

<u>Payment Based on Pavement Thickness</u>

The Inspector has a role in determining if pavement is deficient and how the thickness will affect the payment the Contractor receives.

- When the measurement of the core from a unit is not deficient more than ¼ in. (6 mm) from the plan thickness, make full payment for the pavement in the area represented.
- When such measurement is deficient more than ¼ in. (6 mm) and not more than 1 in. (25 mm) from the plan thickness, take two additional cores at intervals of not less than 300 ft (100 m) within the unit, and determine the average of the three cores.
  - If the average measurement of these three cores is not deficient more than ¼ in. (6 mm) from the plan thickness, make full payment.
  - If the average thickness of the three cores is deficient by more than ¼ in. (6 mm) but not more than 1 in. (25 mm) from the plan thickness, pay an adjusted price for the area represented by these cores.
- Consider each intersection as 1 unit. Small areas, such as crossovers, entrances, etc., may be combined to form a unit of 1000 yd^2 (840 m^2) or less.
  - In each unit so established, make thickness measurements and apply price adjustments, if any, as specified herein for pavement units on the main line and ramps, except the Engineer will designate the location and spacing of cores.
  - In calculating the average thickness of the pavement unit, apply the following:
    - Consider measurements in excess of the average thickness by more than ¼ in. (6 mm) as the specified thickness plus ¼ in. (6 mm).
    - Do not include in the average any measurements that are less than the specified thickness by more than 1 in. (25 mm).
- When the measurement of any core is less than the specified thickness by more than 1 in. (25 mm), determine the actual thickness of the pavement in this area by taking additional cores at not less than 10-ft (3 m) intervals parallel to the centerline in each direction from the affected location until a core is found, in each direction, that is not deficient by more than 1 in. (25 mm).

- The Engineer will evaluate areas found deficient in thickness by more than 1 in. (25 mm), and if in his/her judgment, the deficient areas warrant removal, have the Contractor remove them and replace with concrete of the thickness shown on the plans, at the expense of the Contractor.
- Do not use exploratory cores for areas deficient by more than 1 in. (25 mm) in thickness in the averages for adjusted unit prices.

A-6 Culverts Construction Inspector Best Practices

A-6-1 Preconstruction

Culvert and Drainage Pipe Joints

Before work on culverts and drainage pipe joints starts, the Inspector should do the following (see Figure A-11):

- Upon delivery of the materials for pipe joints and couplers, note whether the materials are on the QPL and pipes have the correct mark inside them.
- Ensure that the Office of Materials Engineering and Testing Services (METS) has inspected and released the pipe joint and coupling material.
  If the Contractor has chosen to supply material of the GDOT Standard Specifications, and the material has been released, METS will have received all paperwork including certificates of compliance, test results, and mathematical analysis.
    - Include a copy of this paperwork in the Project files.

Figure A-11: Drainage and Pipe Joints

Alternative Culverts

Before work starts related to alternative culverts, the Inspector should do the following:

- Review the special provisions and Contract plans to determine the different types of culvert that may be used and the locations where alternative culverts may be installed.
- Ensure that the "Notice of Materials to Be Used" lists the type of pipe, pipe arch, or reinforced concrete box or arch the Contractor chose for alternative culverts.
- Document the Contractor's submittal and Engineer's approval in the Project files.

Plastic Pipe

Before work begins with plastic pipe, the Inspector should do the following:

- Review the plans and specifications.
- Inspect the sites of all planned installations.

Reviewing these items sufficiently in advance helps prevent scheduling conflicts and improper installation.

During the preliminary review and inspections, the Resident Engineers and Assistant Resident Engineers should also do the following:

- Identify any unsolved drainage problems.
- Make any plan changes necessary to fit field conditions.
- Determine the locations and lengths of the pipes (see Figure A-12).
- Once the previous step is accomplished, if necessary, give the Contractor a revised pipe list, including any pipes added or altered by a Contract change order.

Figure A-12: Plastic Pipes

Reinforced Concrete Pipe

Before work related to reinforced concrete pipe begins, the Inspector should do the following:

- Review the plans and specifications.
- Inspect the sites of all planned installations (see Figure A-13).

During the preliminary review and inspections, the Resident Engineers and Assistant Resident Engineers should also do the following:

- Review the "Materials Information" from METS and ensure that the special provisions cover any special requirements.
- Note any unsolved drainage problems, and make any necessary changes by Contract change order.
- As soon as final locations and lengths are determined, give the Contractor a revised pipe list, including those pipes added or altered by Contract change order.

Figure A-13: Reinforced Concrete Pipe

Box Culvert

The station of the intersection of the centerline of the culvert and the survey centerline will be shown on the plans. The skew of this intersection will also be given. The Inspector should do the following:

- Establish the station of this intersection and turn the skew angle. This establishes the plan alignment of the culvert (see Figure A-14).
- If the situation is complex, it may be necessary to traverse the stream, take cross sections, plot the traverse and cross sections, and select the culvert alignment from these data.

Figure A-14: Box Culvert

- In all cases, however, use the culvert alignment most suitable for the site as it exists in the field. This ideally would be the plan alignment, but sometimes actual field conditions will make a change necessary.
- If the actual skew does not fit the standard skews, use the following:
  - The actual skew for determining barrel length
  - The closest standard skew for wing wall lengths.

Flow Line

The establishment of the flow line of a culvert is very important. The way to check or establish the flow line is as follows:

- Plot the original ground line profile along the centerline of the culvert.
- Using these visual data, set a flow line that best fits the stream conditions.

Basically, the ends of the culvert or the channel extensions on each end should fit the natural flow line of the stream. There may be conditions up or downstream from the culvert ends that would make a lowering of the culvert and the channel advisable, but these changes should be approached with caution.

Original Ground Data

The Inspector should establish the original ground data as follows:

- Station the centerline of the culvert with the intersection of the culvert centerline and the upstream right-of-way line as Station 0+00.
- Take cross sections that extend beyond the limits of excavation along the culvert centerline at the break points in the terrain.
  - Take these cross sections normal to the centerline of the culvert.
  - Note any unusual conditions, rock, muck, etc. on the cross sections.

Culvert Length

The length of the culvert is best determined from a cross-section plot along the culvert alignment. The Inspector should follow the steps below to determine that length:

- First, plot a cross section of the original ground along the centerline of the culvert.
  - On this same plot, plot a cross section of the roadway taken along the culvert centerline.
  - On the roadway cross section, modify the normal roadway widths, shoulder widths, slopes, etc. for skew. A normal 2:1 slope when plotted on a skew will be flatter than a 2:1 slope.
  - After these two sections (original and roadway) are plotted, plot the proposed flow line on the same section.
  - If it is evident that changes must be made in the flow line, make those at this time.
  - Once the flow line is finalized, make the final length determination.

- Determine the length of the culvert from a plot.
  - On the above-described cross section, plot the line of the top of the barrel concrete.
  - Find the length of the culvert between parapets from the distance between the points of intersection of the roadway side slopes and the inside face of the parapet along a line that is 12 in. above the top of the culvert barrel as determined for this plot.
  - Round this length off to the nearest whole foot.
- Once the over-all length of the culvert has been determined, it is possible to determine the length of each section of barrel design.
  - Plot the limiting fill heights as lines parallel to the top of the culvert barrel. These lines must be plotted the proper height above the culvert barrel.
  - Determine the end points of each design section by where the limiting fill height line intersects the roadway side slopes.
  - Determine the length of each section by measuring between these points.
  - Round these lengths off to the nearest whole foot and check their sum to see that it is equal to the total length of the culvert.

A-6-2 During Construction

Excavation

The Engineer will determine the minimum requirements for length and depth of excavation for each structure (see Figure A-15). The Contractor assumes the responsibility for the cost of installing necessary sheeting and bracing. When excavating, the Inspector should ensure the Contractor follows these requirements:

- Excavate through rock or boulder formations to at least 1 ft (300 mm) below the bottom of the structure, except where the entire concrete or masonry structure rests on solid rock.
- Backfill the excavated area with Type I or Type II material to the proper subgrade elevation.
- As the embankment is constructed, excavate and place pipe on the new embankment. Pipe may be placed incrementally on steep gradients.
- Cut surfaces at structure trenches to prevent damage to the adjacent pavement when existing paved areas will be retained.
- The Contractor should saw pavements deep enough to cause all edges to break in straight lines. Ensure that the width, depth, and vertical walls of an excavated imperfect trench conform to plan details and dimensions within 2 in. (50 mm).

Figure A-15: Excavation Example

- Dispose of surplus and unsuitable materials as directed by the Engineer.
- Consider excavated material as unclassified excavation according to Section 205, except that the Department will not pay for excavation for minor structures.
- Include the cost of fulfilling these requirements in the price bid for the pipe.

- Excavate the bottom of the trench to a minimum width of 18 in. (450 mm) on each side for all pipes.

See Georgia Standard Specification 1030d 1030d for more information on trenching and backfill of pipe.

Foundations

The Soils section of the Office of Materials and Research will make a foundation investigation of each culvert site. A one-page report showing the results of the foundation investigation and giving specific recommendations for the foundation design will be issued. The culvert foundation report will normally cover the following topics.

Soil Profile

The culvert borings will be made at intervals along the culvert centerline. The results of these borings will be plotted and a profile of soil types and sub-surface conditions will be drawn.

Foundation Types and Treatment

The foundation must be excavated to the depth of the footings or the undercut as called for on the plans, in the foundation report, or decided upon from field observations.

- Take care not to over-excavate or to disturb the material below the plane of excavation.
- Diversions are required to allow construction of the culvert, while at the same time preventing erosion.
- Pump from sumps outside of the footing area or use diversions to divert water and remove seepage into the footing area.
- When widening a two-barrel culvert (or larger), use pumping to dam water up in one of the barrels and divert it around the construction area.
- Use diversions consisting of plastic-lined channels to capture the water upstream of the culvert and carry it around the construction area.

Sometimes a combination of these methods works best. Specific recommendations will be made in the report for the type and amount of foundation backfill and foundation design.

Foundation on Soil

When the culvert is to be founded on soil, the report will recommend the amount and type of backfill material to be used.

- If actual soil conditions are not as shown on the profile, change the amount and type of the backfill to reflect the actual field conditions.

Foundations on Rock

Any time isolated high points in rock are encountered, a Type II backfill material may be required for a cushion effect to avoid point loads.

- If the character of the rock is such that the bottom slab of the culvert may be omitted and the culvert walls founded on footings on rock, this will be plainly stated in the soils report.
- In the absence of a specific statement allowing the omission of the bottom slab, require that the bottom slab be poured.
- If rock appears in a culvert foundation that is not covered by a foundation investigation report, the Engineer should determine if the extent of the rock is such that the omission of the bottom slab would be practical.
    - If this is the case, the Engineer should then request that the Soils section of the OM&R investigate the character of the rock to determine if wall footings can be used in place of the bottom slab.

Foundations on Piles

In some cases it will be necessary to found culverts on piles.

- In such cases, special design plans and details will be provided in the report.

Backfill around the Culvert

Backfill around culverts is placed as part of the embankment construction operations. There are, however, certain conditions at culverts that will require that the backfilling around the culverts be specially handled. These conditions may occur individually or may occur in combination at any particular site:

- A fill height of no more than 1.5 times the culvert height
- Compressible original ground soils adjacent to the culvert

These conditions can cause the fill and the riding surface on either side of the culvert to settle, leaving a hump in the riding surface. The Soils section of the OM&R has developed two steps to be taken to counteract this settlement, which may be used individually or in combination:

1. Require 100% compaction to a distance of 50 ft from each culvert wall. Use a Class II or better soil within this area according to the GDOT Standard Specifications.
2. Require the removal of compressible material adjacent to the culvert and backfill with select material requiring 100% compaction.
    a. Unless otherwise stated in the foundation report, remove the compressible material to a distance of 50 ft from each culvert wall.
    b. Where the compressible soils are excavated and the backfill material will be below the ground water table, use concrete Class IA or IA materials, according to the GDOT Standard Specifications.

If the OM&R feels that these steps are necessary, this will be so stated in the culvert foundation investigation report. The design office should also show these requirements on the plans. If such requirements are in the report and not on the plans, the matter should be referred to the District Construction Engineer.

A-6-3 Reinforcement

All of the reinforcement must be checked before the pour is commenced (see Figure A-16). The Inspector's role includes the following:

Figure A-16: Reinforcement for Culverts

- Ensure reinforcement steel is not tied while the concrete is being poured.
- Verify that all wall steel or dowels are placed and securely held in position. This, too, must be done before the pour is commenced. Always remember that:
  - Accurate placement of reinforcement steel is necessary if a reinforced concrete structure is to achieve its design strength.
  - The proper quantity of reinforcement steel is essential to the strength of a reinforced concrete structure. Therefore, check the following against the plans:
    - Spacing of each bar
    - Size and type of each bar

In checking the reinforcement, give particular attention to barrel steel at design changes. Spacing and sizes of bars can change at these points of design change.

Unloading and Handling Pipe

Unload and handle pipe with reasonable care (see Figure A-17). The Inspector is responsible to do the following:

Figure A-17: Unloading and Handling Pipe

- Take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe.
- Remove from the Project pipe that is severely damaged or is rejected as being unfit for use.
- Allow use of undamaged portions of a joint or section where partial lengths are required.
- Ensure the rubber seal is completely seated around the pipe.

Laying Pipe

Pipe laying should begin at the downstream end of the line (see Figure A-18). The Inspector should perform the following checks:

- Ensure the pipe is in contact with the foundation throughout its length.
- Ensure metal pipes provided with lifting lugs are only lifted by these lugs.
- After pipe has been laid and before backfill is placed, inspect the pipe for:
  - Alignment
  - Grade
  - Integrity of joints
  - Coating damage

Figure A-18: Laying Pipe

Joining Pipe

The Inspector should use the following guidelines for joining pipe:

- For reinforced concrete pipe, ensure the following:
  - Use approved grease.
  - Make sure the gasket does not twist when seated.
  - Make sure the male end is all the way in the bell end and seated properly.
  - Plug the carrying hole with approved bituminous plug material.
- For other pipe materials, ensure installation requirements meet related Georgia Standard Specifications
- For transverse construction joints, ensure the joints are:
  - Made in the barrel of the culvert at all locations indicated on the plans and at all design change locations
  - Full construction joints, constructed at an angle of 90° with the barrel
- After the concrete has achieved its initial set in a floor or top slab pour, permit removal of a header and pour the adjacent section.
- When this is done, coat the concrete surface along the joint with curing compound to prevent bonding of the two surfaces.
- At all transverse construction joints outside the limits of the payment width, do not allow reinforcement steel to extend through the joint.
- Avoid construction joints inside the limits of the pavement width.
  - If conditions require that such a joint be made, extend all longitudinal reinforcement steel through the joint for a distance of at least 1 ft, with no bond-breaking procedure

Relaying Pipe

If specified or directed, the Contractor must remove existing pipes and relay suitable sections as specified for new pipes. Usually a junction box is used for this purpose.

Concreting

The Inspector must check all placement equipment, such as chutes, vibrators, or tremies, before placement commences. Also check stand-by equipment.

Backfilling

The Contractor must obtain backfill materials that meet the Specifications from sources approved by the Engineer (see Figure A-19).

Figure A-19: Backfilling

Foundation Backfill Materials, Types I and II

The Inspector should ensure the Contractor uses, places, and compacts the following materials as shown on the plans or as directed by the Engineer:

- Use Type I material in dry structure trenches and Type II material in wet trenches.
- Use Type I material as a finishing course for Type II material when permitted by the Engineer.
- Backfill excavations beyond the specified limits with the same type of material required for the adjacent area; however, the Department will not measure excess backfill material for payment.
- Place Type I and Type II backfill material in layers of no more than 6 in. (150 mm) loose.
- Compact each layer as follows:
    - *Type I Backfill Material*: Compact to 95% of the theoretical dry density.
    - *Type II Backfill Material*: Compact to a satisfactory uniform density as directed by the Engineer.

Imperfect Trench Backfill Material, Type III

The Inspector must check that the Contractor places this material as loose, uncompacted backfill over pipe structures as shown on the plans where imperfect trench backfill is specified.

Normal Backfill

The Inspector must ensure that normal backfill material meets the requirements of Subsection 810.2.01, Class I or II. Check that the Contractor places and compacts the backfill according to Section 208 except as follows:

- Do ***not*** place rock more than 4 in. (100 mm) in diameter within 2 ft (600 mm) of any drainage structure.
- For backfill behind retaining walls, use a pervious material that meets the requirements of Case I or Case II as follows:
  - *Case I*: Refers to backfills for retaining walls that support roadbeds and parking areas.
    - Ensure that the backfill conforms to Section 208. Do ***not*** place rock more than 4 in. (100 mm) in diameter within 2 ft (600 mm) of the retaining wall or finished surface.
  - *Case II*: Refers to backfills for retaining walls that do not support roadbeds or parking areas.
    - Ensure that the backfill conforms to the requirements of Case I above, except compact the backfill to the density of the adjacent soil.
- Prior to backfilling, remove and reinstall, or replace pipes found to be damaged or out of alignment or grade.

Backfill Applications

Backfill to paved and non-paved areas is important to the overall appearance and structural integrity of the rehabilitated highway.

The Inspector should be familiar with the allowed applications for the types of backfill material, as follows:

- *Paved Areas*:
  - Backfill cross drains and side drains in paved areas subject to traffic loads, such as roadway travel lanes, shoulders, and turnouts, with Type I material.
  - Use Type II backfill material in all other paved areas, including driveways, detour roads, and similar installations.
  - Do not allow selected soils as backfill material.
  - Specify placement and compaction as specified in Backfill Methods below.
- *Nonpaved Areas*:
  - Use Type II backfill material placed by approved methods and compacted to the density of the surrounding soil for pipe backfill material, except for plastic pipe.
  - Backfill plastic pipe with granular material or Type I backfill material.

Backfill Methods

The Inspector should not allow compaction by flooding. Follow these guidelines for placement and compaction of various types of material:

- *Selected Soils*:

- Place backfill at or near optimum moisture content in layers not exceeding 8 in. (200 mm) compacted thickness.
- Thoroughly compact backfill material under the haunches of the pipe.
- Compact each layer by approved methods to at least 95% of maximum dry density prior to placement of a subsequent layer.

- *Granular Material*:
  - Place backfill at or near optimum moisture content.
  - Thoroughly compact backfill material under the haunches of the pipe and then in layers not exceeding 12-in. (300 mm) compacted thickness.
  - Compact each layer by approved methods to at least 95% of maximum dry density prior to placement of a subsequent layer.
  - Cover exposed slopes at the pipe ends by at least 12-in. (300 mm) compacted thickness of plastic soil blanket.
- *Stone or Recycled Portland Cement Concrete*:
  - Place backfill at or near optimum moisture content.
  - Thoroughly compact backfill material under the pipe haunches and then in layers not exceeding 8-in. (200 mm) compacted thickness.
  - With the approval of the Engineer, increase layer thickness to 12 in. (300 mm) with verification of satisfactory installation and performance.
  - Compact each layer by approved methods to at least 95% of maximum dry density prior to placement of a subsequent layer.
  - The Contractor will control placement operations so as not to damage protective coatings on metal pipes. The Contractor will repair damaged coatings at no additional pay.
- *Even Placement*:
  - In placing backfill material around the culvert, take care not to damage the culvert by loading one side more than the other.
  - Backfill on both sides of the culvert so that the backfill on one side of the culvert will never be more than 3 ft higher than on the other side of the culvert.

Inspection of Pipes

After completion of embankment and prior to roadway surfacing, the Inspector will inspect pipes for proper alignment and integrity of joints (see Figure A-20).

- Any misaligned pipe or defective joints must be corrected by the Contractor at no direct pay.

<u>Plastic Pipe</u>

Installed plastic pipe will be tested to ensure that vertical deflections do not exceed 5.0%. Maximum allowable deflections will be governed by the mandrel requirements stated herein.

- Perform deflection tests no sooner than 30 calendar days after installation and compaction of backfill.
- Clean and inspect the pipe for offsets and obstructions prior to testing.

Figure A-20: Inspection of Pipe

- For pipe 36 in. (900 mm) and less in diameter, pull a mandrel through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. The Engineer must approve the mandrel prior to use. *Use of an unapproved mandrel or a mandrel altered or modified after approval will invalidate the test.*
- If the mandrel fails to pass, the pipe is over deflected.
  - Unless otherwise permitted, uncover and, if not damaged, reinstall deflected pipe.
  - Do not reinstall damaged pipe, but remove and replace it with new pipe.
  - Remove and replace with new pipe any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any over deflection.

  The mandrel must:
  - Be a rigid, nonadjustable, odd-number legged (minimum 9 legs) mandrel having a length not less than its nominal diameter or 24 in. (600 mm), whichever is less
  - Have a minimum diameter at any point 5.0% less than the base inside diameter of the pipe being tested
  - Be fabricated of steel, aluminum, or other approved material fitted with pulling rings at each end
  - Have the nominal pipe size and outside diameter of the mandrel stamped or engraved on some segment other than a runner
  - Have a suitable carrying case furnished
- For pipe larger than 36 in. (900 mm) in diameter, determine deflection by a method approved by the Engineer. If a mandrel is selected, ensure the minimum diameter, length, and other requirements conform to the above requirements.
- Conduct mandrel testing by the Contractor in the presence of the Engineer. Mandrel testing will be at no direct pay.

<u>Metal Pipe</u>

The Inspector must examine metal pipe for deficiencies that will require removal, as follows:

- If the inside diameter of metal pipe or rise dimension of metal pipe arch deflects more than 5.0% from the original dimensions, remove and reinstall them, unless they do not rebound or are damaged.
- Remove and replace at no direct pay pipe or pipe arch that is damaged or does not rebound.

- The Engineer will make measurement of deflection away from rerolled ends.

Cleaning Pipes

The Inspector must see that pipes are cleaned by the Contractor as follows:

- *Existing Pipes*:
    - Clean those pipes designated to be cleaned of soil, debris, and other materials to the invert of the pipe.
        - Clean designated pipes by approved methods that will not damage the pipes.
        - Have any damage caused by the Contractor’s operations satisfactorily repaired at no direct pay.
        - Dispose of removed soil, debris, and other materials.
- *Contractor-Installed Pipes*:
    - Prior to final acceptance, clean pipes of all debris and oil to the invert of the pipe at no direct pay.
    - Dispose of removed soil, debris, and other materials.

Stubbing and Plugging Pipes

The Inspector must ensure that pipes are stubbed or plugged properly when such is necessary:

- When it is required that pipes be plugged, construct such plugs of Class C or better concrete.
    - Ensure the thickness of the plug and method of construction are as directed.
- When new pipes are to be stubbed into new or existing pipes or other structures, make the connection with approved mortar.

A-7 Erosion Control Construction Inspector Best Practices

A-7-1 Introduction

Purpose and Significance

Preventing erosion is an important task in road construction for several reasons, with one of the primary benefits being the prevention of pollution. Rainfall, especially heavy rainfall, causes runoff that carries pollutants such as pesticides, fertilizer, and oil, which contaminate water. Although successful erosion control requires attention from more than just road workers—for instance, it also requires the practice of sustainable agriculture—road construction crews can play a major role in the prevention of erosion through the use of several useful methods contained in this manual.

In addition, road construction Projects often contribute to erosion of the land surface, especially when tilling, grubbing, and harrowing are involved. Therefore, the Department of Transportation and Contractors are responsible for protecting the land before, during, and after construction Projects.

Figure A-21 shows average Georgia rainfall by month. There is not a distinct "wet season" in the state of Georgia, despite an annual rainfall of nearly 50 in. With that being said, many areas of the state experience torrential downpours during the summer months, which can exacerbate the situation and increase the rate of erosion. As a result, erosion control methods must be implemented year-round, with an emphasis on the summer months, to be effective in reducing erosion.

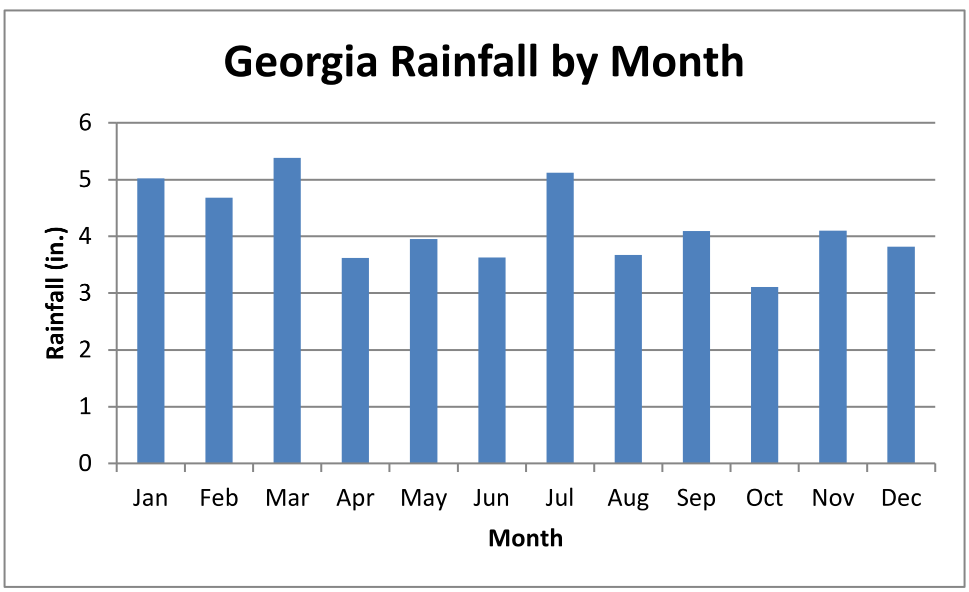


Figure A-21: Average Georgia Rainfall by Month

Land development and construction Projects impact the erosion process in many different ways. The following are some effects that land development has on the erosion process:

- Alteration of groundwater process, causing reduced infiltration of water into the soil
- Increased runoff, causing additional uptake of pesticides, herbicides, fertilizers, and oil by stream water, which results in increased water pollution
- Larger amounts of runoff concentrated into shorter periods, causing increased erosion
- Decreased slope stability
- Little or no vegetation growth due to the exposure of subsurface materials that are not suitable for vegetation; vegetation is a necessary protector against erosion

Significance of Runoff

As a rain shower begins, water infiltrates the soil and permeates deeper until it reaches the water table (Figure A-22). It then becomes groundwater as it recharges the existing aquifer, which helps to prevent drought. However, eventually, the soils are infiltrated to capacity and, as a result, water begins to accumulate as surface runoff, which then flows across the land and causes erosion to occur.

The infiltration capacity and permeability of a type of soil depends upon several factors, including the porosity and density of the material. Permeability varies among soil types.

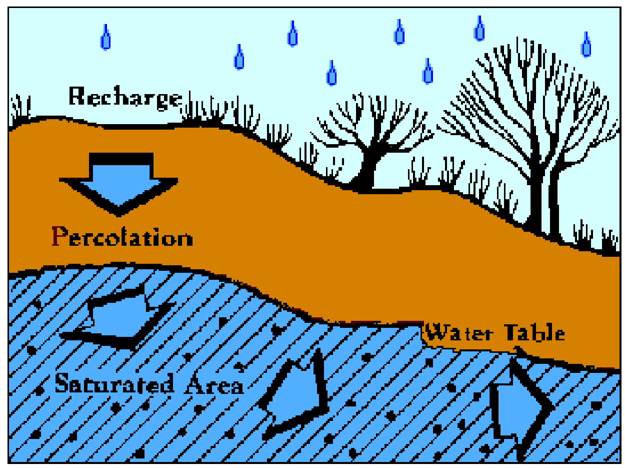


Figure A-22: Groundwater Recharging

Georgia Soils

Before implementing erosion control practices, it is imperative that all Inspectors understand the soil types most commonly found in Georgia. It is also important that they understand the properties of the soils and apply that knowledge while inspecting the worksite.

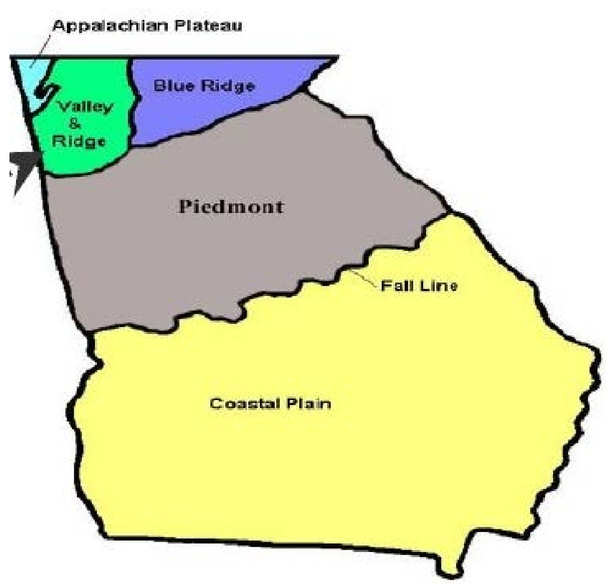


Figure A-23: Georgia Regions

Georgia Red Clay

Many areas in Georgia contain red soils called "Georgia Red Clay." Soils formed when rocks were weathered over time, leaving behind materials that mixed with organic plant material, animal matter, and other natural substances. Soils in many parts of Georgia, especially the Southern Piedmont Region (see

Figure A-23) developed in materials weathered from gneiss and granite. Weathering in Georgia occurred at a high rate due to high rainfall and warm temperatures. These processes left behind materials composed of silica, aluminum, and iron, with iron oxides being the primary substituent responsible for the red color in Georgia Red Clay.

The consistency and hardness of clay depends heavily upon the amount of available moisture:

- During wet periods, clay retains moisture but does not allow it to permeate through the soil, which often causes runoff.
- During dry periods, clay becomes extremely hard, making it difficult to work with. It is difficult for plant roots to penetrate the hard material, which reduces the strength of any existing vegetation.

Areas that do not contain strong vegetation should be carefully monitored by Erosion Control Inspectors; these Inspectors should pay close attention to the stability of the land, as well as the amount of runoff occurring in those areas.

<u>Sand</u>

Sand, which is much more permeable than clay (Figure A-24), is another type of soil often found in Georgia. Sand has the following features:

- During storms, water penetrates sand very quickly, which helps reduce runoff amounts.
- Fast penetration makes it easier for sand to lose nutrients, which results in less vegetative growth within the soil.

<u>Loam</u>

Loam (Figure A-24), as opposed to sand, retains enough moisture for plant growth but is fairly permeable.

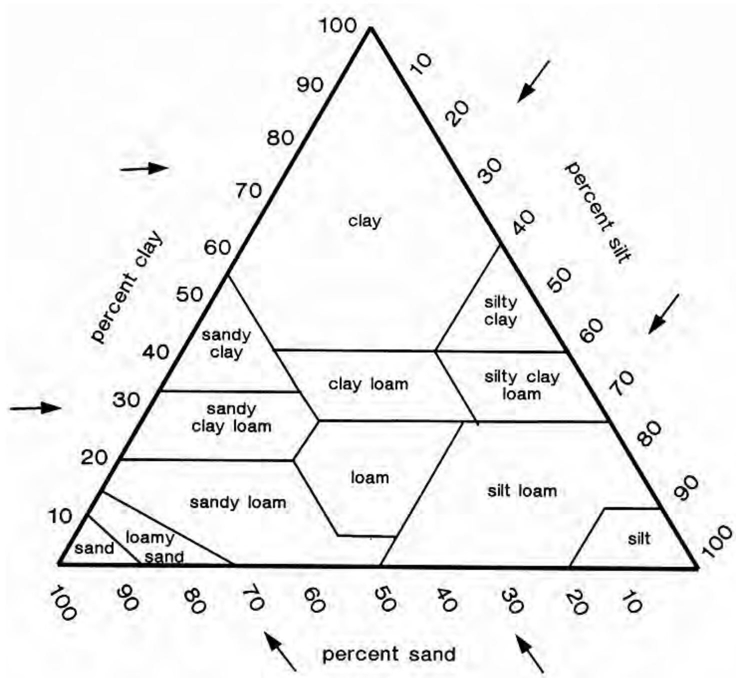


Figure A-24: Soils: Clay, Silt, and Sand

A-7-2 Preconstruction

Plans and Specifications

One of the main goals of erosion control is to prevent water pollution. To achieve this goal the Inspector should consider these guidelines:

- Apply erosion control measures properly, efficiently, and at the correct time.
- Apply erosion control measures at a time when rainfall is at a minimum. For instance, if a large thunderstorm occurs immediately after reclaiming a material pit, the material pit may sustain damage, which will lead to more erosion.
- Install erosion control measures prior to road construction operations. Many road construction operations create soil disturbances. Such operations include, but are not limited to:
  - Clearing
  - Grubbing
  - Grading
  - Stripping
  - Installation of underground utilities
- Complete certain road construction operations before implementation of erosion control measures. For instance, complete tree felling before measures are employed, because tree felling can damage and destroy erosion control measures.

There are several methods available for preventing damage to soil and other earth materials. Some of these methods are:

- Silt fences
- Temporary seeding
- Mulching slopes
- Erosion control blankets

Rather than clearing the entire worksite, the Contractor should clear, grub, and strip ***only*** areas required to progress construction operations.

A-7-3 Duties and Responsibilities of the Inspector

Because erosion control requirements are often based on environmental regulations from many agencies, it is important that the Inspector pays close attention to these permits before work begins on erosion control and sedimentation.

- Review plans and specifications; determine the time of application and type of erosion control material to be used.
- If borrow pits will be used, ensure that there is a sufficient quantity of material available and that the material is suitable for use.
- Before excavating borrow pits, ensure that the planned excavation site is not severely eroded or damaged.
- When using topsoil and other native materials, examine the materials to determine whether there is sufficient quantity available. Also, confirm that the material is suitable for use.

- Ensure that the equipment is safe and meets requirements.
- Determine if fertilizer meets requirements by checking the chemical analysis on the fertilizer bag label. It is especially important that fertilizer meets requirements because it is often a major contributor to water pollution.
- Check all silt fences and other materials for damage prior to installation.
- Refer to the provisions in the specifications manual to confirm that the correct species of seed is being used.
- Confirm that the correct types of fertilizer and topsoil are being used. Refer to the Georgia Standard Specifications.
- Ensure that the Contractor applies erosion control materials at a reasonable application rate.
- During operations, abide by all erosion control policies set forth by the Georgia Environmental Protection Division.

A-7-4 During Construction

Topsoil

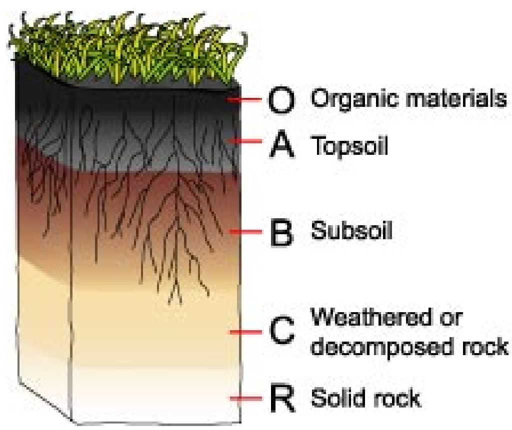


Figure A-25: Soil Layers

Figure A-25 shows the soil layers. One of the main functions of topsoil is its ability to support plant life. It contains organic matter, sand, clay, and nutrients. Some types of topsoil are composed mostly of sand, while others contain mostly clay. Because of this, it is important to ensure that the Contractor carefully chooses topsoil with the correct proportions of sand, clay, and silt.

Topsoil choice often depends upon the area in which construction is being done. For instance, if construction is being done in an area where aquifers are often depleted and groundwater is at a minimum, silt may be a good choice, as opposed to clay. Clay is not very permeable, and as a result will produce more runoff and less groundwater.

Straw

Straw helps prevent slope erosion and, therefore, should be used on slopes. The benefits of straw include:

- Protection of the surface from the impact of rainfall
- Reduction of runoff velocity
- Protection of the soil from eroding agents, such as wind and rain

For some slopes, it is not feasible to use straw to protect the land and hold seeds to the slope; one of the primary disadvantages of straw is the difficulty in anchoring it to the slope. For possible alternatives, see Georgia Standard Specifications Sections 710 through 718.

Fertilizer

Fertilizer offers several benefits, including its ability to support plant life. Oftentimes, the use of fertilizer results in high crop yield. There are several types of fertilizers that are natural, while others are synthetic.

Despite those benefits, the Inspector should understand that excessive use of fertilizer can be detrimental to the environmental health of the land. Fertilizer can get caught in runoff, causing drinking water to become polluted. Goals for the Inspector are as follows:

- Check environmental regulations before using fertilizer.
- Ensure that the proper type and amount of fertilizer are being used.

See Georgia Standard Specifications Subsection 700.3.05D for more information.

Seed

Seed can be used to install grasses and other plants, providing the following benefits:

- More root support in the soil; thus, making it more difficult for soil to erode (see Figure A-26)
- Less water pollution
- Increase in the aesthetic value of the land

See Georgia DOT Standard Specifications Section 700 for a planting table with a list of available plants and other details regarding planting methods.

Figure A-26: Stabilized Slope with Vegetation

Hydroseeding

See Georgia Standard Specifications Subsection 700.3.05F for information on hydroseeding.

Reclamation of Material Pits and Waste Areas

Oftentimes, a Project requires the use of soil and other earth materials. One of the simplest ways to obtain earth materials is to dig a pit and use the remaining materials. A major downside of using material pits is the fact that it disturbs land and exacerbates the erosion process.

- To help reduce the negative impact on the land, reclaim material pits and waste areas as quickly as possible by planting seed and other materials. Reclamation of material pits and waste areas is the responsibility of the Contractor.
- Oftentimes, borrow pits are located far outside of the right-of-way, which prevents the Inspector from having the ability to oversee those operations.

The procedure for reclamation of material pits and waste areas includes the following:

- Seed or sprig areas near the material pits that are susceptible to erosion.
- Ensure that planting is ***not*** done on areas composed of materials that cannot support permanent vegetation, such as rock.
- Plow all areas that are to be planted to a depth of 6 in.
- Apply lime and fertilizer:
    - Ensure that the materials are spread uniformly at a reasonable rate.
    - Ensure that the lime and fertilizer are mixed into the top 2 in. of soil.
- Use seed and mulch on these areas of interest.
- Dig holes and install the plants.
- Harvest and apply sprigs.

For more information, see Georgia Standard Specifications Section 160.

Erosion Control Check Dams

Check dams are typically built in a narrow stream, channel, or drainage ditch, and their main purpose is to reduce erosion and allow sediment to settle, rather than continue downstream (Figures A-27 and A-28). They help prevent erosion and water pollution. For more information on check dams, see Georgia Standard Specifications Section 162.

Figure A-27: Improper Use of Silt Fence as a Check Dam

<ins>Materials</ins>

- Woven wire (14.5 gauge)
- Other materials, such as logs, stakes, or brush, that may be obtained from the right-of-way
- Number 57 stone

Figure A-28: Proper Channel Lining

<ins>Duties of the Inspector</ins>

Related to check dams, the Inspector is responsible for the following:

- Ensure that all earth materials used in construction of the dams meet regulatory requirements.
    - If any material (logs, stakes, brush, etc.) has been obtained from the right-of-way for use in dam construction, ensure that the removal of these items does not cause significant damage to the land. Confirm that ***only*** the necessary quantity of materials is being removed from the right-of-way.
    - Ensure that all other materials remain in place.

    - Do not disturb other natural ground cover.
- Ensure that check dam construction is being done before clearing, grubbing, or grading operations.
- Use only rubber-tired vehicles in the drainage area prior to completion of the check dam.
- Ensure that all dam materials are being obtained from outside of the drainage area.
- Place number 57 stone on the downstream side of the dam.
- Stabilize slopes that drain toward the dam using straw or mulch.

Restoration of Lakes and Ponds

Oftentimes, work plans and proposals will indicate that the Contractor should use the lake or pond as a basin to collect silt and other debris during construction. If this is the case, the pond or lake should be restored following the completion of construction work. The Inspector should do the following:

- Before work begins, assess the condition and determine the existing contour of the lake or pond.
- After work ends, ensure silt is removed from the lake or pond.
- Ensure that silt removal is done carefully so that surrounding areas are not being polluted by sediment.
- Make sure that the lake is restored to its original contour.
- Grade and grass any disturbed areas that are not under water.

For more information, see Georgia Standard Specifications Section 166.

Silt Fences

Silt fences (Figures A-29 and A-30) are significant because they help remove suspended particles from drainage water, helping to reduce water pollution. They remove particles like silt, sediment, and other sands from the runoff water. See Georgia Standard Specifications Section 171 for more information on the different types of silt fences.

Figure A-29: Close-Up View of Silt Fence

Materials

Silt fences are often supplied pre-assembled, but can also be constructed from the following materials:

- Fabric
- Stakes
- Mesh
- Wire

Duties of the Inspector

The Inspector should make inspection related to silt fences as follows:

Figure A-30: Silt Fence

- If the silt fence is being constructed manually rather than using a pre-assembled fence:
  - Assure that fabric is approved for use.
  - Ensure that the fabric and mesh are strong enough to use in the building of the fence.
  - For weaker fabrics, place posts closer together to provide additional support.
- Ensure that the stakes are placed on the downstream side of the silt fence to provide additional support when sediment and water push against the fence.
- Before using trenching machines, motor graders, or any other type of machinery, assure that regulations allow the use of machinery on erosion control worksites.
- Ensure that the equipment is safe and that the operator is qualified to control the machinery.
- Check silt fences for holes, rips, and other flaws; do not use materials that have been damaged in any way.

Installation of the Silt Fence

A reasonably effective method of installing the silt fence involves cutting a narrow trench, placing the stakes into the ditch, and backfilling the edge of the fabric. More detailed instructions are included below.

- Use one of the following methods to install the silt fence:
  - *Excavated Trench Method*:
    - Excavate a trench to a depth of 4–6 in. This can be done by hand, or by using a trenching machine or motor grader.
  - *Soil Slicing Method*:
    - Slice the soil approximately 8–12 in. deep, but not greater than 3 in. wide, and insert the fabric into the slice simultaneously.
    - Ensure that the depth of the slice is consistent across the entire length of the slice.
- When backfilling the trench, compact the upstream side before compacting the downstream side.
- Install the first post at the center of the low point.

- Space the remaining posts no more than 6 ft apart—spacing will vary in distance depending on what type of fence is being used.
- Bury the posts to a depth of at least 18 in. to ensure stability during sediment loading.
- Attach the fabric to the posts.
    - If using wooden posts, it is reasonable to use staples and nails to fasten the fabric to the posts.
        - Ensure that the staples or nails are spaced evenly.
        - Check specifications to determine how many nails or staples should be used for each post.
    - Ensure that the bottom of the silt fence is not fastened to the post—more specifically, leave 6–8 in. of fabric at the bottom to be buried.
    - Some fences require additional support between posts; check specifications to determine whether a woven wire support fence (or any other type of support) is needed.
- Install the fabric into the trench, ensuring depth consistency along the length of the trench.
- Backfill the trench and ensure that flow cannot pass under the fence barrier.

When dealing with waterways that produce significant runoff, consider using a settling basin in front of the silt fence to handle the large sediment load.

Removal of the Silt Fence

The fence should be kept in place until otherwise directed. If removal is appropriate, the Inspector should do the following:

- Check the condition of the fence before using it at other locations.
- After removing the silt fence, ensure that the area is aesthetically pleasing by seeding and mulching the areas containing trenches.

A-7-5 After Construction

Quality and Damage Check

The Inspector must periodically check all structures for damage after installation:

- *Silt Fences*
    - Check for holes, scars, rips, deterioration, and other damage.
    - Replace the materials and repair immediately.
- *Check Dams*
    - Ensure that the structure is maintaining shape and stability.
- *Reclaimed Material Pits*
    - Ensure that the material pit is not experiencing large amounts of erosion; if so, reclaim the pit again by placing soils, fertilizer, and vegetation.
- *Restored Lakes and Ponds*
    - Check that the restored lake or pond is maintaining stability.

Removal of Excess Material

Ensure that all excess material is removed from the worksite when work is complete; this includes:

- Additional soils not used in backfilling holes and pits
- Excess fertilizer and seed
- Excess straw and fiber
- Additional earth materials, such as sediment and rock

A-8 Clearing and Grubbing Construction Inspector Best Practices

A-8-1 Preconstruction

Plans and Specifications

The primary goal of clearing and grubbing operations is to remove and dispose of vegetation and other debris within the limits of construction and adjacent to the right-of-way. It is necessary to clear and grub effectively and to properly dispose of all debris prior to grading operations. The successful completion of clearing and grubbing Projects not only benefits road construction workers, but also drivers, pedestrians, and residential communities near the roadway. See Section 2.2.3: Clear Zone for more information.

The Inspector should consider the following plans and specifications prior to any clearing and grubbing operation:

- Obtain proper permits and authorization before the commencement of the Project.
- Ensure Inspectors and other workers are familiar with the surrounding land and whether there is private property near the construction site.
- Ensure workers are aware of any environmentally sensitive areas and wetlands.

Roots within the right-of-way that may hinder construction operations should be grubbed and removed. These roots are often referred to as objectionable roots. Objectionable roots include any of the following types of roots:

- Individual roots with diameter greater than 0.75 in. (20 mm)
- Individual roots longer than 3 ft (1 m)
- Large quantities of roots present in the top 1 ft (300 mm) of the finished subgrade or road surface when they are detrimental to the work

Duties and Responsibilities of the Inspector

The Inspector is responsible to ensure the following tasks are completed:

- Review all plans, provisions, and right-of-way agreements that may require Contract changes.
- Ensure that water pollution and erosion control methods are in place.
- Review all environmental protection regulations that are to be followed by the Contractor.
- Review any planned disposal sites to ensure that disposal methods adhere to regulations.
- Inspect equipment for safety and quality.
- Speak with the Contractor about the marking of special locations to be preserved, especially environmentally sensitive areas.
- Determine the amount of clear zone that should be provided within the right-of-way.

A-8-2 During Construction

Equipment

The following equipment may be useful during clearing and grubbing operations.

<u>Tractor</u>

- Use the tractor with towing attachments such as tillers or mowing add-ons (Figures A-31 and A-32).
- Ensure that the land and soil are strong enough to support wheel pressure without sinking.
    - Crawler tracks, as opposed to wheels, distribute weight more evenly over the surface, making it less likely for sinking to occur.

<u>Mowing Attachment</u>

- Utilize the mowing attachment with the tractor for all mowing operations (Figure A-32).
    - Mowing attachments may be useful in the final stages of clearing and grubbing if large grasses or weeds act as obstacles during grubbing operations.
    - Do not use on steep slopes.

<u>Tiller</u>

- Use a tiller during grubbing operations in addition to the grubbing fork.
- Attach tillers to tractors in the same way as mowing attachments (Figure A-33).
- Before using a tiller, ensure that the land and soil are strong enough to support tilling operations.
- Do not use a tiller on steep slopes.

<u>Grubbing Fork</u>

- Use a grubbing fork to remove deep roots during grubbing operations.
- Attach grubbing forks to several different vehicles, such as the motor grader (Figure A-34).

Figure A-31: Tractor

Figure A-32: Tractor with Mowing Attachment

Figure A-33: Tractor with Tiller Attachment

Figure A-34: Grubbing Fork Attached to Motor Grader

Harrow

- Use the harrow for breaking up and smoothing out the surface of the soil (Figure A-35).
    - Use this tool immediately following grubbing operations when surfaces require smoothing operations.
    - Use it prior to grading operations to give the surface a "final touch."

Figure A-35: Harrow

Stump Remover

- Use a stump remover for clearing stumps that are too large for the grubbing fork and tiller (Figure A-36).

Figure A-36: Stump Remover

Excavators and Brush-Cutters

- Use these tools for clearing operations (Figure A-37).

Figure A-37: Excavator

A-8-3 Extent of Clearing

Before clearing begins, the Inspector should briefly inspect the construction site to ensure that the area not only requires clearing and grubbing, but also that the site is safe and prepared for clearing and grubbing to begin.

The Inspector should use the following guidelines.

- Ensure that all buildings, facilities, trees, and other features that will be preserved are clearly marked. The markings should be easily visible from a moderate distance (20–30 ft).
- Before beginning the clearing and grubbing operations, make sure Inspectors and the workers are familiar with environmentally sensitive areas near the right-of-way. Ensure that these areas are marked for preservation.

Adherence to Policies

The Inspector should do the following:

- Confirm that the clearing and grubbing operations adhere to any laws, policies, or plans regarding water pollution, other pollution control, and environmental regulations
- Check for any regulations on the extent of "clear zone" that should be provided.

Damaged Trees

The Inspector should be proactive in preserving or removing trees as necessary.

- Check standing trees, especially those near cut slopes, for root damage (see Figure A-38).
    - Check the extent of the damage and make a reasonable decision on whether to remove those trees.
    - If root damage is minimal, do not remove the trees unless the damage poses some other danger.
- Check all other trees, especially those that appear to be dead or dying, and determine if they are hazardous or unsafe.
    - Preserve trees that do not interfere with the highway's drainage system and its safety.
- Ensure traffic safety while trees are being removed.
- Remove any tree branches extending over the roadway.
    - Check to see whether there are such branches.
    - During the removal of branches, ensure that the trees have a balanced appearance. If not, inform the Contractor of the problem.

Figure A-38: Tree with Root Damage

Clear Zone

It is best to provide as much clear zone as possible without severe socio-environmental impacts. The more clear zone road constructors provide, the safer the environment is for drivers. For instance, if a driver accidentally exits the road, the presence of a nearby tree can exacerbate the situation. ***Head-on collisions with trees account for many one-car accident fatalities.***

With that being said, trees are aesthetically valuable to drivers and nearby residential areas.

- Trees absorb sound, helping to reduce noise pollution, which benefits those who live near the roadway.
- In addition, trees trap carbon dioxide and reduce ozone in urban areas.

Thus, it is important that the project team consider these factors during operations and only clear what is necessary.

Refer to Georgia Standard Specifications Subsection 201.3.05 for more information on clear zone.

Safety of Workers

The Inspector should ensure that the Contractor's equipment is safe and has the required safety devices to protect workers from serious injury.

- Check that all backing horns on vehicles are working properly.

- Ensure that all employees have proper safety equipment.
- Ensure the Contractor is safe during tree-felling operations; ***more people are killed during tree felling than all other logging activities.***

Prevention of Damage

The Inspector is part of a project team that must proactively work to avoid causing damage of any kind. Following these guidelines will help with damage control:

- Periodically observe the operation.
- Ensure that all possible measures are being taken to prevent damage to adjacent property and environmentally sensitive areas.
- If the operation causes damage to surrounding areas, it is the Contractor's responsibility to repair and rebuild.
- It is the Contractor's decision regarding which methods to use to prevent damage to property.
- If property is damaged, the Contractor is responsible for rebuilding and repairing.
- Document all efforts taken to prevent damage to property.
- Consider felling all trees that will be removed to help protect trees that will be preserved.

Clearing and Grubbing Operations

Clearing:	The removal and disposal of materials within the right-of-way such as trees, brush, weeds, roots, stumps, and boulders.
Grubbing:	The removal and disposal of objectionable material embedded in the underlying soil.

The Inspector should ensure that the following areas are grubbed:

- Underneath pavements
- Underneath structures
- Other areas in the right-of-way

The following are guidelines for grubbing:

- Remove roots to prevent future road failures.
- When using a root rake in areas containing objectionable roots, rake to a depth of at least 6 in. below the surface.
- Cut any objectionable stumps within the right-of-way that cannot be easily grubbed. After cutting the stumps, dispose of them properly.

<u>Prevention of Invasive Pest Species</u>

The Contractor must take measures to control plants that are invasive. The Inspector can ensure these practices are kept:

- Dispose of vegetative parts of plants that may reproduce.
- Either bury such plants with at least 3 ft of cover, or burn them (if permitted).

Modifications of Clearing and Grubbing

The Inspector should become familiar with requirements related to clearing and grubbing for the following specific conditions.

Steep Slopes:

- ***Do not grub slopes that are too steep for the use of power mowers.*** Roots help prevent excessive erosion, which is a significant concern on steep slopes.

Grassed Areas:

- With the approval of the Engineer, do ***not*** grub large areas outside of the construction limits that are covered with grasses and smooth enough for power mowers.
- Simply remove trees, stumps, and other objectionable materials.

Bridge Sites:

- *Stream Bridges*:
  - Clear the right-of-way.
  - Cut stumps and brush flush with the ground line.
  - If high water prevents cutting stumps flush, require a second cutting.
  - Remove drift and stumps where necessary for installation of materials.
  - Backfill the holes in a proper fashion.
  - Preserve root systems at stream banks where they have been cut flush with the ground line.
- *Embankment Areas:*
  - *Under 4.5 ft (1.4 m)*: Clear and grub areas without modification.
  - *Over 4.5 ft (1.4 m)*: Clear, but do not grub, these areas. Remove any unsound or decaying stumps.
- *Embankment Areas over Old Roads*:
  - Clear and grub without modification.
  - Grub to a depth that removes all objectionable matter in order to provide a firm foundation.

A-8-4 After Construction

Quality Check

The Inspector is responsible to ensure all areas related to clearing and grubbing are properly finished:

- Check for scars from tree and branch removal.
  - Have the scars treated before the Project is complete.
- Ensure grubbed areas are smooth enough for the use of power mowers.
- If all areas do not have a neat and finished appearance, do not make payment until the Project is fully complete.

Removal of Debris / Combustible Materials

When disposing of debris, the Inspector should follow these guidelines:

- If burying debris, ensure that the burial will not block drainage and is aesthetically pleasing.
- Before burning debris, ensure that the Contractor is permitted to burn and maintains a safe environment by controlling the fire from spreading to other areas.
- Prohibit burning within reasonable proximity of roads to maintain a safe, smoke-free environment for drivers.
- Ensure that the Contractor has firefighting equipment on hand and ready to use.
- Remove all earth material and debris from the roadway. Regularly clean streets to remove debris.

Vehicle Washing and the Environment

The Inspector should ensure cleanup of vehicles and the roadway as follows:

- Do not wash vehicles at a location where runoff will flow directly into a waterway or storm water system.
- Remove all earth material and debris from the roadway. Regularly clean streets to remove debris.

A-9 Traffic Control Construction Inspector Best Practices

A-9-1 Preconstruction

Duties and Responsibilities of the Inspector

The Contractor will designate a qualified individual as the Worksite Traffic Control Supervisor (WTCS) who will be responsible for selecting, installing, and maintaining all traffic control devices in accordance with the plans, specifications, and special provisions (Section 150: Traffic Control), and the *Manual on Uniform Traffic Control Devices*.

- A written resume documenting the experience and credentials of the WTCS will be submitted and accepted by the Engineer prior to beginning any work that involves traffic control.
    - The WTCS must have a minimum of one year's experience directly related to worksite traffic control in a supervisory or responsible capacity.
    - The WTCS will be currently certified by the American Traffic Safety Services Association (ATSSA) Worksite Traffic Supervisor certification program or the National Safety Council certification program.
- The WTCS will be available on a 24-hour basis to perform duties.
    - If the work requires traffic control activities to be performed during daylight and nighttime hours, it may be necessary for the Contractor to designate an alternate WTCS.
        - An alternate WTCS must meet the same requirements and qualifications as the primary WTCS and be accepted by the Engineer prior to beginning any traffic control duties.
- The Worksite Traffic Control Supervisor's traffic control responsibilities will have priority over all other assigned duties.
- As the representative of the Contractor, the WTCS will have full authority to act on behalf of the Contractor in administering the Temporary Traffic Control (TTC) Plan.
- The WTCS will have appropriate training in safe traffic control practices in accordance with Part VI of the MUTCD.
    - In addition to the WTCS, all other individuals making decisions regarding traffic control will meet the training requirements of Part VI of the MUTCD.
- The WTCS will supervise the initial installation of traffic control devices.
    - The Engineer prior to the beginning of construction will review the initial installation.
    - Modifications to traffic control devices as required by sequence of operations or staged construction will be reviewed by the WTCS.
- Any work performed on the Interstate or limited-access highway right-of-way that requires traffic control will be supervised by the certified Worksite Traffic Control Supervisor.
    - No work requiring traffic control will be performed unless the certified WTCS is on the worksite.
    - Failure to maintain a Certified Worksite Traffic Control Supervisor on the worksite will be considered as nonperformance under Subsection 150.08.

- The WTCS will perform, as a minimum, weekly traffic control inspections on all Interstate and limited-access highways.
    - The inspection must be reported to the Engineer on a TC-1 report.
    - The Engineer will furnish a blank copy of the TC-1 report to the Contractor prior to the beginning of any work on the Interstate or limited-access right-of-way.
- The WTCS must be available on a full-time basis to maintain traffic control devices with access to all personnel, materials, and equipment necessary to respond effectively to an emergency situation within forty-five (45) minutes of notification of the emergency.
- The WTCS must regularly perform inspections to ensure that traffic control is maintained.
    - Unless modified by the special conditions or by the Engineer, routine deficiencies must be corrected within a twenty-four (24) hour period.
    - Failure to comply with these provisions will be grounds for dismissal from the duties of WTCS and/or removal of the WTCS from the Project.
    - Failure of the WTCS to execute his/her duties will be considered as nonperformance under Special Provisions Subsection 150.08.

Temporary Traffic Control (TTC) Plans and Specifications

The Contractor must develop detailed staging and temporary traffic control plans for performing specific areas of the work, including but not limited to all traffic shifts, detours, bridge widenings, paces, or other activities that disrupt traffic or pedestrian flow. The Engineer may require detailed staging and TTC plans for lane closures or disruption to pedestrian facilities.

- Submit these plans for approval ***at least 2 weeks*** prior to the scheduled date of the activity.
- Reschedule activities that have not been approved ***at least 7 days*** prior to the scheduled date.

Where traffic is permitted through the work area under stage construction, the Contractor may choose to construct, at no additional expense to the Department, temporary on-site bypasses or detours to expedite the work.

- Submit plans for such temporary bypasses or detours to the Engineer for review and approval 30 calendar days prior to the proposed construction.
- Remove such bypasses or detours promptly when, in the opinion of the Engineer, they are no longer necessary for the satisfactory progress of the work.
- Ensure bypasses and detours meet the minimum requirements of Subsection 150.02.B.4 of Special Provision 150: Traffic Control.

The traffic control details should include, but not be limited to, the following:

- A detailed drawing showing traffic locations and lineage for each step of the change.
- The location, size, and message of all signs required by the MUTCD, plan, special provisions, and other signs as required to fit conditions. Any portable changeable message signs used must be included in the details.
- The method to be used in, and the limits of, the obliteration of conflicting lines and markings.
- Type, location, and extent of new lines and markings.

- Horizontal and vertical alignment and superelevation rates for detours, including cross-section and profile grades along each edge of the existing pavement.
- Drainage details for temporary and permanent alignments.
- Location, length, and/or spacing of channelization and protective devices (e.g., temporary barrier, guardrail, barricades).
- Starting time, duration, and date of the planned change.
- For each traffic shift, a paving plan, erection plan, or worksite plan, as appropriate, detailing workforce, materials, and equipment necessary to accomplish the proposed work. This will be the minimum resource allocation required to start the work.

Details must be submitted and approved, and preparatory work completed as follows before work may commence:

- Submit a minimum of three copies of the above details to the Engineer for approval at least 14 days prior to the anticipated traffic shift.
- Ensure the Contractor has traffic control details for a traffic shift that has been approved by the Engineer prior to commencement of the physical shift.
- Accomplish all preparatory work relative to the traffic shift, which does not interfere with traffic, prior to the designated starting time.
- Have the Engineer and the Contractor's representative verify that all conditions have been met prior to the Contractor obtaining materials for the actual traffic shift.

A.9.2 Work Zone Traffic Control

Introduction

The safety of road users, including pedestrians and bicyclists, as well as personnel in work zones, should be an integral and high priority element of every Project in the planning, design, maintenance, and construction phases. The following principles should be applied to temporary traffic control zones:

- Disrupt traffic movement as little as possible.
- Guide road users in a clear and positive manner in the approach and within construction, maintenance, and utility work areas.
- Perform routine inspection and maintenance of traffic control elements both day and night.
- Design traffic control in TTC zones on the assumption that road users will only reduce their speeds if they clearly perceive a need to do so, and then only in small increments of speed.
    - Temporary traffic control zones should not present a surprise to the road user.
    - Frequent and/or abrupt changes in geometrics and other features should be avoided.
    - Transitions should be well delineated and long enough to accommodate driving conditions at the speeds vehicles are realistically expected to travel.

Traffic Control (TC) Zones

A TC zone is an area of a highway where road user conditions are changed because of a work zone, an incident zone, or a planned special event through the use of TC devices, uniformed law enforcement officers, or other authorized personnel.

- *Work Zone*: An area of a highway with construction, maintenance, or utility work activities. A work zone typically:
  - Is marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles
  - Extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last TC device
- *Incident Zone*: An area of a highway where temporary traffic controls are imposed by authorized officials in response to a traffic incident (see MUTCD Section 6I.01). An incident zone:
  - Extends from the first warning device (such as a sign, light, or cone) to the last TC device or to a point where road users return to the original lane alignment and are clear of the incident
- *Planned Special Event Zone*: An area of highway(s) where a planned special event creates the need to establish altered traffic patterns to handle the increased traffic volumes generated by the event.
  - Size of the TC zone associated with a planned special event can be small, such as closing a street for a festival, or can extend throughout a municipality for larger events.
  - Duration of the TC zone is determined by the period of the planned special event

Traffic Interruption Restrictions

The Department reserves the right to restrict construction operations when, in the opinion of the Engineer, the continuance of the work would:

- seriously hinder traffic flow,
- be needlessly disruptive, or
- unnecessarily inconvenience the traveling public.

The Contractor must suspend and/or reschedule any work when the Engineer deems that conditions are unfavorable for continuing the work.

Advance notification requirements to the Contractor to suspend work will be according to the events and the time restrictions outlined in Table A-6.

Table A-6: Advance Notification Requirements

Incident management	No advance notice required
Threatening/Inclement weather	24 hours
Holidays, sporting events, unfavorable conditions	Three (3) calendar days

If the work is suspended, the Contractor may submit a request for additional Contract time as allowed under Section 108.

- The Department will review the request and may grant additional Contract time as justified by the impact to the Contractor's schedule.
- Compensation for loss of productivity, rescheduling of crews, rental of equipment, or delays to the Contractor's schedule will not be considered for payment.
- Additional Contract time will be the only consideration granted to the Contractor.

Traffic Interruption Procedures

This Standard Operating Procedure (SOP) provides direction and parameters for providing accurate and timely information to the citizens of the State of Georgia relevant to construction projects. The Traffic Interruption Report (TIR) is a report of current and planned construction road closures, emergency road closures, and road conditions statewide. The intent is to capture all traffic interruptions that occur on Interstates and State routes throughout the state.

The Department uses a web-based TIR application to enter road closures into the network database. TIRs are primarily submitted by personnel from the offices of Construction and Maintenance; however, any office within the Department that interrupts the flow of traffic with a lane closure must submit a TIR into the database.

- Submit a TIR for situations that include, but are not limited to, travel lane closures, shoulder closures, traffic paces, and/or moving operations. Specific examples of the type of work in which a TIR should be submitted include:
  - Closing a lane(s):
    - due to bridge work
    - for widening a roadway
    - for pavement repair
    - to protect employees working on the shoulder
    - to pave the roadway
    - for concrete work
    - for bridge painting
    - for striping
    - to construct a sound barrier wall
  - Pacing traffic
    - to move construction equipment
    - to hang overhead signs
  - Any other planned lane closing event
- Enter the information into the TIR application updates 511 and the Georgia NaviGAtor website (http://www.georgia-navigator.com) to provide real-time construction information to the public.
  - Once the scheduled times on TIRs are reached, the road closure is considered "active" and all information is disseminated automatically to 511, Georgia-Navigator.com, TREX, Automated Routing and Permitting System (ARPS), and other databases.

    - The accuracy, timeliness, and reliability of these systems are contingent upon the data entry and reporting features being complete within each TIR.
    - It is essential to ensure that TIRs are updated as roadway conditions change.
- Be aware that the TMC Operators also assist the Districts with creating and updating TIRs when necessary.
    - The TMC Operators have the ability to create TIRs when none are present in the TIR application for closures.
    - TMC Operators also have the ability to make revisions to TIRs, such as lane changes, date/time updates, contact information, etc.
    - To ensure accuracy of the Georgia-NaviGAtor website and 511, the TMC has developed procedures internally to continually review all closures on the website, and make sure the TIR application is updated accordingly.

Procedure for Daily/Weekday Closure

Daily lane closures are required to have a TIR posted in the database ***at least 24 hours prior*** to the closure being active in the roadway.

- Once TIRs are received, they are compiled by the TMC Operations staff and reviewed daily to ensure there are no potential conflicts or Projects that may overlap.
    - Any overlapping Projects, conflicts or major events that may be impacted by construction will be brought to the attention of the Director of Construction, who will ultimately allow or reject the proposed closure.
- Once a TIR has been submitted in the database for the closure, the designated Project Engineer/Project Manager must contact TMC via phone at least 30 minutes prior to the scheduled start time to advise that the closure is active (in the roadway affecting traffic/ before traffic control is put in place so the TMC can display messages on the Changeable Message Signs).
- Once a closure has been removed from the roadway, the designated personnel must advise TMC that the closure has been removed and the roadway is reopened. This allows TMC to remove any CMS message related to the closure and the public is hereby aware that all lanes are open.
- If the lane closure will be in the roadway beyond the scheduled end time, revise the TIR with the new end time.
- When information concerning the closure changes, such as lanes affected, end time, mile post numbers, or contact person on scene, update the TIR as soon as possible.
    - District personnel are responsible for making the updates to the TIR.
    - If the closure is cancelled for the day, district personnel are required to edit the TIR to reflect the change and notify TMC.

Procedure for Weekend Closures

The criteria for posting and making notifications for weekend closures are very similar to daily closures. The difference for weekend closures is that the TIR for weekend lane closures must be posted in the database ***by 12:00 p.m. on the Wednesday before the start date*** of the weekend lane closure.

- Once TIRs are received, they are compiled by the TMC Operations staff by 12:00 noon on Thursday and reviewed to ensure there are no potential conflicts or Projects that may overlap.
    - Any overlapping Projects, conflicts, or major events that may be impacted by construction will be brought to the attention of the Director of Construction, who will ultimately allow or reject the proposed closure.
- Provide detailed contact information for all weekend closures. All other criteria for daily lane closures apply to weekend lanes closures.

<u>Tips for Creating/Updating TIRs</u>

All closure information should be entered into the TIR application as accurately as possible. Below are a few tips to keep in mind when creating or updating TIRs.

- All TIRs are subject to approval by the Director of Construction.
- If a closure is in both directions, enter two TIRs (one for each direction of travel).
- Make appropriate updates to the TIR in a timely manner if closure information changes.
- Call closures in/out to the TMC in a timely manner, including changes, delays, or cancellations.
- If District personnel are unable to update the TIR themselves:
    - They should notify someone in the Area or District office.
    - If they are not able to reach anyone at the District office, they must call the updates in to TMC, and TMC will make the changes to the TIR. ***Failure to do this will result in inaccurate information for the public.***
- Verify, edit, and modify all TIRs daily.

Work Zone Speed Limits

The Inspector should verify that speed limits in work zones are clearly posted and in accordance with the following:

- The minimum reduction of the posted speed limit will be no less than 10 mph (16 kph) and a maximum reduction of no greater than 20 mph (32 kph).
- Do not use regulatory speed limit signs (black on white) to reduce speeds to less than 10 mph (16 kph) below the original speed limit unless one or more of the following conditions exist in the work zone:
    - Sharp cresting vertical curves
    - Horizontal shifts
    - Work performed near a travel lane

Traffic Control for Utility Work

When GDOT's Contractor or Subcontractor performs utility work, traffic control must be in accordance with the Contract Specifications (typically Special Provision 150).

- A Utility Owner, or a Contractor hired by the Utility Owner, performing utility work, whether by permit or agreement, must control traffic according to the current policy of the Utilities Office, even if the department is reimbursing the Utility Owner through a Force Account or the work lies within a construction work area.
- The Utilities Office is responsible for planning with the Department's Contractor a schedule of operations that will clearly set forth at which stage of the Contractor's operations the Utility Owner will be required to perform its relocation and adjustment work.
- The utility traffic control must be in accordance with the *Manual on Uniform Traffic Control Devices*, current edition.
    - The Utility Owner will plan and determine the scope of a temporary traffic control plan (TCP).
    - The Utility Owner will indicate on each individual permit application whether the TCP is based on the typical application drawings contained in Part 6 of the MUTCD or a detailed TCP designed solely for a particular worksite, or a combination of both.
        - If the Utility Owner determines that a detailed TCP designed solely for a particular worksite is needed, a copy of the detailed TCP must be submitted with the permit application.
        - The Department reserves the right to request a detailed TCP upon review of the permit applications.
- Prior to commencing work associated with highway construction, whether by permit or agreement, the Utility Owner must notify the Department's Area Engineer or Project Engineer and present its work schedule and temporary traffic control plan. This allows for:
    - A review for any changes from the preconstruction phase submittal
    - Understanding by all parties prior to occupying the worksite
- All flaggers must be certified from a Department-approved training program.
    - Flaggers must have their certification with them at all times when flagging, and may be subject to inspection.
    - Failure to provide certified flaggers will be reason for suspending work requiring the flagger(s) until a certified flagger can be provided.
- The Engineer reserves the right to require additional flaggers, signs, warning lights, channelization devices, and other safety devices as may be necessary to properly protect, warn, and safeguard the traveling public.
    - Continued failure of the Utility to comply with the requirement of this or any other related section will result in the Engineer issuing a written order to stop work (i.e., stop work order).
    - Upon issuance of a stop work order, all utility work on the right-of-way will be suspended, except erosion control and traffic control, until corrective actions or deficiencies are addressed, and the Engineer issues a written resume work order.

Contact the State Utilities Office or the appropriate District Utilities Office for further guidance. To obtain photocopies of the Georgia Utilities Coordinating Council (GUCC) Manual and copies of individual traffic control plans, contact the District Utility Office.

One-Lane, Two-Way Traffic Control

When traffic in both directions must use a single lane for a limited distance, movements from each end must be coordinated. The Inspector should ensure these guidelines are followed:

- Make provisions for alternate one-way movement through the constricted section via methods such as:
    - flagger control,
    - a flag transfer,
    - a pilot car,
    - traffic control signals, or
    - stop or yield control.
- Choose control points at each end to permit easy passing of opposing lanes of vehicles.
- If traffic on the affected one-lane roadway is not visible from one end to the other, then use:
    - flagging procedures,
    - a pilot car with a flagger as described in MUTCD Section 6C.13, or
    - a traffic control signal to control opposing traffic flows.

Flagger Method of One-Lane, Two-Way Traffic Control

Traffic should be controlled by a flagger at each end of a constricted section of roadway. This should be accomplished following these guidelines:

- Designate one of the flaggers as the coordinator.
- To provide coordination of the control of the traffic, ensure the flaggers can communicate with each other orally, electronically, or with manual signals.
    - These manual signals should not be mistaken for flagging signals.

When a one-lane, two-way TC zone is short enough to allow a flagger to see from one end of the zone to the other, traffic may be controlled by ***either*** a single flagger or by a flagger at each end of the section as follows:

- Station a single flagger:
    - on the shoulder opposite the constriction or work space, or
    - in a position where good visibility and traffic control can be maintained at all times.
- Control traffic by a flagger at each end of the section when good visibility and traffic control cannot be maintained by one flagger station.

Temporary Traffic Control Devices

The Inspector should ensure the Contractor installs and maintains temporary traffic control devices as detailed in the plans.

- Erect the required temporary traffic control devices to prevent any hazardous conditions and in conjunction with any necessary traffic re-routing to protect the traveling public and workers, and to safeguard the work area. ***Immediately remove or cover any devices that do not apply to existing conditions.***
- Ensure all temporary traffic control devices meet the MUTCD requirements. Manufacturers seeking evaluation must furnish certified test reports showing that their product meets all test requirements set forth by NCHRP 350.
- Have the worksite traffic control supervisor notify the Engineer of any scheduled operation that will affect traffic patterns or safety sufficiently in advance of commencing such operation to permit a review of the plan for the proposed installation of temporary traffic control devices.
- Assign the WTCS the responsibility of maintaining the position and condition of all temporary traffic control devices throughout the duration of the Contract.
    - Keep the Engineer advised at all times of the identification and means of contacting this employee on a 24-hour basis.
    - Be certain the WTCS is able to respond effectively to an emergency within 45 minutes of notification.
- Keep temporary traffic control devices in the correct position, properly directed, clearly visible and clean at all times. ***Immediately repair, replace, or clean damaged, defaced, or dirty devices.***

Work Zone Signs

Signs provided in work zones must be in accordance with the plans and design standards. They must also do the following:

- Meet the requirements of Special Provision Section 150.
- Provide Federal Highway Administration’s (FHWA) accepted sign substrate for use with accepted sign stands on the National Highway System (NHS) under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features.”

All sections or segments of the roadway under construction or reconstruction must be signed as a highway work zone except non-State highway two-lane two-way resurfacing projects. Two conditions can be applied to a highway work zone.

- *Condition 1*: No reduction of the existing speed limit is required
- *Condition 2*: A reduction of the speed limit through the designated work zone is required

Properly marking a highway work zone for these conditions will include the following minimum requirements:

- *Condition 1 – No Reduction of the Existing Posted Speed Limit in the Highway Work Zone*
  - Post signage (Detail 150-HWZ-1) at the beginning point of the highway work zone warning the traveling public that increased penalties for speeding violations are in effect.
    - Place the HWZ-2 sign a minimum of 600 ft in advance of the highway work zone and not more than 1000 ft in advance of the work zone.
    - Place the HWZ-2 at 750 ft from the work area between the ROAD WORK 500 FT and the ROAD WORK 1000 FT signs, as recommended if no speed reduction is required.
  - Place HWZ-2 signs at intervals not to exceed 1 mile for the length of the Project.
  - Place HWZ-2 signs on the mainline after all major intersections except State routes.
  - Sign State routes as per the requirements for intersecting roadways below.
  - Post the existing speed limit at the beginning of the work zone. Maintain existing Speed Limit signs (R2-1).
  - Intersecting Roadways:
    - Sign intersecting State routes in advance of each intersection with the work zone with an HWZ-2 sign to warn motorists that increased fines are in effect.
    - Sign all other intersecting roadways that enter into a designated highway work zone in advance of each intersection with the work zone.
    - When construction equipment and personnel are present in the intersection on the mainline of a multi-lane roadway, sign the intersecting side roads in advance with HWZ-2 signs.
    - Remove the signage as soon as the work operation clears the intersection.
  - Post an HWZ-3 sign at the end of the highway work zone indicating the following:
    - End of the zone
    - Increased penalties for speeding violations are no longer in effect
  - Remove all signs immediately when a designated highway work zone is no longer necessary.

- *Condition 2 – Reduction of the Speed Limit in a Highway Work Zone*
  - For limited-access (Interstate) highways and controlled-access multi-lane divided highways, reduce the posted speed limit as required below.
    - Post highway work zone signs as required in Condition 1 above.
    - Place signs as follows:
      - ✓ Erect speed limit signage (R2-1) for the reduced speed limit at the beginning of the work zone.
      - ✓ Place additional signs to ensure that the maximum spacing of the reduced speed limit signs is no greater than 1 mile apart.
      - ✓ Cover or remove existing speed limit signs.
  - On multi-lane divided highways, double indicate the speed limit signs when the reduced speed is in use.

- Use the following guidelines to determine the appropriate highway work zone speed:
  - If the existing speed limit is 60 mph, reduce the speed limit by 5 mph.
  - If the existing speed limit is 55 mph or less, allow the Contractor to reduce the speed limit only with the prior approval of the Engineer.
  - Reduce the speed limit by no more than 10 mph when any one or more of the following conditions exist *and* the existing speed limit is 65 mph or 70 mph:
    - ✓ Lane closure(s) of any type and any duration
    - ✓ When the difference in elevation exceeds 2 in. adjacent to a travel lane as shown in Subsection 150.06, Detail 150-B, Detail 150-C
    - ✓ Any areas where equipment or workers are within 10 ft of a travel lane
    - ✓ Temporary portable concrete barriers located less than 2 ft from the traveled way
    - ✓ As directed by the Engineer for conditions distinctive to this Project
  - When the above reduction of speed limit conditions are not present, return the speed limit immediately to the existing posted speed limit.
- Adhere to these general requirements when reducing the speed:
  - Do not put a speed reduction in place for the entire length of the Project unless conditions warranting the speed reduction are present for the entire Project length.
  - Cover or remove all existing speed limit signs within the temporary speed reduction zone while the temporary reduction in the speed limit is in effect.
  - Ensure all signs are erected to comply with the minimum requirements of the MUTCD.
- Require as a minimum the following records be kept by the WTCS:
  - Identify the need for the reduction.
  - Record the time of the installation and removal of the temporary reduction.
  - Fully describe the location and limits of the reduced speed zone.
  - Document any accident that occurs during the time of the reduction.
- Submit to the Engineer a copy of the weekly records for reduced speed zones.
- Sign reduced speed zones, at a minimum, as per Detail 150-HWZ-1.
  - Ensure interim signs meet the requirements of Subsection 150.03 D.
  - Use additional signs as necessary to adjust for actual field conditions.
- When a pilot vehicle is used on a two-lane two-way roadway, do not reduce the speed limit.
- For special conditions specific to the work, on two-lane two-way roadways or multi-lane highways, allow the Contractor to reduce the posted speed limit with prior approval of the Engineer.

Roadwork Ahead Sign

The ROADWORK AHEAD sign (Figure A-39) should be used to give advance warning of all long-term worksites. It is used in advance of the traffic control taper of the work area.

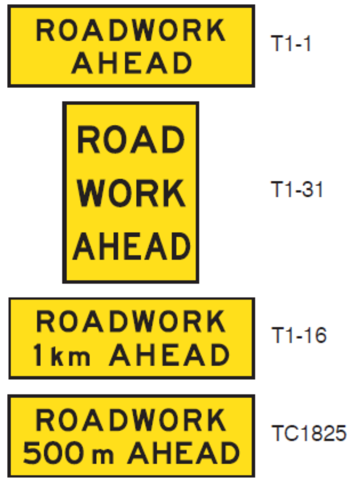


Figure A-39: Roadwork Ahead Signs

Exit Closed Signs

An EXIT CLOSED sign (Figure A-40) is placed in advance of a closed freeway exit.

Figure A-40: Exit Closed Sign

A.9.3 Temporary Traffic Control Elements

Reflectorization Requirements

To provide visibility of traffic control elements, the following requirements for reflectorization apply:

- All rigid fluorescent orange construction warning signs (black on fluorescent orange) must meet the reflectorization and color requirements of ASTM Type VII, VIII, IX, or X, regardless of the mounting height.
- Portable signs that have flexible sign blanks must meet the reflectorization and color requirements of ASTM Type VI.
- Warning signs (W3-1a) for stop conditions that have rumble strips located in the travelway must be reflectorized with ASTM Type IX fluorescent yellow sheeting.

- All other signs must meet the requirements of ASTM Type III or IV, except “Pass With Care” and “Do Not Pass” signs may be ASTM Type I, unless otherwise specified.
- Channelization devices must meet the requirements of ASTM Type III or IV high-intensity sheeting.

Refer to GDOT Qualified Products List–29 “Reflective Sheeting.”

Sign Panels, Vertical Panels, Barricades, and Other Devices

The Inspector must ensure sign panels, vertical panels, barricades, and other devices meet the requirements of ASTM D 4956 for Type III or higher retroreflective sheeting materials identified in Section 994, except mesh signs must meet Section 994, Type VI requirements for:

- Color
- Daytime luminance
- Nonreflective property requirements

Also refer to Qualified Products List–34 “Work Zone Traffic Control Devices.”

Collars for Traffic Cones and Bands for Barrels

Collars for Traffic Cones and Bands for Tubular Markers must meet the requirements of ASTM D 4956 Type VI.

Drums

Drums (Figure A-41) must meet the requirements of ASTM D 4956 for Type III or higher retroreflective sheeting materials identified in GDOT Standard Specifications Section 913, including supplementary requirements for reboundable sheeting.

Figure A-41: Drum

Changeable Message Sign and Housing

The Inspector should ensure that the portable changeable message signs (PCMS) meet the requirements of Section 632 and the MUTCD.

- Delineate any PCMS in use that is not protected by positive barrier protection by a minimum of three drums that meet the requirement of Section 150.05.A.1.
  - Do not exceed drum spacing of a maximum of 10 ft as shown in Detail 150—PCMS.
  - When the PCMS is within 20 ft of the opposing traffic flow, delineate the trailing end of the PCMS with a minimum of three drums spaced in the same manner as the approach side of the PCMS.
- When not in use:
  - Remove the PCMS from the roadway unless protected by positive barrier protection.
  - If the PCMS is protected by positive barrier protection when not in use, turn the sign panel away from traffic.
- Ensure the display housing assembly is weathertight.
- Use only nuts, bolts, washers and other fasteners of corrosion-resistant material.
- Equip the display assembly with an automatic dimming operational mode capable of a minimum of 50% dimming and a separate manual dimmer switch.
- Ensure the following minimum heights:
  - The display panel for arrow boards and changeable message signs, when raised in the upright position, must have a minimum height of 7 ft from the bottom of the panel to the ground, in accordance with the MUTCD.
  - The display panel for radar speed display units, when raised in the upright position, must have a minimum height of 5 ft from the bottom of the panel to the ground.
  - The regulatory speed sign panel for regulatory signs and radar speed display units, when raised in the upright position, must have a minimum height of 7 ft from the bottom of the regulatory sign panel to the ground.
- Verify that the unit has an accessible mechanism to easily raise and lower the display assembly. Provide a locking device to ensure the display panel will remain in the raised or lowered position.

Also refer to Qualified Products List–48 “Changeable Message Signs” and Qualified Products List–82 “Portable Changeable Message Signs.”

Arrow Panels

The Inspector should ensure that portable sequential or flashing arrow panels as shown in the plans or specifications for use on Interstate or multi-lane highway lane closure only meet the following requirements:

- Ensure the following size and legibility minimum requirements are met:
  - Minimum size panel is 48 in. high by 96 in. wide with not less than 15 lamps used for the arrow
  - Arrow occupies virtually the entire size of the arrow panel and has a minimum legibility distance of one mile

    - Minimum legibility distance is that distance at which the arrow panel can be comprehended by an observer on a sunny day or clear night
    - Arrow panels are equipped with automatic dimming features for use during hours of darkness
    - Arrow panels meet the requirements for a Type C panel as shown in the MUTCD
- Do ***not*** use the sequential or flashing arrow panels for lane closure on two-lane, two-way highways when traffic is restricted to one-lane operations. In that case, appropriate signing, flaggers, and, when required, pilot vehicles will be deemed sufficient.
- Require placement according to the following:
    - Place the sequential or flashing arrow panels on the shoulder at or near the point where the lane closing transition begins.
    - Mount the panels on a vehicle, trailer, or other suitable support.
    - Provide vehicle-mounted panels with remote controls.
    - Ensure the minimum mounting height is 7 ft above the roadway to the bottom of the panel, except on vehicle-mounted panels, which should be as high as practical.
- Use the following guidelines for emergency situations:
    - Use arrow display panels that meet the MUTCD requirements for Type A or Type B panels until Type C panels can be located and placed at the site.
    - Hold the use of Type A and Type B panels to the minimum length of time possible before having the Type C panel(s) in operation.
    - Allow the Engineer to determine when conditions and circumstances are considered to be emergencies.
    - Ensure the Contractor notifies the Engineer, in writing, when any nonspecification arrow display panel(s) is being used in the work.

Refer to Qualified Products List–79 “Portable Arrow Boards.”

Temporary Barriers

Temporary barriers must meet the following standards:

- MUTCD and Subsection 150.05 of Special Provision 150: Traffic Control
- GDOT Standard Specifications Section 622: Precast Concrete Barrier
- GDOT Construction Standard 4961: Details of Precast Temporary Barrier.

The Inspector must ensure that temporary barriers are placed as required by the plans, standards, and as directed by the Engineer.

- When Temporary barrier is located 20 ft or less from a travel lane, fix yellow reflectors:
    - to the top of the barrier at intervals not greater than:
        - 40 ft in the longitudinal section and
        - 20 ft in the taper section, and
    - mounted approximately 2 in. above the barrier.
- If both lanes of a two-lane two-way roadway are within 20 ft or less of the barrier, install the reflectors for both directions of traffic.
- Ensure the reflectors are 100 $in.^2$ (ASTM Type VII or VIII) reflective sheeting mounted on flat-sheet blanks.
- Attach the reflectors to the barrier with adhesive or by a drilled-in anchor type device.

- Do ***not*** attach the reflectors to a post or board that is placed between the gap in the barrier sections.
- Ensure the approach end of a temporary barrier is flared or protected by an impact attenuator (crash cushion) or other approved treatment in accordance with Construction Details/Standards and GDOT Standard Specifications.
- On Interstate or other controlled-access highways where lane shifts or crossovers cause opposing traffic to be separated by less than 40 ft, use portable barrier as a separator.

Temporary Traffic Signals

Temporary traffic signals must meet the requirements of Section 647: Traffic Signal Installation of the GDOT Standard Specifications and the MUTCD.

Rumble Strips

Rumble strips incorporated into the work must meet the requirements of Section 429: Rumble Strips and the MUTCD.

The Inspector should ensure that existing rumble strips that are positioned in the traveled way to warn traffic of a stop condition are reinstalled based on the following requirements:

- *Intermediate Surfaces*:
  - For intermediate surfaces that will be in use for more than 45 calendar days, reinstall rumble strips on the traveled way in the area of a stop condition.
  - Be aware that nonrefundable deductions in accordance with Subsection 150.08 will be assessed for any intermediate surface in place for greater than 45 days without rumble strips.
- *Final Surfaces*:
  - Install rumble strips on the final surface within 14 calendar days of the placement of the final surface in the area of the stop condition.
  - Failure to install within 14 calendar days will result in assessment of nonrefundable deductions in accordance with Subsection 150.08. 10
- Prior to the removal of any rumble strips located in the travelway, Stop Ahead (W3-1a) warning signs will be double indicated ahead of the stop condition.
  - Ensure a minimum size for the warning signs of 48 in. × 48 in.
  - Ensure the reflectorization of the warning signs is as required by Subsection 150.01.D.
  - Keep these warning signs in place until the rumble strips have been reinstalled on the traveled way.
  - Remove or cover any existing warning signs for the Stop Ahead condition while the 48 in. × 48 in. (W3-1a) signs are in place.
  - When the rumble strips have been reinstalled, promptly remove these warning signs and place any existing signage back in service.

A.9.4 Traffic Control Devices, Barricades, Cones, Etc.

Standard Traffic Cones

The Inspector must ensure that all cones meet the requirement of the MUTCD.

- Make certain all cones are a minimum of 28 in. in height, regardless of application.
- Allow reflectorization to be deleted from all cones.
- For longitudinal channelizing only, permit cones for daylight closures or minor shifts. (Drums are required for all tapers.)
- Do ***not*** permit the use of cones for nighttime work.
- Do ***not*** store cones or allow them to be visible on the worksite during nighttime hours.

Portable Plastic Drums

The Inspector should expect that drums meet the minimum requirement of the MUTCD and be reflectorized as required in Subsection 150.01.D.

- Locate the upper edge of the top reflectorized stripe on the drum a minimum of 33 in. above the surface of the roadway.
- Maintain a minimum drum diameter of 18 in. for a minimum of 34 in. above the roadway.
- Use drums as the required channelizing device to delineate the full length of a lane closure, shift, or encroachment, except as modified by this Subsection.
- *Transition Tapers for Lane Closures*:
    - Use drums on all transition tapers.
    - Use the minimum length for a merging taper for a lane closure on the travelway as shown in Table A-7.
- If site conditions require a longer taper, then lengthen the taper to fit individual situations.
- Ensure the length of shifting tapers is at least ½ L.
- Limit the length of a closed lane or lanes, excluding the transition taper(s), to a total of 2 miles. Prior approval must be obtained from the Engineer before this length can be increased.

Table A-7: Minimum Lengths for Merging Tapers of Lane Closures

Posted Speed Limit, mph	Lane Width 9 ft	Lane Width 10 ft	Lane Width 11 ft	Lane Width 12 ft	Maximum Drum Spacing Tapers (ft)
	Minimum Taper Length (L) in Ft				
20	60	70	75	80	20
25	95	105	115	125	25
30	135	150	165	180	30
35	185	205	225	245	35
40	240	270	295	320	40
45	405	450	495	540	45
50	450	500	550	600	50
55	495	550	605	660	55
60	540	600	660	720	60
65	585	650	715	780	65
70	630	700	770	840	70
75	675	750	825	900	75

- *Night Time Conditions*: When a merge taper exists into the night, ensure all drums located in the taper have, for the length of the taper only, a 6-in. fluorescent orange (ASTM Type VI, VII, VIII, IX, or X) reflectorized top stripe on each drum.
    - Allow the top 6-in. stripe to be temporarily attached to the drum while in use in a taper.
    - The Engineer may allow the fluorescent orange reflectorized 6-in. top stripe on each drum in a merging taper to remain in place during daylight hours provided there is a lane closure(s) with a continuous operation that begins during one nighttime period and ends during another nighttime period.
    - Do not use for any other conditions those drums that have the 6-in. top stripe permanently attached.
- *Multiple Lane Closures*:
    - Close a maximum of one lane at a time with each merge taper.
    - Install a minimum tangent length of 2 L between each individual lane closure taper.
- *Longitudinal Channelization*: Space drums as listed below for various roadside work conditions except as modified by Subsection 150.06 of Special Provision 150: Traffic Control. Use spacing for situations meeting any of the conditions listed as follows:
    - *40-ft spacing maximum*
        - For difference in elevation exceeding 2 in.
        - For healed sections no steeper than 4:1 as shown in Subsection 150.06, Detail 150-E of Special Provision 150: Traffic Control
    - *80-ft spacing maximum*
        - For difference in elevation of 2 in. or less
        - Flush areas where equipment or workers are within 10 ft of the travel lane

    - *200-ft spacing maximum*: Where equipment or workers are more than 10 ft from travel lane. Lateral offset clearance is to be 4 ft from the travel lane.
        - For paved areas 8 ft or greater in width that are paved flush with a standard width travel lane
        - Disturbed shoulder areas not paved with the typical section of asphalt should be flush to the travel lane and considered a usable shoulder

Vertical Panels

All vertical panels must meet the minimum requirements of the MUTCD.

- Ensure all vertical panels have a minimum of 270 in.^{2} of retroreflective area facing the traffic and are mounted with the top of the reflective panel a minimum of 36 in. above the roadway.
- Ensure lane encroachment by the drum on the travelway permits a remaining lane width of 10 ft.
    - When encroachment reduces the travelway to less than 10 ft, use vertical panels to restore the travelway to 10 ft or greater.
    - Be aware that no other application of vertical panels will be permitted.

Barricades

<u>Type III Barricades</u>

The Inspector must ensure that Type III barricades meet the minimum requirements of the MUTCD and are reflectorized as required in Subsection 150.01.D of Special Provision 150: Traffic Control.

- Reflectorize the barricades with a Type III High Intensity retroreflective sheeting unless otherwise specified by the plans and the specifications.
- Ensure that the retroreflective sheeting has alternate orange and white stripes sloping downward at 45-degree angles.
- Apply the sloping orange and white stripes in accordance with the requirements of the plans.

<u>Barricades, Warning Signs, and Flaggers</u>

All barricades, warning signs, lights, temporary signals, other protective devices, flaggers, and signaling devices must meet or exceed the minimum requirements contained in the MUTCD that is current at the time bids are received. The Inspector should follow these guidelines:

- Where side roads intersect a multi-lane street or highway that has a speed limit of 45 mph or higher, ensure the minimum size of the STOP signs facing the side road approaches, even if the side road only has one approach lane, is 48 × 48 in.
- Where side roads intersect a multi-lane street or highway that has a speed limit of 40 mph or lower, ensure the minimum size of the STOP signs facing the side road approaches is as shown in the Single Lane or Multi-lane columns of Table A-8 (from the MUTCD) based on the number of approach lanes on the side-street approach.

- Ensure that signs mounted on barricades and barricade/sign combinations are crashworthy.
- Ensure sign supports are crashworthy. Where large signs having an area exceeding 50 ft^2 are installed on multiple breakaway posts, the clearance from the ground to the bottom of the sign must be at least 7 ft.

Table A-8: Stop Sign Size

Sign or Plaque	Sign Designation	Section	Conventional Road		Expressway	Freeway	Minimum	Oversized
			Single Lane	Multi-Lane				
Stop	R1-1	2B.05	30 x 30*	36 x 36	36 x 36	–	30 x 30*	48 x 48

Temporary Barrier Wall

Temporary concrete barrier wall for use on roadway sections must comply with requirements as specified in the plans. For further information, refer to the following:

- GDOT Standard Specifications, Section 621: Concrete Barrier
- GDOT Construction Standards Section 4960: Concrete Barrier, Temporary

Temporary Glare Screen

Furnish, install, maintain, remove, and relocate glare screen systems in conjunction with temporary barrier wall at locations identified in the plans. The Inspector should verify the following usage related to the glare screen:

- Ensure the anchorage of the glare screen to the barrier is capable of safely resisting an equivalent tensile load of 600 lb/ft of glare screen, with a requirement to use a minimum of three fasteners per barrier section.
- When glare screen is utilized on temporary barrier wall, do not require warning lights.

Other Traffic Control Devices

Some signs that might be applicable in a temporary traffic control zone on a low-volume road are shown in Figures A-42 and A-43.

Figure A-42: Regulatory Signs and Plaques in Temporary Traffic Control Zones

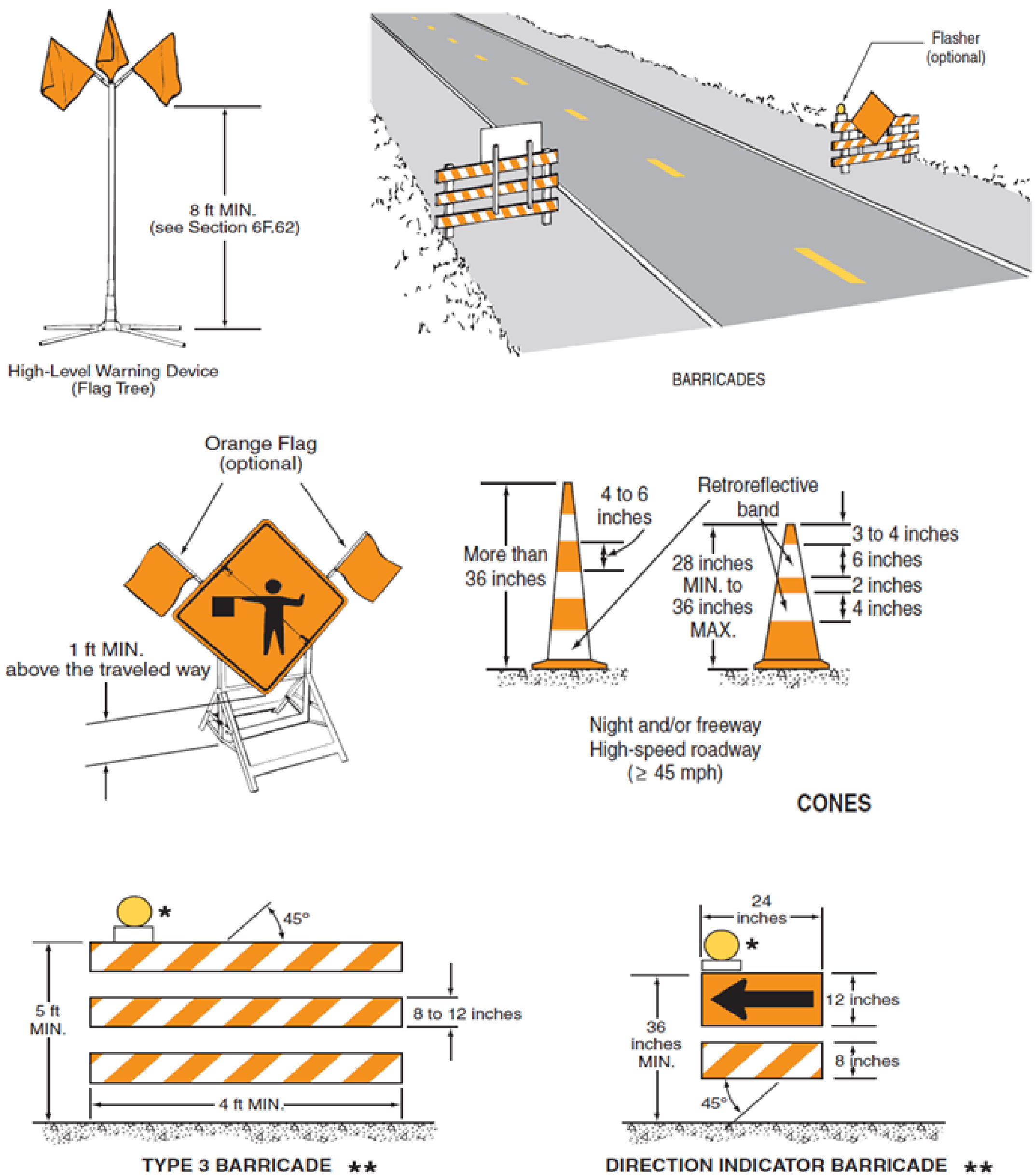


Figure A-43: Traffic Control Devices in Temporary Traffic Control Zones

A.9.5 Impact Attenuator

This work consists of the furnishing (including spare parts), installation, maintenance, relocation, re-use as required, and removal of portable impact attenuator units/arrays.

Portable Impact Attenuator

<u>Materials</u>

Materials used in the attenuator must meet the requirements of Section 648: Portable Impact Attenuators of the GDOT Standard Specifications.

<u>Construction</u>

Portable impact attenuator unit/arrays installation must:

- Conform to the requirements of Section 648, the manufacturer's recommendations, and Georgia Standard 4960
- Be installed at locations designated by the Engineer, and/or as shown on the plans

Permanent Impact Attenuator

<u>Material</u>

Use attenuators that have been approved by FHWA as meeting NCHRP 350 for the test level required. The Inspector should ensure they also meet the following requirements:

- Section 650: Impact Attenuator Units (Compression Crash Cushion) of the GDOT Standard Specifications Qualified Products List–64 "Impact Attenuator Units"
- Requirements as shown in Table A-9

Table A-9: Requirements of Cell Type Attenuator

Type 1	Cell sandwich	High speed (45 mph [70 kph] and over)*
Type 1-A	Cell cluster	Low speed (up to 45 mph [70 kph])*
* mph (kph) shown are for general information and may change due to actual design conditions.		

Cells

The Inspector is responsible to inspect the attenuator cell cartridges for consistency with the following requirements:

- *Flexible Cell Cartridges for Cell Sandwich Type Attenuator:*
  Provide material for a cell sandwich type attenuator as follows:
  - Use flexible cell cartridges with:
    - Outside diameter of approximately 5½ in. (140 mm)
    - Standard lengths of 24 in. (600 mm), 30 in. (750 mm), and 36 in. (900 mm)
  - Use cartridges made of vinyl-coated nylon fabric (Shelter-lite style 3022-RG-0) or equal with these features:
    - Consists of 6.1 oz/yd² (207 g/m²) of nylon and 16 oz/yd² (543 g/m²) of vinyl to produce a total weight of 22.1 oz/yd² (750 g/m²)

    - Remains flexible and watertight in extreme heat and cold
    - Has a hydrostatic resistance of 300 psi (2070 kPa) or better
  - Permanently glue an insert containing orifices to regulate the release of water into the open end.
  - In the nose of the cell sandwich type attenuator, use vinyl wall cells as described in this subsection, except equip each unit with a flexible cell cartridge assembly suspended in the open end.
- *Vinyl Wall Cells for Cluster Type Attenuator*:
  Provide material for a cluster type attenuator as follows:
  - Use cells that are hollow, vinyl plastic cylinders with:
    - ¼-in. (6 mm) thick walls
    - Nominal outside diameter of 6 in. (150 mm)
    - 39 in. (1 m) length, unless otherwise indicated on the plans
  - Permanently glue an insert with orifices to regulate the release of water into the open end of the cells.
  - Use cells made of high-quality plastic specially formulated from high molecular weight homopolymer vinyl resins combined with the appropriate plasticizers.
    - Ensure that the plasticizers can produce a high-strength and flexible vinyl in high and low temperatures.
  - Use ultraviolet stabilizers, heat stabilizers, antibacteriological agents, and other additives to give maximum protection and long life in outdoor environments.

Fasteners for Cluster Type Attenuator

The Inspector should follow these guidelines regarding the fasteners:

- Ensure that the fasteners are the proper length.
- Use self-drilling, heat-treated, sheet-metal screws (No. 14 hexagonal head) and speed nut-washer combinations that are cadmium plated or hot-dip galvanized.
- Join the cells at the top and bottom to adjacent or adjoining cells as required by the design.
- Attach to the structural backing system with straps and fasteners specified above, as shown on the drawings, or as recommended by the manufacturer.
- Ensure that other fastener types, such as nuts and bolts, are commercial grade, galvanized, or zinc-plated steel.

Orifice Inserts and Evaporation—Control Caps

The Inspector should follow these guidelines for the inserts and caps:

- Use insert-cap combination units made of the same quality vinyl plastic as the cells.
- Permanently attach the caps to the inserts with an adhesive that can bond the parts together.
- Determine the orifice sizes from the design requirements and permanently bond the orifice insert to the cell with a vinyl adhesive as recommended by the manufacturer.

Miscellaneous Metal Work

The Inspector should ensure use of metal parts that are:

- Consistent with ASTM A 709 Grade 36 (A 709 M Grade 250) or merchant-quality M-1020, unless otherwise specified
- Hot-dip galvanized, painted, or both, to protect against corrosion

Wire Rope

As Inspector, follow these guidelines for the wire rope:

- For the two ⅞-in. (22 mm) wire ropes, use preformed galvanized 6 × 19 wire ropes with independent wire cores.
- Have the manufacturer furnish the four pullout wire ropes.
    - Ensure they are flexible, ⅜-in. (10 mm) galvanized, 7 in. × 12 in. (175 mm × 300 mm) wire ropes, or an approved equal.
    - Use wire rope that meets the requirements of ASTM A 741, Type 2.

Diaphragms, Fender Panels, and Interior Panels

The Inspector should ensure the diaphragms and fender panels meet requirements as follows:

- Use diaphragms with a nominal thickness of 1½ in. (38 mm) and a fiberglass coating on both sides.
- Use diaphragms and fender panels designed by the manufacturer to meet the strength requirements of the unit.
- Allow fender panels that vary in thickness from ¾ in. to 1¼ in. (19 mm to 32 mm).
    - Coat both sides with fiberglass.
    - Overlay the interior panels with plywood.
    - Seal and paint the edges for further protection.

Color

The Inspector should require the attenuator to be painted as follows:

- Use a yellow attenuator painted by the manufacturer with yellow fender panels with a 6-in. (150 mm) reflectorized vertical white stripe along the outer edge of each panel, according to the plan details.

Safety Flex Belt

The Inspector must verify use of a safety belt according to these requirements:

- Have a safety flex belt wrapped around the cell clusters and nose section of cell sandwich units. Ensure that the belt is :
    - 30 in. (750 mm) high
    - Made of polypropylene cloth and resins combined to distribute loads vertically yet allow longitudinal or transverse deflections
- Use ½-in. (13 mm) diameter carriage bolts to fasten the belt to the backup or other sections of the belt or to the fender pane.

Concrete Work, Anchors, and Back-Up Assemblies

The Inspector must ensure the following applies:

- Perform concrete work with anchors.
- Construct back-up assemblies according to the plan details and the manufacturer's recommendations.

Construction Requirements

Construction requirements for the attenuator should be inspected to comply with the following requirements:

- *Personnel*:
  - Have the attenuator assembly installed by experienced workers.
  - Have experienced workers attach a cable, strap, or other device to the existing pavement, bridge, or other structure.
- *Preparation*: Before installing the attenuator unit, prepare the site, including removing and replacing concrete and other items.
- *Fabrication*: Ensure that traffic impact attenuators of the type shown are installed according to the manufacturer's recommendations and conform with the plans.
- *Construction*:
  - *Type 1 and Type 1-A Cell Sandwich and Cell Cluster*: Use vinyl wall cells in the nose portion of Type 1 and Type 1-A.
    - Use flexible cell cartridges in the cell sandwich portions of the Type 1 attenuator and place them according to the plan details.
    - Install the cells according to the manufacturer's recommendations and the plan details.
      - ✓ Installation includes filling the cells with water and enough antifreeze consisting of calcium chloride 78% flake or ethylene glycol at the rate of 3.7 lb/gal (443 g/L) to prevent freezing to −38°F (−39°C).
      - ✓ Do ***not*** use calcium chloride in attenuators mounted on structures.
    - Fasten the cells together at the top and bottom according to the manufacturer's recommendations. Ensure that the concrete portions of the attenuator are according to the plan details.
    - Have the manufacturer provide the standard anchors, clips, straps, or other incidentals to mount the attenuator.
  - *Type 2 and Type 2-A Sand-Loaded Modules*: Assemble the parts of the completed module, including filling it with sand, in sequence and according to the recommendations of the manufacturer.
    - Ensure that the weight, height, and location of each module and overall arrangement of each installation are as shown on the plans.
    - Use the bottom disc when placing Type 2 modules on soft ground or when directed by the Engineer.
    - Place the modules so they will remain in their final position after being filled with sand. Mark the location and weight of each module on the bearing surface for easy replacement.
    - After the modules are set and filled with sand, drill each lid for Type 2 attenuators at four equidistant points.
      - ✓ Pop-rivet the lids in place to prevent loss or theft.

- When placing Type 2 modules on sloping areas subject to extreme vibration, use steel half-ring locators to prevent serious displacement. These cases will be noted on the plans.
  - ✓ Install half-ring locators on the side of the downward slope according to the manufacturer's recommendations.
- When placing Type 2-A modules on surfaces subject to vibration (i.e., bridge decks) or on slopes, fasten to the surface a ¼ in. (6 mm) × ±$^{1}/_{16}$ in. (2 mm) thick stem block with a 6-in. (150 mm) diameter hole in the center. The block holds the stem of the inner container in place and prevents the module from moving.

A-9-6 After Construction

Traffic Control Device and Attenuator Check

The traffic control supervisor for Traffic will routinely review all traffic control devices and attenuator on all significant construction projects and report findings to the chief District Engineer.

- Bring major deficiencies to the immediate attention of the Section Engineer and Branch Manager for Construction.
- Solve all deficiencies before opening to the traffic.

Remove Traffic Control Devices Not in Use

When construction equipment and/or traffic control devices are not in use, the Inspector should require the Contractor to place them outside the clear zone, beyond the ditch line, behind the guardrail, or off existing right-of-way, as well as follow these guidelines.

- Have the Engineer:
  - Approve these locations if they are within the existing right-of-way
  - Designate specific areas within the right-of-way where personal vehicles may be parked
- Move vehicles and construction equipment with the flow of traffic, not against the normal traffic flow.
- When entering and leaving the work zone, ensure the movements do not interfere with or cause hazard to traffic flow.

A-10 Advanced Traffic Management System Inspector Best Practices

A-10-1 General Information

The provisions contained in this manual include general requirements for all Automatic Traffic Management System (ATMS) equipment and materials used in the construction of signalized intersections. The Inspector should ensure the following:

- Automatic Traffic Management System devices include devices electrically or mechanically operated, by which traffic is alternately directed to stop and permitted to proceed or controlled in any manner.
- Devices must meet the requirements of the Manual on Uniform Traffic Control Devices.
- Prior to installation, the Engineer will review and approve any system design plan ATMS devices that are controlled and/or operated from a remote location by electronic computers or similar devices, and which affect the movement of traffic on any portion of the State Highway System.

A-10-2 Preconstruction

Preconstruction includes all tasks performed before the actual construction site becomes active. This step is important to identify any areas of discrepancy before the project starts.

- Ensure that all devices, furnished and/or installed, are marked by the manufacturer with a permanently affixed ID plate or stamp, bearing the name or trademark of the manufacturer and the part number.
- Prior to installation, submit a complete listing of all device hardware with certification number(s) to the Engineer for approval on a form provided by the Department.
    - The Department is not liable for any equipment or material purchased, work done, or delay incurred prior to such approval.
- Provide a complete operable signal installation as specified in the Contract, regardless of any failure of the Department to discover or note any unsatisfactory material.
- Prior to final acceptance, furnish the Engineer with two copies of the following documentary items obtained from the manufacturer for the electronic equipment listed below:
    - Manual describing the theory of operation
    - Manual for troubleshooting
    - Electronic schematics of circuit boards
    - Pictorial layout of components of circuit boards
    - Parts list, including the location
    - Diagram of the field installation wiring (not applicable to the detectors)
- Before the installation of the traffic control system(s) or unit(s), have the Contractor perform a ***pre-installation test***.
    - Require that this test includes the bench testing of all controllers, signals, detectors, etc., under signal load conditions during a 14-consecutive-day “burn period.”

- Have the Contractor:
  - Secure an acceptable site, approved by the Engineer, for the bench test
  - Notify the Engineer of the date that the test is to begin ***a minimum of 7 days before that date***
  - Perform all work required in the performance of the test
- Have the Engineer schedule an inspection of the equipment with the Maintenance Engineer.
  - The 14-calendar-day burn period will not begin until the Engineer has notified the Contractor that the Maintenance Engineer has approved for this test to begin.
- Do not install any of the equipment on the Project until:
  - The bench test has been completed
  - The Contractor has submitted a letter to the Engineer certifying that the equipment performed satisfactorily during the test
    - ✓ The Engineer may shorten the length of time required for the bench testing.
- Be aware that there will be no direct payment to the Contractor for the cost of the pre-installation test, including the cost of a suitable test site and the setting up of equipment for the test.

- Allow the Engineer to inform the Contractor of:
  - The exact diameter and depth of ***concrete foundation*** required at each signal pole foundation.
  - Any changes that are required to the size and number of ***reinforcing bars*** required at each signal pole foundation.
    - This information will be given to the Contractor at the completion of the review of the Contractor's submittal of designs and details of the signal pole structures.
  - All conduit systems, elbows, etc., must be installed securely and inspected by the Project Manager before concrete is poured.
  - The Contractor must contact the utility companies to determine the location of underground utilities in the area where the foundations are to be located and will be responsible for repairing, to the satisfaction of the utility company, any damaged utilities.
- Do not install ***traffic or pedestrian signal heads*** until all other signal equipment, including the controller, is in place and ready for operation.
  - As an exception, install signal heads if no face of the head is directed toward traffic or if the entire assembly is hooded.
  - Adjust each signal face vertically and horizontally such that its beams will be of maximum effectiveness to the approaching traffic for which it is intended.

A-10-3 Construction Phase

Conduits

The following section includes all information related to conduits required for highway rehabilitation and construction projects.

- *General*:
  - Ensure that weatherproof fittings of identical or compatible material are provided to the conduit using standard factory elbows, couplings, and other fittings.
  - Make sure that the manufactured conduit sealing compound used:
    - is of readily workable material at temperatures as low as 30°F and
    - will not melt or run at temperatures as high as 300°F.
- *Steel Conduit and Fittings*:
  - Comply with ANSI C80.1.
  - Ensure that weatherproof expansion fittings with galvanized, malleable iron, fixed and expansion heads jointed by rigid steel conduit sleeves are used. As an option, the fixed head may be integral with the sleeve, forming a one-piece body of galvanized malleable iron.
  - Provide steel bushings.
- *Plastic Conduit and Fittings*:
  - *PVC*:
    - Use PVC Schedule 40 plastic conduit and fittings complying with NEMA TC-2 (pipe), NEMA TC-3 (fittings), and UL 651 for Schedule 40 heavy wall type.
    - Use solvent-welded, socket-type fittings, except where otherwise specified in the Contract documents.
    - Ensure that threaded adaptors for jointing plastic conduit to rigid metal ducts are used.
    - Make sure that bell end fittings or bushings are provided.
  - *HDPE*:
    - Comply with ASTM F 2160 (conduit) and ASTM D 3350 (HDPE material), SDR 13.5.
    - Use orange-colored conduit.
    - Use continuous reel or straight pieces to minimize splicing.
    - For dissimilar conduit, provide an adhesive compatible with both materials.
  - *Wiring and Cable*:
    Provide wire that is plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.
    - *Power Cable*: Ensure that the cable complies with GDOT standards.
    - *Signal Cable*: Comply with International Municipal Signal Association (IMSA) Specifications 19-1 (PVC jacket) or 20-1 (polyethylene jacket) for polyethylene insulated, 600 volt, solid, multi-conductor copper wire, #14 American Wire Gauge (AWG).
    - *Tracer Wire*: Comply with #10 AWG, single-conductor, stranded copper, Type thermoplastic high-heat nylon-coated (THHN), with UL approval, and a green-colored jacket.
    - *Communications Cable*: Comply with IMSA Specifications 39-2 or 40-2 for #19 AWG, solid copper conductor, twisted pairs. Use polyethylene-insulated, aluminum-shielded, complying with REA Specification PE-39 for paired communication cable with electrical shielding.
    - *Category 5E (Cat5E) Cable*: Provide outdoor use–rated cable.

        - *Fiber Optic Cable and Accessories*: Use such cable and accessories as allowed by the Jurisdiction or specified in the Contract documents.
    - *Foundations*:
        - Use structural concrete according to the approved shop drawings.
        - Use reinforcing steel complying with the approved shop drawings.
    - *Bonding and Grounding*:
        - *Grounding Rods*: Provide ⅝ in. × 8 ft copper clad, steel ground rod at each pole and controller footing.
        - *Bonding Jumper or Connecting Wire*: Provide #6 AWG bare conductors, copper wire, exothermic welding.
- *Placement of Conduits*:
    - Place conduit to a minimum depth of 30 in. and a maximum depth of 60 in. below the gutter line.
        - When conduit is placed behind the curb, place to a minimum depth of 24 in. and a maximum depth of 36 in. below the top of the curb.
    - Change direction at hand holes or by bending, such that the conduit will not be injured or its internal diameter changed.
        - Ensure bends are uniform in curvature.
        - Ensure the inside radius of curvature of any bend is no less than six times the internal diameter of the conduit.
    - On the exposed ends of conduit, place bell-end fittings on PVC or HDPE conduit and bushings on steel conduit prior to installing cable.
        - Extend all conduits a minimum of 2 in. and a maximum of 4 in. above the finished surface of any footing or structural base.
    - When it is necessary to cut and thread steel conduit, do not allow exposed threads. ***Ensure conduits and fittings are free from burrs and rough places.***
        - Clean, swab, and ream conduit runs before cables are installed.
        - Use nipples to eliminate cutting and threading where short lengths of conduit are required.
        - Coat damaged galvanized finish on conduit with zinc rich paint.
        - Use only galvanized steel fittings with steel conduit.
    - Pack conduit ends with a conduit sealing compound.
- *Wiring and Cable*:
    - Where practical, follow color codes so that the red insulated conductor connects to the red indication terminal, yellow to yellow, and green to green.
        - Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables.
        - Label home runs for cables as follows:
            - ✓ Northwest corner is red
            - ✓ Southeast corner is blue
            - ✓ Northeast corner is green
            - ✓ Southwest corner is orange
    - Install continuous runs of vehicle and pedestrian signal cables from the vehicle or pedestrian signal head to the handhole compartment of the signal pole base and from there to the terminal compartment in the controller cabinet. ***Do not splice signal cables in underground handholes.***

- Check the installation of continuous runs for video detection and emergency vehicle preemption cables from the unit to the controller cabinet**.**
- Install continuous runs of power lead-in cables from the service point to the meter socket and from the meter socket to the controller cabinet.
- Install continuous detector cable from each detector loop to the first handhole adjacent to the loop.
    - Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, that are attached to the cables.
    - Install continuous home-run cable from the splice made in the first handhole to the terminal compartment in the controller cabinet.
    - Attach the drain wire of the shielded cable to the ground in the controller cabinet.
- Provide a minimum of 4 ft of additional cable at each handhole and loosely coil the extra cable on the handhole cable hooks.
    - Provide a minimum of 2 ft of additional cable at each signal pole (measured from the handhole compartment in the pole to the end of the cable).
    - Provide a minimum of 10 ft of additional cable at each controller base.
- Pull cables through conduit using a cable grip designed to provide a firm hold upon the exterior covering of the cable or cables, and minimize dragging on the ground or pavement.
- Inspect each signal head assembly while still on the ground for the following:
    - Physical defects
    - Visor type
    - LED wattage
    - Lens orientation
    - Wiring connections
        - ✓ Attach signal head mounting hardware according to the manufacturer's recommendations.
            - Apply anti-seize compound to all mechanical fasteners.
        - ✓ Adjust each signal head both vertically and horizontally to approximate a uniform grade of all like signal heads.
            - During the course of construction and until the signals are placed in operation, cover the signal faces or turn them away from the approaching traffic.
            - When ready for operation, plumb and aim the heads.

Loops

Loops are used to house conduit needed for traffic detection on highways. These are often removed and installed during highway construction.

- Coordinate the location of the detector loop with the Engineer. Obtain the Engineer's approval prior to cutting the pavement.
- Saw to ensure the proper depth and alignment of the slot.
    - Make a 2-in. deep clean, straight, well-defined ⅜-in. wide saw cut without damage to adjacent areas.
    - Overlap the saw cuts where the detector loop changes direction to provide full depth at all corners.

    - Do not use right angle or corners less than 90 degrees.
- Before installing the detector loop cable, check the saw cuts for the presence of jagged edges or protrusions and remove if present.
    - Clean and dry the saw cuts to remove cutting dust, grit, oil, moisture, or other contaminants.
        - Clean by flushing with a stream of water under pressure.
        - Use oil-free compressed air to dry the saw cuts.
- Install the detector loop cable without damage.
    - Place three turns of the detector loop cable into the saw cut.
    - Seal the ends of the tubing at the time of placement to prevent the entrance of moisture.
- Ensure the detector loop cables are in the bottom of the saw cut.
    - Place detector loop sealant within the saw cut area.
    - Comply with the manufacturer's instructions for mixing and using the detector loop sealant.
- Identify each detector loop cable in the handhole by phase and location.
    - Wind the traffic detection loops so that they are physically adjacent in an individual lane or adjacent lanes with opposite rotation (i.e., #1 clockwise, #2 counterclockwise, #3 clockwise, etc.).
    - Rotation reversal can be accomplished by reversing leads at the handhole.
- Twist, with at least five turns per foot, all lengths of loop wires and tubing that are not embedded in the pavement.
- Identify all detector loop lead-in cables with appropriate detector numbers.
- Use a detector loop cable splice kit for the electrical splice between the detector loop cable and the detector loop lead-in cable to the controller.
- Ensure the splice kit provides a watertight protective covering for the spliced wire, the shielding on the detector loop lead-in cable, and the end of the tubing containing the detector loop cable.
- Use a manufactured electrical splice kit approved by the Engineer.
- Test all loops and document by using the following procedures:
    - Determine the insulation resistance of the loop wire using a "megger" with 500V applied to either loop wire to earth ground. The resistance is to be greater than 100 megohms.
    - Determine the inductance of the loop using a loop inductance meter.
- Ensure the loop wire:
    - Outside the sawcut is twisted three turns per foot
    - Is one continuous run without splices
    - Is pushed to the bottom of the saw cut with a nonmetallic tool that will not damage the insulation
    - Is placed in its own individual sawcut
- Ensure that no portion of the loop is located within 3 ft (1 m) of any conductive material in the pavement such as manhole covers, water valves, and grates, etc.
- Verify that all loop connectors are connected to a shielded home-run cable located in the junction box or when so directed or shown on plans at the base of the traffic signal strain pole.
- Test loops prior to sealing sawcuts.

- Place loop sealant in sawcuts in accordance with manufacturer's recommendations.
- Do not permit loop sealant when:
  - there is moisture on the surface,
  - the air temperature is below 40°F (4.4°C), or
  - other conditions exist that in the opinion of the Engineer would affect the bonding of the material.
- After installation of the loops, seal the slots with an approved sealant manufactured specifically for embedding loop detector wire in concrete or bituminous pavements.

Pull Boxes

Pull boxes are used on highways to house electronic systems needed for traffic control and detection. They are typically offset of the highway travel lanes for access by GDOT personnel.

- Install pull and junction boxes for traffic signals.
- Use pull and junction boxes listed on the Department's Approved Product List (APL).
- Ensure that all pull and junction boxes are marked and the markings are visible after installation.
- Ensure that the pull box cover is flush with the finished grade or sidewalk.
- Do not install pull boxes in roadways, driveways, parking areas, ditches, or public sidewalk curb ramps.
- Ensure that the bottom surface of pole-mounted junction boxes is a minimum of 4 ft above the finished grade.
- Make cable terminations in junction boxes.
  - Rout and form the cable to allow access to the terminal screws.
  - Do not cover the terminal identification numbers with the cable.
- Do not pull the signal or interconnect cable through a pull box used for loop termination.
  - Use separate pull boxes for signal and interconnect cables.
  - Use embedded junction boxes that include junction boxes, conduit, conduit expansion couplings, and miscellaneous hardware to make a complete and accepted installation.
- When specified in the Contract Documents, disregard the grounding requirements for metal covers for pull and junction boxes powered strictly by battery or a combination of battery and solar energy or used exclusively for vehicle loop wires where signal or 120V interconnect power is not present.

Pole Foundation, Wire, and Appurtenance

<u>Traffic Signal Poles and Mast Arms</u>

Specifications required for construction and standards that are to be met by inspection; measurement, sight inspection, and/or testing may be necessary to meet requirements.

- Comply with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.
- Design to support the loading necessary for all traffic control equipment.
  - Ensure the support is capable of withstanding winds up to 80 mph with a 1.3 gust factor without failure.

- Use a mast arm length and vertical pole height as specified in the Contract documents.
- Ensure the mast arms, poles, and supporting bases are galvanized inside and out according to ASTM A 123.
- Use poles that are:
    - Continuous tapered, round, steel poles of the transformer base type
    - Fabricated from low carbon (maximum carbon 0.30%) steel of US standard gauge
- When a transformer base is not specified, provide a 6 in. × 16 in. handhole in the pole shaft for cable access.
    - Provide a cover for the handhold.
    - Secure the cover to the base with simple tools.
    - Ensure the cover has a GDOT communication stamp and hardware is corrosion-resistant.
- Ensure a minimum yield strength of 48,000 psi after manufacture.
    - Supply base and flange plates of structural steel complying with AASHTO M 183 (ASTM A 36) and cast steel complying with ASTM A 27, Grade 65-35 or better.
- Where a combination street lighting/signal pole is specified in the Contract documents, mount the luminaire arm in the same vertical plane as the signal arm unless otherwise specified.
    - Use a single-member tapered type arm for the luminaire arm type.
    - Equip the pole with a minimum 4 in. × 6 in. handhold and cover located opposite the signal mast arm.
- If allowed by the Engineer, fabricate poles and mast arms by welding two sections together, resulting in a smooth joint and factory welded as follows:
    - Ensure a minimum of:
        - 60% penetration for plates ⅜ in. and less in thickness for longitudinal butt welds, except within 1 ft of a transverse butt-welded joint
        - 80% penetration for plates over ⅜ in. in thickness
    - Ensure 100% penetration for longitudinal butt welds on poles and arms within 1 ft of a transverse butt-welded joint.
    - Ensure 100% penetration, achieved by back-up ring or bar, for transverse butt welds for connecting.
    - Examine 100% of transverse butt welds and 100% penetration for longitudinal butt welds by ultrasonic inspection according to the requirements of AWS D1.1-80.AH.
    - Comply with Structural Welding Code AWS D1-180, as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel Highway Bridges and by Supplemental Specifications No. 969.

Traffic Signals

<u>Traffic Signal Heads</u>

Traffic signal heads are used to house individual lights needed for directing traffic at highway intersections or other traffic information systems. These signal heads are connected with conduits to junction boxes and traffic control networks.

Vehicle Traffic Signal Head Assembly

- Housing:
    - Ensure the individual signal sections are made of a durable polycarbonate.
        - Use the color specified in the Contract documents.
        - Consider color to be an integral part of the materials composition.
    - Use a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together.
    - Ensure the housing is equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
    - Ensure use of doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of noncorrosive material.
- *Optical System*: Design to prevent any objectionable reflection of sun rays even at times of the day when the sun may shine directly into the lens.
    - Use 12-in. diameter polycarbonate.
    - Do not use glass lenses.
- *Visors*: For standard installation, ensure each signal lens:
    - Has a visor with the bottom 25% open
    - Is a minimum 0.1 in. thick and black in color
    - Fits tightly against the housing door with no filtration of light between the visor and door
    - Is a minimum length of 9½ in. ***Ensure the visor angle is slightly downward.***
- *Optically Programmed Sections*: Make sure the optical unit and visor are designed as a whole to eliminate the return of outside rays entering the unit from above the horizontal.
- Inspect signal heads to obtain optimum visibility for the motorist without showing the background.
- Orient LED modules in the correct position with the signal head section.
- Ensure the signal head tabs firmly hold the LED module in place.
- Paint all signal heads, span wire hanging hardware, and side of pole mounting hardware yellow unless otherwise required by the Project special provisions.
- Ensure vehicle signal head clearance is between 16.5 ft to the bottom of the signal head or 25.6 ft to the top of the signal head from the highest point of the roadway.
- Mount pedestrian heads between 7 and 10 ft from the ground.
- Place vehicle signal heads not closer than 50 ft to the stop bar with the exception of a nearside head and no farther than 180 ft without a nearside head.
- Verify visibility and clarity of the signal heads by observing each approach. ***Notify the Engineer if any visibility issues are identified.***

Traffic Signal Span & Vertical Span

Sag and Vertical Clearance

Figure A-44 illustrates sag guidelines and vertical clearance standards for traffic signals. This figure is from the GDOT Standard Specifications.

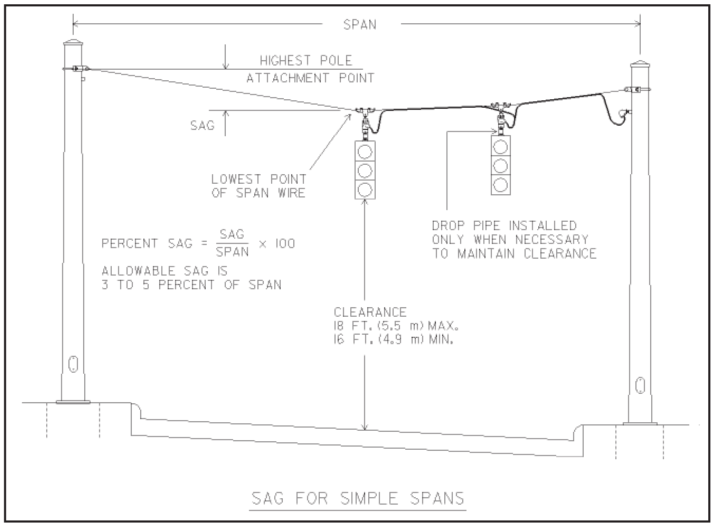


Figure A-44: Sag and Vertical Clearance Diagram

- *Signal Messenger Wire and Cable*:
  - Ensure messenger wire and accessories comply with the GDOT Standard Specifications and messenger wire diameter is in accordance with the plans.
  - Determine the height at which the messenger wire is to be attached to the pole:
    - In some instances, this will be as shown on the plans.
    - In cases where this is not shown, allow the Contractor to determine the proper attachment height.
      - ✓ Consider the relative elevation of the pavement to the pole foundation top and the desired clearance between pavement and the bottom of each signal, (i.e., 16–18 ft [4.9–5.5 m], the sag in the messenger wire [3–5%], and the height of each signal).
- Allow use of alternate methods of attaching messenger wire to strain poles, as follows:
  - Span wire clamp with clevis, anchor shackle, and thimbles on the messenger wire.
  - Wrap messenger wire twice around the strain pole and secure with a three-bolt clamp of the proper size, when used on round, tapered strain poles.
- If the messenger wire attachment to strain poles makes use of the alternative with pole clamps and anchor shackles, hook the wire through the shackle using a thimble and secure with a three-bolt clamp.
  - Do not use a preformed guy grip for messenger wire attachment at the pole.
  - Allow use of guy grips of the proper size at bull rings (aerial corners).
- Use thimbles with a correct groove size for the messenger wire (or the wire and eye of guy grips) at anchor shackles and bull rings. When three-bolt clamps are used, serve the wire tail as shown in the GDOT Standard Specifications Section on Messenger Wire.
- Use thimbles with a correct groove size for the messenger wire or the preformed guy grip to connect to anchor-type shackles or to bull rings at span wire aerial corners.

- Ensure messenger wire sag complies with the GDOT Standard Specifications 632.22 and the GDOT Standard Specifications Section on Sag and Vertical Clearance.
- Attach the signal cable to the messenger wire by lengths of preformed lashing rod**.**
    - Ensure the lashing rod is the proper internal diameter to snugly hold the cable, but does not cut into its jacket. See the section on Wire Lashing for further information.
    - Ensure a drip loop is formed in the signal cable at each weatherhead, and extends at least 6 in. (150 mm) below the weatherhead (see Figure A-45).
- Ensure cables or groups of cables up to a maximum of four, hanging within pole interiors, have their strain relieved by cable support assemblies (Figure A-45).

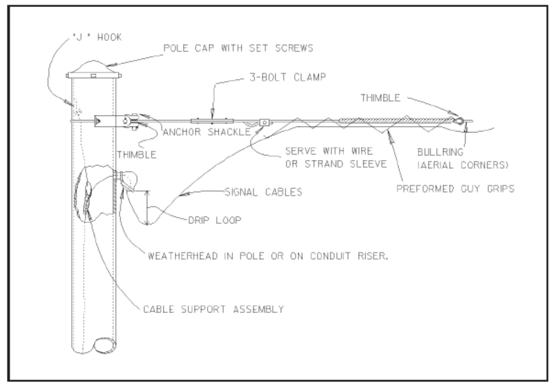


Figure 498-14. Cable Support Assembly

Figure A-45: Cable and Support Assembly

<u>Temporary Traffic Signal Installations</u>

****Consider these guidelines prior to final installation of permanent structures****

The Inspector should consider these guidelines for signals that are installed during construction and removed prior to final acceptance of the Project.

- Restore areas impacted by the temporary signal installation to like-new conditions.
- Ensure the Contractor gets the intersection ready for sign control, including installation of regulatory signs.
    - Place the signal in flash immediately when the signs are uncovered.
        - Make sure the flashing operation does not conflict with sign displays (i.e., flashing yellow signals on a stop-signed approach).
    - Let the signal flash a minimum of 7 days to allow motorists to gain familiarity with the intersection operation. (More protocol than inspection).
- As Project Inspector, ensure that the work for traffic signals is in conformance with the construction methods and details specified in Section 660 of the GDOT Standard Specifications; GDOT Standard Specifications for Structural Supports for Highway Signs, Luminaries, GDOT Standard Specifications for Traffic Signals also included in the MUTCD; National Electric Code; and other national criteria as defined.
    - Verify the proper removal of existing signal equipment, if specified.
    - Check the excavation of the footing for compliance.
    - Ensure that loop detectors are installed in accordance with the Contract plans and standard detailed drawings.
    - Verify that the support structure is erected and connected in accordance with the Contract plans.
    - Check the signal head mounting for compliance, paying particular attention to height and viewing angle with respect to a vehicle at the stop bar.
    - Ensure that cabinets are properly located and the messenger cable, conduit, junction boxes, and wiring are installed as specified.

    - Check for proper backfilling.
    - Ensure that the electrical service is connected as arranged.
- Coordinate with the Project Engineer/Supervisor to perform the final field test.

Pedestrian Signal Heads

Pedestrian signal heads refer to the housing of electronic devices used to communicate to pedestrians when it is safe and not safe to cross a traffic intersection.

<u>Pedestrian Push Button Detectors</u>

- *Assembly*:
    - Ensure the entire assembly is weathertight, secure against electrical shock, and withstands continuous hard usage.
    - Provide a removable contact assembly mounted in a die cast aluminum case.
    - Ensure the contacts are normally open with no current flowing except at the moment of actuation.
    - Ensure the contacts are entirely insulated from the housing and operating button with terminals for making connections.
    - Provide housing with one outlet for ½-in. pipe.
- *Operating Button*:
    - Use a button made of nonrusting metal alloy.
    - Ensure the button does not protrude out from the case.
    - Supply an ADA-compliant operating button.
- *Signs*:
    - Furnish push button signs complying with MUTCD.

<u>Pedestrian Traffic Signal Head Assembly</u>

The Inspector should ensure that the signal head assembly complies with current MUTCD and ITE standards.

- *Housing*:
    - Ensure the individual signal sections are made of a durable polycarbonate.
        - Use the color specified in the Contract documents.
        - Consider color to be an integral part of the materials composition.
    - Use a self-contained unit capable of separate mounting or inclusion in a signal face containing one or more signal sections rigidly and securely fastened together.
    - Ensure the unit is equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
    - Ensure the doors and lenses have suitable watertight gaskets and doors that are appropriately hinged and held securely to the body of the housing by simple locking devices of noncorrosive material.
        - Doors are to be easily removed and reinstalled without use of special tools.
- *Visor*:
    - Use a tunnel-type visor attached to the housing door by stainless steel screws.
    - Ensure the visor has a minimum 7 in. length.

- Ensure the visor encompasses the entire top and sides (bottom open) of the pedestrian signal face and fits tightly against the housing door to prevent any perceptible filtration of light between the door and the visor.
- Ensure the visor angle is slightly downward.

- *LED Module*:
  - Provide an LED unit(s) for the filled upraised hand symbol, walking person symbol, and countdown timer.
  - Ensure immediate blank out of the countdown timer display upon recognizing a shortened "Walk" or a shortened "Flashing Don't Walk" interval.

Intelligent Systems

Intelligent systems refers to automated and electronic systems used for traffic control and monitoring on Georgia's highways.

- *Inductive Loop Vehicle Detector*: A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.
  - *Cables*: Ensure all cables are UL approved.
    - *Tube Loop Detector Cable*: Comply with IMSA Specifications 51-5.
    - *Preformed Loop Detector Cable*: As approved by the Engineer.
    - *Loop Detector Lead-in Cable*: Comply with IMSA Specifications 50-2.
- *Detector Loop Sealant*:
  - Use a rapid-cure, high-viscosity, liquid epoxy sealant formulated for use in sealing inductive wire loops and leads embedded in pavement.
  - Ensure the cured sealer is unaffected by oils, gasoline, grease, acids, and most alkalis.
  - Use a sealant complying with the GDOT Standard Specifications.
- *Sensor (Amplifier) Unit*:
  - Use a sensor unit that is solid state, digital, providing detection channel(s) with an inductance range of 0 to 2000 microhenries.
    - Verify that output circuits of the sensor unit are provided by relays.
    - Verify that vehicle presence results in a continuous call indication.
  - Provide a sensor unit with the following qualities:
    - Sensitivity adjustment to allow, as a minimum, the selection of high, medium, or low sensitivity
    - Capability of providing reliable detection of all vehicles with plates
    - Indicator light for visual indication of each vehicle detection
    - No requirement for external equipment for tuning or adjustment
    - Operation in the pulse mode or presence mode
      - ✓ Ensure mode switch is readily accessible.
    - Self-tuning system that is activated automatically with each application of power
      - ✓ Provide automatic and continuous fine-tuning to correct for environmental drift of loop impedance.
    - Fail-safe operation (continuous call) in the event of detector loop failure

        - Capability for each detector channel to respond to a frequency shift in an increasing or decreasing value, as occurs with temperature shifts in the pavement, without requiring a locked call
        - Detector units with delay and extension timing
            - ✓ Select the delay feature and adjust externally on the sensor unit housing.
            - ✓ Select digitally derived timing in 1-second increments from 0 to 30 seconds.
            - ✓ Ensure delay timing inhibits detector output until the presence has been maintained for the time selected.
            - ✓ Restart the delay timer at each new detection.
        - Capability of normal operation without interference and false calls between sensor units ("crosstalk") when installed in the physical environment of the controller cabinet and the electrical environment of the associated electronic equipment installed therein, including other detectors
- *Video Detection Camera System*: Detects vehicles by processing video images and providing detection outputs to the traffic signal controller.
- *Video Detection System and Processors*:
    - Ensure the processor is card-rack mounted or located within the camera, and compatible with NEMA TS-1, TS-2, and Type 170 controllers and cabinets.
    - Ensure the system is capable of the following:
        - Shadow rejection without special hardware
        - Non-impaired operation under light intensity changes
        - Maintained operation during various weather conditions (e.g., rain, fog, snow)
        - Anti-vibration, 5% rejection based on image change
        - Proper operation during sunrise and sunset
        - Ability to select direction of flow parameters
        - Ability to properly detect bi-directionally
    - Provide user-defined detection zone programming via a graphical user interface (GUI) using a monitor and mouse, or laptop computer.
        - Store detection zones in nonvolatile memory.
        - Provide monitor and mouse, or computer software to the Jurisdiction.
    - Comply with NEMA TS-1 environmental and physical standards with:
        - an operating temperature of −34°C to +74°C, and
        - 0% to 95% relative humidity.
    - Ensure a factory-certified representative from the supplier provides on-site VDS programming and testing.
- *Video Cameras*:
    - Provide a charge-coupled device (CCD) image sensor with variable focus color or black-and-white lens providing a 6- to 48-degree horizontal field of view.
    - Ensure the cameras are equipped with an internal thermostatically controlled heater and external sunshield.
        - Meet NEMA-4 or NEMA-6P environmental standards.
    - Use camera cable(s) meeting the manufacturer's recommendations.

        - Provide a continuous run, without splices, from the camera to the controller cabinet.
- *Microwave Vehicle Detectors*: Detects all vehicles moving within the field of detection at speeds from 2 to 80 mph, and meets the following requirements:
    - Minimum detection range from 3–200 ft for all vehicles
    - Pattern spread of the detection field no more than 16 degrees
    - Self-tuning and capable of continuous operation over a temperature range of −35°F to 165°F
    - Side-fire mount or overhead mount
    - Detects traffic flow and travel direction
    - Microprocessor-based using Doppler microwave at an operating frequency of 10.525 GHz
    - FCC certification and tested to the applicable FCC specifications
    - Enclosure constructed of aluminum or stainless steel and water resistant
    - All user-operated controls and adjustments clearly marked and easily accessible.
    - Detection output relayed to the controller with a minimum 5-amp rating and is designed to place a constant call to the controller in the event of any failure
    - Easily accessible indicator showing activation of detection relay
    - Required wiring as recommended by the manufacturer
    - Provides mounting hardware for the type of mounting specified in the Contract documents and power supply equipment as recommended by the manufacturer

Ramp Meters

Performance measures (aspects to be measured) represent the traffic and travel characteristics that are measured to assign benefits of installing a system to the traveling public. Performance measures should:

- reflect the goals and objectives for installing the ramp control signal,
- be readily measurable,
- assist in the decision-making process, and
- facilitate improvement.

Use the following performance measures related to ramp meters:

- *Freeway Performance*: Evaluate the effectiveness of ramp control signals on freeway performance using the following recommended measures:
    - Frequency and rate of crashes (collisions) occurring on the freeway in the vicinity of the ramp
    - Observed travel times and speeds of traffic traveling on the freeway
    - Amount of average delay experienced by freeway travelers (delay could be estimated by taking the difference in observed travel times and the free-flow travel times)
    - Variability in travel times or speeds on the freeway
    - Observed throughput (or volume) of vehicles utilizing the freeway section
    - Level of service or volume-to-capacity ratio on the freeway section
    - Estimated amount of fuel consumption used by vehicles traveling on the section of freeway

- Amount of vehicle emissions produced by vehicles traveling on the section of freeway

- *Ramp Performance*: Evaluate the effectiveness of ramp control signals on ramp performance using the following recommended measures:
  - Frequency and rate of crashes (or collisions) on the ramp and surface street attributed to the ramp control signal
  - Amount and standard deviation of delay (seconds) experienced by ramp travelers waiting to enter the freeway
  - Travel time associated with drivers entering the ramp
  - Throughput (or volume) of traffic utilizing the ramp
  - Percent of time ramp queues spill back and impact on adjacent arterial street performance
  - Amount of vehicle emissions produced by traffic waiting to enter the freeway from the ramp
  - Estimated amount of fuel consumed by vehicles waiting to enter the freeway from the ramp
- *Merge/Weave Area Performance*: Gauge the effects of ramp control signals on freeway-ramp merge area performance using the following measures:
  - Number of crashes (or collisions) observed in the merge area
  - Number of conflicts or erratic maneuvers that occur in the merge area
  - Throughput (or the number of vehicles passing through the merge area)
  - Speed of traffic in the merge area
- *"Before and After" Analyses*: A "before and after" study is a common approach used to measure the effectiveness of ramp meters. Before and after studies provide an accurate assessment of the ***actual*** benefits as opposed to ***estimated*** **or** ***predicted*** benefits of installing a ramp control signal. With a before and after study:
  - Collect operational data before the ramp control signal is installed.
  - The same data are then collected after the ramp control signal has been activated.
  - Allow time between those "before and after" study assessments to allow motorists to familiarize themselves with the signal.
- *Monitoring Effectiveness*: Monitoring the operation is different than measuring performance in that monitoring is a continuous process (as opposed to measuring, which implies a sampling of performance conditions). Monitoring allows district operations personnel to identify the manner in which the operation of the ramp meter signal can be modified to maximize its effectiveness. The operation of the ramp control signal (as opposed to its impact on traffic operations) is to be measured. The following are some of the measures that can be used to monitor the operations of the ramp control signal:
  - *Average Ramp Meter Start Time*: Average time-of-day at which the ramp control signal is first activated
  - *Average Ramp Meter End Time*: Average time-of-day at which the ramp control signal is deactivated for the last time
  - *Average Number of Activations*: Average number of times that the ramp control signal is cycled to service vehicles on the ramp
  - *Average Activation Duration (minutes)*: Average number of minutes during a typical day that the ramp meter was in operation

    - Compute this measure by averaging the daily difference in the ramp meter end time and the ramp meter start time for the operation period.
- *Average Cycle Time (seconds)*: Average cycle length for the ramp control signal
    - Measure the cycle length from the beginning of a red indication to the beginning of the next red indication.
- *Average Number of Vehicles Serviced during a Cycle*: Average number of vehicles that traverses the stop line of the ramp control signal (or passage detector, if available) during each cycle of the ramp control signal
- *Average Wait Time*: Average amount of time that a driver has to wait in the queue before being serviced by the ramp control signal
    - Define wait time as the time difference between when the vehicle first arrived at the back of the queue to when it crossed the stop line (or passage detector) at the ramp control signal.
- *Average Ramp Control Service Flow Rate (vph)*: Average number of vehicles serviced during a cycle divided by the average cycle length and multiplied by 3600 to convert to hourly flow rate
- *Average Total Service Flow Rate (vph)*: Average of the total number of vehicles serviced on the ramp during the hours of operation
    - Note that this measure also includes the number of vehicles that used the ramp during flushing operations and during the ramp control signal start-up time (if any) after each flush.
- *Average Freeway Speed (mph)*: Average speed of freeway traffic during the time period at which the ramp control signal is operating
    - Obtain this measure from the freeway traffic sensor data.
- *Ramp Signal Control Efficiency*: Ratio of the average ramp control service flow rate to the average total service flow rate
    - If this value approaches unity, then the majority of traffic serviced at the ramp is under the control of the ramp signal.
    - As this value approaches zero, it implies most of the ramp demand is serviced while the ramp meter is active.
- *Operating Philosophies*: Once the decision to install a ramp meter has been made, the next step in the process is to determine how the ramp meter will operate. In selecting an operating strategy, the practitioner must decide the following:
    - Will the meter be operated locally or as part of a system?
    - Will the meter operate in a pre-timed or traffic responsive manner?
    - Will the meter be intended to restrict the amount of traffic from entering the freeway? If so, how are queues on the ramp going to be managed?

Cable & Wire

In certain instances, the plans will assign a color code usage for each cable, or a typical usage by color code. Make all connections observing these assignments, and record any deviations, if determined necessary. When a color code usage is not provided, the Inspector should ensure good electrical wiring practice is followed, which dictates that color code wiring on the Project be consistent. ***Typically, reserve white for the neutral or common leg of a circuit.***

- Use the signal cable as the electrical connection between signal heads and the controller cabinet at an intersection.
  - Ensure the cable is of the following types:
    - IMSA19-1, which has a jacket of polyvinyl chloride
    - IMSA 20-1, which has a polyethylene jacket
    - IPCEA S-61-402
  - Determine the number of conductors and wire gage as specified on the plans.
  - Ensure conductors are of copper and stranded, and that conductor insulation is color coded.
  - Do not permit splices in signal cable (632.23); scan the cable to be sure there are none.
    - As temperatures decrease, signal cable gets stiffer and harder, becoming brittle when below freezing. ***In very cold weather, handle the cable with care so as not to damage the jacket or insulation when unreeling, flexing, and installing.***
    - Follow the method of measurement of signal cable as shown in TEM Figure 498-16 (Figure A-46).

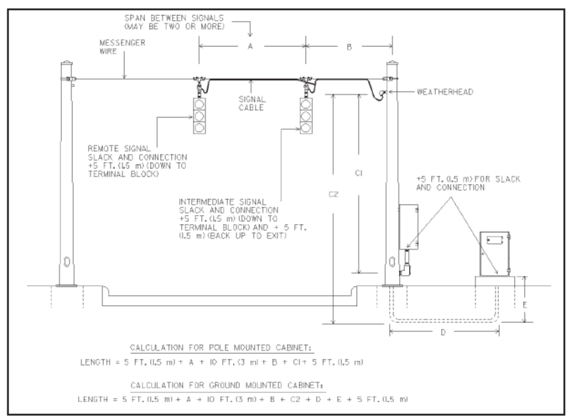


Figure A-46: Method of Measurement for Signal Cable

- Use interconnect cable as the connection between intersections for systems of signals.
  - Ensure the cable is one of the following types:
    - IMSA 19-1
    - IMSA 20-1
    - IPCEA S-61-402 as in signal cable
    - Twisted pair/shielded interconnect cable conforming to RUS PE-39, if required by the plans
  - Use twisted pair/shielded cables, which are less prone to pick up induced current as a result of nearby electrical devices or magnetic fields, and are necessary for certain types of communication systems that may be used to interconnect signals.
    - Ensure the number of conductors and wire gage are as specified in the project plans.
      - ✓ Note that in the case of twisted pair/shielded cable, the number of conductors is typically referred to as the number of pairs (pair count) (i.e., six-conductor cable would be referred to as a three-pair cable).
    - Ensure the conductors are of copper and are usually solid.

- Use interconnect cable of the integral messenger type that is aerial self-supporting cable with a “figure 8” cross section.
  - Ensure the cable is of one of the following types:
    - IMSA 19-3, which has a jacket of polyvinyl chloride
    - IMSA 20-3, which has a polyethylene jacket
    - Shielded versions, IMSA 19-4 and IMSA 20-4, if required by the plans
  - Use the number of conductors and wire gage as specified.
  - Use conductors that are of copper and are stranded
  - Ensure the conductor insulation is color coded. (See GDOT Standard Specifications 600 Incidentals 794.)
  - Use twisted pair/shielded interconnect cable of the integral messenger type conforming to RUS PE-38 if required by the plans.
- Lay loop detector wire in turns in saw slots cut into the pavement and route by the groove to the edge of pavement and to a pull box.
  - Ensure the wire is single-conductor No. 14 AWG.
  - Use conductor that is copper and stranded.
  - Ensure the loop detector wire consists of detector wire inserted into a flexible plastic tubing (732.19) meeting specifications IMSA 51-5.
    - Ensure the tubing encases the wire completely from the splice at the lead-in cable, through the entire loop turns, and back to the splice.
- Splice the lead-in cable for detector loops to the loop wire and route it to detector units in the controller cabinet.
  - Ensure the cable is two-conductor No. 14AWG with a jacket of 0.04 in. (1 mm) minimum black polyethylene and insulation of polyethylene.
  - Use conductor that is stranded copper.
  - Ensure the conductor pair is twisted and shielded.
- Splice the lead-in cable for magnetometers to the lead, which is a part of the magnetometer probes, and route to the detector units in the controller cabinet.
  - Ensure the cable is four-conductor No. 18 AWG with a jacket of 0.026 in. (0.66 mm) minimum high-density polyethylene and low-capacitance insulation.
  - Use conductor that is stranded copper with insulation that is color coded.
  - Ensure the four conductors are twisted.
- Use power cable as the connection between the service pole or service drop and the controller cabinet.
  - Typically, use cable that is two-conductor and UL:RHH/RHW/USE type.
    - When specified, use a power cable that is three conductors.
    - Allow substitution of single-conductor cable for a two- (or three-) conductor cable, but ensure color coding is still provided.
  - Use wire gage as specified.
  - Ensure conductors are color coded, of aluminum, and stranded.
    - Allow substitution of stranded copper with an AWG one gage higher (wire one size smaller).
- Use service cable to bring power to the vicinity of an isolated intersection.
  - Typically, use cable that is two-conductor (duplex) and XHHW type or cross-linked polyethylene with a 0.045 in. (1.14 mm) minimum jacket.
  - Use wire gage as specified.

    - Ensure the cable is aerial self-supporting with one conductor being an uninsulated ACSR (aluminum conductor, steel reinforced) messenger wire.
    - Ensure an insulated conductor of stranded aluminum is twisted around the messenger.
        - Allow substitution of stranded copper with an AWG one gage higher (wire one size smaller) for the aluminum conductor.
        - Allow a three-conductor (triplex) to be specified where two insulated conductors are twisted around the messenger wire.
            - ✓ The uninsulated messenger serves as the grounded neutral of the power supply.
- Use ground wire to connect the signal or sign supports to the ground rods.
    - Ensure the wire is single-conductor No. 4 AWG made of seven-strand soft drawn copper with white insulation and rated at 600 volts.
    - Use the wire as part of the 625.16 Ground Rod item.

<u>Aerial Interconnected Cable</u>

For aerial interconnect cable, the following standards and guidelines apply:

1. Use interconnect cable supported on separate messenger wire or of the integral messenger self-supporting type with a “figure 8” cross section, if specified on the plans.
2. Furnish pole clamps with the metal poles with messenger wire supported interconnect cable. The pole clamp may provide:
    - clevis(es) to which the messenger is attached and terminated, or
    - a stud to which a clamp assembly can be bolted.
3. Loop and secure messenger wire ends with three-bolt clamps or a messenger vise, or use a preformed guy grip dead end (see GDOT Standard Specifications 632).
    - If clamps or vises are used, serve the wire tail (see GDOT Standard Specifications 632).
    - Use thimbles with a correct groove size for the messenger wire to connect to the clevis of the pole clamp.
4. When messenger wire is to be grounded to a metal pole, use a ground clamp, an insulated ground wire, and a bolt tapped into the pole.
5. Fit wood poles with interconnect cable with through-bolts holding a clamp assembly or with a thimble eye-bolt to which the messenger may be attached and terminated.
6. Ensure the clamp assembly is suitable to the type of cable support, either messenger wire or self-supported cable with “figure 8” cross section.
    - Clamp assemblies for “figure 8” interconnect cable differ slightly from those intended for use with separate messenger, inasmuch as the clamp used with “figure 8” must allow a small gap for the web of the “figure 8” cable that joins the messenger to the cable.
7. When messenger wire or “figure 8” cable is to be grounded on a wood pole, use a ground clamp and an insulated ground wire stapled to the pole and covered by a molding (also see item 10 in this section).
    - Ensure the ground clamp used with “figure 8” cable is a type with teeth to penetrate the jacket over the messenger.
    - Ensure the ground wire is bonded to an existing ground wire or to a ground rod.

    - Ensure standard interconnect cable conforms to the Consumer and Market Space (C&MS) Table 732.19-1 and has the number of conductors and wire gage specified.
        - There is no difference between standard interconnect cable and signal cable, only in the application.
    - Use interconnect cable of the shielded type if specified in the plans.
    - Ensure the interconnect cable is marked with the correct nomenclature.
    - Do not permit solid conductors (732.19) unless specified in the plans.
    - Use splices on long lengths of interconnect cable (632.23) and only in weathertight splice enclosures.
    - Locate splice enclosures either aerially on the messenger wire or use a pole-mounted box type (see SCD TC-84.20).
        - Where the aerial enclosure is clamped to the span, ensure it is within 2 ft (0.6 m) of a pole to improve accessibility.
    - Note that no measurement allowance is given for splices.
8. Allow aerial interconnect cable to have a sag of 3–5% of the pole spans or to match existing utility lines.
9. Ground messenger wire supporting interconnect cable, and the integral messenger of self-supporting type cable, in cable runs at the first and last poles and on intermediate poles at intervals not to exceed 1200 ft (366 m) (also see item 4 of this section for grounding on metal poles, and item 7 for grounding on wood poles).
10. As temperatures decrease, interconnect cable gets stiffer and harder, becoming brittle when below freezing. In very cold weather, handle the cable with care so as not to damage the jacket or insulation when unreeling, flexing, and installing.
11. Attach standard interconnect cable to supporting messenger wire by lengths of preformed lashing rod or by spinning wire.
    - Use lashing rods of the proper internal diameter to snugly hold the cable but not cut into its jacket.
12. Increase wind stability of aerial interconnect cable of the integral messenger self-supporting type (with a “figure 8” cross section) by being twisted or spiraled once every 15 ft (4.6 m) of span.
    - Do this by clamping the tensioned cable to every other pole and then going to intermediate poles and twisting the cable before tightening their attachment clamps.
        - When the interconnect cable is attached to a pole and continues in a relatively straight line past the pole, this is an intermediate support; whereas, if the interconnect cable turns at the pole, it is a corner or turning point.
        - Certain types of clamps may be well suited for intermediate support applications, while other designs are required for corner clamps.

A-10-4 Testing Phase

Insulation Testing

The Inspector must perform an isolation test for testing insulation resistance for each conductor in the cable.

- Use Article 110-19 of the NEC as a guide for the testing.
- If resistance measured with all protective devices in place is less than 250,000 **Ω**, require the Contractor to remove the defective cable, install new cable, and repeat the test.
- For interconnect cable, upon completion of a run from one controller installation to the next controller installation, the Contractor must conduct a test for insulation resistance in the presence of the Engineer.

Functionality of Conduits Test

Short-Circuit Test

Before the performance of any cable insulation test, a short-circuit test must be performed by the Contractor using a volt-ohmmeter or other approved instrument (Transmission Electron Microscopy (TEM) Form 496-6 and 632.28(C)).

- Ensure the short-circuit tests are conducted with all electrical loads, power sources, equipment grounds, and earth grounds disconnected
- Allow the signal cable routed to signal heads to be tested with connection made to the lamp sockets, but without the lamps being installed
- Measure each conductor against every other conductor and ground to assure that no short-circuits, cross-circuits, or other improper connections exist.
- Do not allow continuity to exist between any conductor and any other conductor, including the ground.

Functional Test

Before energizing the traffic signals, the following functional checks should be made:

- Check the incoming AC voltage.
- Check the operation of the following equipment: cabinet ventilating fan, automatic temperature control setting, and convenience outlet with lamp (when furnished). The filter(s) used with the fan should be unobstructed.
- Vary timing settings on solid state controllers over their ranges and activate all functions to verify that the controls are operable without fault.
- Enter timing settings in accordance with the plans now on the controller, time clock, etc. and check for corrections.
    - On some Projects, timing settings will be provided by the maintaining agency and are not listed in the plans.
- Prior to acceptance, reach an agreement with the Contractor and the maintaining agency on the procedure to be followed in the event of a signal failure.
- Before signals are energized to control traffic, notify the maintaining agency and also check the installation and timing settings.

- After energizing the traffic signals, make the following functional checks. In the event the signals are controlling traffic at the time, make these checks with caution to protect the safety of workers, pedestrians, and drivers.
    - Check the function of all cabinet switches, including the power on/off switch and manual control (when furnished).
    - Observe the traffic signals (and controller indicator lights) to verify that the controller is timing consistently the intervals and phases set into the controls.
        - Consider using a stopwatch, especially to check critical short intervals.
        - Activate all controllers' functions to verify proper operation.
    - Investigate the detector units to determine which pavement loop(s) or other type sensor is associated with which unit.
        - Observe the visual indication of units (light, meter, etc.) to determine that each vehicle (truck, car, motorcycle, etc.) entering the sensor areas is properly detected on the associated unit and that no extraneous calls occur when the sensor area is vacant.
        - When a detector unit is set for "presence," ensure a detection call continues as long as a vehicle is positioned over the associated sensor**.**
        - Ensure that, concurrent with detection, the appropriate controller indicator light also exhibits the detection.
    - Activate the flasher switch to cause the signal heads to flash.
        - Check their indications to verify if they are correct.
        - Return the flasher switch to the normal or signal mode and make a check of the resumption of normal stop-and-go operation. ***The default setting is to flash in case of trouble.***
    - Ensure the conflict monitor is not activated by normal signal operation or by the manipulation of cabinet switches.
        - If at any time the monitor is activated, require the Contractor to determine the cause of the problem and make appropriate changes and adjustments before beginning the 10-day performance test.
        - The Contractor should test the conflict monitor by:
            - ✓ artificially causing a number of different conflicting indications and
            - ✓ checking that at each test the monitor causes the signals to begin flashing and places the controller in a "stop timing" mode.

      Artificial conflict may be caused by touching a jumper wire between two load switch outputs that would signal a traffic conflict. Other methods of artificially caused conflicts may be used at the discretion of the Contractor.
    - Observe signals that are interconnected to determine if offset relationships are maintained in accordance with settings during all periods of the day.
- When preemption equipment is furnished as part of the cabinet installation, check the proper functioning of the equipment.
    - Activate the equipment and make observations to determine if the required sequence of intervals and phases is called for in a correct and safe manner.
    - On Projects having equipment furnished for future use only, check the equipment to verify that it is properly installed and operable in a correct manner.
    - Some signal control equipment, such as time clocks (or switches) and weekly programmers, are intended to vary the timing patterns at different periods of the

day or days of the week. To determine if these required changes are occurring at the proper times, make observations to check the operation at transition times over a period of 30 days.
    - Ensure the change in timing is not extremely drawn out or abrupt.
    - Check the accuracy of time clocks and weekly programmers.
    - Ensure programmed changes occur:
        - ✓ within 5 minutes of scheduled times for clocks of the electromechanical type and
        - ✓ within 1 minute for clocks of the solid state type.
    - Ensure no significant cumulative clock error is noted during the 10-day performance test.
- After successful completion of the 10-day performance test, and after a partial or final acceptance of a Project, the Contractor is to turn over to the Engineer all manuals, diagrams, as-built plans, instructions, guarantees and related material. Verify that the Engineer performs the following final steps:
    - List this material in the Project diary as a permanent record of the transfer.
    - Transfer the material to the maintaining agency.
    - For maintained signals, give the material to the District Roadway Services Manager.
    - After a traffic control system Project has been accepted by GDOT, immediately notify the maintaining agency that as of a certain exact time and date, the agency is responsible for the operation and maintenance of the system.

<u>Ground Resistance Test</u>

At each ground rod location, the Inspector must make a ground resistance test.

- Determine the effectiveness of the ground rod by measuring resistance from the pole enclosure to a convenient underground water line, with:
    - a 0–50 Ω merger where a water line is available and
    - an auxiliary ground method where the water line is not available.
- Ensure the two auxiliary ground rods are not less than 50 ft and 100 ft (15 m and 30 m), respectively, from the tested rod.
- If the reading is greater than 25 Ω , install additional rods until a reading of 25 Ω or less is obtained.

<u>Traffic Signal Installation Test</u>

The Inspector should perform the following tests on all traffic signal installations in the presence of the Engineer and, when applicable, a representative of the agency designated to accept maintenance responsibility.

- *Continuity*: Test each signal head circuit, pedestrian detector circuit, vehicle detector loop circuit, and interconnect signal circuit for continuity.
- *Functional*: Perform a functional test that demonstrates that each and every part of the signal installation functions as specified.

- *Induced Voltage*:
  - Measure the voltage between each signal head indication field terminal and the AC neutral circuit in the controller cabinet during the off (dark) state of each signal head indication.
  - Ensure that the voltage does not exceed 2 VAC, RMS. If this value is exceeded, take the following action to reduce the value to 2 VAC, RMS:
    - Check for loose or broken connections in the signal head circuit from the controller cabinet to the signal heads.
    - If the above step does not correct the problem, connect additional neutral circuits between the signal head and the controller cabinet.
- *Inductive Loop Assembly*: An inductive loop assembly is defined as a loop plus the lead-in cable.
  - Measure and record the series resistance of each inductive loop assembly.
    - Ensure that the resistance does not exceed 10 Ω.
  - Perform an insulation resistance megger test, at 500 VDC, for each inductive loop assembly at the cabinet in which the inductive loop assembly is terminated.
    - Do not connect the inductive loop assembly to the cabinet terminal strips during the test, except for the drain wire of a shielded lead-in cable.
  - Insulation resistance is defined as the resistance between one wire of the lead-in cable and a ground rod or bussbar.
    - Record the insulation resistance of each inductive loop assembly.
    - Ensure that the resistance is equal to or greater than 100 MΩ.
- *Forty-Eight–Hour Test*: Perform the 48-hour test only after achieving acceptable results from the other tests listed in GDOT Standard Specifications 611-4.
  - Before beginning the 48-hour test, place all new signal installations (no existing signals) in flash for 48 to 336 hours.
    - The length of the flash period will be determined by the Engineer.
  - Continuously operate each new or modified traffic signal installation or system for not less than 48 hours.
    - If unsatisfactory performance of the system develops, correct the condition, and repeat the test until obtaining 48 hours of satisfactory continuous operation.
  - During the 48-hour test period, the Contractor is fully responsible for the signal or signal systems.
    - Provide a responsible representative (technically qualified) who can monitor signal operation and troubleshoot any malfunctions within a 1-hour period.
  - When coordination is specified in the Contract Documents, provide a 2-hour training session on the operation and programming of the coordination features of the controller units during the 48-hour test.
    - Arrange the time and place of the training session with the Engineer.
  - Perform a 48-hour test for flashing beacon installations in the same manner as for traffic signal installations.
  - Start the 48-hour test on a Monday, Tuesday, or Wednesday. However, do not start the 48-hour test on the day preceding a holiday.
  - Start the 48-hour test between 9:00 a.m. and 2:00 p.m.

- Before the 48-hour test, install and have standing by all equipment specified in the Contract Documents.

After all equipment has been installed and the operational check has been instigated, the Contractor must submit a set of plans showing in detail all changes on construction from the original plan details with special notation given to conduit location and elevation and schematic circuit diagrams.

A.10.5 Maintenance

Providing adequate maintenance is critical to ensuring the long-term success and acceptance of an automatic traffic management system. By having maintenance plan for the ATMS, agencies maximize returns on their investments and help ensure that the technologies and equipment operate up to and possibly beyond their design life. Failure to maintain the ATMS to an acceptable standard can result in disruptions of equipment and strategies. Common maintenance activities include:

- Replacing defective or broken components
- Updating software and system inventories
- Logging events
- Testing equipment
- Cleaning system components

Responsive Maintenance

Responsive maintenance is the type of maintenance that occurs in response to alarms, customer requests, or identified problems.

- Responsive maintenance usually involves repairing or replacing a failed piece of equipment to return the control signal (or one or more of its components) to full operation or functionality (or as intended by the manufacturer).
- Generally, responsive maintenance is an emergency or critical repair—actions need to be taken based on the priority of the subsystem that has failed.
- Responsive maintenance takes precedence over preventative maintenance because of its emergency-like nature.

Preventative Maintenance

Preventative maintenance involves performing checks, tests, inspections, recordkeeping, cleaning, and replacement based on the function and rated service life of the equipment. The emphasis on preventative maintenance is on:

- checking for proper operation and
- taking proactive steps to repair or replace defective equipment, thus ensuring that problems are not left until equipment fails.

An Inspector should perform the following activities at least every 6 months on each control signal installation:

- Inspect all ramp control signals/flashing beacon signs and clean or replace as necessary.
- Inspect all signal lenses and clean or replace as necessary.
- Inspect each signal head for damage and replace as necessary.
- Refocus all signal heads and align with the correct lane of traffic.
- Replace all signal lamps in each signal head (unless light-emitting diodes [LED] signals are used).
- Inspect each loop detector amplifier and retune or replace as necessary.
- Inspect each time clock (internal or external) and reset as necessary.
- Inspect all steel pole surfaces for scratches or rust and apply cold galvanizing material as necessary.
- Inspect each foundation bolt for tightness and retighten as necessary.
- Inspect all pull boxes and replace as necessary.
- Inspect all pole bases and controller cabinets for insect and rodent buildup, remove any buildup or debris, and replace pesticides as necessary.
- Check the ventilation fans and thermostats. Install new dust filters.
- Lubricate locks and ventilation fan motors, and graphite the cabinet locks.
- Check voltages and current for abnormal readings.
- Check the cabinet seals and repair or recaulk, if necessary.
- Remove graffiti from the cabinet.
- Check the communication system to the traffic management center, if provided.
- Log the service activities performed.

In addition to these maintenance items, routine field inspections should also be performed at each ramp meter location. As part of these inspections, the Inspector should check the following items:

- Review the placement and condition of all advance warning and regulatory signs.
    - Observe if the signs are in good condition, missing, damaged, turned, or obstructed.
    - Check to see if vegetation is impeding visibility to these signs.
- Review the condition of the pavement markings associated with the ramp control signals.
    - Include the stop bar, edge lines, lane skips (if any), and HOV lane designation symbols (if any).
    - Note if pavement markings are missing or faded.
- Observe the general condition of the pavement on the ramp.
    - Note if the pavement conditions are new, good, fair, or poor.
    - Note if pavement appears to be “polished” or if potholes are present.
    - If loop detectors have been installed:
        - Review the pavement conditions of the saw cuts and note if depressions, cracks, or deterioration are occurring.
        - Check that saw cut seals are still intact.
- Notify the appropriate Maintenance section or Area Office of any deficiencies observed during the inspection.

A.11 Drainage Construction Inspector Best Practices

A.11.1 Introduction

Drainage covers a wide range of installations whose primary purpose is to draw water away from the roadway. While moisture is essential to the compaction of bases, too much moisture can destabilize the base courses, as well as accelerate the erosive effects of the freeze/thaw cycles. Proper drainage installation is used to optimize the effects of moisture with primary concern toward removing water from the roadway.

- Storm drains and side drains are used to remove rainwater from the roadway.
- Underdrains and edgedrains (a.k.a. drain tile) are used to remove moisture from the base foundation.

While storm drainage typically appears on every Project, underdrains are used in wet areas that have poor drainage and tend to hold water instead of shedding it.

Weather can be a primary source of delay on the progress of Project completion. One major rainfall event can delay the Project for weeks. It is the Project Manager's responsibility to ensure that proper drainage is considered during construction and to assess potential problems from improper drainage. Consult the Area Engineer if potential problems are detected.

A.11.2 Storm Drainage

Preconstruction

The Inspector should take prudence to review the plans before construction begins.

- Review the planned profiles with the Contractor to circumvent design and construction discrepancies.
- Ensure that the plan grades correspond to the actual conditions.
- Ensure that outflows are cleared and will not back up drainage onto the Project.
- Ensure that precautions are taken to safeguard environmentally sensitive areas.
- Attain Engineer approval for any changes to the plan.

Pipe Profile Requirements

The Inspector should ensure the work meets the following requirements regarding pipe profiles:

- Profile both inlet and outlet ends of proposed drainage structures for at least 100 ft (30 m) in the existing ditch line or stream bed.
- Adjust flowline elevations, if necessary, to enhance the hydraulics and to reduce silting, scouring, or backwater.
- Calculate the length of each structure and provide sketches of the structure to the Engineer for review and approval ***at least 24 hours before*** beginning work.

See GDOT Standard Specifications Subsection 149.1.03 C for more details.

Installation

See Georgia Standard Specifications Section 1030D for the typical process for installation of a storm drain (Figure A-47).

Figure A-47: Storm Drain Installation

<u>Materials</u>

The installed pipe for a storm drain must meet the specifications of the contract; any deviations must be brought to the Area Engineer's attention for approval. Typically, the following pipes will be used for installation:

- Concrete pipe
- Ductile iron pipe
- Corrugated aluminum or steel pipe and pipe-arches
- Smooth-lined corrugated polyethylene pipe
- Other DOT-approved materials

See GDOT Standard Specifications Sections 840–848 for more information on types of pipe. The Inspector should provide the following guidance regarding the materials used:

- Use the appropriate joint material for the pipe installation:
    - Mortar
    - Bituminous plastic cement
    - Rubber-type gasket
    - O-ringed gasket
    - Preformed plastic gasket

  See GDOT Standard Specifications Section 550 for more information on joints.
- Cap storm drain pipes with the appropriate end section. End sections consist of prefab end pieces or are poured in place as headwalls. The plans will specify which is to be used.
    - Use flared end sections to help stabilize the soil and disperse the kinetic energy of the outflow, which minimizes the effects of erosion.
    - Use safety end sections modified with support bars across the opening to safeguard against potential damage from accidents.

- Ensure that safety end sections are installed on pipe ends that face toward oncoming traffic.

See Georgia Standard Specification 1120-1125 for details on end sections.

- Inspect each pipe piece for damage that may occur during transport, handling, and installation and ensure that the OMR Inspector's mark is inside the Reinforced Concrete Pipe (RCP) pipe and concrete flared end sections.

Figure A-48: LaserForce Pipe Laser

- Ideally, use a pipe laser (Figure A-48) for grade establishment; however, a level will suffice.
    - Ensure that the inlet and outlet grades are according to plan and that there is a straight fall between them.
    - Ensure the line of the bell end is parallel to the lip of the male end of the previous pipe. ***Unparallel lines are an indication that the pipe is not seated properly or that the grade is off.***
    - Have the Contractor fix all deficiencies, ideally before the pipe has been covered.

  See Georgia Standard Specifications Section 550 for more information on storm drains.

Backfill Operation

Backfill is an important part of the installation process for drainage, especially for cross drainage underneath the roadway. See Georgia Standard Specifications 1030d (Figure A-49) for guidelines on backfill. The Inspector should monitor the Contractor's work in the following procedures:

- Ensure backfill material is classified as Type I or II, Type I earthwork material for areas.
- Place backfill material in layers of no more than 6 in. (150 mm) loose.
- Notify the lab to perform the required classification and compaction testing.
- Clean pipes and pipe-arch culverts before final acceptance of the work.
    - The Department may conduct video surveillance on storm drain (cross drain and longitudinal drain) installations after all activities that may damage the pipe are complete, but before the placement of the base and paving when applicable.
    - If video surveillance shows problems such as pipe deformation, cracking, or joint separation, the Contractor must repair or replace these pipes at no cost to the Department.
- Use a nine-point mandrel to test a minimum of 25% of the installed length of smooth-lined corrugated polyethylene or PVC profile wall drain pipe for deformation (pieces will be selected by the Engineer).
    - Use a mandrel that has an effective diameter equal to 95% of the base inside diameter.
    - Provide the Engineer with a proving ring to verify the mandrel size.
    - Do not pay mandrel testing separately.

- Ensure that smooth-lined corrugated polyethylene or PVC profile wall drain pipe installations have a maximum of 5% deflection when checked after completing all construction activities that may damage the pipe, but before placing the base and paving when applicable.
- If mandrel testing reveals problems, the Engineer may require that up to 100% of the storm drain installations be checked for deformation.
- Remove and replace pipe with over 5% deflection at no cost to the Department.

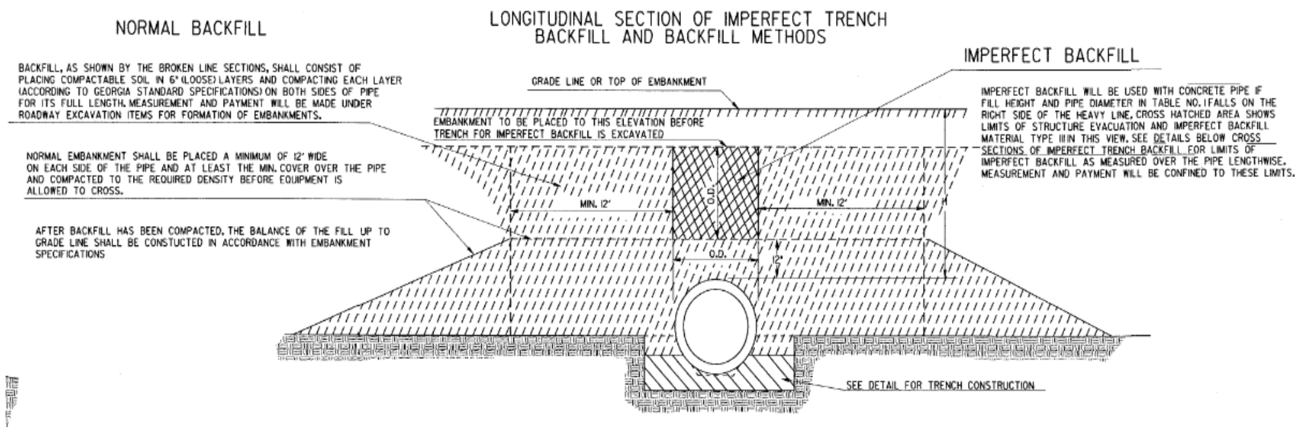


Figure A-49: Imperfect and Normal Backfill Methods (GDOT Standard Specification 1030)

A.11.3 Underdrains

Material Requirements and Inspection

Pipe

Any one of the pipes listed below may be used unless otherwise specified in the plans (Figure A-50). The Inspector should ensure that only one type of pipe is used in each continuous, interconnecting line.

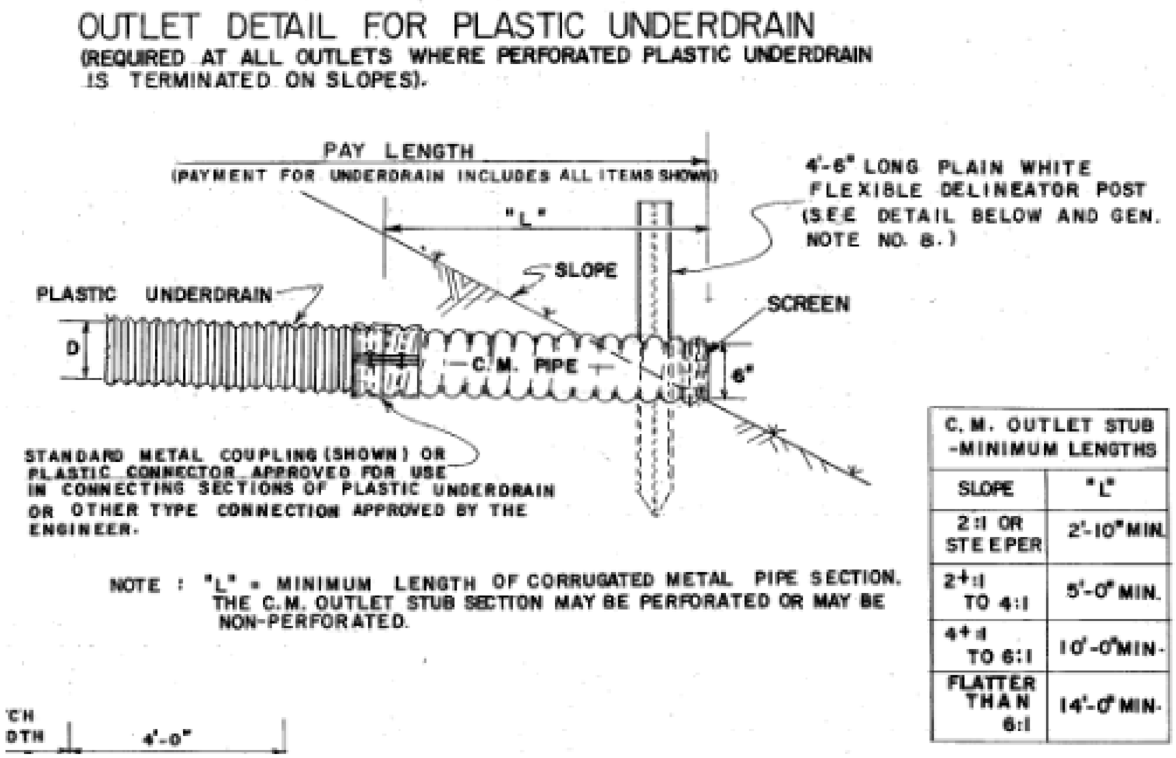


Figure A-50: Underdrain Detail (GDOT Standard Specifications 9029B)

- *Corrugated Aluminum Alloy Pipe*:
  - Review the requirements of AASHTO M196.
  - Inspect according to GDT 17.
  - Refer to Section 840 of the GDOT Standard Specifications for more information.
- *Corrugated Polyethylene Pipe*:
  - Ensure that the pipe and fittings conform to the requirements of AASHTO M252, with the exceptions given in GDOT Standard Specifications Section 839.2.01.
  - Make sure that pipe is supplied in individual lengths not shorter than 10 ft.
  - For pipe 6 in. or larger in diameter, confirm that coils are not used.
    - Coils will be permitted only in 4 in. or 6 in. diameters, provided it is machine installed.
  - If pipe lengths have developed bends, allow them to be straightened by force. Inspect the pipe for stress cracks that may develop during the process.
  - If pipe lengths have developed bends and cannot be sufficiently straightened, ensure that the pipe is replaced.

- Ensure that pipe is stored properly and that precaution is taken to avoid crushing or stretching of the pipe on hot days with bright sunlight.
    - Confirm that the tubing has been installed properly and there is no blockage in the drainage outlet.
- *Corrugated Steel Pipe*:
    - Review the requirements of AASHTO M36, Type III or IIIA for the specified diameter.
    - Measure and determine whether the metal thickness meets the requirements given in GDOT Standard Specifications Section 844.2.04.
    - Locate perforations either on the inside crests or on the neutral axis of all corrugations.
        - Perforations are not required within 4 in. of each end of each length of pipe or in a corrugation where seams are located.

Aggregate

The Inspector must perform the following tasks related to the aggregate during underdrain installation:

- *Backfill Aggregate*:
    - Ensure that Class A or B coarse aggregate, graded for Size No. 89
    - Perform the sieve analysis according to AASHTO T27.

Geotextile

The Inspector must perform multiple inspections related to the geotextile, particularly of the plastic filter fabric, as follows:

- *Plastic Filter Fabric*:
    - Check that the fabric does not have any defects, rips, holes, or flaws of any kind.
    - Ensure that the fabric:
        - consists of plastic yarn made from a long-chain synthetic polymer and
        - contains stabilizers and/or inhibitors to make the filaments resistant to deterioration as a result of ultraviolet light and/or heat exposure.
    - Check that the fabric is finished so that the filaments will retain their relative position with respect to each other.
    - Make sure that no stone is dropped on the fabric from a height greater than 3 ft.
    - Where a filter fabric repair is required, ensure that a piece of filter fabric is placed over the damaged area and extended 3 ft beyond the perimeter of the tear or damage.
    - Make sure that less than 10 days elapses between installation of the filter fabric and when it is covered with backfill.
    - Check that the fabric is placed such that the downstream edges overlap the upstream edges.
    - Ensure that all splice joints are provided with a minimum overlap of 3 ft.
        - Install securing pins to anchor the filter fabric if it does not remain in place during the construction of the drain.

- Require that the thread used to sew fabric is of the same chemical requirements as the fabric; fabric may also be bound with cement or heat (at the point of manufacture or at a location approved by the Engineer).
- Where an outlet pipe passes through the filter fabric, ensure that a separate piece of filter fabric of sufficient size is wrapped around the pipe and flared against the side of the filled drain filter.
- For rip raps and behind retaining walls, make sure that fabric bound or sewn together forms sections at least 6 ft wide.
- Ensure that fabric is wrapped in burlap or similar heavy-duty protection during shipment and storage to protect it from mud, dirt, dust, and debris.

<u>Excavation</u>

For excavation, consult the GDOT Earthwork Inspection Manual for Construction Inspectors.

<u>Installation</u>

During installation of underdrains, the Inspector should closely monitor the placement of the pipes, as follows:

- Ensure that all pipes are laid with perforations on the underside of the pipe, unless otherwise directed.
- For bell-and-spigot and tongue-and-groove pipe, ensure that all pipes are laid with the bell or grooved end upstream and the bells are imbedded in the foundation material.
- Ensure that fork-type attachments to front-end loaders and backhoes are not used for moving/handling plastic or other flexible pipe.
- Check that the influent end of the pipe is protected in a manner that will prevent any soil from entering the drain.
- Confirm that pipe screens, caps, plugs, ells, wyes, tees, and/or markers are installed as indicated on the plans or otherwise directed.

<u>Joints</u>

The Inspector must ensure that joints are properly connected and protected during the underdrain installation, as follows:

- Check that pipe and butt joints are securely connected using the appropriate size and type of band or coupling.
- Check that fittings and materials necessary to make splices of the plastic pipe and to make connections of the plastic pipe to the nonperforated outlet pipe are from the same manufacturer as the pipe.
- If the soil is of a composition such that it will wash into the joints, ensure that joints are wrapped with strips of tar paper approximately 4 in. wide.
- Ensure that the joints of butt-end drain tile are covered with burlap, roofing paper, or other approved material that is:
    - not less than 6 in. in width,
    - is of sufficient length to wrap the entire joint,
    - covers at least 3 in. on each section of pipe,

- turns outward, and
- lays flat on the bedding course.

Outlets

The Inspector should work to assure appropriate design and installation practices are employed so that the outlets of the underdrain function as intended for good drainage.

- Confirm that each outlet end of the drainage system is marked according to plan details.
- Ensure that the foundation is prepared to the required depth with forms set rigidly to the line and grade designated, and the concrete is placed, spaded, vibrated, and finished with a wood float to a true and even surface.
- After the precast unit has been placed on the foundation, confirm that the underdrain pipe is firmly secured to the outlet protector.
- Ensure that the outlet protector is placed in such a manner that the underdrain lateral has a uniform slope to allow proper drainage.
  - Do not permit abrupt changes in slope along any portion of the lateral.
- Where perforated pipe outlets into an open ditch, ensure that a minimum of 8 ft of nonperforated pipe from the outlet is provided.
- Ensure that pipe with less than 1 ft of cover at the outlet end is encased in 6 in. thick concrete of any class or flowable fill.
- Oversee the installation of headwalls to a slope of ½ in. in 1 ft.
  - When practical, place the toe of the headwall a minimum of 6 in. (1 ft desirable) above the bottom of the ditch.
  - Place crushed aggregate to a minimum depth of 4 in. around the headwall.

Backfill

Refer to Georgia Standard Specifications Section 812 for more information. The Inspector should perform the following steps during the backfill operation for underdrain installation:

- Ensure that backfill aggregate is placed in 6-in. layers and compacted thoroughly until reaching the total plan depth, making sure that the pipe alignment is not disturbed.
- Ensure that the material is not dropped on the filter fabric from a height greater than 1 ft.
  - Permit greater drop heights if a cushioning layer of sand on top of the fabric is provided before dumping of any stone.
- Oversee backfill operations to make sure that the pipe and covering at open joints are not displaced.
- Ensure that bulldozers or other blade equipment are not used to backfill the trench.
- To ensure that backfill material is protected from contamination by foreign material, pay particular attention to the top surface of the filter blanket when it will be covered by an aggregate drainage course.
  - Do not consider soil infiltration from placing soil courses over the filter material to be contamination; it is incidental to the work.
  - Remove and replace contaminated portions of the aggregate before placing succeeding layers of filter blanket or aggregate drainage course.
- Confirm that suitable earth material and not aggregate is being used to backfill the trench for pipe outlets.

    - Place and compact the earth material in 4-in. layers.
- Where wet conditions apply:
    - Ensure that material is placed and compacted using timbers or hand tampers until reaching an elevation at which its moisture content will permit the use of mechanical tampers.
    - After reaching this elevation, confirm that normally acceptable backfill aggregate is used for the remaining volume of the trench.
        - Compact the material using mechanical tampers in such manner and to such extent as to transfer the compacting force into the material previously tamped by hand.

A.11.4 Edgedrains

Material Requirements and Inspection

<u>Pipe</u>

Any one of the pipes listed below may be used unless otherwise specified in the plans. The Inspector must ensure that only one type of pipe is used in each continuous, interconnecting line.

- *Corrugated Aluminum Alloy Pipe*:
    - Review the requirements of AASHTO M196 for nonperforated pipe.
    - Inspect according to GDT 17.
- *Corrugated Polyethylene Pipe*:
    - Ensure that the pipe and fittings conform to the requirements of AASHTO M252, with the exceptions given in GDOT Standard Specifications Section 839.2.01.
    - Make sure that pipe is supplied in individual lengths not shorter than 10 ft.
    - If pipe lengths have developed bends, allow them to be straightened by force.
        - Inspect the pipe for stress cracks that may develop during the process.
    - If pipe lengths have developed bends and cannot be sufficiently straightened, replace the pipe.
    - Ensure that pipe is stored properly and that precaution is taken to avoid crushing or stretching of the pipe on hot days with bright sunlight.
    - Confirm that the tubing has a minimum pipe stiffness of 46 psi at 5% deflection and is capable of 60% vertical deflection in parallel plate loading without splitting or cracking when tested in accordance with ASTM D 2412.
- *Concrete Pipe*:
    - Ensure that pipe conforms to the requirements of AASHTO M175 or AASHTO M176 with the exceptions given in GDOT Standard Specifications Section 843.2.03.
    - Inspect according to GDT 16.
    - Check for the following issues:
        - Visible fractures or cracks
            - ✓ A single end crack that does not exceed the depth of the joint is allowable
        - Defects that indicate imperfect proportioning, mixing, and molding
        - Surface defects indicating honeycombed or open texture
        - Damaged or cracked ends that would prevent a satisfactory joint

        - Defects indicating incorrect positioning of reinforcing steel
    - Check that spalls are not more than 1.5 in. in diameter or $^{3}\!/_{16}$ in. in depth and do not adjoin.

<u>Aggregate</u>

The Inspector must perform the following tasks related to the aggregate during edgedrain installation:

- *Backfill Aggregate*:
    - Review the requirements of GDOT Standard Specifications Section 800.2.01 for coarse aggregate.

<u>Geotextile</u>

The Inspector must perform multiple inspections related to the geotextile, particularly of the plastic filter fabric, as follows:

- *Plastic Filter Fabric*:
    - Check that the fabric does not have any defects, rips, holes, or flaws of any kind.
    - Ensure that pervious sheets of plastic yarn made from a long-chain synthetic polymer are used.
    - Ensure that the fabric contains stabilizers and/or inhibitors to make the filaments resistant to deterioration as a result of ultraviolet and/or heat exposure.
    - Check that the fabric is finished so that the filaments will retain their relative position with respect to each other.
    - Require that the thread used to sew fabric is of the same chemical requirements as the fabric; fabric may also be bound with cement or heat (at the point of manufacture or at a location approved by the Engineer).
    - For rip raps and behind retaining walls, make sure that fabric bound or sewn together forms sections at least 6 ft wide.
    - Ensure that fabric is wrapped in burlap or similar heavy-duty protection during shipment and storage to protect it from mud, dirt, dust, and debris.

<u>Excavation</u>

Consult the GDOT Excavation Inspection Manual for Construction Inspectors.

<u>Installation</u>

During installation of edgedrains, the Inspector should closely monitor the placement of the materials, as follows:

- Before the edgedrain is placed, ensure that pavement slabs in the immediate area are pressure-grouted and cured.
- Oversee the installation process during other operations on the Project to prevent conflict, damage, or improper infiltration of other materials.
- Ensure that all pipes are laid with perforations on the underside of the pipe, unless otherwise directed.

- For bell-and-spigot and tongue-and-groove pipe, ensure that all pipes are laid with the bell or grooved end upstream and the bells are imbedded in the foundation material.
- Confirm that pipe screens, caps, plugs, ells, wyes, tees, and/or markers are installed as indicated on the plans or as otherwise directed.

Joints

The Inspector must ensure that joints are properly connected during the edgedrain installation, as follows:

- Check that pipe and butt joints are securely connected using the appropriate size and type of band or coupling.
- Ensure that each segment of the edgedrain is joined to the adjacent segment prior to installation.
- Check that splices do not disturb the alignment of the adjoining drain and do not separate during installation.

Outlets

The Inspector should work to assure appropriate design and installation practices are employed so that the outlets of the edgedrain function as intended for good drainage.

- Confirm that each outlet end of the drainage system is marked according to plan details.
- Where perforated pipe outlets into an open ditch, ensure that a minimum of 8 ft of nonperforated pipe from the outlet is provided.
- Ensure that pipe with less than 1 ft of cover at the outlet end is encased in 6 in. thick concrete of any class or flowable fill.
- Oversee the installation of headwalls to a slope of ½ in. in 1 ft.
    - When practical, place the toe of the headwall a minimum of 6 in. (1 ft desirable) above the bottom of the ditch.
    - Place crushed aggregate to a minimum depth of 4 in. around the headwall.

Backfill

The Inspector should perform the following steps during the backfill operation for edgedrain installation:

- Ensure that backfill material is placed in 6-in. layers.
- Check that coarse aggregate is placed at least 1 ft above the top of the pipe.
- Before compacting, confirm that the target density is established based on the method given in the GDOT Standard Specifications.
- Oversee the process of compaction to 100% of the target density to the depth shown on the plans or details, or as directed by the Engineer.
    - Ensure that pipe alignment is not disturbed and that filter fabric is not damaged.
- Ensure that backfill material is protected from contamination by foreign material.
    - Remove and replace contaminated portions of the aggregate before placing succeeding layers.

Quality Assurance

The Inspector must prepare for and perform the post-installation inspection for the edgedrain construction as follows:

- For Projects located on the State route system, including Interstates, inspect:
  - 100% of pipe under the roadbed,
  - 100% of pipe in a closed drainage system, and
  - a minimum of 10.0% of all other locations, except in side drain applications that are short enough to inspect from each end of the pipe.
- Conduct post-installation inspections in accordance with the requirements of this Specification and GDT 136.
- Before post-installation inspection, ensure that the installed pipe is dewatered (if necessary) and provide the Engineer with a post-installation inspection schedule.
  - Notify the Engineer ***at least 7 days in advance*** of beginning inspection.
- Perform post-installation inspections:
  - once compacted backfill has reached a depth of 8 ft or
  - after completion of the pipe installation and final cover, which includes the embankment and all non-asphalt bases and/or subgrades.

  Notify the Engineer of problems found during the inspection. The Engineer will determine if corrective action is necessary.
- Perform post-installation inspections with the use of low-barrel distortion video equipment with laser profile technology, noncontact video micrometer, and associated software.
- Ensure video and laser profiling and measurement technology are certified by the company performing the work to meet the requirements of GDT 136.
  - Inspection Contractor personnel completing remote inspections must be National Assocation of Sewer Services Companies – Pipleine Assessment Certification Program (NASSCO - PACP) Certified Inspectors.
- For video-recorded, laser-profiled pipe indicating deflection in excess of Specification requirements, the Contractor may elect to further test the pipe with the use of a mandrel.
  - Ensure the mandrel meets requirements of GDT 136 and has Engineer approval before use.
  - Pull the mandrel by hand.
- Allow manual post-installation inspection for pipe diameters greater than 48 in., per GDOT Standard Specifications Subsection 550.3.06.B.
- Re-inspect 100% of pipe remediation locations or where replacement was required.

A-12 Surface Treatments Construction Inspector Best Practices

A-12-1 Preconstruction

General Duties of Inspector

Inspectors are responsible for all equipment, materials, and overall work meeting the requirements of the appropriate specifications and plans for the particular job. It is recommended that the inspection of surface treatment consist of multiple Inspectors, with at least one highly experienced in surface treatment work.

The Project Inspector is responsible for the overall job and determining the application rates for the aggregate and the binder, as well as traffic control. The two primary points of inspection are:

- the asphaltic concrete application and
- the aggregate application.

Both applications must be monitored closely to achieve the best surface treatment. One Inspector should:

- be responsible for application of binder and
- modify the rate as specified by the Project Inspector.

Another Inspector should:

- be responsible for the application of aggregate and rolling operations, and
- modify the rate of aggregate spread as directed by the Project Engineer.

Inspectors must alert the Project Engineer and Contractor of any practices that do not follow the plans and specifications.

The Inspector must keep a daily Project log/diary documenting the following conditions and items:

- Weather conditions are favorable for the particular surface treatment, and air and surface temperatures are recorded in the morning and afternoon.
- Traffic control plans are established and implemented.
- The type and source of liquid asphalt meets DOT standards.
- Certain changes have been made (note each change).
- The existing asphalt is cleaned and patched (patching can only occur if the line item for patching is an original part of the proposal; if not, it will require a Contract modification; Figure A-51), resulting in a smooth surface.
- The temperature of binder meets specifications.
- The asphalt is applied at the appropriate rate and equally distributed.

Figure A-51: Patching of Surface

- The aggregate meets the right specification and its source is on the QPL.
- The aggregate is spread evenly and neatly.
- Optimal rolling patterns are established.
- Widths and distances of the work done.
- Events of significance.

Other items for the Inspector to note include the following:

- The parked binder distributor's spray bars are positioned so that excess binder is not dripping.
- Any clogged spray nozzles are corrected.
- The tack coat and prime coat have been placed during the appropriate weather conditions and have been cured properly.
- The surface to be covered with binder has been swept and cleaned, and there is no standing water or moisture (Figure A-52).
- Existing deficiencies, holes, and damages have been corrected.
- The quantity of binder material in the trucks is the correct amount for the length of spread.
- The binder does not overlap more than 4 in. for longitudinal joints (GDOT Standard Specifications Section 424).
- Aggregate is spread in accordance with Contract special provisions (typically, in 12-ft lane widths) immediately after the binder application (Figure A-53).

Figure A-52: Surface Preparation

- Rolling is done as soon as possible after the aggregate application.
- Aggregate is not being crushed by rolling, but firmly set in the binder.
- Any problem areas are properly repaired or rerolled.
- Excess material is swept off the surface by a power broom.
- All equipment meets the requirements in the specifications for surface treatment.
- All materials meet the requirements in the specifications for surface treatment.

Figure A-53: Asphalt Placement

- Application rates meet the specific requirements or changes as directed by the Technical Services Engineer from the Office of Materials and Research.
- Appropriate equipment is on site and in good working order.
- Traffic control devices and flaggers are in appropriate places and devices are covered when not in use.

Plans and Specifications

Surface treatment Projects must meet requirements in all special provisions and specifications. The Standard Specifications and the Contract detail:

- how a Project should be measured and priced,
- the required quality and type of equipment and materials, and
- the appropriate method of work.

For details on the Standard Specifications, reference Section 424 of the GDOT Standard Specifications. Any plans detail the specific work to be done according to the Contract.

Preconstruction Meeting

A meeting must take place at least 2 weeks prior to any surface treatment Project. The Project Engineer, Inspectors, and Contractor representatives must be in attendance. Also, invitations should be sent to county officials, the Materials Engineer, Utility Engineers, the Technical Services Engineer of OM&R, and the pavement marking Subcontractor; they may all be in attendance. Written minutes and an attendance list should be recorded and distributed as needed. The following are discussed in the preconstruction meeting:

- *Maintenance and Protection of Traffic*:
    - Take note of the Contractor’s designated worksite Traffic Control Supervisor.
    - Submit the traffic control plan for approval by the Contractor’s Traffic Control Supervisor.
    - Decide upon a list of appropriate equipment.
    - Decide upon flagger locations.
    - Establish a plan for traffic flow, including:
        - alerting local businesses and residents;
        - considering pedestrians, cyclists, and supply trucks; and
        - accommodating emergency vehicles.
    - Identify appropriate signage for the Project.
        - Establish a plan for variable message signs and who will be responsible for these.
    - Determine a lighting plan for night construction.
        - Submit the plan for approval, and any other nighttime construction precautions.
    - Discuss lane closure details.
    - Establish what types of pavement markings will be used.
- Review safety requirements.
- Determine who will be responsible for each aspect of the Project.

- Obtain Engineer approval of the Contractor's Project schedule.
    - Delays will be handled based on Contract special provisions.
- Have the Contractor complete and submit binder mix designs ***at least 15 days prior*** to production.
- Determine that the paver chosen by the Contractor is on the approved list or that a written approval for a different paver is submitted ***no later than 30 days before*** work begins.
- Verify that the roller meets the minimum weight requirement and is fully equipped with scrapers.
- Discuss and prepare the existing surface a few days before the Project starts.

A-12-2 During Construction

Equipment

General Information

For each piece of equipment applicable, the Inspector must ensure that it is appropriate and in working order.

- All equipment must be visually inspected for leaks that may contaminate the binder of the surface treatment.
- Remove any piece of equipment that exhibits any contamination from construction.
- Repair such equipment as soon as possible.
- The manufacturer's safety procedures for inspection and operation must be closely followed for any equipment used in surface treatment work.
- Ensure haul trucks have identification numbers.
- Ensure weigh tickets are accurate and available for collection.
- Require the weigh master to have State certification.
- ***The Inspector must record that each piece of equipment was inspected and found acceptable for use.***

Power Broom

The power broom should remove debris from the existing surface and any excess aggregate that was applied.

- Ensure the brooms have safety markings, lights, and flags in place to safeguard the motorists.
- Ensure the bristles on the broom are in good condition, including evenness of the width.
- Inspect the brush to confirm it is able to be raised and rotated.
- Verify the broom has the ability to discharge aggregate on either side.

Asphalt Distributor

The asphalt distributor is a piece of construction equipment that emits liquid asphalt material for preparing a pavement surface for rehabilitation.

- A current calibration ticket must be available for the distributor being used.
- Clean and visually check the distributor to prevent any contamination from occurring.

- Verify that each burner operates individually and is adjustable.
- Ensure thermometers/temperature gauges are accurate.
    - Use a separate thermometer to check the temperature of the asphalt, as needed.
- Ensure that heating equipment will heat and maintain the bituminous material uniformly at the temperature required.
    - Provide an accurate thermometer.
- Inspect the spray bar (Figure A-54) by raising and lowering it, and securing the ends in the raised position.
    - Ensure spray bars are straight when the ends are lowered in all directions.
    - Check the height of the spray bar by parking the distributor on a flat surface, spraying in the lowered position, and measuring the bottom of the nozzle to the surface of the pavement.
    - Take the measurements at different points along the length to ensure proper height of the spray bar.
        - Ensure the height complies with the manufacturer's recommendations.
        - Measure the heights before and after the tank is filled and correct if the difference is more than 1 in.

Figure A-54: Spray Bar Dispensing Asphalt

- Ensure the correct number of nozzles are available for the surface being treated.
    - Close off any extra nozzles.
    - Ensure the angle of the nozzles meet the manufacturer's specifications.
    - Check the spray width as follows:
        - Check the nozzles to make sure they are not clogged before this test.
        - Back the distributor onto a flat surface, and place paper under the spray bar.
        - Instruct the Operator to spray the paper very quickly, or otherwise spray a short test strip of 20 ft.
        - Shape the buckets for the bucket test to fit under the nozzle, side-by-side.
        - Spray the distributor for a specified time, and measure each bucket to ensure accurate quantities coming from each nozzle.
            - ✓ Ensure there is no more than a 10% variation in the weights of each container.
            - ✓ This test can also be done with water.
        - Hold the Contractor responsible to ensure the accurate spray distribution and proper utilization of the distributor (Figure A-55).

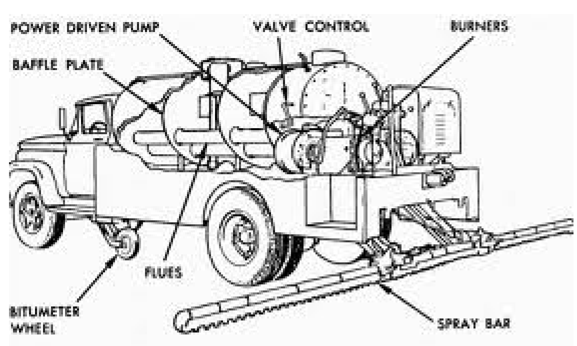


Figure A-55: Asphalt Distributor

- Ensure the pump pressure is at the maximum amount, without atomizing the asphalt.
    - Use field tests to determine the appropriate pump rate.
    - Ensure the distributer is equipped with a calibrated Digital-Measuring Instrument (DMI), with an accuracy of ±6 ft per mile.
    - Hold the Contractor responsible for ensuring proper spray distribution and calibration.

<u>Aggregate Spreader</u>

<u>An aggregate spreader is used to distribute well-graded aggregate across a pavement desired to be rehabilitated.</u>

- Inspect the discharge hopper (Figure A-56) to ensure no aggregate from past Projects is present.
    - Ensure the scalping grate covers the entire top of the discharge hopper.
    - Inspect the hopper for holes and cracks to prevent foreign material from getting mixed with the aggregate.
    - Inspect discharge gates to ensure they close fully.
- Check the discharge roller for the following:
    - Is the discharge roller straight, not strangely molded, to ensure an even distribution?
        - To determine this, stretch a string line from one end to the other.
    - Does the discharge roller have debris on its surface?
    - Does the discharge roller have excessive wear?
        - Check this by examining it as the roller is turned (wobbly or noisy bearings).
- Examine the wheels for any wobble that may be occurring (especially on turns).
    - Repair any wobbles before construction begins.

Figure A-56: Chip Spreader

- Inspect the clutch and brakes by stopping and starting the vehicle a few times before use on the Project.
- Check that the tires of the rollers (Figure A-57) are
  - inflated so there is no more than a 5 psi variation between any two tires,
  - smooth,
  - have no tread pattern, and
  - the same size and ply rating.
- Observe the tires to find any gouges/scratches that may negatively affect the aggregate arrangement.

Figure A-57: Pneumatic Tire Roller

- Check that the rollers are:
  - self-propelled and
  - able to reverse, start, and stop smoothly.
- Take care of any gouges in the rollers that may alter the contact pressure of the tire.
- Ensure brushes are in good repair.
- Ensure drums have no dents or cracks, and are smooth across the length of the drum.
- Check that the weight is evenly distributed.
- Set vibratory rollers to maximize compaction without breaking the stone.
- Check that scrapers are in good repair.

Aggregate Care

- Do not wash aggregate less than 24 hours before spreading. Ensure it is saturated surface dry (SSD).
- Unless otherwise permitted by the Technical Services Engineer, ensure aggregates specified for the same route are from the same source.
- Ensure aggregate is free of dust, silt, clay, or other materials that may reduce adhesion to the binder.
- Locate stockpiles of aggregate at least 30 ft from the roadway at a pit approved by the Office of Environment and Location.
  - They must not interfere with:
    - traffic sight distances,
    - access from surrounding properties, or
    - roadway drainage.
  - They must not be located in areas of potential contamination.
- Handle stockpiles so that segregation and degradation are kept to a minimum.
- Direct the loader operator to take a test bucket of aggregate from the very bottom to determine if the stockpile is uniform throughout and free of grass, clay, or soil. ***If unacceptable, correct the operation immediately.***
- Monitor the loader operator to make sure the loader's front wheels are not contributing to any degradation of the aggregate.
- If an emulsion is used, sprinkle the stockpile of aggregate with water, if necessary, to remove any dust that may prevent proper adhesion to the binder.

- Inspect the aggregate for uniformity and make sure that no blending or premixing is needed.

Road Surface Preparation

This section describes the methods used to plan and prepare an existing travel surface for new asphalt pavement.

- Prepare the existing surface per the appropriate Contract plans and in accordance with the GDOT Standard Specifications.
- Perform all repairs of existing surface deficiencies or irregularities prior to surface treatment construction.
- For new binder to adhere to the existing surface, ensure the edges of the existing roadway are cleaned, clipped, and swept before surface treatment construction.
- Remove loose material and any vegetation from the existing surface.
- Use the rotary broom to rid the entire surface of any dirt and other debris.
- Ensure the surface is not moist or wet, or have any standing water.

Weather Conditions

Weather conditions can be one hinderance in preparing and placing asphalt pavement.

- Obtain Engineer approval for exceptions to the date ranges (Table A-10) for the application of bituminous surface treatment.
- Overall, be in agreement with the supervisor on daily weather conditions, and more specifically, which weather conditions will prohibit asphalt pavement placing operations.
- Record the temperature each morning of construction.
- ***Never apply surface treatment when it is raining.***

<u>Observing Seasonal and Weather Limitations</u>

- Apply bituminous surface treatment and corresponding bituminous materials only between the dates given in Table A-10.
    - Correlate these dates with the zones shown on the Georgia Geographic Map in Figure A-58.
    - Do not permit exceptions unless authorized by the Engineer.

Table A-10: Surface Treatment Seasonal Restrictions

Zone	**Asphalt Cement**	**Emulsified Asphalt**
1	May 1–September 15	April 10–September 15
2	April 15–October 5	April 1–October 5
3	April 10–October 20	March 25–October 20
4	April 1–November 1	March 15–November 1

Binder Application

Asphalt binder application refers to the placing of liquid asphalt on an existing highway surface in preparation for rehabilitation.

- To monitor the rate of application, the width of one shot of liquid asphalt must be equal to the width of a full spreader pass.
- Prior to application, calculate the amount of asphalt needed and mark areas on the existing pavement. ***The distributor must never be completely emptied during a shot.***
    - Measure and mark each shot with a calibrated DMI.
    - If a spread check is necessary, place a strip of paper across the width of the lane being treated and hold it down with some aggregate sprinkled over the paper.
    - Remove the paper as the distributor begins the shot.
    - Place another strip of paper at a measured distance from the beginning of the shot.
    - Terminate the shot of asphalt as it encounters the paper.
    - Determine the amount of binder from the tank readings.
    - Determine the rate from the gallons per area measured.
- When a distributor is needed for a different type of binder, thoroughly clean out the distributor, removing the previous binder.
- To prevent foaming and overflow, use the first two or three shots to only fill the distributor about halfway.
- Use a strap stick to accurately measure the amount of binder in the tank.

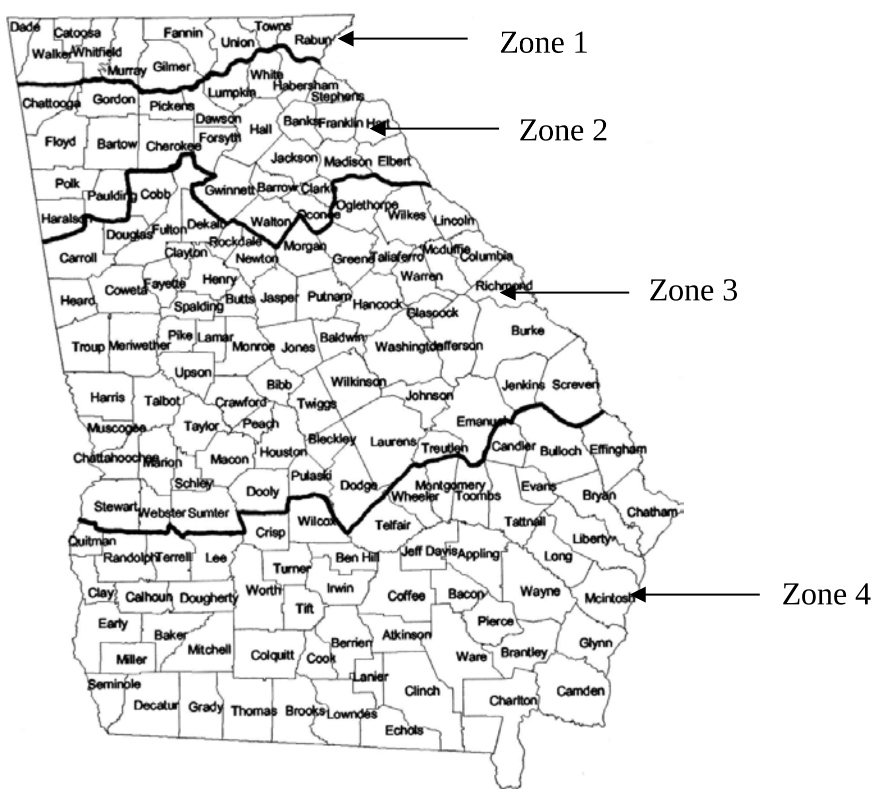


Figure A-58: Weather Zones in Georgia

- Take these measurements on a level surface
  - Record the measurements before and after each shot of binder.
- Check the temperature of the binder frequently to ensure it is within the specified range.
  - To increase the temperature, direct the operator to light the burners of the heater unit.
- Use the pump to begin circulating the binder through the pipes.
- Increase the pump speed to ensure the correct pressure is met for application.
- Ensure the designated Inspector is in an appropriate position to visually inspect the binder application. He/she must perform the following tasks:
  - Check for the proper fan pattern and a uniform spray from the distributor nozzles.
  - Ensure the road is sprayed so that it results in a smooth, flat surface.
  - In the case of any deficiencies, stop the operation and correct them immediately.

Aggregate Application

- Apply aggregate immediately (about 1 minute) after application of the binder, being careful not to have rocks turn over or binder be displaced by the tires of the trucks and rollers.
  - Ensure aggregate spreading follows closely behind the binder distributor.
  - Have the patching crew follow the spreading operation closely, ready to correct deficiencies.
- Have the spreader begin aligning itself as the joint paper is being removed.
  - Once positioned, open the discharge gates to ensure full coverage.
  - If these gates cover a wider area than that of the asphalt, close some of them.
- Monitor the connection and operation of the aggregate haul truck.
  - To connect the aggregate haul truck (Figure A-59), have the driver back the truck to the spreader and have someone ensure proper connection.
  - Keep the haul truck in neutral to be pulled by the spreader.
  - Designate someone to signal the haul truck driver when the spreader is nearly full of aggregate, so the spreader does not overflow.

Figure A-59: Chip Spreader Connected to Aggregate Haul Truck

- Prior to binder application, check the aggregate for uniform coverage.
  - To check this, cover a 50-ft test strip of bare pavement with aggregate.
  - Repair any spreader gates that malfunction and correct for uniform coverage before the start of the surface treatment.
- Open the spreader gates just before the start of the binder shot.
  - Ensure the truck bed stays raised until it is empty and a signal is given for the driver to lower the bed.
  - Release the truck before the spreader is completely empty.

        - Stop the spreader to connect to the next haul truck.
        - Carry out the same process as before to connect the truck.
- To assist in proper application rates, use rock landmarkers to help monitor the correct application rates throughout the spreading.
    - Generate a calculated distance from the weight ticket of the truck to be dumped.
    - Set the marker at the appropriate distance from the spreader.
        - Allow the marker to be slightly further than the calculated distance, since there is some aggregate left over from the previous truck.
    - Once the truck is hooked up and spreading is resumed, have the spreader operator gage the flow of aggregate to finish at the marker.
        - Consider the aggregate as being spread too thinly if the spreader passes the marker before the truck is empty.
        - Consider the aggregate as being spread too heavily if the second truck is attached more than 25 ft before the marker.
        - ***Fix these spreader gate problems immediately.***
- Ensure the designated Inspector in charge of visually monitoring the spreading is in a position to view the aggregate as it leaves the spreader gates adequately.
    - The section of aggregate being applied is one aggregate thick and able to transmit light for visual approval by the Inspector.
    - Correct any irregularities as soon as possible.
    - Monitor the scalping grate, ensuring there is no accumulation of contaminants.
    - To keep track of the number of truckloads being applied, list the identification numbers of each haul truck with the corresponding weight ticket.
    - Every time a truck is emptied of its contents, calculate the spread rate.
- Monitor the tires of the spreader and haul trucks for binder sticking to them.
    - Correct any deficiencies prior to the rolling operation such as aggregate sticking to the roller drums or water build-up in the asphalt..
    - Clean tires immediately.

Rolling

The rolling operation should begin immediately after the application of aggregate (finished within 30 minutes of spreading). It is important that the binder be soft and moldable when rolling the aggregate over it. The pneumatic rollers must maintain a low enough speed to ensure their tires do not displace the aggregate.

The Inspector should follow these guidelines for the rolling process.

- Begin roller passes on the edges and overlap each pass by a minimum of one-half of the roller width.
- Monitor each pass to ensure that no roller stops and starts too quickly, resulting in aggregate scuffing.
- Ensure every area is rolled at least three times.
    - The first pass should take approximately 1 minute.
    - Roll the surface with a tire roller, immediately followed by a steel-wheeled roller.
    - Finally, roll the surface again with a tire roller.
- Correct any deficiencies immediately, and reroll the surface.

- The rolling is acceptable when the majority of the aggregate particles are lying as flat as possible.
- Rolling will persist until a uniform surface is accomplished.

Brooming

Brooming (Figure A-60) is done to remove excess aggregate (at least 85% of loose chips) from the roadway in hopes to prevent damage to vehicles on the road, as well as the dislodging of loose aggregate from the surface treatment itself.

- Require brooming operations be performed:
  - Before and after the treatment operation
  - Once the binder has successfully stiffened, following the rolling operation
  - In the early hours of the day, following surface treatment, since temperatures are lower in the mornings and the surface is more likely to be stiff
- Check that the sweeper has the necessary warning devices to alert motorists of its operation and to ensure they stay on the appropriate side of traffic cones.
  - In an event of excessive amounts of dust in the air, provide a flagger for extra visibility.
- In general, ensure each 12-ft lane receives the required two to three passes by the sweeper.
  - For optimal results, ensure the sweeper begins on the inner lane and moves toward the shoulder.
  - Alter some patterns for specific cases; however, always perform brooming away from traffic.
- Keep brooming at a steady pace well ahead of the surface treatment application, ensuring brooming never delays treatment.
  - To prevent accumulation of dust in certain instances, do not allow the sweeping operation to be ahead by more than two shots of binder.
- Have Inspectors make sure the roadway surface is free of excessive aggregate and debris after brooming.
- Do ***not*** use adjacent private property to dump excessive aggregate from the roadway.
- Strictly monitor the sweeper to ensure excess aggregate is not being dislodged from the binder.
- Ensure brooming occurs safely and with little inconvenience to traffic.

Figure A-60: Brooming Existing Surface

A-12-3 After Construction

Final Documents

The Inspector and Contractor should agree on total payment quantities for the Project and document these agreements in writing.

- Ensure that the spread rates are within tolerance of the Contract quantities to avoid over-payment.
- Review the daily report, and discuss and document any improvements of the operation for future Projects.
- Document the area calculations of the treated surface, and organize and retain the weight tickets.

Finished Pavement

In the finished pavement, a uniform surface that conforms to the lines and grades in the plans must be delivered. The Inspector should follow these guidelines for inspecting the final surface:

- Ensure no defects are visible, including:
    - ridges,
    - rolling marks,
    - cracking,
    - segregation, or
    - other deficiencies.
- Remove temporary covers over drainage inlets, manholes, recessed pavement markings, and utility structures prior to road opening.
- Ensure all excess material is removed by the Contractor.
- Replace any unsatisfactory areas of the Project with a completed, sufficient surface.
- GDOT typically uses surface treatment as a crack relief interlayer. In those cases, apply leveling after the water has dissipated from the binder/aggregate mixture, and once leveled it can be open to traffic.
- If possible, do not allow traffic on the newly treated pavement for 48 hours. If this is not possible, limit traffic to a maximum speed of 15 mph during the next 48 hours.

A-13 Curbs and Gutters Construction Inspector Best Practices

A-13-1 Preconstruction

Plans and Specifications

A qualified/competent person must examine the plans and its proposal, looking for errors or mistakes while comparing to the site conditions. When the plan comes into conflict with the standard, the "Plans will govern over the GDOT Standard Specification."

Specific examination related to curbs and gutters may include, but is not limited to:

- Satisfactory access along sidewalk and road interface
- Mountable/non-mountable curbs
- Notation for curb stationing, in particular transitioning areas at inflow/outflow gutter areas
- Discrepancies with abutting driveways and/or property prior to build

Other examinations for the Inspector to conduct are the following:

- Verify that all environmental permit conditions will be met, and that erosion and sediment control devices have been installed.
- Verify "plan quantity" excavation with actual field conditions.
- Verify and document that width, length, and height meet field and slope conditions.

Equipment

Several pieces of equipment are required to construct a new asphalt pavement. The following section provides a description of equipment need to place asphalt.

<u>Asphalt Paver</u>

- Ensure the use of a string line to indicate proper stationing and elevations, or other qualified method

<u>Pump Truck</u>

Figure A-61 shows a typical pump truck. The Inspector conducts the following examinations:

- Identify and avoid any overhead utilities.
- Ensure base plates are used to level the truck.
- Get a uniform release of air bubbles by watching the vibrator's influence area.
- Do ***not*** drag the hand vibrator through concrete; rather, ensure it is pulled up and down at each location.

Figure A-61: Pump Truck

<u>Compaction Equipment</u>

- Accomplish compaction of subgrade by any type of tamping or rolling equipment that will produce the desired results.

Mixing and Finishing Equipment

- When approved by the Engineer, use a curb machine that will place the concrete in a satisfactory manner.
- Ensure finishing equipment includes satisfactory floats, edgers, spades, and tamps (Figure A-62).

(a) (b) (c) (d)

Figure A-62: Mixing and Finishing Equipment: (a) Concrete Edger, (b) Floats, (c) Tamps, (d) Spade

Materials

For curb and gutter construction, the Inspector will determine which materials need to be checked or what is already certified for use. In addition, the Inspector will have the following duties related to materials:

- Contact the supplier to coordinate material samples, spec sheets, and gradation tests.
- Ensure trial batches of cement are complete before operations begins.
- Test the concrete unless the source is a producer of good standing with GDOT.

Curb Quality Assurance

The Inspector is responsible to verify that the curbs constructed will be accepted when complete. For some surfaces, the test panel method is required for quality assurance prior to placing concrete, as follows:

- Use test panels as the standard of comparison for accepting textured and colored concrete surfaces.
- Construct and finish test panels at the job site with materials, tools, equipment, and methods the Inspector will use in the work.
    - If a test panel is rejected, construct an additional test panel the same size as the original.
- Do not place concrete that requires a test panel until the Engineer accepts the test panel.

A.13.2 During Construction

Subgrade

The Inspector can perform the checks indicated below visually and with the help of the Engineer.

- Check thorough compaction to plan specifications prior to crushed stone aggregate placement.
- Visually inspect for a smooth surface, checking that all:
    - soft, unstable, or unsuitable material is removed;
    - rocks or boulders are not present on subgrade and are removed; and
    - holes, ruts, or depressions are filled.
- Visually ensure a moist surface prior to the concrete pour.
- Check that the subgrade compaction is to 18 in. outside the area occupied by the pavement structure, including curb and gutter, and sidewalk as applicable, to not less than 95.0% of maximum density.
    - Where the concrete is a contiguous type, check that the area of the base and subbase extends 2 ft in width, extending beyond the back of the concrete.
- Check that the base and subbase are complete at least 2500 ft in advance of the concrete placing operations when this distance is available.
- If the subgrade is constructed on an old roadbed:
    - check that it conforms to or approximates the elevation of the subgrade, and
    - scarify and grade the existing surface so that the subgrade has a uniform density when compacted.
- ***Never, under any circumstances, place any base, surface course, or pavement on frozen, muddy, or unstable subgrade.***
- Check that the preparation is to the required depth and a width that will permit the installation and bracing of the forms.
- Check that the shape and compaction is a firm, even surface, in reasonably close conformity to the plans.
- Check that all soft and yielding material has been removed and replaced with acceptable material.

Construction tolerances should be checked before laying the pavement. These tolerances include conforming to the lines, grades, and cross sections shown in the plans. Check for a tolerance of 0.3 ft above or below the plan cross section with the following exceptions:

- Shape the surface of shoulders to within 0.1 ft of the plan cross section.
- Shape the earthwork to match adjacent pavement, curb, sidewalk, structures, etc.
- Shape the bottom of ditches so that the ditch impounds no water.
- When the work does not include construction of base or pavement, shape the entire roadbed (shoulder point to shoulder point) to within 0.1 ft above or below the plan cross section.
- Ensure that the shoulder lines do not vary horizontally more than 0.3 ft from the true lines shown in the plans.
- Check tolerances at regular intervals conforming to a rate of 100 ft/min along the planed curb line.

Staking Procedure

Setting stakes is a coordinated effort between the Inspector, Contractor, and the survey party. The Inspector should consider these guidelines:

- Generally, offset tack hubs outside the curb line to establish the back-of-curb line.
- Take profiles on the hubs and mark the cut or fill to the top of the curb on the hub guard stake, along with the offset distance and the station number.
- Have the Contractor stake the curb and/or gutter for construction to the proper line and grade. The staking procedure generally consists of a hub and tack at a maximum spacing of 50 ft.
    - Ensure these control points are offset approximately 2 ft back of the back of curb.
    - Set the nominal values for offset points at the preconstruction meeting. ***Note that if this offset distance can be the same for the entire Project, chances of error will be reduced.***
- Decrease the spacing of the control points as the percent of grade decreases.
    - Use spacing as close as 10 ft when the percent of grade is approximately flat, especially in intersection areas where drainage is very critical.
    - See Figure A-63 for the appropriate staking procedure.

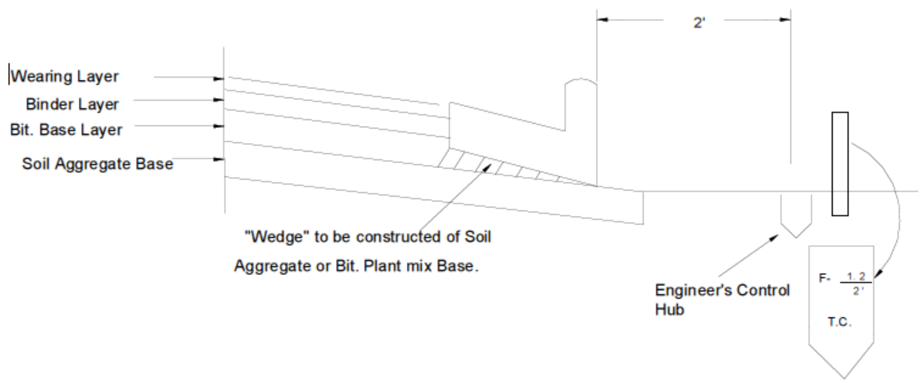


Figure A-63: Staking Procedure

- As Inspector, perform the following checks:
    - Check that staking is not separated by more than 50 ft and follows plans.
    - Check that the staking procedure favors those level surfaces where drainage is important.
        - Note that a desirable interval for stakes is as close as 10 ft.
    - Check that the distance from the curb's back face to the stake line conforms to the plans.
        - A 2-ft distance is recommended.
    - Check that the line between the stakes is taut and level for accurate readings of elevation.
- Hold the survey party responsible for the staking of the location for each catch basin, inlet, and/or manhole to be installed. Locating will consist of either:
    - setting "straddle" stakes for crossing out a particular point on the structure or

    - setting two stakes with tacks for the stretching of a string line along the front or other designated wall of the structure.

  If the inlet is located within a curb-and-gutter section, the stakes are usually set for the stretching of a string line by the Contractor along the face of the curb.

- Utilizing plan details, ensure the Contractor can then construct the drainage structure in proper relationship to the string line.
    - In addition to providing stakes for proper alignment, ensure the survey party provides a graded hub or stake in the immediate vicinity of the structure for "leveling over" with a carpenter's level.

Preparing Forms

The Inspector should understand the importance of proper form preparation and implement the guidelines below:

- Unless otherwise specified or permitted, use check forms of either timber or metal.
- Ensure check forms have been designed for the pressure exerted by a liquid weighing 150 pcf.
- Provide forming systems that are practically mortar-tight, rigidly braced, and strong enough to prevent bulging between supports.
    - Maintain forms to the proper line and grade during concrete placement (see Figure A-64).
    - Maintain forms in a manner that prevents warping and shrinkage.
- Do not allow offsets at form joints to exceed $^{1}/_{16}$ in.
- For forms to be left in place, use only material that is inert, nonbiodegradable, and non-absorptive.
- Rigidly attach inside forms for curbs to the outside forms.
- Clean all forms and footing areas of any extraneous matter before placing concrete.
    - Provide openings in forms if needed for the removal of laitance or foreign matter.
- Treat the facing of all forms with a bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface.
- Take care to prevent coating of the reinforcing steel.
- ***If the forms show signs of bulging or sagging at any stage of the placement, cease placement and remove the portion of the concrete causing this condition immediately, if necessary***.
    - Reset the forms and securely brace them against further movement before continuing the placement.

Figure A-64: Curb Formwork

Curb-Specific Form Information

Curbs constructed with concrete require a special set of construction aspects that are outlined in this section.

- See that forms are oiled and cleaned immediately prior to pour.
- See that forms have dividers at a maximum of 50-ft intervals.

- Check that forms are free of kinks and placed properly on grade with secure stakes or similar.
- Test the form with a straightedge to check levelness.
    - See that the deflection of form is less than ⅛ in.
    - Reset unsatisfactory forms.
- Observe the pins on every form at least at the middle and near each end.
- Look for form sections to be tightly joined and keyed together to prevent relative displacement.
- Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections.
- Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement will be met.
- Use flexible or curved wood or metal forms for curves of 100-ft radius or less.

<u>Timber Form Inspection</u>

Formwork for concrete construction often uses timber as the foundational material. The following section details how to inspect timber formwork.

- Ensure that properly seasoned good-quality lumber is provided.
    - It should be free from imperfections that would affect its strength or impair the finished surface of the concrete.
- Make sure that timber or lumber that meets or exceeds the requirements for species and grade in the submitted formwork plans is used.
- Make sure forms or form lumber that will be reused are maintained so that they stay clean and in good condition.
- Do not use any lumber that is split, warped, bulged, or marred or that has defects that will produce inferior work. ***Promptly remove such lumber from the work.***
- Ensure that form lining is provided for all formed surfaces except:
    - The inside of culvert barrels, inlets, manholes, and box girders
    - The bottom of bridge slabs between beams or girders
    - Surfaces that are subsequently covered by backfill material or are completely enclosed
    - Any surface formed by a single finished board or by plywood
- Make sure that form lining of an approved type such as plywood is provided.
- Ensure plywood used for forming surfaces that remain exposed meets the requirements for B-B Ply form Class I or Class II Exterior of the US Department of Commerce Voluntary Product Standard PS 1.
- Space wales closely enough to hold forms securely to the designated lines, scabbed at least 4 ft on each side of joints to provide continuity.
    - Place a row of wales near the bottom of each placement.
- Place facing material with parallel and square joints, securely fastened to supporting studs.
- Unless otherwise shown on the plans, fill forms at all sharp corners and edges with triangular chamfer strips measuring ¾ in. on the sides.
- To hold forms in place, make sure metal form ties of an approved type or a satisfactory substitute are used that permit ease of removal of the metal.

    - Cut back wire ties at least ½ in. from the face of the concrete.
- Make sure that devices used to hold metal ties in place are able to develop the strength of the tie, and adjust them to allow for proper alignment.
- Entirely remove metal and wooden spreaders that separate the forms as the concrete is being placed.
- Provide adequate clean-out openings for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

<u>Inspection Requirements for Metal Forms</u>

Concrete forms can also be made of metal forms. Details relating to the inspection of metal forms is included in this section.

- Use the same requirements as given for timber forms regarding:
    - design,
    - mortar-tightness,
    - filleted corners,
    - beveled projections,
    - bracing,
    - alignment,
    - removal,
    - reuse, and
    - wetting,

  as these also apply to metal forms—except that metal forms do not require lining unless specifically noted on the plans.

- Use forms that are thick enough to maintain the true shape without warping or bulging.
- Countersink all bolt and rivet heads on the facing sides.
- Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without damage to the concrete.
- Use metal forms that present a smooth surface and that line up properly.
- Keep metal free from rust, grease, and other foreign materials.

<u>General Checks</u>

This section includes inspection information on curb construction for highways.

- Check the geometry of forms along the grade and stationing with the plans.
    - Look for elevation strings that coincide with the form’s topside.
- Check to see that all form panels are tied off or secured to each other.
    - This includes back of curb panel, front of curb and gutter panels, and metal templates conforming to the curb and gutter section.
- Metal templates must not extend beyond a point 2 in. below the finished gutter.
- Check that forms are staked or otherwise held in place to prevent deflection during operations.
- Allow flexible forms used to construct radii or structure tie-ins to be metal, fiber, or of a material suitable to adequately perform the work.
    - Flexible forms require closer spacing of stakes to obtain the rigidity that is needed.

Removal of Forms

After the concrete has cured, several inspection practices are required to ensure a proper removal of all formwork. The following outlines those practices.

- Avoid damage to the edge of the pavement when removing forms.
- Repair damaged areas resulting from form removal and honeycombed areas using a mortar mix within 24 hours after form removal, unless otherwise approved.
- Clean the joint face and repair honeycombed or damaged areas within 24 hours after a bulkhead for a transverse construction joint has been removed, unless otherwise approved.
- When forms are removed before 72 hours after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement.
- Remove forms from the face of the curb 1 to 6 hours after placing concrete.
- Leave forms in place for sidewalk, gutter depression, island paving, curb ramp, and driveway for a minimum of 12 hours after surface finishing.
- ***Do not remove forms if concrete is plastic enough to slump.***

Curbs on Existing Pavement

Curbs may be constructed over existing pavement, where the method of construction includes using steel dowels/reinforcement or glue. Requirements are as outlined below:

- Check that where anchor points are needed, that anchor points are mortared with 1 part cement to 1 part sand; otherwise, ensure an approved method is used.
- Check that a clean surface prior to adhesive application is present. Approved methods for cleaning are by:
  - wire brush or
  - blast cleaning.
- Check that all dust, loose materials, and oils have been removed from the surface.
- Where an adhesive is required by the plan outlined by the Engineer, ensure the rate of application of adhesive matches that of the plans or as directed by the Engineer.

Placing Concrete

This section provides inspection and construction practices for placing concrete.

Cold Weather Restrictions

- Do not place concrete when the temperature of the concrete at placement is below 45°F.
- During the curing period, if NOAA predicts the ambient temperature to fall below 35°F for 12 hours or more or to fall below 30°F for more than 4 hours, enclose the structure in such a way that the concrete and air within the enclosure can be kept above 60°F for a period of 3 days after placing the concrete or until the concrete reaches a minimum compressive strength of 1500 psi.
- If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

Hot Weather Restrictions

- When the temperature of the concrete as placed exceeds 75°F, incorporate in the concrete mix a water-reducing retarder or water reducer, if allowed by the Engineer.
- Spray reinforcing steel and metal forms with cool fresh water just prior to placing the concrete in a method approved by the Engineer.
- Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

General placing operations must abide by the following; the bold areas below should be the focus of the inspection:

- Place the concrete in the forms, and **tamp and spade** it to prevent honeycombing, and until the top of the structure can be floated smooth and the edges rounded to the radius shown in the plans.
- Provide **adequate lighting** for all concrete operations conducted at night.
    - Obtain approval of the lighting system prior to starting the concrete operations.
- Do not place concrete until the depth and character of the foundation and the adequacy of the forms and false work have been **approved** by the Engineer.
- Do not deposit any concrete until all **reinforcement** is in place and has been inspected and approved by the Engineer.
- Do not expose concrete to the action of salt or brackish water for a period of 7 days after placing the concrete. Protect the concrete during this period by keeping salt or brackish water pumped out of cofferdams.
- Do not deposit large quantities at one point and then run or work it along the forms
- Take special care to fill each part of the forms, to work coarse aggregate back from the face, and to force concrete under and around reinforcing bars without displacing them
- Use a method and manner of placing concrete that avoids the possibility of segregation or separation of aggregates.
- If additional water is required, uniformly apply it ahead of the concrete placement as directed by the Engineer.
- Do not place concrete on supporting material that is frozen.
- Allow the Contractor to use a moisture barrier in lieu of controlling the foundation grade moisture when approved by the Engineer.
- Consolidate the concrete by continuous working with a suitable tool in an acceptable manner, or by vibrating as set forth in the GDOT Standard Specifications
- When not using vibrators, thoroughly work and compact all thin section work with a steel slicing rod.
    - Spade all faces, and flush the mortar to the surface by continuously working with a concrete spading implement.

Placing Concrete by Belt Conveyor

This section is largely regulated by the Engineer of Record and does not include specific inspections for all jobs, but serves as a guide.

- Place concrete by means of a belt conveyor system with written Department authorization.
- Remove conveyor belt systems that produce unsatisfactory results before continuing operations.
- Take concrete samples for assurance testing at the discharge end of the belt conveyor system.
- Make available to the Engineer the necessary platform to provide a safe and suitable place for sampling and testing.
- Remove any concrete placed in an unsatisfactory manner at no expense to the Department before continuing operations.
- Use conveyor belt systems that do not exceed a total length of 550 ft, measured from end to end of the total assembly.
- Arrange the belt assembly so that each section discharges into a vertical hopper arrangement to the next section.
- To keep segregation to a minimum, situate scrapers over the hopper of each section to remove mortar adhering to the belt and to deposit it into the hopper.
- Equip the discharge end of the conveyor belt system with a hopper and a chute or suitable deflectors to cause the concrete to drop vertically to the deposit area.
- To avoid delays due to breakdowns, provide stand-by equipment with an alternate power source prior to the beginning of the placement.
- After the beginning of the placement, direct the discharge from the belt conveyor so that the concrete always falls on freshly placed concrete.

<u>Placing Concrete by Pumping</u>

Concrete material can be installed using a pumping method that is described in this section.

- In general, use concrete pumping equipment that is suitable in kind and adequate in capacity for the work proposed.
- Use a pump discharge line that has a minimum diameter of 4 in.
- Use a pump and discharge lines that are constructed so that no aluminum surfaces are in contact with the concrete being pumped.
- Operate the pump to produce a continuous stream of concrete, without air pockets.
- When using cement slurry or similar material to lubricate the discharge line when pumping begins, collect such material at the point of discharge.
- Dispose of the collected slurry in areas provided by the Contractor.
- Control the pump discharge locations so that the placement locations of the various ***lots*** of concrete represented by strength test cylinders can be identified in the event the test cylinders indicate deficient strength.
- In cases where, because of obstructions, difficulty is encountered in puddling the concrete adjacent to the forms, bring the mortar content of the mix into contact with the interior surfaces by vibrating the forms.
    - Produce the vibrations by striking the outside surfaces of the forms with wooden mallets or by other satisfactory means.
- In placing concrete around steel shapes, place it only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which place it on both sides to completion.

- After the concrete has taken its initial set, exercise care to avoid jarring the forms or placing any strain on the ends of the projecting reinforcing bars.

Finishing Concrete

After the concrete has been placed, several construction activities are required to properly finish the concrete material. This section provides inspection and construction practices for finishing concrete.

- Give the surface a light broom finish with brush marks parallel to the curb line or gutter line.
- Remove all form ties or metal spacers to a depth of at least 1 in. below the surface of the concrete, and clean and fill the resulting holes or depressions with grout.
    - Metal devices with exposed cross sectional area not exceeding approximately 0.05 $in.^2$ on surfaces permanently in contact with earth fill may be broken off flush with the surface of the concrete.
- Remove all fins caused by form joints and other projections.
- Remove stains and discoloration.
- Clean all pockets and fill with grout as directed.
- Thoroughly soak the surface of all concrete with water prior to the application of a grout repair.
    - Use grout consisting of 1 part cement and 2 parts sand.
    - Use cement from the same source as originally incorporated in the work.
    - Cure the grout for at least 3 days.
- After the grout has thoroughly hardened, rub the patch with a carborundrum stone as required to match the texture and color of the adjacent concrete.
- On surfaces that are to be backfilled or surfaces that are enclosed, do ***not*** require the following:
    - Removal of form marks, fins, and pockets
    - Rubbing of grouted areas to uniform color
    - Removal of stains and discoloration

Rubbed Finish

One type of concrete finish is referred to as a rubbed finish based on the type of methods required to achieve this finish. The following section provides construction steps for obtaining a rubbed finish.

- After the ordinary surface finish has been completed, thoroughly wet and rub the entire surface.
- Use a coarse carborundrum stone or other equally good abrasive to bring the surface to a smooth texture and remove all form marks.
- Finish the paste formed by rubbing and by carefully stroking with a clean brush, or spread the paste uniformly over the surface and allow it to take a rest.
- Finish by floating with a canvas, carpet-faced, or cork float; or rub down with dry burlap.

Float Finish

Another type of concrete finish is referred to as a float finish based on the type of methods required to achieve this finish. The following section provides construction steps for obtaining a float finish.

- Finish the surface with a rough carpet float or other suitable device, leaving the surface even but distinctly sandy or pebbled in texture.

Extruded Construction

The following section provides information regarding the construction and inspection of extruded construction methods.

- Ensure the cementitious material content of concrete is at least 463 lb/yd^3. The aggregate size may range from ⅜ to 1 in.
  - If the Inspector uses ⅜-in. maximum size aggregate, cementitious material content must be at least 505 lb/yd^3.
- Follow important operational procedures, including the following:
  - Feed concrete into the extrusion machine at a uniform rate
  - Restrain forward travel of the extrusion machine to produce a well-compacted mass of concrete requiring no further finishing other than a light brushing.
  - Minimize finishing operations based on the equipment.
    - Brushing is allowed with water, but not a brush application of grout.
  - Ensure the traveling forms are rigid enough to produce the required cross section.
  - Ensure the machine produces a dense homogeneous concrete true to grade and a cross section requiring minimum handwork.
  - Consolidate concrete with internal vibrators or other authorized method.
- If the extruded or slipform machine fails to produce concrete with web marks of water on the surface or has surface pits larger than $^3/_{16}$ in. in diameter, be aware that aggregate grading limits are further restricted.

Checklist for Curbs

The following section provides a summary checklist for constructing concrete curbs alongside highways.

- If using an extrusion machine, determine the offset guide line used to set the grade for the top of the curb from survey marks established by the Inspector.
  - The extrusion machine must be equipped with a grade line gage or pointer that allows for continual comparison between curb placement and the offset guide line.
  - The extrusion machine must be capable of vertical adjustment during forward travel to construct curbs of varying height as determined by the offset guide line.
- Place curbs that are not on a structure with an extrusion machine or slipform paver if the Inspector passes the following:
  - Finished curb is true to line and grade
  - Concrete contains the maximum amount of water that maintains curb shape without support
  - Required surface texture is obtained

Joints

The following section contains all information related to constructing and inspecting joints on concrete pavement construction.

<u>General Inspection</u>

This section contains all aspects related to the general inspection of concrete joints in highway pavements.

- ***Construct joints at right angles to the surface of the concrete.***
  - Locate joints at right angles to the longitudinal centerline of curb, curb and gutter, gutter, island, median, median barrier, and all paved areas, except where different joint locations are called for on the plans.
- Where concrete is to be placed adjacent to any existing slab or pavement that has a broken or irregular edge, provide a reasonably vertical edge by sawing.
- Locate joints as shown on the plans except as provided herein.
  - Space joints no closer than 5 ft.
  - Locate joints to line up with the joints in the concrete pavement when placed adjacent to the concrete pavement.
- Form grooved contraction joints as required on the plans.
- Seal all joints except those in curb sections not having an integral gutter.
- Fill joints in the gutter with joint sealer to the top surface of the gutter.

<u>Expansion Joints</u>

The following section details how to construct and inspect the building of expansion joints in concrete pavement.

- Unless otherwise indicated on the plans, place pre-molded expansion joint filler, 1 in. (25 mm) in thickness, at the locations and in line with expansion joints in the adjoining pavement, gutter, or curb.
- Cut all pre-molded expansion joint filler to full width or length of the proposed construction and extend it to within 1 in. (25 mm) of the top or finished surface.
- Place all longitudinal expansion joints as indicated on the plans or as directed by the Engineer.
- Ensure all expansion joints are true, even, and present a satisfactory appearance.
- Form construction joints around all appurtenances, such as manholes, utility poles, etc., extending into and through the sidewalk or median area.
  - Install pre-molded expansion joint filler, 1 in. (25 mm) thick, in these joints.
- Install expansion joint filler 1 in. (25 mm) thick between the concrete curb and the median pavement and, unless otherwise specified, between the concrete curb and the sidewalk.
- Cut joint filler to the full cross section of the curb, gutter, or curb and gutter.
- Construct expansion joints in accordance with plan details.
- Form expansion joints about all bridge piers, drainage inlets, concrete gutters, and other features projecting through, into, or against the barrier curb and base.

Contraction Joints

The Inspector may allow the Contractor to use dummy joints (either formed or sawed or sheet metal), following these guidelines:

- When using sheet metal, ensure that they are of dimension and set to plan and lines.
- Place the templates firmly during the pour and leave them held in place.

The following may be applied to any type of placement:

- Allow contraction joints to be sawed or another method used, as directed by the Inspector.
- When sawing joints, ensure that concrete has hardened to the degree where excessive raveling will not occur and where uncontrolled shrinkage has not begun.
- Ensure joints are spaced at 10 ft and are altered for closure of a section; the joints should be no less than 4 ft apart.

Curing Procedure

This section provides information concerning the curing of concrete pavements.

General Curing

- Ensure curing happens continuously for 72 hours. Begin operation after concrete finishing and as soon as it will be able to bond with the curing material.
- Remove and then replace any curing material damaged within the 72 hours.
- After removing the forms from the concrete, cure the exposed surface by placing a berm of moist earth against them or by any of the three methods below:
    - *Wet Burlap Method*:
        - Ensure wet burlap covers the entire surface with sufficient extension on each side ensuring complete coverage.
        - Overlap bags by a minimum of 6 in.
        - Keep the burlap saturated and continuously in contact with the concrete, and prevent earth from entering the burlap.
            - ✓ Do not use burlaps previously used as a sugar container.
            - ✓ Wash burlaps if being used for the first time to get rid of starches.
            - ✓ Ensure burlaps furnished are at least 3 ft wider × 3 ft longer than the item being covered.
    - *Membrane Curing Compound*:
        - Use clear membrane curing compound or white pigmented curing compound.
        - To prevent settlement of the pigment, thoroughly agitate the curing compound in the drum prior to application.
        - Apply the curing compound with a hand sprayer in a single continuous film at a uniform coverage of at least 1 gallon per 200 ft^2.
        - Immediately recoat any cracks, checks, or other defects.
    - *Polyethylene Sheeting Method*:
        - Place sheeting over the entire surface of the concrete with sufficient extension beyond each side to ensure complete coverage.
        - Overlap adjacent strops a minimum of 6 in.

- ✓ Hold the sheeting securely in place and in continuous contact with the concrete at all times.
- ✓ Ensure waterproof bags, polyethylene film, and white burlap polyethylene sheet meet the requirements of AASHTO M 171.

Membrane Curing

When membrane materials are added to concrete pavements, several items need to be completed in order to cure the material and surrounding concrete.

- After texturing and immediately after the free surface moisture has disappeared, spray the concrete surface uniformly with two coats of membrane curing compound at an individual application rate of not more than 180 ft^2/gallon.
- Apply the first coat within 10 min. after completing texturing operations. Apply the second coat within 30 min. after completing texturing operations.
- Before and during application, maintain curing compounds in a uniformly agitated condition, free of settlement.
- Do not thin or dilute the curing compound.
  - Where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage, apply additional compound at the same rate of coverage to correct the damage.

Asphalt Curing

This section provides information for inspecting asphalt concrete overlays on highway pavement.

- When an asphaltic concrete overlay is required, apply a uniform coating of asphalt curing at a rate of 90 to 180 ft^2/gal, as required.
- Apply curing immediately after texturing and just after the free moisture (sheen) has disappeared.
- Obtain approval to add water to the emulsion to improve spray distribution.
- Maintain the asphalt application rate when using diluted emulsions.
- Maintain the emulsion in a mixed condition during application.

Reconstruction

When an existing concrete pavement is rehabilitated it is referred to as reconstruction. This section provides inspection information for reconstructing concrete pavements.

- Saw-cut and remove the existing concrete to neat lines.
- Unless otherwise shown on the plans, accept ownership and properly dispose of broken concrete in accordance with federal, state, and local regulations.
- Break material retained by the Department into pieces not larger than 24 in.
- Remove existing asphalt pavement prior to disturbing stabilized base.
- Avoid contamination of the asphalt materials and damage to adjacent areas.
- Repair material damaged by operations outside the designated locations.
- Prepare a stockpile site by removing vegetation and trash and by providing for proper drainage.
- Dispose of materials not designated as salvageable in accordance with federal, state, and local regulations.

Reinforcement

Most concrete pavements require the installation of steel reinforcing bars. This section provides inspection information for installing reinforcement in concrete pavement.

<u>Cleaning</u>

- Ensure the reinforcement is embedded and free of mortar, oil, dirt, excessive mill scale and scabby rust, and other coatings that would destroy or reduce the bond.

<u>Bending</u>

- Check that the bars are not bent.
- Check that there are no bars with kinks or improper bends.
- Ensure hooks and bends comply with the Building Code Requirements for Structural Concrete published by ACI.

<u>Placing</u>

- Check the firmness and securement of reinforcement in positions:
  - Wiring at intersections and splices
  - Precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, or other authorized devices strong enough to resist crushing under applied loads. ***Do not use aluminum, plastic, or wood supports.***
- Do not place bars on layers of fresh concrete as the work progresses.
- Ensure metal supports have a clear cover of at least 1 in.
  - Do not consider protective coatings on metal supports when determining clear cover.
- The center-to-center spacing of parallel bars must be at least 2.5 times the bar diameter. The clear distance between bundles of bars and adjacent bundles or single bars must be at least:
  - 1.5 times the maximum size of the coarse aggregate
  - 2 times the larger bar diameter for 2-bar bundles
  - 2.5 times the larger bar diameter for 3-bar bundles
- Tie bundle bars together at not more than 6-ft centers.
- Unless otherwise shown, ensure reinforcement has a 2-in. clear cover measured from the surface of the concrete to the outside of the reinforcement.

Integral Curb Construction

Integral curbs should be constructed monolithically with the pavement or as a separate operation by anchoring to the pavement.

- For monolithic placement operations:
  - Place the curbs immediately following completion of the placement finishing operations and before the concrete has taken its initial set.
  - Do not exceed an elapsed time between placing concrete in the placement and in the curb of 1 hour.

    - Obtain a good bond between pavements and curb by roughening the surface of the placement covered by the curb by means of a trowel or wire brush.
    - Place stirrups according to the plan at intervals of 2½ ft, before placing the curb.
    - Do not place stirrups closer than 3 in. to the centerline of sawed construction joints.
- With the separate operation of integral curb construction:
    - Clean the surface of the concrete in the pavement, ridding it of all foreign material prior to placing the concrete of the curb.
    - Insert preformed joint filler that is cut to conform to the cross section of the curb, directly into the curb, directly over the expansion joint in the pavement while placing the curb.
    - Construct contraction joints at the same locations as those in the pavement.
    - Use side forms with a depth equal to that of the curb, ensuring that the forms are rigid.
    - Check the curb forms for grade and alignment to the same degree of accuracy required for placement forms.
    - After the concrete in the curb has hardened sufficiently, but in no less than 6 hours after placement, remove the inside forms and finish the inside face to a uniform color and texture.

Correct any honeycomb or other surface defects by pointing with mortar of the same proportions of cement and sand used in the concrete.

Textured and Colored Concrete Surfaces

The following section provides information for adding texture or color to a newly installed concrete pavement surface.

- Do not place concrete that requires a test panel until the Inspector accepts the test panel.
- Texture concrete by imprinting with stamps, tools, brooms, or other method to achieve what is shown in the plans.
- For each color used in a dry-shake method of coloring, submit the manufacturer's data for color hardener, and curing and finishing compounds.
- For each combination of textured and colored concrete, construct a 4 ft × 4 ft test panel for quality assurance.
- With the dry-shake method, apply the surface color hardener in two applications during the plastic stage.
- Use the recommended 60 lb of hardener per 100 ft^2 of surface.
- Do not texture or grout grooved areas.
- If grout is to be applied onto a textured surface, cure the surface first.
- Remove the curing seal and other deleterious substances before applying grout.
- Removing should not stain or discolor areas that remain exposed after grouting; proceed according to manufacturer's recommendations.
- Remove excess grout with a damp squeegee, burlap, or other authorized method.

Asphalt Curb

Rather than concrete curb, it is sometimes desired to construct an asphalt curb near a highway. This section covers aspects associated with asphalt curb construction.

- Construct the asphalt with a self-propelled automatic curb machine or a paver with a curbing attachment.
- Ensure the paver is able to meet the following requirements; these should be checked by the Inspector:
  - The automatic curb machine ought to be able to create a dense mass free of voids.
  - The machine ought to form the curb true to line and grade and produce a product that is uniform in shape and texture.
  - In addition to the above two, the Site Engineer ought to check that the machine is well constructed and will be operated so as to obtain the finished product.
- The Site Engineer may permit curb construction by means other than the automatic curb machine for short distances or sections with short radii or other reasons that warrant a deviation from the normal. However, check that the resulting form remains true to the plan and its dimensioned curb.
- Prior to work start, inspect equipment necessary for ***any*** construction to verify acceptable working condition and approval by the Site Engineer.
- Do not place the asphalt curb where the pavement or base is wet or frozen.
  - Check the temperature.
- Prepare the subgrade to ensure that plan specifications are met prior to asphalt placement.
- Thoroughly sweep and clean the ***preparation*** of the pavement or base, that is portland cement concrete, asphalt pavement, or other base, using compressed air or similar method.
  - So long as the surface is dry and clean, the application of tack coat of asphalt material can be done.
- Ensure upon inspection that tack coat has not spread to areas outside the lay of areas occupied by the curb.
  - This is considered to be aesthetically unsuitable.
- Ensure ***backfill*** happens after the curb has reached an ambient temperature and as soon thereafter because the fill will provide added support and protection to the structure.
- Perform any painting or sealing on a curb that is clean and dry and has reached the ambient temperature.

A-13-3 After Construction

Final Curb and Gutter Surface Check

Inspectors should perform a final curb and gutter surface check once the construction is completed. The following are items an inspector should check.

- Check that the broom is perpendicular to the traffic.
- Check that joints are well rounded.
- Visually ensure there are no tool marks.
- See that spilled aggregated particles are cleaned up.
- Broom all sidewalk, gutters, medians, and driveways, unless otherwise noted.

- Have all visible cracks removed by section.
- Ensure honeycombed sections are filled with 1 part cement and 2 parts sand.
- As soon as the forms are removed from all concrete shapes, fill honeycombed places and other minor defects with a mortar composed of 1 part portland cement and 2 parts sand.

Backfilling Curb

After installing a construction curb, backfill material should be added to ensure proper drainage and aesthetics of the highway.

- Prior to filling, check to see that all honeycombs have been filled.
- After form removal and repair of defective areas, backfill the area behind the curb and/or gutter immediately.
- Use early backfilling to prevent pockets of water from standing along the back of the curb and possibly saturating the pavement structure buildup or subgrade.
- Ensure that the curb/gutter is not deformed with backfill.

Opening to Traffic

Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities, unless otherwise shown in the plans or directed.

- Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified.
- Before opening to traffic, protect the pavement from damage due to crossings using approved methods.
- *Opening Pavement to All Traffic*:
  - Pavement that is 7 days old may be opened to all traffic.
  - Before opening to traffic,
    - clean the pavement,
    - place stable material against the pavement edges,
    - seal the joints, and
    - perform all other traffic safety–related work.
- *Opening Pavement to Construction Equipment*:
  - Unless otherwise shown on the plans, allow concrete pavement to be opened early to concrete paving equipment and related delivery equipment after the concrete is ***at least 48 hours old*** and opening strength has been demonstrated in accordance with GDOT Standard Specifications Section 360.4.K.4: Early Opening to All Traffic before curing is complete.
  - Keep delivery equipment at least 2 ft from the edge of the concrete pavement.

A.14 Utility Relocation Construction Inspector Best Practices

A.14.1 Preconstruction

Introduction & Utility Agreements

Utility relocation is the adjustment of utility (e.g., water, gas, and sewer) facilities required by a highway Project. These utilities are relocated because they conflict with installations on a construction Project. The utilities may be relocated outside or inside the right-of-way or they may be abandoned and removed. All these procedures come under the broad concept of utility relocation.

The Project Manager must invite all Utility Owners that are affected by the Project to the preconstruction meeting. The concept is that the service of a utility should be restored so that it will continue to provide its product to its users in a similar fashion to that which existed prior to its relocation as a result of the highway Project. Various facilities will have to be restored in order for the utility to be functional again. There are two major categories of utilities evident throughout the GDOT Standard Specifications

- *Overhead Utilities*: Generally these utilities carry electric currents. Some common overhead utilities and their equipment are:
  - *Power Companies*:
    - Distribution poles
    - Conductors and transformers
    - Transmission and distribution lines
    - Service connections
  - *Telecommunication Companies*:
    - Telephone and telegraph poles and lines
    - Cable television lines
  - *State, County, Municipality*:
    - Traffic signals
    - Lighting systems
- *Underground Utilities*: These infrastructure include electrical conductors, as well as other types of utilities:
  - *Water, Gas, and Sewer*:
    - Mains
    - Valves
    - Service connections
    - Manholes
  - *Power Companies*:
    - Distribution and transmission facilities
    - Vaults
    - Television cables
    - Telephone and fiber optic cables

Relocation can also mean the construction of a functionally equivalent replacement facility necessary for continuing operation of the utility service, the Project economy, or sequence of highway construction. There are several cases when a utility is entitled to partial or full reimbursement for relocation work to accommodate highway Projects. Among these cases are:

- when a Utility Owner has land rights,
- for select relocations for Interstate Projects,
- for select service line relocations, and
- when extraordinary costs are involved.

The removal, relocation, or adjustment of utilities will be accomplished at the sole expense of the Utility Owner except as it may qualify for reimbursement under the provisions of Chapter 4 of GDOT's *Utility Accommodation Policy and Standards Manual*.

The ***Area Permit Inspector*** is the Engineer's authorized representative assigned to make detailed inspection of agreement or permit performance. The Project Manager will coordinate efforts with the Permit Inspector to ensure that all utility work is performed properly and according to the Department's policies. The Area Engineer may assign a Construction Inspector to verify compliance with GDOT standards and specifications. There are several duties that an Inspector is required to perform, which are discussed in this chapter as follows:

- This section (A.14.1) offers an overview of Inspector duties and responsibilities, along with the requirement for an Inspector to review plans and specifications before beginning the inspection process. The recordkeeping duties of the Inspector are also highlighted in this section.
- The second section (A.14.2) goes into detail about each inspection procedure before and during the process of relocation.

Duties and Responsibilities of an Inspector

GDOT is responsible for inspecting utility relocation work when it is performed as part of a construction Project or in conjunction with a construction Project. Only then does a GDOT Inspector have the oversight responsibility. The following discussion applies to such a case.

An Inspector is an individual who is normally assigned various duties during the utility relocation process. Some duties of the Inspector from beginning to end are:

- Attend Preconstruction or pre-relocation meetings and be aware of all utility agreements, plans, and relocation schedules.
  - The Inspector assigned to observe operations should be familiar with the permit before the work starts.
- Record the times and dates of Inspector visits and complete daily records of the status of the Utility Contractor's work performed, materials, and equipment.
- Ensure that the utility company representatives are familiar with the pertinent parts of the highway construction plans, alignment, grades, and right-of-way.
- Ensure that proper backfill methods and materials are used where proposed and future road surfaces are involved.
- Ensure that minimum horizontal clearances between installations and the proposed highway are obtained as related to right-of-way lines, limits of access lines, back of curbs, etc.
  - Minimum horizontal clearances are noted in the *Utility Accommodation Policy and Standards Manual*.

- Verify that overhead installations have the minimum required clearances above the proposed highway.
  - The Utility Contractor should provide the actual and minimum required clearances.
- Ensure that casings for underground pipes are installed to meet the design standards in the *Utility Accommodation Policy and Standards Manual*, and that vent pipes are properly placed.
- Report the location and elevation of highway Project benchmarks to utility company representatives for use in setting grades for pipelines, structures, etc.
  - ***Insist on the use of benchmarks so that highway and utility grades are based on the same data.***
- It is an Inspector's duty to know/oversee:
  - Who is responsible for removing or relocating and installing new utilities
  - Which utilities are being removed or relocated
  - Where utilities are being relocated
  - Backfilling and compaction
  - Patches and landscaping
- Be able to spot underground utilities easily and be able to identify them.
  - It is the responsibility of the Utility Contractor to get all utilities located before underground digging is performed.
  - The utility locators should have all utilities visibly marked/flagged before the commencement of work.
  - All nondetectable utilities (e.g., PVC water pipes, plastic gas lines) to be installed should have detectable marking tape installed with new installations.
- Be sure that the Utility Contractor's foreman is familiar with symbols furnished on the construction stakes, such as cut and fill information and that both the Utility and Project Contractors use the same data.
- Ensure that construction does not conflict with other utility companies' facilities or highway construction items.
  - Do this by checking the locations of existing or proposed underground structures such as sanitary sewer lines, manholes, water lines, gas lines, etc., in relation to the following:
    - Highway installations such as storm drains, drop inlets, catch basins, manholes, box culverts, and bridges, including planned foundations or footings
    - Lighting, signing, strain poles, and other items that may not be identified on the initial construction plans

<u>Review of Plans and Specifications by Inspector</u>

The District Utilities Office is responsible for coordinating the relocation or removal of utility facilities that are either in physical conflict or in violation of the Department's *Utility Accommodation Policy and Standards Manual* for transportation Projects including Local Let Projects in which the Department is providing funding or other administrative responsibilities in accordance with the Project Agreement. The primary role of an Inspector in plans and specifications is highlighted in the following points:

- Inspectors should familiarize themselves with the plans, specifications, and special provisions for the particular job. This will help them form an understanding of the Utility Contractor's proposed activities and sequence of work.
- Inspectors should look to these documents for valuable details about the requirements that the Contractor must meet on the job. In Georgia, there is a governing order for plans, specifications, and special provisions that is valid for all jobs.
    - Supplemental specifications govern over specifications.
    - **Plans** govern over specifications and supplemental specifications.
    - **Special provisions** govern over both specifications and plans
- Inspectors can look to the plans for information necessary to evaluate the impact to the right-of-way and the safety of the highway users. The plans show the size, material, pressure (design, normal, maximum), capacity, etc. of facilities to be installed, and their relationship to highway features such as right-of way lines, pavement type, pavement edge, structures, roadway drainage, etc., horizontal and vertical clearance to critical elements of the roadway, other existing utilities, and proposed test hole locations.

The Inspector should verify the following regarding utilities and the Project documents:

- Check the adjustment sheet to ensure that utilities shown as relocations or removals are mentioned in various agreements.
- Check the drainage sheets to ensure that drainage structures will not interfere.
- Make sure that relocations are realistic by thoroughly reviewing plans and permits to avoid conflict between utilities and proposed construction.
- Be aware of Contract plan requirements and be able to read these plans.

Daily Recordkeeping

Prior to the incorporation of materials in the work, the Utility Inspector should make certain that **test report records or certificates of compliance** for utility work in the Project as pay items have been received for materials tested off the Project site. The Inspector should maintain **Contract and Inspector diaries** and **Inspector reports** (when the utility work is in the Project as pay items) consistent with Department practice as are needed for a record of the Contractor's, Utility Owner's, or Utility Owner's Contractor's progress. These records should contain:

- *General Information*: Include date, Project identification number, Contractor's name, Subcontractor(s)' names, and time of inspection.
- *Conditions* (weather, moisture, soil conditions, etc.): Document any adverse conditions that hampered or delayed the Contractor's operations.
- *Hours of Work and Personnel on Site*: Include names of visitors to the site.
- *Activities* (including details of each activity): Identify scheduled activities and note the starting date and completion date.
- *Controversial Matters* (disputes, questionable items, etc.): Note if items were settled and the methods used to settle them
- *Instructions Given and Received*: Include who the instructions were transmitted to and from whom.

- *Progress Information*: Report all delays and action taken.
- *Schedule*: Include schedule activity information.
- *Major Material and Equipment Deliveries to the Site*: Include type, quantity, how delivered, and a statement on the condition of all deliveries.
- *Tests*: Report the location and the results.

Note: *Description of Accidents*: A separate accident report is to be filled out and signed by the Contractor.

A-14-2 Inspection Procedures

The Project can be divided into the Pre-installation Phase and Construction/Relocation Phase and the duties accorded to each phase have been elaborated there. Below is an overview of all inspection procedures during utility relocation.

- Pre-installation Phase
  - Utilities on Structures
  - Changes to Planned Relocation Work
- Construction/Relocation Phase
  - Clearing and Grubbing
  - Backfilling and Compaction
  - Utility Staking
  - Installation of New Utilities
    - Underground Utilities
      - ✓ Crossing
      - ✓ Gas and Petroleum Pipelines
      - ✓ Water Lines and Sanitary Lines
      - ✓ Electric Lines and Communication Lines
    - Overhead Utilities
      - ✓ Power and Communication Lines
  - Discovered Work and Emergencies/Conflicts
  - Final Inspection of Utility

Pre-installation Phase

The purpose of this phase is to develop the Project plans, utility adjustment schedules/utility work plans, utility relocation plans, and associated agreements necessary to address all foreseeable utility impacts that might affect the Project.

<u>Utilities on Structures</u>

The Inspector has special duties in the case of attaching utilities to structures such as bridges. Bridge attachment of a utility facility will not be considered unless the structure in question is of a design that is adequate to support the additional load and to accommodate the utility facility without compromise of highway features, including ease of bridge inspection and maintenance. The final design plans for utility attachments to bridges must be on reproducible plan sheets.

The required duties of an Inspector in relation to plans for accommodating utilities on structures are the following:

- Ensure that a minimum radial clearance of 20 ft in the case of power and communication lines is provided from the nearest part of all bridge structures.
- Prohibit the installation of heavy aerial cables (as a general rule any cable larger than 1 in. diameter and depending on the geographical region) over divided highways since these lines usually are difficult to maintain over high-speed traffic.
- For the best interest of the highway user, require communication cables (telephone, cable, etc.) crossing divided highways to be placed underground or in a duct on bridges. Review plans in order to ensure this.
- Ensure that water lines have welded or restrained joints or will be cased for the length necessary to prevent water from falling on an underlying highway, railway, or other areas determined by the Department.
- Require that sewer lines have welded or restrained joints or are cased for the length necessary to prevent sewage from dropping on an underlying highway, railway, or other areas determined by the Department.

<u>Changes in Relocation Work Design/Plans</u>

Changes to the site, changes to standards, and changes to traffic conditions should be included in plans. Where the need for minor changes arises in the utility relocation, the Inspector and the Utility Owner representative should provide adequate documentation in their daily records to indicate the nature of the change, reasons for it, and the final action. ***All changes to the Contract and plans must be verified by the Engineer's approval.***

Minor changes include such things as:

- adding a pole,
- making more convenient beginning or terminal connections to a facility,
- adding anchor guys, and
- slight changes in the location of the relocated facilities.

Minor changes do not require written approval; however, it should be determined that such changes are made to conform to the proposed transportation Project. A determination must be made if the change will affect relocation activities.

The Inspector deals with inspecting design change activities such as:

- Proposed changes in class or types of material (e.g., steel pipe for cast iron pipe, fiber optic cable for copper cable, concrete casing or concrete encasement in lieu of metal casing, buried wire for aerial wire)
- Proposed changes in sizes of conductor, pipe, casing, cable, or ducts, etc.
- Proposed changes in the treatment of a facility due to the conditions in the field not anticipated at the time of original design or review by the Utility Section, such as:
    - the need for wrapping pipe,
    - filling casing with bitumen compounds or concrete grout,
    - butt treatment for poles,
    - addition of grounding beds for cathodic protection,
    - placing joint clamps on disturbed and/or leaking metallic pipe joints, etc.

The Inspector should also deal with other changes, such as:

- Proposed changes in horizontal or vertical alignment of pipe, cable, conduit, or casing not considered in the original design or review
- Proposed change in length of pipe, cable, conduit, or casing due to field revisions to the basic construction
- Changes of construction limits
- Changes in grade
- Proposed changes resulting from trench or ground conditions requiring special footings, extra guying, bracing, sheeting, dewatering, grouting, or stabilization.

Construction/Relocation Phase

<u>Clearing and Grubbing</u>

The Contractor must notify the Project Engineer or Inspector ***at least 2 weeks in advance*** of the planned beginning of clearing operations, so that all vegetation scheduled to remain can be flagged and an Inspector be made available.

- Clearing and grubbing inspection is performed in excavation areas, embankment areas, borrow pits, structure areas including pipe placement areas, and any other areas required by the plans.
- Clearing and grubbing will include the disposal of
  - timber and brush;
  - stumps and roots;
  - rubbish and debris; and
  - buildings, structures, and other obstructions.

  Inspectors should look into specific requirements about how deep the roots, stumps, and debris are to be removed below ground surface to accommodate the relocation.
- The Inspector should take care not to disturb the ground under a tree, either by removing or adding dirt, or damaging the bark on a tree because this leads to a weakened condition from which many trees cannot recover.

Clearing and grubbing must be completed in advance of any grading operations. ***Much of the success of the Project depends upon the proper performance of the clearing and grubbing operation.*** The final appearance of the Project and the stability of cleared surfaces can be affected by improper procedures.

<u>Backfilling and Compaction</u>

One of the most important inspection duties during relocation is ensuring proper backfilling and compaction around and over **underground utilities**.

- Ensure backfilling or refilling of an excavated area of trenches is accomplished immediately after placement of a pipe.
- Do ***not*** leave trenches open during hours of darkness.
  - Place backfill in 6-in. layers or less with each layer being thoroughly tamped and compacted.
  - Exercise care to thoroughly compact the material around and over the pipe.

- Check that basements or cavities left by structure removal that require backfilling are backfilled and compacted.
    - Ensure backfilling of trenches is accomplished immediately after the pipeline or other utility is placed therein or as directed by the Engineer.
- Place backfill in two stages:
    - First, side-fill to the level of the top of the underground utility.
    - Second, overfill to the former surface grade.
- Ensure side-fill consists of granular material laid in 6-in. layers, each consolidated by mechanical tamping and controlled addition of moisture, to a density determined by specifications. The basic requirements are:
    - Place embankment material in 8-in. loose lifts compacted to 6-in. lifts.
    - Place base material in lifts where the base thickness is greater than 6 in.

<u>Utility Staking</u>

The purpose of staking is to facilitate the field review by showing the utility's proposed position with respect to the ROW line, the highway prism, highway structures, drainage facilities, other utility facilities, or other pertinent features. The Inspector should do the following:

- Identify sewer, water, gas, and other underground utilities with stakes that indicate the depth at which the lines are buried.
- Use stakes to identify station number and depth of a utility.
- Tie ribbons and flags to utility stakes to make them more visible.

The Inspector must be aware of the color codes and ensure that utility staking is in order with this system**.** The color code system is discussed at the Utility Coordination Meeting.

<u>Installation of Underground Utilities</u>

Lines crossing highways do not require encasement except where, in the judgment of the Department, such encasement is necessary for the protection of the highway facility. ***At crossings, no poles will be permitted in the center median of any highway.***

Pipelines

Inspectors should be aware of locations suitable for pipeline crossings and locations that are generally unsuitable for pipeline crossings. Examples of unsuitable locations for pipeline installation include:

- At deep cuts
- At locations near footings of bridges, culverts, and retaining walls
- Across at-grade intersections or ramp terminals
- At cross drains where flow of water, drift, or streambed load may be obstructed
- Within basins of an underpass drained by a pump if the pipeline carries a liquid or liquefied gas
- In wet or rocky terrain where it will be difficult to attain required bury

Crossover carrier pipes must be designed to withstand all applied and/or superimposed loadings resulting from the roadway section, traffic, potential pipe settlements, and installation procedures.

Encasement should be considered for the following highway crossing conditions:

- As an expediency in the insertion, removal, replacement, or maintenance of carrier pipe crossings of freeways, expressways, and other controlled-access highways and at other locations where it is necessary in order to avoid open-trenched constructions
- As protection for carrier pipe from external loads or shock, either during or after construction of the highway
- As a means of conveying leaking fluids or gases away from the area directly beneath the traveled way to a point of venting at or near the right-of-way line

Allied mechanical protection or other approved methods may be used in lieu of encasement to protect the pipe, pending justification in writing by the Utility Owner and approval by the Engineer. The Department at its discretion may require encasement of any pressurized carrier pipes or of any carriers transmitting dangerous and deleterious substance under any road.

Encasement or allied mechanical protection will be required for any pipeline:

- with less than minimum bury,
- near footings of bridges or other highway structures or across unstable or subsiding ground, or
- near other locations where there may be a hazard as deemed by the Engineer.

Encased:

- Ensure casings are designed to support the load of the highway and superimposed loads thereon and, as a minimum, should equal the structural requirements for highway drainage facilities.
- Use casings composed of materials of satisfactory durability under conditions to which they may be subjected.

Uncased:

- Ensure uncased carrier pipe provides sufficient strength to withstand the internal design pressure and the dead and live loads of the pavement structure and traffic. Additional protective measures should include:
    - Greater depth of cover (minimum of 4 ft)
    - Increased wall thickness/higher strength steel
    - Adequate coating and wrapping
    - Radiograph testing of welds
    - Hydrostatic testing
    - Cathodic protection
- Allow the length of the additional protection to extend the full width of the right-of-way but as a minimum 36 in. beyond the flow line of parallel ditches, the toe of the fore slope, or the back of the curb, as applicable for the highway section.

Gas and Petroleum Pipelines

Liquid petroleum pipelines must conform to the currently applicable sections of *Steel Pipelines Crossing Railroads and Highways* of the American Petroleum Institute (API) for pipeline crossings under highways. Inspectors must be aware of the methods of installation of gas and petroleum pipelines to effectively inspect their installation procedures in the State ROW.

Depth of Cover:

- Only permit distribution lines providing natural gas service longitudinally within the highway right-of-way; ensure they have a minimum depth of cover of 30 in.
- Do not permit longitudinal installations of transmission-type facilities.

Vents

- Provide one or more vents for each casing or series of casings.
- For casings longer than 150 ft, provide vents at both ends. On shorter casing, locate a vent at the higher end and place a marker at the lower end.
- Place vents at the right-of-way line immediately above the pipeline, situated to not interfere with highway maintenance or be concealed by vegetation.
- Ensure ownership of the lines are clearly shown on a sign attached to the vent pipe.
- Require markers for pipelines carrying hazardous transmittants.

Water Lines

The Inspector should ensure that water lines conform to current specifications of the American Water Works Association (AWWA) and GDOT's Standard Specifications, current edition.

- Ensure that potable water systems and slurry pipelines are marked blue.

Electric Lines

The Inspector should inspect several points during the installation of electric lines:

- Continuously monitor the location and alignment of the pilot drill progress to ensure compliance with the proposed installation alignment and to verify the depth of the bore.
- Obtain readings or plots for every drill rod and provide those to the Inspector on a daily basis during trenchless construction.
- Ensure underground communication lines have a minimum cover of 3.2 feet under ditches and within the ROW limits on conventional highways and freeways.
  - Minimum cover under pavement will be 3.9 feet.
- Allow accepted methods for undergrounding such lines, which include:
  - Trenching for conduit or duct construction for uncased buried cable
  - Plowing for direct burial of cable
  - Jacking or pushing of pipe as conduit, especially for crossings of existing highways
  - Small boring without conduit on highway crossings where soil conditions permit
- Ensure that electric power and communication facilities conform to the National Electrical Safety Code.
  - Use red locator tape for electric lines.

- Have an electric utility company relocate a line of the utility, at the Utility Owner's own expense, to allow the:
  - Widening of a right-of-way
  - Changing of a traffic lane
  - Improving of a road bed
  - Improving of a drainage ditch located on a right-of-way

Installation of Overhead Utilities

Power and Communication Lines

The type of construction, vertical clearance above pavement, and location of poles, guys, and related ground-mounted utility appurtenances, such as transformers or wiring cabinets, are factors of major importance to preserve a safe traffic environment. They are large factors in the appearance of the highway and the efficiency and economy of highway maintenance, as well.

The Inspector should take care of the following inspection points during the installation of overhead power and communication lines:

- Ensure the minimum vertical clearance above the roadway is 22 ft for electric lines, and 18 ft for communication and cable television lines.
- Keep track of the ruggedness of the terrain as a controlling factor for locating guys, poles, and related facilities on the ROW line.
- Check that electrical power and communication lines meet nationally recognized standards pertaining to loading and strength criteria.
- Locate poles and towers as far away as practicable from flammable material or structures.
  - Place the poles or towers supporting the crossing span and the adjoining span on each side, preferably, in a straight line.
  - Ensure there is no obstruction to driveways connecting highways, roads, paths, or sidewalks.
  - Set poles in line and plumbed.
- The Inspector must be able to read the details of anchoring guys as located on plans.
  - Ensure wooden poles supporting the crossing span are side guyed in both directions, if practicable, and are head guyed away from the crossing span.
  - Check that the next adjoining poles are also guyed.
  - If necessary, allow the use of braces instead of guys.

Changes to Relocation Work

Major Changes

Approval from the District Utilities Engineer or designee for a major change is required prior to performance of the relocation.

- Have the Utility Owner submit a written request, complete with:
  - plans showing the changes,
  - list of materials increased and/or decreased, and
  - a written explanation and justification for the change.

- When the change results in an increase or decrease in cost, ensure an estimated amount is given.
    - The cost change will be reflected in the final bill.
    - The Utility Owner must prepare a revised cost estimate to accompany the revised plans when the changes are extensive.

Major changes occur when the intent of the relocation deviates from the approved method of adjustment. Examples of such changes are:

- Construction of an underground facility instead of an aerial facility
- Location change from one side of the road to the other
- Additional crossings
- Extensive shift in highway crossings
- Change in size of materials that may require betterment credit
- Addition of major appurtenances to the utility facility

Discovered Work and Emergencies

In the case of discovered work, the Inspector must document the circumstances and provide details of the readjustment in writing to the Utility Owner, setting forth the following information:

1. Reason for the readjustment
2. Type of utility involved
3. Notation that the facility involved was installed under the original relocation plan and estimate indicating the date of original authorization
4. Identification of the approximate materials required to accomplish the readjustment, such as number of poles or linear feet of the utility involved
5. Approximate cost for the readjustment, as furnished by the Utility Owner
6. Request for the Utility Owner to submit a plan and estimate for consideration and approval prior to submitting a final bill for payment

An **emergency** is a sudden or unforeseen occurrence involving a clear or imminent danger to life, health, property; interruption of utility services; or repairs to transportation facilities that require immediate attention.

- It is beneficial for the Inspector to inform emergency services such as 911, police, fire departments, and ambulance companies.
- Where operations will have significant impacts to school buses or local transit vehicles, it is also necessary to inform those groups.

Also refer to the GDOT *Utility Accommodation Policy and Standards Manual* at http://dot.cobbcountyga.gov/2009-UAM.pdf.

A.14.3 After Construction

While permit work is handled by the Area Permit Inspector, utility installations in conjunction with Project work will be done by Construction Inspectors. It is important to get the Utility

Contractor to address all deficiencies and punch list items before leaving the worksite. Some items may include:

- Remove all construction debris from the worksite and grade to ground levels
- Have proper erosion control in place
- Ensure traffic control devices are in place and warning sign/markers are erected where warranted
- Pass final inspection
    - Perform a review to determine the extent that the utility work has been completed in reasonably close conformance with the plans, specifications, and authorized changes.
    - Notify the Project Manager and Primary Contractor when work is complete.

The Inspector’s diary is to be prepared on a daily basis beginning on the earliest of the following days:

- The day listed in the Contract for Contract time to start
- The day the Contractor starts work
- The day engineering expenses first occur

The diary is to be kept until time is stopped or the final inspection/punch list is complete.

A-15 Bridges Construction Inspector Best Practices

A-15-1 Preconstruction

Duties and Responsibilities of the Inspector

Inspect materials and construction work related to bridges for quality and conformance with plans, specifications, and special provisions. Accomplish inspection of bridges by ensuring the completion of the following tasks:

- *Field Inspection*: Ensure field inspections are performed in an orderly and systematic way as described in the manual.
- *Documentation*: Fulfill the Inspector's duty to create reports.
    - Enter data gathered during the field inspection into the Bridge Management System.
    - Make recommendations for repair and enter those into the Bridge Management System.
    - Create inspection reports and inventory data reports.
- *Signing*: Obtain the required signatures at the appropriate times.
    - When satisfied that the inspection report and inventory data report accurately describe the condition of the structure, ***the Inspectors will initial the cover sheet of the inspection report.***
    - The reviewing Bridge Inspection Supervisor will initial the report on the completion of the review of the inspection report and inventory data report.
    - The Professional Engineer responsible for confirming the accuracy of the report will sign and seal the inspection report.
- *Processing*:
    - When the inspection report and inventory data report are finalized, ensure the official copies are stored by the District Structures Maintenance Engineer for state-owned structures, and the respective owner for local government bridges.
    - Allow storage to be in a conventional paper file or store the official copies of the reports in the Department's Electronic Document Management System (EDMS).
- *Electronic Signature*: When a method acceptable to the Department of State, Board of Professional Engineers, and GDOT for electronically signing reports created in the Department's Bridge Management System is developed, electronic signature will be acceptable.

Construction Plans and Specifications

The construction plans and specifications provided in the project description give specific instructions and information on how to construction the project.

The Contractor must supplement the construction plans with drawings for fabrication (shop drawings) and construction methods (working drawings). The Inspector should do the following:

- Ensure shop drawings and working drawings are submitted as a part of the verification that the materials and methods selected by the Contractor for fabrication and construction:
    - will be in accordance with the requirements given in the Contract and

        - will ***not*** be detrimental to the quality of the completed roadway facility.
    - Require the Construction Supervisor or Lead Engineer to ensure issues such as vertical clearance, horizontal clearance, and access are addressed.
    - Ensure all Projects have obtained the proper permits or authorization.

Preconstruction Procedures

The Inspector's role during preconstruction include the following:

- Allow the Project Manager to make sure the Contractor understands the procedures for submitting shop drawings, working drawings, pile driving hammer submittals, drilled shaft installation plans, etc., so that they can be submitted early enough for the required review.
    - Where utilities or railroads are involved, verify if approval is required from the utility or railroad and ensure ample submittal time is allowed.
    - Ensure the Contractor is made aware of what materials will be tested and require a test report so that the work will not be delayed due to the lack of adequate material testing.
- Require clearing and grubbing within the right-of-way at a bridge site.
    - When stream banks are exposed due to clearing and grubbing operations, stabilize banks with indigenous vegetation or rip rap.

A-15-2 During Construction

Pre-cast, Pre-stressed Structural Members

Unless stated otherwise, the Inspector should ensure concrete used on infrastructure Projects is Class A or Class B.

- Use Class A concrete in structural concrete, headwalls, small retaining walls, culverts, sidewalks, curbs, driveways, pavements, paved ditches, and paved channel linings.
- Use Class B concrete for concrete encasements, caps, cradles, lateral risers, gravity retaining walls, and for all nonreinforced concrete deposited as fill for cavities or voids, and mass footings.

The minimum compressive strength at 28 days (f 'c) for Class A and Class B concrete is 3500 and 2500 psi, respectively.

<u>Storage of Materials</u>

Structural materials typically are delivered well before the installation and need to be stored on the project grounds. The following are inspection information for storing materials.

- Hold the Contractor responsible for handling, storing, transporting, and erecting prestressed members without damage.
- Ensure cement is properly stored and protected from the weather.

<u>Inspector's Checklist</u>

The following is a list detailing inspection questions that should be verified during construction.

- Are prestressed concrete units visually inspected for defects when delivered?

- Are prestressed concrete piles driven only after 7 days and attaining the minimum design strength?
- Are prestressed units handled and supported properly?
- Are bearing surfaces parallel to the bottom surface of the unit or as specified on the plans?
- Do prestressed units meet the tolerances as specified in GDOT Standard Specifications Section 405?
- Is waterproofing performed if required by the plans?
- Is the beam bearing 100% on bearing pads?
- Does the Inspector have approved shop drawings for pre-stressed items?
- Have shop drawings as required been approved by the District Bridge Engineer and been used for construction and erection of prestressed members?

Beams

- *Handling and Placing Concrete and Precast Units*:
    - Deposit concrete in girders uniformly for the full length of girder and bring it up evenly in horizontal layers.
    - Ensure precast girders are handled, transported, and erected using extreme care to avoid twisting, racking, or other distortion that would result in cracking or damage.
        - Place girders on elastomeric pads at certain locations shown in the plans.
        - Brace and hold together girders by temporary wooden blocking.
- Determine the top of the girder elevation by profiling each girder.
    - Allow the profile grade to determine the location of the finished grade of the top slab and the location of the slab forms.
    - After girders have been profiled and finished grades have been determined, allow placement of forms for the top slab to start.
    - Prestressed concrete panels are a type of slab form that is left in place and becomes the bottom part of the concrete slab. Allow them to be 4 inches thick, rectangular shaped, and to vary in width and length.
- Ensure beams are installed in accordance with plans, specifications, and shop drawings.

Steel Beams

- Verify that fabricators of welded plate girders are certified under the American Institute of Steel Construction (AISC) Quality Certification, Major Steel Bridges Category.
- Unless otherwise shown on the plans, make certain all structural steel conforms to the requirements in Table A-11. Protect the stock steel to be used in the Project such that all surfaces are free from heavy rust and rust pitted areas at the start of and during fabrication.

Table A-11: Structural Steel Requirements

Type of Steel	Grade per Specification	
	AASHTO M 270	**ASTM A 709**
Structural Steel	Grade 36	Grade 36
High-Strength Low Alloy Steel	Grade 50	Grade 50
High-Strength Low Alloy Steel	Grade 50W	Grade 50W
Quenched and Tempered Low Alloy Steel	Grade 70W	Grade 70W
High Yield Quenched and Tempered Alloy Steel	Grade 100/100W	Grade 100/100W
High Performance Steel Quenched and Tempered	Grade HPS 70W	Grade HPS 70W

Notes:
- When these materials are specified on the plans, ensure that the longitudinal Charpy V-Notch criteria comply with the requirements of AASHTO M 270, Zone 2.
- Sample in accordance with the H frequency in AASHTO T 243.
- Perform testing in accordance with AASHTO T 266.
- For High Performance Steel Quenched and Tempered, nonquenched and tempered thermo-mechanical controlled processed (TMCP) HPS 70W steel may be directly substituted for Q&T HPS 70W steel for plate thickness up to 2 in.

- Ensure all structural steel is cleaned to the requirements of Near White Blast Cleaning in accordance with the current edition of Steel Structures Painting Council Surface Preparation, SSPC SP-10, Near White Blast Cleaning Method.
    - Remove all contamination of the structural steel resulting from erection or concrete placement.
    - Clean structural steel by an acceptable method approved by the BCE (Bridge Construction Engineer) and restore the surface finish to the specified Near White Blast Clean condition.
- *Inspector's Checklist*:
    - Do welders have current certifications for the types of welds being made?
    - Are the surfaces of the welds relatively even, smooth, and of the required size?
    - Are the structural steel stud shear connectors the size and spacing as shown on the plans?
    - Do the shear connectors project 2 in. above the bottom of the deck slab and 3 in. below the plane of the top of the deck slab?
    - Has each unit been identified with an erection mark?
    - Has the Contractor furnished the materials order shipping statement and erection diagrams?
- *Storage of Materials*:
    - Ensure steel and cement are appropriately stored and protected from the weather.

Pre-cast Piles

- Do not drive piling until after the excavation is complete.
- Make cut-offs for precast concrete piles perpendicular to the axis of the pile at the elevation shown on the plans or as directed. ***Exercise care to minimize spalling of concrete below the cut-off elevation.***

Foundation

Caissons are relatively large-diameter, underground columns of reinforced concrete that are constructed in pre-drilled holes to provide foundation support for structures. They are designed to transfer and distribute structural loads to underlying support strata or bedrock (i.e., an end-bearing design). In general, caisson construction consists of drilling a hole at a designated location, depth, and diameter; constructing and placing a cage of reinforcing steel; and placing and finishing concrete to the elevation required by the foundation details of the Contract plans. The Inspector should consider the following inspection guidelines.

<u>Preliminary Considerations</u>

Prior to the construction of caissons, the Inspector should consider the following guidelines:

- *Contract Plans and Specifications*:
    - Review the Contract plans and specifications with respect to the requirements for drilling equipment; materials for reinforcing steel and concrete; and caisson location, depth, diameter, and elevation.
    - Pay particular attention to the operation sequence and dewatering requirements.
- *Caisson Location/Utilities*:
    - Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins.
    - Check that all caisson locations have been properly staked in accordance with the Contract plans.
- *Boring Log/Geological Reports*:
    - Review the boring log and geological reports.
    - Become familiar with the appearance of the type of material anticipated at the depth of the bearing strata.
    - On many Projects, the Contract Documents require the Contractor to perform pre-installation core holes.
    - See Section 625.5 of the GDOT Standard Specifications.
- *Equipment*:
    - Verify that a heavy-duty drilling rig in good operating condition is provided for the work.
    - Ensure the rig is capable of drilling to the required depth and penetrating the underlying bearing material or bedrock.
- *Blasting*:
    - Be aware that the use of explosives for caisson construction is generally ***not*** permitted.

- *Materials*:
  - Check that the type of reinforcing steel and class of concrete conforms to specified requirements.
  - Where steel casing is required, verify conformance with respect to wall thickness, strength, diameter, and condition.
- *Alternative Methods*:
  - If methods other than those discussed in this section are proposed, verify that the Project Engineer/Supervisor has reviewed the Contractor's step-by-step procedures prior to beginning the operation.
  - Ensure that the Contractor performs the work as proposed.

Drilling Operation

Where holes are drilled for caissons, the Inspector should consider the following:

- *Location*:
  - Check the location of the center of the shaft to ensure it is within allowable tolerance from that designated on the Contract plans.
- *Depth of Embedment*: The designated bottom elevation is an approximation only, which may be revised by the Project Engineer/Supervisor to ensure proper load bearing capacity.
  - Document the depth drilled into the target bearing strata, and compare the excavated material with geological information to ensure that adequate bearing material has been reached.
- *Diameter/Sides*:
  - Check the hole diameter and sides to ensure compliance to size, vertical orientation, and allowable tolerance.
  - Where caving is encountered, halt the operation until the situation can be evaluated and corrected.
  - Contact the Project Engineer/Supervisor for assistance. Protective steel casing may be needed.
- *Excavated Material/Cleaning*:
  - Verify that excavated material is disposed of properly.
  - Check that the hole is dewatered and cleaned of all loose material.
    - The Inspector should verify that the bottom of the hole is clean and flat.
    - If dewatering is not practical, the provisions of the Contract with respect to placing concrete under water will govern.
    - If it is necessary to enter the hole for inspection purposes, ensure that the Contractor provides steel shoring, proper ventilation, electric lighting, and a suitable means of access.
- *Protective Covers*:
  - Once the hole has been accepted, verify that protective covering is installed to prevent persons and materials from falling into the hole.
- *Shale/Rock Considerations*: Where a caisson is to be socketed into shale or rock, the reinforcing cage, support system, and concrete must be placed within the specified time limit after drilling.
  - If the limit is exceeded:

        - require the Contractor to drill the specified additional depth into the shale just prior to placement of the concrete, and
        - verify that the reinforcement cage is adjusted to the new depth.

<u>Caisson Reinforcement/Steel Casing</u>

Caisson reinforcement generally consists of a single-unit cage of reinforcing steel. The cage must be inspected prior to being placed into the drilled hole. Consider the following:

- *Cage Construction*:
    - Inspect the cage for proper bar size, spacing, and fastening.
    - Check the cage height and diameter for conformance.
    - Where required, verify that splices are reviewed by the Project Engineer/Supervisor. Document the number of splices.
- *Steel Casing*:
    - Where designated or as directed, ensure that the proper size of steel casing is installed and properly oiled prior to placement of the cage, support system, and concrete.
- *Installation Timing*: After the hole and cage have been inspected, the cage and support system must be installed just prior to pouring concrete.
    - If the concrete is not immediately poured,
        - require removal of the cage,
        - re-inspect the hole for loose material, and
        - check the surface condition of the steel for acceptability.
    - Where required by the plans or specifications, allow use of Crosshole Sonic Logging (CSL). See Subsection 625.2.6 of the GDOT Standard Specifications.
- *Support System:* A support system must be provided so that the cage does not sit on the bottom nor lean against the wall of the hole.
    - Check bottom and side clearances.
    - Check conformance with respect to the number and interval of spacers along the length of the cage.
    - Verify that the support system does not rack or skew the cage, and require additional steel as needed to stiffen the cage.

<u>Concrete Placement</u>

Acceptability of the placement method used for concrete will depend on whether or not the hole is considered dry or wet. Just prior to placement, check the depth of water at the bottom of the hole. If the depth, without pumping, is less than approximately 2 in. (50 mm), the hole may be considered dry for the purpose of method approval. Otherwise, the hole should be considered wet. Consider the following guidelines:

- *Dry-Hole Placement*:
    - Where the hole is dry, allow the concrete to be poured continuously in a free fall from the surface with the use of a hopper or approved device.
    - Check to ensure that the concrete does not hit the reinforcing cage nor the sides of the hole on the way down.
- *Wet-Hole Placement*:

  - For wet holes, have the Project Engineer/Supervisor review the proposed method of placement.
  - See Subsection 625.5.4 of the GDOT Standard Specifications.
- *Steel Casing*:
  - Unless otherwise designated or directed, remove the steel casing from the caisson.
  - Where removal is impractical or will cause damage to the caisson, contact the Project Engineer/Supervisor for assistance. It may be necessary to leave the steel casing in place.
    - In such cases, ensure that the top of the casing is cut by an approved method to the designated elevation.
    - Ensure that additional concrete is placed, and monitor the elevation of the reinforcing cage and final caisson surface for compliance.
    - Reject the caisson if movement or settlement exceeds specified limits.
- *Key Construction*:
  - Where designated on the Contract plans, verify compliance of the key constructed at the top of the caisson.
- *Concrete Curing*:
  - Check that the top surface of the concrete is properly cured. ***Pay particular attention to the curing material and curing period used.***
- *Adjacent Construction*:
  - Where work for foundation piles, excavation, or caissons is to be performed adjacent to the freshly poured caisson, check compliance with respect to minimum lateral clearance and compressive strength requirements.
- *Final Inspection*:
  - After the caisson has been constructed, check the top elevation of the caisson for compliance to that designated on the Contract plans.
  - Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar.
  - See Subsection 625.2.6 of the GDOT Standard Specifications regarding requirements for CSL testing where required by the plans or specifications.

Columns and Caps

- *Removal of Cofferdams*:
  - Do not remove cofferdams until after the substructure has been constructed above normal water elevation or above the ground lines, whichever is applicable, and after the Engineer has inspected the work.
  - Take care in removing the temporary construction so as not to damage the footings and columns.
  - Replace or repair any damage as a result of the cofferdam removal without additional compensation from the Department.
  - Ensure cofferdam sheet piling remains permanently in-place and undisturbed if this is shown to be required on the plans.
- Use **air entrained concrete** in all bridge columns, bent or pier caps, decks, sidewalks, parapets, barrier walls, and other structural elements on the bridge deck regardless of the class of concrete used.

- Adhere to the following time and strength requirements when performing construction activities on or near recently placed concrete:
    - Wait a ***minimum of 12 hours*** between placing footing or drilled pier concrete and erecting column forms.
    - Wait a ***minimum of 24 hours*** between placing footing and drilled pier concrete and placing column concrete.
    - Wait a ***minimum of 72 hours*** between placing column concrete and beginning erection of cap forms or until column concrete attains a ***minimum of 75% of the design compressive strength*** as verified by testing extra test cylinders.
    - Wait a ***minimum of 96 hours*** between placing column concrete and placing cap concrete or until column concrete attains a ***minimum of 75% of the design compressive strength*** as verified by testing extra test cylinders.
- *Finishing Concrete Surfaces*:
    - Give a Class II or Applied Texture Finish to all surfaces of structures over a highway or another structure exposed to general view.
        - Such surfaces, in addition to those set out above, will usually include all parapets, copings, columns, piers, bents, sides and ends of caps, the outside of all fascia beams, the ends of arch rings, outer surfaces of spandrel walls, the exposed surfaces of wing walls, and the faces of abutments.

Bearings

- *Uniform Bearing Surface*:
    - Set bridge bearings (Figure A-65) in exact position.
    - Ensure they have a full and even bearing on the masonry and are not placed on masonry bearing areas that are irregular or improperly formed.
    - General preferences for bearings are shown in Table A-12.
- *Facing of Bearing Surfaces*:
    - Ensure that the surface finish of bearing and base plates and other bearing surfaces that come in contact with each other or with concrete meets the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness, and Lay, Part I indicated in Table A-13.

Figure A-65: Bearing Assembly of Steel Plate Girder

Table A-12: Preferences for Bearings

Types	**'d' (ft)**	**Recommended Bearings**	**Comments**
T Beams and Type I Mod Beams	0–40	U	
T Beams and Type I Mod Beams	40–160	R	For 'd' in excess of 160-ft bearings typically become unstable in sliding.
AASHTO & Bulb 'T' Beams	40–200	R	Limited by length of chase, seismic shear on dowel, beams ability
Steel Girders	0–50 50–160 >160	R, SB R, SBL P	
Steel Beam Widenings			Widen "in-kind"

Glossary:
d: Length in feet from point of fixity to bearing
U: Plain elastomeric pad
R: Steel reinforced elastomeric bearing
SB: Plate bearings (sole and bearing plates only)
SBL: Plate bearings (exp ends use sole, bearing, and lube plate)
P: Pot bearing

Table A-13: Surface Roughness Requirements

Surfaces in Contact	Roughness
Steel slabs	ANSI 2000
Heavy plates in contact in shoes to be welded	ANSI 1000
Milled ends of compression members, milled or ground ends of stiffeners and fillers	ANSI 500
Bridge rollers and rockers	ANSI 125
Pins and pin holes	ANSI 125
Sliding bearings	ANSI 125

Forming System

- *Construction*:
  - Ensure forms are of wood, metal, or other approved material, built mortar tight, and of sufficient rigidity to prevent distortion due to pressure of concrete and other loads incident to construction operations.
- *Form Surface*:
  - Check that forms for exposed surfaces do not adhere to nor discolor concrete.
  - Ensure that forms are made of either metal or dressed lumber of uniform thickness with or without approved form liner and are mortar tight.
  - Ensure that forms for reentrant angles are chamfered and forms are filleted at sharp corners.
  - Give forms for projections, such as girders or copings, a bevel or draft to ensure easy removal.
- *Re-Used Forms*:
  - Maintain the shape, strength, rigidity, mortar-tightness, and surface smoothness of re-used forms.
  - Resize warped or bulged lumber before reusing it. ***Do not re-use unsatisfactory forms.***

Parapet, Sidewalk, and Medians

- Never place concrete railings, sidewalks, and parapets until the falsework for the span has been released, rendering the span self-supporting.
  - Ensure the surface of all bridge sidewalks have a wood-float finish. No other finish will be required.
- *Bridges with Sidewalks*:
  - Provide a 2–3-in. parapet and the Georgia Standard 3626 one-rail aluminum handrail, for a total railing height of 3–6 in. measured from the top of the sidewalk, in accordance with the AASHTO Specifications.
  - Also use this detail when a bicycle route is present, whether the bike traffic is on the road or on the sidewalk.
- *Removable Sidewalk and Median Details*:
  - Where sidewalks or raised medians are required, detail them as removable.

- *Sidewalks and Median Finishing*:
  - Give a Class II or Applied Texture Finish to all surfaces of structures over a highway or other structure exposed to general view.
    - Such surfaces, in addition to these set out above, will usually include all parapets, copings, columns, piers, bents, sides and ends of caps, the outside of all fascia beams, the ends of arch rings, outer surfaces of spandrel walls, the exposed surfaces of wing wall, and the faces of abutments.
- *Inspector's Checklist*:
  - Are railings and parapets constructed at the proper height?
  - Are metal railings constructed in accordance with the specification?
  - Are metal railings or metal parapets grounded properly?
  - Are concrete railings, median barriers, and parapets given a Class I finish?
  - Is reinforcing steel placed as specified?
  - Are chamfer strips placed as required?
  - Are construction and expansion joints constructed as required?
  - Is there sufficient clearance of reinforced steel to the edge of concrete?

Temporary Detour Bridges

- Place temporary barriers as shown on the plans and on the Georgia Standard Specification Number 4960 to provide for 12-ft 0-in. traffic lanes. Supply and use the barrier in accordance with standards.
- Temporary bridge lengths shown on the plans are approximate, and the lengths to be constructed will be determined by the Engineer.
  - The Contractor must construct temporary bridges to allow passage of maximum legal loads.
  - Perform temporary bridge construction in accordance with applicable sections of these specifications.
  - Place guardrail as shown on the plans or as directed.
- Ensure temporary structures are maintained by the Contractor until the completion of the Contract or the opening of the permanent structure, unless otherwise provided on the plans or in the Contract.
- Upon completion and opening to traffic of the permanent construction, the Contractor must
  - remove and dispose of the temporary structure,
  - restore the area as nearly as possible to its original condition, and
  - leave the area in a neat condition satisfactory to the Engineer, unless otherwise noted on the plans or in the Contract.

Rebar

- *Handling and Placing Reinforcement*:
  - *Bending*:
    - Ensure reinforcement is bent in accordance with CRSI Manual of Standard Practice MSP-1-97, accurately to the form and dimensions shown on the plans without heating.

        - In bending, take care not to injure the steel; only employ proper appliances and competent workmen on the work.
        - Ensure the radius of bends are three or more times the diameter of the bar unless shown otherwise on the plans.
        - Avoid abrupt bends.
        - Ensure any reinforcement bent during shipment or handling is properly reshaped, without heating to a higher temperature than that producing a dark cherry-red color, before being placed in the work.
        - Reject bars with kinks or bends and bars appreciably reduced in cross-sectional areas.
    - *Cleaning*:
        - Before placement, clean the metal reinforcement of any loose mill scale and of coatings of dirt, paint, oil, grease, or any other foreign substance.
    - *Placing*:
        - Ensure all reinforcing steel is accurately placed and firmly held in the position shown on the plans during the placing and hardening of the concrete.
        - Allow a +¼ in. (+6 mm) vertical placement tolerance on the top mat of reinforcing steel in the bridge decks.
- Do not allow reinforcing steel to be stored on the ground.
    - It must ***not*** be stored in a manner or in a place where it is likely to be damaged or bent by equipment.
- *Inspector's Checklist*:
    - Are samples sent to the Materials Division and the test reports on file?
    - Is material stored as specified?
    - Do the size dimensions, bends, and hooks of all reinforcing bars conform to the reinforcing bar schedules shown on the plans?
    - Is the surface condition free of loose mill scale, flaky rust, dirt, oil, or other coatings that would inhibit concrete bond?
    - Is epoxy-coated reinforcing steel being used where required?
    - Is epoxy coating intact and free of defects?
    - Is epoxy-coated steel left in sunlight more than 30 days without covering?
    - Was reinforcing steel tied as specified?
    - Was reinforcing steel supported as specified?
    - Was reinforcing steel placed as specified?
    - Were splices and laps made as specified?
    - Did spacing, location, and edge clearances of all reinforcing bar mats conform to the plans and specifications?

A-16 Construction Inspector Best Practices

The following section provides preconstruction inspection practices for installing and maintaining roadside and overhead signs.

A-16-1 Overhead and Roadway Sign Structures

Overhead Sign Structures

Use ASTM A 325 bolt, nut, and washer assemblies for all installations other than anchor bolts as follows.

- Use bolt, nut, and washer assemblies that are free of rust and corrosion and that are lubricated properly as demonstrated by being able to easily hand-turn the nut on the bolt thread for its entire length.
- Tighten nuts to the full effort of an ironworker using an ordinary spud wrench to bring the faying surfaces of the assembly into full contact, which is referred to as “snug tight” condition.
- After bringing the faying surfaces of the assembly into full contact and to a snug tight condition, tighten nuts to achieve the minimum torque as specified in Table 700-1 (see Table A-14).
- Maintain uniform contact pressure on the faying surfaces during snugging and the subsequent final tightening process, by using a bolt-tightening pattern that balances the clamping force of each bolt, as closely as possible, with the equal clamping force of a companion bolt.
- Within 24 hours after final tightening, allow the Engineer to witness a check of the minimum torque using a calibrated torque wrench for 3 bolts or a minimum of 10% of the bolts, whichever is greater, for each connection; however, do not perform this check on alternate splice connections of span sign structures.

Table A-14: Minimum Torque as in Table 700-1

Table 700-1

Bolt Diameter (in.)	Minimum Torque (ft.-lbs.)
3/8	15
1/2	37
5/8	74
3/4	120
7/8	190
1	275
1 1/8	375
1 1/4	525

Sign Background

- Use Type III, IV, V, or VII sheeting for background sheeting, white legends, borders, and shields on all signs, excluding STOP, DO NOT ENTER, and WRONG WAY.

- Use Type VII sheeting for STOP, DO NOT ENTER and WRONG WAY signs.
- Use Type III, IV, V, or VII yellow-green fluorescent sheeting for S1-1 school advance signs and supplemental panels used with S1-1, S3-1, and S4-5 school signs. Do not mix signs having fluorescent yellow-green sheeting with signs having yellow reflective sheeting.
- Use fluorescent orange Type VI or VII sheeting for all orange work zone signs.
- Do not install the mast arm pole, strain poles, or monotube pole until (1) the foundation has achieved 70% of the specified 28-day concrete strength, and (2) the verifying test results have been provided to the Engineer.
    - Determine concrete strength from tests on a minimum of two test cylinders prepared and tested in accordance with ASTM C 31 and ASTM C 39.
    - Before erecting the pole, clean the top of the foundation of any laitance, oils, grease, or any other deleterious materials.
    - Erect strain poles in an orientation that allows the cable forces to produce a plumb vertical pole.
    - Erect monotubes plumb at the time of installation.
        - Plumb the pole supporting the mast arms after the mast arms, traffic signals, or sign panels have been placed.
- If the traffic signals and/or sign panels are not in place within 2 working days after the mast arm is erected, furnish and install a 3 × 2 ft blank sign panel on the bottom of each mast arm within 6 ft of the mast arm tip and plumb the pole.
    - Re-plumb the pole supporting the mast arm after installation of traffic signals and sign panels.

A-16-2 Sign Post and Mounting Hardware

- Construct road edge signs with the sign faces vertical.
    - Place sign faces located less than 30 ft (9 m) from the edge of the travel lane at a 93-degree angle from the center of the travel lane.
    - Place sign faces located 30 ft (9 m) or more from the edge of the travel lane at an 87-degree angle from the center of the travel lane.
    - Where the lanes divide or are on curves or grades, orient sign faces to be most effective both day and night and to avoid specular reflection.
- *Delineator, Object Marker, and Milepost Assemblies*:
    - Place these assemblies:
        - at least 24 in. (600 mm) beyond the outer edge of the roadway shoulder,
        - at least 24 in. (600 mm) beyond the face of the curb, or
        - in the line of the guardrail.
- *Sign Overlay Pa*nels:
    - When specified, completely overlay existing signs with new sign panels placed over the existing sign face.
        - Do not allow any partially overlaid signs to remain exposed overnight.
        - Place only one overlay on a sign.
        - When an overlay is to be placed on an existing overlaid sign, remove the previous overlay prior to placement of the new overlay.

        - Remove raised legends from the existing sign face prior to placing the overlay panel.
        - Ensure the size of the overlay panel does not exceed the size of the existing sign panel by more than 3 in. (75 mm) on any side.
        - Attach overlay panels to the existing sign with rivets.
            - ✓ Place rivets on 12-in. (300 mm) centers (maximum) along the perimeter of the panel and at panel splices, and on 24-in. (600 mm) centers (maximum) both vertically and horizontally in the interior portions of each panel.
            - ✓ Center the rivets horizontally on panels less than 24-in. (600 mm) wide.
        - Place a 4 × 4 in. (100 mm × 100 mm) shim with a nominal 0.080-in. (2.0 mm) thick aluminum plate between the existing panel and the overlay panel at interior rivet locations.
            - ✓ Allow use of shims cut from salvaged sign panels.
        - Keep the existing sign panels reasonably flat during installation of the overlay panels.
- *Square Tube Posts*:
    - Fabricate the post from square tube formed of steel, rolled to size, and welded directly in the corner by high-frequency resistance welding and externally scarfed to agree with corner radii.
    - Provide the sizes as shown in Table A-15.

Table A-15: Sizes for Square Tube Posts

Outside Dimensions (in.)	Corner Radii (in.)	Thickness (in.)	Weight (lb ft)
1¾ × 1¾	$^5/_{32}$	0.08	1.7
2 × 2	$^5/_{32}$	0.08	2.0

    - Provide $^7/_{16}$-in. diameter holes on the centerline of all 4 sides, spaced on 1-in. centers along the entire post length beginning 1 in. from the top.
    - Ensure holes are in true alignment and opposite each other directly and diagonally.
    - Ensure consecutive sizes of square tubes will freely telescope for 10 ft or more of their length without the necessity of matching any particular face to any other face.
- *Pole-Mounted Sign Support System*:
    - Use stainless steel bands, brackets, hardware, and fasteners necessary to mount a sign panel or a sign panel assembly* on traffic signal poles, street lighting poles, or other poles.
    - Ensure bands are a minimum of 0.75 in. × 0.02 in.
    - Allow other methods of attachment to be substituted with prior written approval of the Engineer.

  *A sign panel assembly is defined as a group of contiguous sign panels with a maximum separation of 6 in.

For further information, refer to Sections 638 and 639 of the GDOT Standard Specifications.

A-16-3 Temporary Traffic Control Elements

All Temporary Traffic Control devices must comply with the guidelines of the NCHRP Report 350. For further information refer to the following website: http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/nchrp_350/.

- *Sign Panels, Vertical Panels, Barricades, and Other Devices*:
  - Ensure sign panels, vertical panels, barricades, and other devices meet the requirements of ASTM D 4956 for Type III.
- *Collars for Traffic Cones and Bands for Tubular Markers*:
  - Ensure collars for traffic cones and bands for tubular markers meet the requirements of ASTM D 4956 Type VI.
- *Drums*:
  - Ensure drums meet the requirements of ASTM D 4956 for Type III or higher retroreflective sheeting materials identified in Section 994, including Supplementary Requirements for Reboundable Sheeting.
- *Display Panel and Housing*:
  - Ensure that the display panel and housing include the following features:
    - The display housing assembly is weathertight.
    - All nuts, bolts, washers, and other fasteners are of corrosion-resistant material.
    - The display assembly is equipped with:
      - ✓ an automatic dimming operational mode capable of a minimum of 50% dimming and
      - ✓ a separate manual dimmer switch.
    - The display panel background and frame for the display assembly:
      - ✓ is painted flat black and
      - ✓ meets Federal Specification TT-E-489.
    - The display panel for arrow boards and changeable message signs, when raised in the upright position, has a minimum height of 7 ft from the bottom of the panel to the ground, in accordance with the MUTCD.
    - The display panel for radar speed display units, when raised in the upright position, has a minimum height of 5 ft from the bottom of the panel to the ground.
    - The regulatory speed sign panel for regulatory signs and radar speed display units, when raised in the upright position, has a minimum height of 7 ft from the bottom of the regulatory sign panel to the ground.
    - The unit has an accessible mechanism to easily raise and lower the display assembly.
      - ✓ A locking device will also be provided to ensure the display panel will remain in the raised or lowered position.
- *Arrow Board Matrix*: The minimum legibility distances for various traffic conditions are based on the decision-sight distance concept. The minimum legibility distance is the distance at which a driver can comprehend the arrow panel message on a sunny day or a clear night. The arrow panel size that is needed to meet the legibility distance is listed as follows:

- On the State highway system,
  - use Types “B” or “C” advance warning arrow boards for low- to intermediate-speed (0 to 50 mph) facilities and for maintenance or moving operations on high-speed roadways, and
  - use Type “C” arrow boards on high-speed (50 mph and up) facilities.
- Ensure that arrow boards include the following features:
  - Devices meet all arrow board displays identified in the MUTCD.
  - The lamp lens is 5¾-in. diameter.
    - ✓ Smaller lamp lens diameters are permissible only if they provide an equivalent or greater brightness indication and meet the legibility criteria
  - The color of the light emitted is in accordance with the MUTCD.
  - There is a 360-degree hood for close-up glare reduction.
  - For solar-powered arrow boards, the bulbs provide 350-candle power intensity for day use and an automatic reduction or dimming capacity for night use.
    - ✓ The dimmed night operation provides adequate indication without excessive glare.
  - The flashing rate of the lamps is not less than 25 nor more than 40 flashes per minute as required in the MUTCD.
  - The minimum lamp “on time” is 50% for the flashing arrow and 25% for the sequential chevron.

- *Temporary Traffic Control Signals*: Meet the physical display and operational requirements of conventional traffic signal described in the MUTCD for portable traffic signals. The standard includes but is not limited to the following:
  - Signal heads have three 12-in. vehicular signal indications (red, yellow, and green). Ensure there are two signal heads for each direction of traffic.
  - The traffic signal heads on this device are approved by the Department.
  - Department-approved lighting sources are installed in each section in accordance with the manufacturer’s permanent directional marking(s), that is, an “Up Arrow,” or the word “UP” or “TOP,” for correct indexing and orientation within a signal housing.
  - The masts supporting the traffic signal heads are manufactured with the lowest point of the vehicular signal head as follows:
    - *For “Pedestal” Type Application*: 8 ft above finished grade at the point of their installation
    - *For “Overhead” Type Application:* 17–19 ft above pavement grade at the center of the roadway
  - The yellow clearance interval is programmed for 3 seconds or more.
    - ***Under no condition can the yellow clearance interval be manually controlled.*** It must be timed internally by the Controller as per Department Specifications.
  - The green interval displays a minimum of 5 seconds before being advanced to the yellow clearance interval.
  - The controller allows for a variable all-red clearance interval from 0 to 999 seconds.

- Portable traffic control signals are either manually controlled or traffic-actuated. Indicator lights for monitoring the signal operation of each approach are supplied and visible from within the work zone area.
- When the portable traffic control signals are radio-actuated, the following will apply:
  - The transmitter is FCC Type accepted and does not exceed 1 watt output per FCC, Part 90.17.
    - ✓ The manufacturer must comply with all “Specific Limitations” noted in FCC Part 90.17.
  - The Controller forces the traffic signal to display red toward the traffic approach in the case of radio failure or interference.
- The trailer and supports are painted construction/maintenance orange enamel in accordance with the MUTCD color.
- The device meets the NEMA environmental standard.
  - The test report certified by an independent laboratory is provided.
- The certification number is engraved or labeled permanently on equipment.

For more information, refer to Special Provision 150.

A-16-4 Changeable Variable Message Signs

Message Matrix

- Ensure the message matrix panel is a maximum height of 7 ft by a maximum width of 10 ft.
- Require the message matrix panel to contain three separate lines.
  - Each line consists of eight characters, equally spaced a minimum of 3 in.
  - Each character contains 35 pixels in a 5 × 7 horizontal-to-vertical grid arrangement.
- Ensure each message line of the 7 ft × 10 ft PCMS provides for characters 1 in. wide × 18 in. high minimum and variable graphic and symbol sizes to a minimum of 18 in. high.
- For flip disk matrix signs, coat the disk elements on the display side with a highly reflective florescent yellow Mylar material, and on the back with a flat black to blend in with the flat black background.
- Ensure similar components are interchangeable.

Operation and Performance

- Display the message in uppercase except when lowercase is Project-specific and is allowed by the MUTCD.
- Ensure the message matrix panel is ***visible from ½ mile*** and l***egible from a distance of 650 ft*** under both day and night conditions.
  - Ensure that under variable light level conditions the sign automatically adjusts its light source to meet the 650-ft visibility requirement.
  - Require that the message panel has adjustable display rates, so that the entire message can be read at least twice at the posted speed.

- Ensure the control panel has the capability to store a minimum of 50 pre-programmed messages.
- Ensure the controller in the control panel:
  - Is able to remember messages during nonpowered conditions
  - Allows the operator to generate additional messages on-site via the keyboard
- For a PCMS using Flip-Disk technology, ensure the controller has the capability to provide a stipulated default message upon loss of controller function.
- Flash or sequence all messages.
  - In the sequence mode, the controller must have the capability to sequence three-line messages during one cycle.

Portable Regulatory Signs

- *Sign Panel Assembly*: The sign panel assembly must consist of a 24 × 30 in. “SPEED LIMIT XX” sign panel and a “WHEN FLASHING” sign panel, intended to notify oncoming traffic of the speed limit where workers are present. The sign panel assembly must meet the following minimum physical requirements:
  - Ensure all nuts, bolts, washers, and other fasteners are of corrosion-resistant material.
  - Ensure the sign panel folds down and can be pinned in place for towing.
    - ***Maximum travel height should be 80 in.***
  - Construct the sign panel and light housing to allow the unit to be operated in the displayed position at speeds of 30 mph.
    - Design the sign panel assembly to withstand transport speeds of 65 mph.
  - Construct the sign panel such that, when in the raised position, the sign panel will have a height of 7 ft from the bottom of the lowest panel to the ground, in accordance with the MUTCD.
  - Provide the unit with a mechanism to raise and lower the sign panel.
    - Provide the unit with a device to lock the sign panel in the raised and lowered position.
- *Flashing Lights*:
  - Provide a pair of hooded PAR 46 LED advance warning flashing lamps on each side of the top of the sign panel.
  - Ensure that these lamps are visible day or night at a distance of 1 mile with a flash rate of approximately 55 flashes per minute.
  - Ensure the lamp lens is at least 5¾ in. in diameter.
    - Smaller diameter lens are permissible if they provide an equivalent or greater brightness indication and meet the legibility criteria above.
  - Ensure the color of the light emitted is in accordance with the MUTCD.
  - For solar-powered units, require that the bulbs provide:
    - 350 candlepower intensity for day use and
    - an automatic reduction or dimming capacity for night use.

    The dimmed night operation must provide adequate indication without excessive glare.

A-16-5 Crash Cushions and Delineators

Crash Cushion

Description

This item consists of the following:

- Construction of a foundation pad, including:
    - excavation and/or embankments;
    - transitions from bridge ends; and
    - a backup wall, when specified.
- Furnishing and installing a crash cushion according to these specifications and to the dimensions and at the locations shown on the plans or as directed.

The crash cushion must satisfy the NCHRP Report 350 requirements for a Test Level 3 (TL-3) crash cushion.

Materials

- *Foundation Pad and Backup Wall*:
    - Concrete must comply with Section 802 of the GDOT Standard Specifications for Class M concrete.
        - The Department will perform all acceptance sampling and testing at the frequencies shown for Contractor acceptance testing in Subsection 802.06.
    - Reinforcing steel must comply with Section 804.
    - Preformed joint filler must comply with AASHTO M 153, Type I.
- *Crash Cushion*:
    - The Contractor must furnish a certification from the manufacturer or supplier that the crash cushion meets the requirements of NCHRP Report 350 for a TL-3 crash cushion.
    - The crash cushion must comply with the most current specifications and details for a guardrail energy absorbing terminal crash cushion as recommended by the manufacturer and as approved by the Engineer.
    - The Contractor must provide the Engineer with copies of all necessary manufacturer's details and installation manuals prior to the installation of the crash cushion on the Project.
        - These materials will remain the property of the Department.

Construction Requirements

- Shape and compact the subgrade area for the foundation pad to the required section.
    - Accomplish compaction by any method that is satisfactory to the Engineer.
- Construct the foundation pad, including curb transition from bridge ends, and backup wall to the lines and dimensions shown on the plans.
- Install the crash cushion according to the manufacturer's current recommendations and installation methods.

Delineators

Description

This item consists of furnishing and installing galvanized steel posts with delineators according to these Specifications and to the dimensions and details and at the locations shown on the plans or as directed.

Materials

- Delineators must consist of white, yellow, or red reflectors made of adhesive-coated Type IX reflective sheeting permanently adhered to a sheet of aluminum 0.080-in. (2.0 mm) thick and complying with Section 723 of the GDOT Standard Specifications.
- Steel posts for roadside installation must be made of a U-section channel, manufactured from re-rolled rail steel or equivalent, weighing not less than 2 lb/ft (3 kg/m).
    - The steel must comply with the mechanical requirements of ASTM A 499, Grade 60, and the chemical requirements of ASTM A 1 for rails having a nominal weight of 90 lb/yd (45 kg/m) or more.
    - These chemical requirements will include the following modified limitations:
        - Carbon 0.67–0.89%
        - Manganese 0.70–1.00%
        - Silicon 0.10–0.25%
- The Contractor must submit to the Engineer of Materials mill test reports showing chemical analysis and physical tests.
    - The post must be punched or drilled with ⅜-in. (10 mm) holes on 1-in. (25 mm) centers for the full length of the post.
- Steel posts for bridge rail installation must be a 1 in. × 1 in. × $^{3}/_{16}$ in. (25 mm × 25 mm × 4.76 mm) angle weighing 1.61 lb/ft (2.4 kg/m), and manufactured from AASHTO M 183.
    - Length of post and spacing of holes must be as shown on the plans.
- All delineator posts must be hot dip galvanized, and all fabrication, including punching or drilling holes, must be completed before the posts are galvanized.
- All delineators must be fastened to the posts by means of tamper-proof fasteners as shown on the plans.
- Bridge rail delineator posts must be fastened to the bridge rail by means of galvanized U-bolts with hex nuts and lock washers.

Conform to the most current specifications and details recommended by the manufacturer of the crash cushion designated for use, except as otherwise specified herein.

Construction Requirements

- Install roadside delineator posts along either side of the roadway 2 ft (0.6 m) beyond the shoulder edge or 2 ft (0.6 m) from the face of curbed sections.
    - Locate delineators 4 ft (1.2 m) above the grade of the pavement edge.
    - Drive the post before installing the delineator using an approved metal driving cap that fits snugly in or around the post.
- Mount bridge rail delineators to the top bridge rail as shown on the plans.

- Install white delineators along the right side of the main lanes and ramps and space them as shown on the plans.
- Install yellow delineators along the left side of the main lanes and ramps and space them as shown on the plans.
- Install red delineators as shown on the plans.

For further information, refer to Section 916 of the GDOT Standard Specifications.

A-16-6 Traffic Signals Control System / Signals and Intelligent Transportation Systems

Description

Furnish, install, modify, and remove signals, flashing beacons, intelligent transportation systems, electrical systems, and provisions for future systems.

Construction Methods

- Before beginning signal work, verify all existing signal equipment is in satisfactory working order.
  - Report all defective signal equipment to the Engineer so as not to be held responsible for defects.
  - Locate existing conduit, cable runs, inductive detection loops, lead-in cable, junction boxes, and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown in the project plans as approximate values.
- Locate all underground utilities before beginning drilling, digging, or trenching operations.
  - Ensure that an IMSA-certified, or equivalent, Level II traffic-qualified signal technician is standing by to provide supervision and emergency maintenance services whenever work is being performed on traffic signal controller cabinets and traffic signal controller cabinet foundations.
    - Standby status is defined as being able to arrive, fully equipped, at the worksite within 30 minutes ready to provide services.
  - Immediately cease work and notify the Engineer and affected owners if damage to existing utilities, cables, or equipment occurs.
  - Make all required repairs and replacements.
- *Regulations and Codes*:
  - Notify the Engineer, local traffic enforcement agency, local utility company, and affected railroad companies ***7 business days before operational shutdowns*** to coordinate connection or disconnection to an existing utility or system.
- *Utility Services*:
  - Coordinate all work to ensure electrical power of proper voltage, phase, frequency, and capacity is available to complete the work.
    - Use electrical services cables with THWN wire type insulation.
  - When electrical, telephone, and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure all work can be completed.

        - Obtain authorization for service in the Department’s name and make application for service in the Department’s name.
        - Notify the Engineer immediately if this number is not shown in the Contract.
- *Maintenance and Repair of Material*:
    - Furnish the Engineer with the name, office telephone number, cellular (mobile) telephone number, and pager number of the supervisory employee who will be responsible for maintenance and repair of equipment during all hours.
    - Maintain and repair all signal- and communications-related equipment within the Project construction limits until completion of the observation period and receipt of written notification of final acceptance of the Project.
    - For all failures, malfunctions, or damages to equipment, begin necessary repairs within 4 hours of notification.
        - Complete repairs within 8 hours of notification.
        - Comply with Section 150 of the GDOT Standard Specifications for maintenance of traffic flow.
            - ✓ The inability to contact the supervisory employee or prearranged alternate will not extend repair time requirements.
    - Remove and replace all signal- and communications-related equipment that fails.
        - The Department will furnish the Contractor replacement equipment for Department-furnished equipment that fails.
    - Except for damages and malfunctions caused by the Contractor’s work activities, the Contractor will not be held responsible for pre-existing conditions reported to the Engineer before starting traffic signal work at the specific intersection.
        - The Contractor will assume responsibility for all maintenance and emergency services necessary once traffic signal work has begun at the specific intersection and for all damages and malfunctions caused either directly or indirectly by the Contractor’s work activities.
    - Perform maintenance (testing) on all Traffic Signal Conflict Monitors ***every 12 months for the life of the Project***, beginning with the initial test and every 12 months thereafter.
        - Provide the initial test date via the manufacturer’s certification or via testing prior to installation of the conflict monitor at an intersection.
        - Use the ATSI Incorporated Model PCMT-2600 Conflict Monitor Tester or an Engineer-approved equivalent.
            - ✓ Ensure that the Conflict Monitor Tester is maintained and calibrated per the manufacturer’s recommendation.
            - ✓ Provide to the Engineer a copy of the manufacturer’s certification that the Conflict Monitor Tester is in proper working order before testing the Traffic Signal Conflict Monitors.
        - Perform the test on the Traffic Signal Conflict Monitors per the manufacturer’s recommendation.
        - For each Traffic Signal Conflict Monitor tested, provide two dated copies of the test results: one copy for the Engineer and one copy for the traffic signal cabinet.
    - In the event the Contractor fails to perform in accordance with the plans and GDOT Standard Specifications within the timeframe specified, the Department

reserves the right to perform maintenance and emergency service necessary to ensure continuous traffic signal operation.

        - All expenses incurred by the Department in implementing this option will be deducted from payment due the Contractor, plus $2500 liquidated damage per occasion, per day, or any portion thereof, until corrected.

- *Inspections*:
    - The Department may access the Contractor's equipment to perform railroad, signal, and preventative maintenance inspections or conflict monitor certification as necessary.
        - The Contractor must be present for these inspections.
- *Removal of Existing Equipment and Material*:
    - Remove all Department-owned signals and communications-related equipment and material that will not be used.
        - Assume ownership of removed poles, messenger cable, and interconnect cable, communications cable, and supporting hardware.
- *Timing of Signals*:
    - Implement timing values for signal controllers.
        - Modify proposed phasing and timing of existing controllers.
        - Reinstall all existing time-based coordination.
        - As directed, make modifications to existing coordination to account for changes in signal phasing.
    - The Department reserves the right to make, or have the Contractor make, field timing changes necessary for pattern optimization and to eliminate identifiable, potential hazards to the motoring public.
        - The Engineer will notify the Contractor of timing changes made.
- *Wire and Cable*:
    - For installation in a conduit system, lubricate cable and wires before installing in the conduit.
        - Use lubricant that will not physically or chemically harm the cable jacket, wire insulation, or conduit.
    - Terminate all electrical wire and cable at recessed-screw or barrier-type terminal blocks.
        - Unless specifically allowed, connect no more than two conductors to the same terminal screw.
        - Splice electrical wire and cable in junction boxes or condulets.
        - Maintain color coding of wires throughout each splice.
        - Protect ends of wire and cable from water and moisture.
- *Electrical Service and Grounding*:
    - Where electrical services do not include an external electrical service disconnect, modify service to include electrical service disconnect and a new grounding electrode system.
    - Provide a grounding electrode system at all new electrical service.
        - In addition to NEC requirements, test grounding electrode resistance for a maximum of 20 Ω.
        - Furnish and install additional ground rods to the grounding electrode system as necessary to meet test requirements.

    - Modify existing electrical services, as necessary, to meet the grounding requirements of the NEC, the GDOT Standard Specifications, and the Project plans.
        - Remove any ground rods in the cabinet foundation and install a new grounding electrode system.
        - Cut off abandoned ground rods in the cabinet foundation flush with the foundation surface.
        - Where a grounding electrode system is connected to the electrical service in accordance with the NEC, test the grounding electrode resistance for a maximum of 20 Ω.
            - ✓ The grounding electrode resistance test must be verified or witnessed by the Engineer or the Engineer’s designated representative.
            - ✓ Furnish and install additional ground rods to the grounding electrode system as necessary to meet the GDOT Standard Specifications and test requirements.
    - Follow the test equipment’s procedures for measuring grounding electrode resistance.
        - When using clamp-type ground resistance meters, readings of less than 1 Ω typically indicate a ground loop.
        - Rework bonding and grounding circuits as necessary to remove ground loop circuits, and retest.
        - If a ground loop cannot be identified and removed to allow the proper use of a clamp-type ground resistance meter, use the three-point test method.
    - Submit a completed Inductive Loop & Grounding Test Form, available on the Department’s website.
    - Provide a length of marker tape 6–12 in. below finished grade directly over grounding electrodes and conductors.
- *Traffic Signal Activation*:
    - Do not place the signal in steady (stop-and-go) mode until inspected and authorized by the Engineer.
- *Temporary Traffic Signal Installations*:
    - When a traffic signal is installed for control of traffic during construction of the Project and scheduled for removal during or upon completion of the Project, install and remove the temporary traffic signal as required.
        - Upon removal of the temporary traffic signal, restore the surface to like-new condition.
        - Rake unpaved areas until smooth, repave paved areas, and seed grassed areas that were damaged by Contractor activities.
    - Cover signs with burlap bags until the traffic signal is placed into flashing operation.
    - Place the traffic signal into flashing operation and uncover signs simultaneously.
        - Continue the flashing operation for a period of time as directed by the Engineer.
    - Signal cabinets, controllers, detector units, signal heads and accessories, and microwave detectors are the property of the Department.

        - Return Department-owned equipment between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the Project.
    - Assume ownership of removed poles, messenger cable, interconnect cable, communications cable, supporting hardware, and loop emulator detection equipment, unless otherwise specified.

A-16-7 Structures for Traffic Control Devices and Highway Lighting

Traffic Signal Mast Arm and Pole Foundation Materials

Materials

The following material requirements apply to mast arms, poles, and foundations.

- Poles and mast arms must be ASTM A 1011, SS, Grade 50 (345); AASHTO M 270, Grade 50 (345); or ASTM A 595 Grade A.
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100.
- Anchor bolts must comply with AASHTO M 314, Grade 55 (379), including Supplementary Requirement S1.
    - All exposed portions of bolts must be galvanized according to AASHTO M 232 or AASHTO M 298, Class 40 or 50.
- Anchor base plates must be AASHTO M 270, Grade 36 (250).
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100.
- Cast anchor base plates must be AASHTO M 103/M 103M, Grade 65-35.
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100, or AASHTO M 298, Class 40 or 50.
- Hex nuts must comply with AASHTO M 292, Grade 2H or AASHTO M 291, Grade DH or DH3 (Grade 10S or 10S3).
    - The thread series must correspond with that of the bolt furnished.
    - Washers must comply with AASHTO M 293.
    - Galvanizing must comply with AASHTO M 232 or AASHTO M 298, Class 40 or 50.
    - Nuts must be galvanized by the same process as that of the bolts.
- Clamp plates must be AASHTO M 270, Grade 36 (250).
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100.
- Flange and gusset plates must be AASHTO M 270, Grade 36 (250).
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100.
- Clamp and flange bolts must be AASHTO 164 M.
    - Galvanizing must comply with AASHTO M 232 or AASHTO M 298, Class 40 or 50.
- Concrete must comply with Section 802 for Class S concrete.
    - The Department will perform all acceptance sampling and testing at the frequencies shown for Contractor acceptance testing in Subsection 802.06 of the GDOT Standard Specifications.
    - Reinforcing steel must comply with Section 804 for Grade 40 steel.
- Ground rods must be ⅝-in. (16 mm) diameter or larger Copperweld with ground wire and connections.

- When painting is specified on the plans, the pole, arm, and base plate must be painted according to the provisions of Section 638 of the GDOT Standard Specifications.

<u>Fabrication</u>

- Construct the pole to the dimensions shown on the plans.
  - Ensure the pole shaft has a continuous taper with only one vertical seam electrically welded and rolled smooth.
  - Provide a handhole of sufficient size to allow for internal wiring near the pole base.
  - Weld into the shaft a short distance from the base a reinforcing frame for the handhole tapped for a grounding bolt.
    - Weld a J-hook wire support inside the shaft near the top of the pole.
- Electrically weld to the bottom of the pole a cast steel or plate anchor base of the size and shape shown on the plans.
  - The anchor base and welding thereto must develop the full strength of the adjacent shaft.
- Allow the arm to be connected to the pole using clamp and gusset plates or flange and gusset plates.
  - When using clamp plates, weld one rounded plate conforming to the curvature of the pole to the mast arm and reinforce it with gusset plates as required to develop sufficient strength.
  - Connect the back clamp plate to the mast arm clamp plate with four bolts of sufficient size to develop adequate strength in the connection.
  - When using flange and gusset plates to connect the arm to the pole, weld adequate sized plates to the pole in the proper position.
  - Weld another flange plate of suitable design and strength to the end of the arm. Then connect the arm to the pole by four bolts of sufficient size to develop adequate strength in the connection.
- Provide four anchor bolts with hex leveling nuts with each pole.
  - Ensure the anchor bolts are of the length shown on the plans, have an L-bend on the bottom, and are threaded at the top.
  - Before installation, the Contractor must furnish to the Engineer design details regarding this item.
    - These details must specify materials and include a certification prepared and/or approved by a Professional Engineer who is registered in any of the United States, as follows:
      - ✓ That the design complies with the plans and specifications and meets or exceeds the current standards found in AASHTO’s Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
      - ✓ That the materials specified in the design meet or exceed the requirements of Subsection 714.02 of the GDOT Standard Specifications.

Traffic Signal Pedestal Pole with Foundation Materials

Materials

The following material requirements apply to poles and foundations.

- The poles must be constructed of 4-in. (100 mm) standard steel pipe shaft complying with ASTM A 501 or A 53, Grade B.
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100.
- Anchor bolts must comply with AASHTO M 314, Grade 55 (379), including Supplementary Requirement S1.
    - All exposed portions of bolts must be galvanized according to AASHTO M 232 or AASHTO M 298, Class 40 or 50.
- Anchor base plates must be AASHTO M 270, Grade 36 (250).
    - Galvanizing must comply with AASHTO M 111, Thickness Grade 100.
- Cast anchor base plates must be AASHTO M 103, Grade 65-35.
    - Galvanizing must comply with AASHTO M 232.
- Hex nuts must comply with AASHTO M 292, Grade 2H, or AASHTO M 291, Grade DH or DH3 (Grade 10S or 10S3).
    - The thread series must correspond with that of the bolt furnished.
    - Washers must comply with AASHTO M 293.
    - Galvanizing must comply with AASHTO M 232 or AASHTO M 298, Class 40 or 50.
    - Nuts must be galvanized by the same process as that of the bolts.
- Concrete must comply with Section 802 for Class S concrete.
    - The Department will perform all acceptance sampling and testing at the frequencies shown for Contractor acceptance testing in Subsection 802.06 of the GDOT Standard Specifications.
    - Reinforcing steel must comply with Section 804 for Grade 40 steel.
- Ground rods must be ⅝-in. (16 mm) diameter or greater Copperweld with ground wire and connections.
- When painting is specified on the plans, the pole and base plate must be painted according to the provisions of Section 638 of the GDOT Standard Specifications.

Fabrication

- Construct the pole to the dimensions shown on the plans.
    - Provide a handhole of sufficient size to allow for internal wiring near the pole base.
    - Weld a reinforcing frame into the shaft a short distance from the base for the handhole tapped for a grounding bolt.
- Electrically weld to the bottom of the pole a cast steel or plate anchor base of the size and shape shown on the plans. The anchor base and welding thereto will develop the full strength of the adjacent shaft.
- Provide four anchor bolts with hex nuts with each pole.
    - Ensure the anchor bolts are of the length shown on the plans and have an L-bend on the bottom and are threaded at the top.

- Before installation, the Contractor must furnish to the Engineer design details regarding this item.
    - These details must specify materials and include a certification prepared and/or approved by a Professional Engineer who is registered in any of the United States, as follows:
        - That the design complies with the plans and specifications and meets or exceeds the current standards found in AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
        - That the materials specified in the design meet or exceed the requirements of Subsection 715.02 of the GDOT Standard Specifications.
- The Contractor must also furnish a certification from the manufacturer or supplier that:
    - the traffic signal pedestal pole was fabricated in compliance with the certified design and
    - the materials furnished comply with the specifications.

<u>Construction Requirements</u>

- Construct foundations for the traffic signal pedestal pole in firm earth to the minimum size and depth shown on the plans.
    - Ensure the location of foundations is as shown on the plans or as directed by the Engineer.
    - Place foundations monolithically and include a 1-in. (25 mm) chamfer at the top.
- Place conduit, anchor bolts, and ground rods in the proper positions and hold in place by means of a template until the concrete sets.
    - Construct concrete according to Section 802 of the GDOT Standard Specifications.
    - Give the exposed portion of the foundation a Class 2 finish.
    - After installation, neatly grout the area between the top of the foundation and the pole base.
    - Do not erect the pole upon the foundation for a ***minimum of 24 hours*** after placement of concrete.
- Securely bolt the pedestal pole to the foundation in a perpendicular position, employing galvanized shims, if necessary.
- Effectively ground poles by means of a ground rod.
    - Attach grounding wire to the pole using a solderless steel bolt.
- Subsequent to erection, repair any damaged galvanized coating or paint according to Subsection 807.88 or Section 638 of the GDOT Standard Specifications, as appropriate.
- Machine drill all holes in traffic signal pedestal poles required for traffic signal cable, controller mountings, etc.

For further information, refer to Section 680 of the GDOT Standard Specifications.

A-16-8 Construction Traffic Signs

Panel Traffic Signs

Materials

- *Panel Signs*: Conform to ASTM B 221, Alloy 6063-T6.
  - Fabricate signs from 12-in. wide extrusions and, if specified, compatible 6-in. wide extrusions.
  - When a 6-in. extrusion is specified, use it as the bottom panel of the sign.
  - Use typical cross sections and minimum weights per foot as specified in the plans.
  - Use compatible side extrusions on all sign edges.
  - Prepare surfaces of the extrusions composing the sign face to receive retroreflective background material according to the extrusion and retroreflective material manufacturer's recommendations.
  - Provide all remaining surfaces of extrusions and side extrusions with a soft matte finish.
- *Sheeting Signs*: Conform to ASTM B 209, Alloy 6061-T6 or 5052-H38.
  - Fabricate signs of the size and shape specified.
  - Provide a thickness of 125 mils if any single edge dimension of the sign exceeds 3 ft.
  - If no single edge dimension exceeds 3 ft, provide a thickness of 80 mils.
  - Prepare the side of the sheet to be used as the sign ace to receive retroreflective background material according to the sheeting and retroreflective material manufacturer's recommendations.

Construction

- The Department may inspect fabrication and erection work.
- The Department will perform a day and night inspection after the installation is complete.
- If a manufacturer provides a warranty on any materials covered under these specifications, furnish the same warranty to the State.

Location

- Use the plans as general guidance for the extent and general arrangement of signs.
- Consider sign locations specified in the plans as approximate only.
- Determine the exact location for each sign and obtain the Engineer's approval.
- When it is necessary to relocate any sign more than 25 ft from the station listed, obtain the Division of Traffic's approval.
- Center overhead signs over the lane or lanes to which they apply.
- Allow for differences in elevation across the full shoulder width, as specified in the plans, in maintaining the required 18-ft minimum vertical clearance to the bottom of the lowest parts of the signs or supports for overhead signs.
- Submit all proposed revisions in writing to the Engineer for written approval.

Messages

Sign messages specified in the plans are the final messages.

- Due to construction phasing, the Engineer may make changes in some messages. The Engineer must change a message before the sign installation stores the final message copy on the Project.
- Conform message spacing to the applicable requirements of the previously cited publications for guide signs, and the manufacturer's recommendations for sign sizes indicated, as the Engineer approves.
- Center message copy over the lane or lanes to which they apply.

Attachment

- Attach letters, symbols, numbers, and borders to sign faces with "pop" fasteners (i.e., "pop" rivets).

Shields

For panel sign–mounted route markers, use a retroreflectorized white cut-out for the US shield, omitting the black background of the standard rectangular shapes.

- Do not use borders on the cut-out shapes.
- Use the dimensions shown in the Standard Highway Signs Manual.
- Space route markers evenly across the panel sign face.
- Provide route markers for panel signs that:
    - meet the specification requirements for Type VII, VIII, or IX Class I of ASTM D 4956, and
    - consist of reflective sheeting having an integral air cavity between the front surface and the optical elements, mounted on fully covering aluminum base copy stock not otherwise embossed or crimped, but having a minimum thickness of 0.080 in.

Footings, Bases, and Pedestals

Provide protection for traffic during construction of concrete bases for overhead sign structures. The Department will allow construction of footings against undisturbed earth without forms, unless otherwise directed.

- Slope top surfaces of bases and pedestals to provide for drainage.
- Provide an ordinary surface finish for all exposed concrete.
- Construct a rustication groove in all pedestals.
- Remove beam sign supports concurrently with the relocation of affected signs to new supports.
- Grade, to the existing slope, any areas disturbed by removing existing signs or constructing new signs, and reseed as the Engineer directs.

Sign Beams and Supports

Use beams of sufficient length to extend from the top of the sign to the required base embedment. Use either Type A (standard fixed beam installation), Type B (unidirectional breakaway beam installation), or Type C (omnidirectional breakaway beam installation) as specified in the plans.

- *Type A Beam*: Furnish Type A 36 steel beams galvanized according to ASTM A 123.
- *Type B Beam*: Specifications for Type B unidirectional breakaway beams are listed on the detail sheet for Type B beams.
- *Type C Beam*: Specifications for Type C omnidirectional breakaway beams are listed on the detail sheets for Type C beams.

The Inspector should follow these guidelines for installing sign beams and supports:

- Embed Type A and Type B beams in concrete to a depth equal to the dimension “a” as indicated for each sign.
- Provide a concrete footing for Type C beams according to the design on the Type C beam sheets.
- Wait 7 calendar days after placing concrete before mounting beams and supports to the bases or pedestals.
- Where aluminum is in contact with concrete, thoroughly coat the contacting surface with alumilastic compound or an approved equal in order to completely insulate the aluminum from the concrete.
- Where bond between the aluminum and concrete is desired, coat the aluminum with commercially available zinc chromate paint, and allow it to dry before installation.

<u>Bridge Mounting for Signs</u>

- Do not install brackets for support of bridge mounted signs within 6 in. of open joints in concrete handrail plinths.
- The Department will allow moving of supports to clear handrail posts.
- Place sign brackets on 4-ft maximum centers with a 2-ft maximum sign overhang.
- When necessary, remove existing handrails to drill anchor bolt holes.
    - Reinstall handrails after drilling.
- Locate bolt holes drilled in prestressed concrete beams to not interfere with steel strands.
- Drill holes for concrete beams with a rotary-type core drill.
    - Do not use impact-type drills.
- Install bolts with expansion plugs and lock washers in the holes and fill the void between the plug and face of the concrete with nonshrinking grout.

<u>Mounting Signs</u>

- Install new concrete bases, support beams, etc. before dismantling any existing sign.
- When existing signs are to be out of service for more than one work shift, install temporary signing of the proper color and shape, and with copy of similar configuration to existing signs at the same approximate station as the out-of-service sign.
- Install sign panels on sign structures, beams, or bridge-mounted brackets as specified in the plans.
    - Delay installation as long as possible to avoid any damage to the sign.
    - Replace all damaged signs.

For further information, refer to Section 647 of the GDOT Standard Specifications.

APPENDIX B: CONSTRUCTION INSPECTOR TRAINING MODULES

B-1 General Provisions Training Module

Section 101: Definitions and Terms

Acceptance Plans:	A defined method of taking and evaluating measurements for the purpose of determining the acceptability of a lot of material or construction
Advertisement:	A public announcement, as required by law, inviting bids for work to be performed or materials to be furnished
Available Day:	Any calendar day exclusive of Saturdays, Sundays, and Legal Holidays on which the Engineer determines that the Contractor is not prevented from accomplishing at least 5 hours of productive work
Bridge:	A structure, including supports, erected over a depression or an obstruction, such as water, highway, railway, etc. and having a track or passageway for carrying traffic

Bridge Complete:	An entire bridge including its substructure and superstructure
Bridge Length:	The overall length of a structure measured along the center of the roadway between backs of the abutment backwalls or between ends of the bridge floor
Bridge Roadway Width:	The clear width of a structure measured at right angles to the center of the roadway between the bottom of the curbs or between the inner faces of the parapet or railing
Calendar Day:	Every day shown on the calendar beginning at 12:00 midnight
Chief Engineer:	The Engineer Executive appointed by the State Transportation Board, or other authority as may be provided by the law, and acting for the Department within the authority and scope of duties assigned

Completion Date: The calendar date by which the Contract shall be completed when such date is shown in the Proposal in lieu of the stipulation of a number of available days or calendar days

Contract: The written agreement between the Department and the Contractor setting forth the obligations of the parties thereunder, including the performance of the Work, the furnishing of labor and materials, and the basis of payment

Contract Bond: The approved form of security executed by the Contractor and his/her Surety which guarantees complete execution of the Contract and all Supplemental Agreements

Contract Item: A specifically described unit of Work for which a price is provided in the Contract

Contract Time: The number of Available Days or Calendar Days allowed for the completion of the Contract, including authorized time extensions

Contractor: The individual, firm, corporation, or combination contracting with the Department for performance of prescribed work

Culvert: Any structure under the roadway with a clear opening of 20 ft (6 m) or less measured along the center of the roadway

Easement: A right acquired to use or control property for a designated purpose

Engineer: The Chief Engineer of Georgia, acting directly or through a duly authorized representative

Equipment: All machinery, apparatus, and tools necessary for the proper construction and acceptable completion of the Work, plus the necessary repair parts, tools, and supplies for upkeep and maintenance


Direct Industry

Extra Work: An item or work not provided for in the Contract as awarded but found essential to the satisfactory completion of the Contract

Force Account: A method of payment for Extra Work when a Supplemental Agreement is not arrived at between the Engineer and the Contractor

Holiday Dates:

Date	**Holiday**
January 1	New Year's Day
3rd Monday in January	King's Birthday
April 26	Confederate Memorial Day
Last Monday in May	National Memorial Day
July 4	Independence Day
1st Monday in September	Labor Day
2nd Monday in October	Columbus Day
November 11	Veteran's Day
4th Thursday in November	Thanksgiving Day
December 25	Christmas Day

Inspector: The Engineer's authorized representative assigned to make a detailed inspection of the Contract performance of any or all portions of the Work

Liquidated Damages: The fixed charges assessed against the successful Bidder or the Contractor for failure to execute the Contract or to complete the Contract within the Contract Time

Median: The portion of a divided highway separating the traveled ways for traffic moving in opposite directions

Minor Structures: Any structure not defined as a bridge

Notice to Contractors: A written Notice to soliciting Proposals, mailed to Contractors, suppliers, and others in the construction industry

Notice to Proceed: Written notice to the Contractor to proceed with the Contract Work

Pavement Structure: The combinations of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed

Plans: The approved plans, profiles, typical cross sections, working drawings, and supplemental drawings, which show the locations, character, dimensions, and details of the Work

Prequalification: The procedure established and administered by the Department by virtue of which prospective Bidders are required to establish their responsibility and competence in advance of submission of Proposals

Project: The specific section or sections of the transportation system together with all appurtenances and construction to be performed under the Contract

Proposal: The offer of a Bidder to perform the Work and furnish the labor and materials at the quoted price

Right-of-Way: A general term denoting land, property, or interest therein acquired for highway and its appurtenant structures

Roadbed: The graded portion of a highway within top and side slopes

Roadway: The portion of a highway within the limits of construction

Salvaged Material: Material having value that is to be removed, preserved, or stockpiled as directed for later use by the Department

Special Provisions: Additions or revisions to the Standard or Supplemental Specifications

Specifications: A general term applied to all directions, provisions, and requirements pertaining to performance of the Work

Station: When used as a term of measurement, will be 100 linear ft (1 km) measured horizontally

Structures: Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, building sewers, service pipes, underdrains, foundation drains, and other features that may be encountered

Subcontractor: Any individual, firm, corporation, or combinations of which the Contractor with the written consent of the Department sublets any part of the Contract

Substructure: All of that part of the bridge structure below the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames, including backwalls, wingwalls, and wing protection railings

Superintendent: The Contractor's authorized representative directly and solely responsible for the supervision and direction of the Work

Superstructure:	The entire bridge structure except the substructure
The Work:	The furnishing of all labor, materials, equipment, superintendence, and other incidentals necessary or convenient to the successful completion of the Project
WECS:	(Worksite Erosion Control Supervisor) A GDOT employee who inspects and reports the status of erosion control on construction Projects
WTCS:	(Worksite Traffic Control Supervisor) A GDOT employee who inspects and reports the status of traffic control on construction Projects

General Provisions Inspection

Section 102: Bidding Requirements and Conditions

Prequalification of Bidders

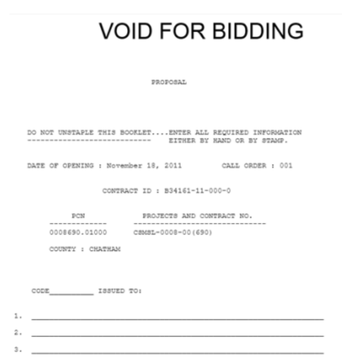
- The Bidder shall be prequalified with the Department before submitting a bid in excess of $2,000,000
- Aggregate total amount a nonprequalified Bidder may have under Contract shall not exceed $4,000,000
- Bidders intending to consistently submit Proposals shall prequalify at least once every two years

Competency of Bidders

- The Department may limit the amount of work awarded to any Contractor
- The Department may limit aggregate amount of work awarded to any nonprequalified Contractor
- The Department may refuse Contractor proposals to bid on additional work if the Contractor is behind schedule

Contents of Proposal Forms

- The Department will make a prospective Bidder a Void for Bidding Proposal Form
- The Proposal Form will state the location and description of the contemplated construction
- The Proposal form states the time in which the work must be completed, the amount of Proposal Guaranty, and the date of Proposal opening
- The Proposal Form also includes any special provisions or requirements that vary



VOID FOR BIDDING

PROPOSAL

DO NOT UNSTAPLE THIS BOOKLET....ENTER ALL REQUIRED INFORMATION
EITHER BY HAND OR BY STAMP.

DATE OF OPENING : November 18, 2011 CALL ORDER : 001

CONTRACT ID : B34161-11-000-0

PCN	PROJECTS AND CONTRACT NO.
0008690.01000	CSMSL-0008-00(690)

COUNTY : CHATHAM

CODE________ ISSUED TO:

1. ____________________
2. ____________________
3. ____________________

GDOT

Interpretation of Estimates

- Quantities are for work to be performed and materials to be furnished to complete the construction
- The Department does not guarantee quantities indicated on the plans or given in the Proposal
- The Contractor shall not plead deception or misunderstanding due to variation in quantities
- Payment to the Contractor is to be made only for actual quantities performed in accordance with plans and specifications

Examinations of Plans, Specifications, Special Provisions, and Worksite

- The Bidder is expected to examine the proposed worksite, proposal, plans, specifications, supplemental specifications, special provisions, and contract
- Proposal submission shall be considered prima facie evidence that the Bidder has made such examination and is satisfied as to conditions encountered when performing the work
- Bidders must interpret subsurface data available, including extent of materials to be excavated, graded, or driven through

Proposal Preparation

- The Bidder shall submit the Proposal on the form furnished by GDOT
- Blank spaces on the Proposal shall be filled in correctly for each Pay Item
- The Bidder shall show products of the respective Unit Prices and quantities
- The Unit Price will govern and the Bid will be recalculated in the event of discrepancy of any figures
- The Unit Prices shall be entered for only one alternate for Alternate Items

Bid Submission

- Hand-delivery of the electronic bid to the Department should be to the place specified in the Notice to Contractors
- Electronic bid submission can be by Internet or Bid Express™
- Electronic bids shall be prepared through use of a computer-controlled printer
- The Bidder shall sign the electronic bid in the appropriate areas
- Zero (0) is considered to be a valid bid
- Proposals shall be submitted in a sealed envelope unless submitted electronically on the Internet

Rejection of Proposals

Proposals may be rejected as irregular if:

- Their consideration is conditioned upon acceptance or rejection of Proposals submitted by the same Bidder
- They are not properly signed
- The Department believes collusion exists among bidders
- The Department receives more than one Proposal from any person, partnership, or corporation under the same or different names on any Project
- Unit Prices are obviously unbalanced
- Omissions, alterations of form, additions, or conditions exist
- The Bidder has not paid or satisfactorily settled all legal debts due on other Contracts
- They were created by nonprequalified Bidders
- They fail to list Disadvantaged Business Enterprises (DBE)

Withdrawal or Revision of Proposals

- Any Bidder may withdraw a Proposal before the advertised cutoff time
- The Bidder must use the DOT Bid Proposal Withdrawal Form
- Any Bidder may submit a Bid change before the advertised cutoff time

Section 103: Award and Execution of Contract

Consideration of Proposals

- If a discrepancy between the Unit Bid Prices and extensions exists, Unit Bid Prices will govern
- Until the final Award of the Contract, the right will be reserved to reject any and all Proposals
- If the low bidder discovers an obvious error prior to awarding of a contract, a request may be made to allow Bid withdrawal

Award of Contract

- The Contract is awarded to the lowest reliable Bidder whose Proposal met all prescribed requirements
- The Contract is awarded 50 calendar days after opening of Proposals
- Single and multiple Project proposals are publically opened and read
- No awarded Bids will be negotiated or adjusted
- Award to successful Bidder is made public through publication of Award Announcement

> The Department reserves the right to cancel the Award of any Contract any time before the execution of the Contract

Contract Bid Requirements

Contractor Location	Requirements
Georgia Resident	• Performance bond in full penal sum of Contract and payment bond in amount equal to 100% of final penal sum of Contract
Nonresident Contractor	• Performance bond in full penal sum of Contract and tax bond of 10% of full penal sum of Contract • Aggregate amount of bonds shall be 210% of full Contract sum

Execution and Approval of Contract

- The Contract shall be signed by the successful Bidder and returned within 15 calendar days after letter date
- No Contract shall be considered as effective until it is fully executed by all parties

Failure to Execute Contract

- Failure to execute the Contract within 15 calendar days after the letter is transmitted is just cause for cancellation of Award

Failure to execute the Contract within 15 calendar days after the letter is transmitted is just cause for cancellation of Award

Georgia Department of Transportation Construction Inspection Training

General Provisions Inspection

Section 104: Scope of Work

Intent of Contract

- The Contractor provides construction and completion in every detail of the work described in the project description.
- The Contractor shall furnish labor, materials, equipment, tools, transportation, and supplies required to complete the work

Alteration of Plans or Change of Work

- The Department reserves the right to make changes such as increasing or decreasing quantities
- Increases or decreases and alterations will not invalidate the Contract
- When alteration involves a substantial change in Contract, a Supplemental Agreement shall be executed before work is started
- All work shall be performed as directed by the Specifications

> Changes made by the Engineer will not be considered a waiver of provisions of the Contract

- The Engineer may increase or decrease quantities of any/all Pay Items without changing the Unit Price
- Changes cannot decrease the original Contract amount by more than 20%
- Engineer has the authority to extend or reduce total length or cost of Project by at most 20%
- An Extension Agreement will be executed if the Project length is extended

Maintenance During Construction

- The Contractor shall maintain the Project from the beginning of operations until Maintenance Acceptance or Final Project Acceptance
- The Contractor shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces to complete the construction project
- Maintenance includes signing, pavement markings, and traffic control devices as outlined in the *Manual on Uniform Traffic Control Devices*

- The Contractor shall maintain existing guardrail, signs, pavement, pavement markings, bridge handrail, and other safety appurtenances in good condition
- The Contractor shall not allow vegetative growth to obstruct signs, delineation, traffic movements, or sight distance
- The Contractor shall remove debris at 6-month (maximum) intervals
- The Contractor shall assume responsibility of damage to the work until Final Acceptance

The Engineer will be the sole judge of work to be classed as Special Maintenance (e.g., slope stabilization work)

Detours

- The Department is responsible for construction and maintenance outside of the right-of-way
- Payment for construction maintenance and removal of detour bridges/roads shall be by Bid Item

Delays to Traffic

- Two-way traffic shall be maintained at all times
- When approved, the Contractor must provide necessary flagman to direct traffic

Use of Project Materials

- Salvaged materials shall remain the property of the Department
- Usage of materials shall be directed by the Engineer
- The Contractor shall not excavate or remove material without authorization from the Engineer
- The Contractor shall not make any claim upon the State for damages or loss for Project materials
- The Department does not warrant or guarantee existence, quality, or quantity of materials

Final Clean Up

- Highway borrow pits and the construction site shall be cleaned of rubbish, excess material, temporary structures, and equipment
- Weeds and high grass shall be cut and disposed of
- Assure no disposal of construction materials on the right-of-way by the Contractor
- Temporary buildings or other structures built for the Contractor's use and located within view of the right-of-way shall be removed and disposed of as directed

Value Engineering Proposals

These guidelines apply to cost reduction proposals initiated and developed by the Contractor. Proposals must provide the following:

- A product comparable to the original design at lower cost and/or improved quality
- A description of the difference between the existing Contract requirement and the proposed change
- A required detailed estimate of the cost of performing the proposed work
- Prediction of any effects of proposed changes on the Department
- A life-cycle cost analysis

Georgia Department of Transportation Construction Inspection Training

General Provisions Inspection

Section 105: Control of Work

Authority of the Engineer

- The Engineer will decide all questions that may arise as to quality and acceptability of materials furnished, work performed, and rate of progress of the work
- The Engineer will determine quantities of several kinds of work performed and materials furnished
- Examples include Area Engineer, Assistant Area Engineer, and Project Manager Engineer

Plans and Working Drawings

- Plans will show details of structures, lines, grades, and typical cross sections of the roadway
- Plans will be supplemented by working drawings to adequately control the work
- All working drawings must be approved by the Engineer

Conformity with Plans and Specifications

- Work performed and materials furnished shall conform reasonably close with lines, grades, cross sections, dimensions, and material requirements

- Plan dimensions and Contract specification values are considered as target values to be achieved
- The purpose of tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable

Governing Order of Documents:

1. Special Provisions Project
2. Plans including Special Plan Details
3. Supplemental Specifications
4. Standard Plans including Standard Construction Details
5. GDOT Standard Specifications
6. Calculated dimensions will govern over scaled dimensions.

Contractor shall take no advantage of any apparent error or omission in Plans or Specifications

Contractor Cooperation

- The Contractor shall be accessible to the Engineer at all times
- The Superintendent shall have full authority to execute orders or directions of the Engineer without delay

Project Personnel	Authority and Duties
Resident Engineer	• Engineer designated by the Department to be the direct representative of the Chief Engineer • Has immediate charge of engineering details of each construction Project, and is responsible for Contract administration
Inspector	• Authorized to inspect all work done and materials furnished • Not authorized to alter or waive provisions of the Contract

Inspection of Work

- All materials and each part of detailed work shall be subject to inspection by the Engineer
- The Engineer shall be allowed access to all parts of the work
- Upon the Engineer’s request, the Contractor shall remove or uncover such portions of finished work at any time before Final Acceptance
- Any work done or materials used without supervision or inspection by authorized Department representative may be ordered removed and replaced

Removal of Unacceptable and Unauthorized Work

- All work not conforming to Contract requirements is considered unacceptable

No work shall be done without lines and grades having been given by the Engineer

- Unacceptable work shall be removed immediately and replaced in acceptable manner

Final Inspection and Acceptance

- The Engineer will determine if the Project is ready for Final Inspection
- The Engineer will schedule the Final Inspection
- The Engineer will provide the Contractor with a written punchlist with necessary instructions
- The Contractor shall immediately comply and execute the punchlist

Section 106: Control of Materials

> Materials are not considered as finally accepted until all tests of materials taken from the finished work have been completed and evaluated

Construction Materials

- The Contractor shall furnish formal written invoices from materials suppliers
- Invoices shall show date shipped, quantities, and unit prices
- When the Contractor's quality control procedures do not achieve the desired objective, operations shall be suspended until satisfactory results are obtained
- Material not conforming to requirements of specifications will be considered as unacceptable

Samples, Tests, Cited Specifications

- All materials will be inspected, tested, and approved by the Engineer before incorporation into the work
- Samples are taken by a qualified representative of the Department (see the *Sampling, Testing, and Inspection Manual*)
- Copies of tests will be furnished to the Contractor's representative upon request
- The Contractor shall be responsible for quality of construction and materials incorporated

- The Department will monitor the Contractor's Quality Assurance Acceptance Program to verify test accuracy
- The Engineer may accept the manufacturer's certification from the Contractor

Storage of Materials

- Material may be stored on the right-of-way when approved by the Engineer
- Private property shall not be used for storage purposes without written permission of the owner

- Materials shall be stored to assure the preservation of their quality for the work
- All storage sites shall be restored to their original condition by the Contractor
- All materials shall be handled to preserve their quality for the work

The Contractor may be required to provide a field laboratory on the Project

Section 107: Legal Regulations and Responsibility to the Public

Laws to be Observed

- The Contractor shall keep fully informed and comply with Federal and State laws, local laws, ordinances, codes, and regulations
- The Contractor shall procure permits and licenses; pay charges, taxes, and fees; and give all notices necessary

> Contractor shall plan, coordinate, and prosecute work such that disruption to personal property and business is minimized

Traffic Control

- The Contractor shall conduct the work as to assure the least possible obstruction of traffic
- Traffic whose origin and destination is within the Project's limits are to be provided ingress and egress
- The Contractor shall furnish, install, and maintain necessary barricades, signs, and other traffic control devices

Use of Explosives

- The Contractor shall exercise utmost care not to endanger life or property
- The Contractor is responsible for any damage resulting from transportation, storage, use, and control of explosives
- Explosives and detonators shall be stored in separate storage facilities in separate areas
- Whenever electric detonators are used, radio transmitters shall be turned off within a radius of 500 ft (150 m)
- Appropriate signs shall be placed to give warning to anyone driving a vehicle equipped with two-way radio

Erosion and Silt Control

- The Contractor shall control erosion and silting of rivers, streams, lakes, reservoirs, and other bodies of water.
- The Contractor shall carry out construction of drainage facilities in conjunction with clearing and grubbing, and earthwork operations

- Pollutants (chemicals, fuels, lubricants, raw sewage, and other harmful waste) shall not be discharged into or alongside rivers, streams, and impoundments, or into natural or manmade channels

Project Limits

Within	• No hauling equipment loaded beyond the weight limits is allowed on new or existing pavement structures • Axle loads and gross weight limits are evaluated in accordance with Georgia law • Damage caused by equipment is repaired by the Contractor
Outside	• No vehicle shall carry loads in excess of that specified by Georgia law • Maximum total gross weight is 56,000 lb (25,400 kg) on County Roads

Opening Sections of Project to Traffic

- The Engineer may direct that a bridge or section of roadway should be opened to traffic
- Necessary repairs or renewals made on a section of roadway or bridge should only be opened to traffic after instructed by the Engineer

Acquisition of Right-of-Way

- Rights-of-way for the Project will be obtained by the Department in coordination with local governments
- The Contractor’s access to portions of the right-of-way may be restricted

Environmental Considerations

- Erosion control measures shall be installed prior to clearing and grubbing
- Particular care shall be exercised along stream buffers, wetlands, and open waters
- Construction equipment shall not cross streams, rivers, or other waterways
- Construction activities within wetland areas are prohibited

- The Engineer will inform the Contractor in writing as to a grant or denial of environmental clearance

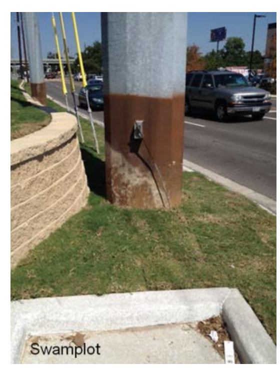
Borrow and Excess Material Pits

- Specific written environmental clearance from the Engineer is required for sites not included in plans as excess material or borrow areas
- The Department will not begin studies on such sites before a Notice to Proceed is issued
- An official Notice to Proceed is required (not a Conditional Notice to Proceed)

Subletting of Contract

- No Subcontractor shall commence work in advance of the written approval of the Subcontract by the Department
- Each Subcontractor shall be prequalified or registered with the Department
- Subcontract agreements between the Prime Contractor and Subcontractor shall be in writing
- The following items are designated Specialty Items:

General transportation
Grassing items
Fencing items
Highway lighting items
Sign items
Guardrail items (except bridge handrail)
Utility items
Comfort and convenience items in rest areas
Landscaping items
Pressure grouting, slab removal and replacement
Permanent traffic markings
Signal systems
Railroad track work above sub-ballast
Floor covering
Drilled caisson foundations
Raised flooring
Landscaping
Security system
Fire protection
Gutters
Painting
Insulation
Doors
Elevators
Building contract
Structural steel
Plumbing
HVAC
Electrical
Telephone service
Masonry
Glass work
Drywall
Ceiling installation
Roofing
Carpentry



Prosecution and Progress

- The Contractor will provide materials, equipment, and labor to guarantee the Project's completion
- Each work activity is expected to continue from the date it is begun until completed

- Contract Time as shown in the Proposal is the allowable time
- At least 48 hours before commencing work, the Contractor shall notify the Engineer of intention to begin

Contractor Methods

- If the Contract specifies certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer
- The Contractor may request authority from the Engineer to use another method not specified in the Contract

Contract time can be in available day contracts, calendar day contracts, and completion day contracts

Liquidated Damages

The following deductions are specified in each individual Contract:

- *Deduction from Partial Payments*: Liquidated damages are deducted from periodic partial payments
- *Deduction from Final Payment*: Liquidated damages will be deducted from the final payment to the Contractor

Georgia Department of Transportation Construction Inspection Training

General Provisions Inspection

Section 109: Measurement and Payment

Measurement and Quantities

- Longitudinal measurements for area computations are made along the surface
- Transverse measurements for area computations will be the dimensions shown on the plans
- Structures will be measured according to lines shown on the plans
- All items which are measured by the linear ft (linear m) are measured parallel to the base or foundation upon which such structures are placed
- Volumes of excavation are calculated using the average end area method

Measurement of Bituminous Materials

- Weigh by material, as the Department prefers
- Weigh tank trunks of bituminous material on scales previously inspected by the Department

- Alternatively, weigh bituminous material by extraction tests made in the field laboratory
- Use the amount of bituminous material as shown on the printed ticket
- Convert the tack coat measurement to tons (megagrams) and deduct it from the bituminous material quantities

Force Account

When no agreement is reached for Extra Work done at Lump Sum or Unit Prices, such work may be authorized by the Department to be done on a Force Account basis

Payment

Payment for force account work is divided into:

- Labor
- Bond, Insurance, and Tax
- Materials
- Equipment
- Miscellaneous
- Compensation

Note: Payment for specific construction items is listed at the end of each training course

Section 149: Construction Layout

Includes placing, replacing, and maintaining construction layout points

Contractor Submittals

Submittal	Notes
Project construction records	Includes survey records, bound field notes, computer printouts of Project's construction
Survey documents	Furnish Engineer with copies that relate to construction layout
Drainage structure sketches	Provide inlet and outlet ends of proposed drainage structures for at least 100 ft (30 m) in existing ditch line or stream bed
Bridge layout sketches	Furnish layout sketch before staking on bridges Verify plan elevations for bridge bearing seats on substructure
Wall layout sketches	Submit to Engineer who verifies the wall will fit in final field conditions

Preparation

- Ensure plan dimensions, alignment, and elevations are compatible with field conditions
- Ensure alignment tie-ins by coordinating construction layout with other Contractors

Widening and Reconstruction

- Take 3-point levels of pavement throughout length to be retained
- Prepare graphic grade plot that "best fits" existing pavement
- Furnish data to the Engineer before beginning widening and reconstruction
- *Bridges*: Verify existing elevations and dimensions and confirm required new cap elevations

During Construction

- Verify the plan elevations and bent layout
- *Establish centerline*: (1) Establish the monuments and reference points, (2) Establish the horizontal and vertical alignment, and (3) Modify the plan horizontal and vertical alignment
- Verify the accuracy of bench mark(s)
- Flag the in-place survey control monuments
- Set the line and grade stakes needed to construct the Project
- Stake the centerline control alignments (accuracy of 1:5000)
- Provide graphic sketches of superelevation runout on curves and tie-in of ramps

- Maintain the stakes after construction has begun
- Furnish the layout and clean traffic markings
- Provide the bridge construction layout

References

dailyreporter.com
www.americanconcrete.com
www.pavementinteractive.org
www.publicdomainpictures.net
www.mabeybridge.com
www.dreamstime.com
www.highwaysigning.com
www.driversed.com
www.desmogblog.com
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www.4wdaction.com.au
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www.pavementinteractive.org
www.damagepreventionprofessional.com
www.hydradynellc.com

B-2 Auxiliary Items Training Module

Georgia Department of Transportation Construction Inspection Training

Auxiliary Items Inspection

Section 151: Mobilization

Mobilization includes preparatory work, operations, and moving personnel, equipment, supplies, and incidentals to the Project site

Note: Mobilization also includes all other work and operations performed or costs incurred before beginning work on various items on Project site

Measurement

- Mobilization is not measured separately for payment

Georgia Department of Transportation Construction Inspection Training

Auxiliary Items Inspection

Section 152: Field Laboratory Building

Field Laboratory Physical Requirements

Provide a structure approved by the Engineer, including building, trailer, fixed building erected on site, vacated house at approved location, as follows:

- Each laboratory shall house required testing equipment to meet minimum requirements for dimensions, space, and facilities
- Each building or trailer shall be 7 ft (2.1 m) wide and 7 ft (2.1 m) high inside and contain 120 ft^2 (11 m^2) minimum floor space
- Each unit shall be floored, roofed, and weathertight and have the following:
  - At least one hinged or sliding window on each window having at least 6.5 ft^2 (0.6 m^2) of openings
  - An entrance door that securely locks
  - A built-in work table with at least two drawers (one lockable)
  - Lighting and ventilation
  - Heating with necessary fuel
  - Potable running water and electric current
  - Sheds and platforms required for special testing equipment
  - Sanitary facilities as required by local State Health Departments
  - Approved fire extinguisher in each building

Asphaltic Concrete Plant Laboratory Requirements

The asphaltic concrete plant laboratory shall have the following equipment and facilities:

- Equipment with ventilation system that can maintain a temperature between 65°F and 80°F (18°C and 27°C) with windows and doors closed
- Enclosures for procedures where extracting solvent vapors are emitted
- Dry samples under enclosure or inside oven that is vented outside the lab
  - Enclosure must have hood, glass, or other doors capable of enclosing the extracting solvent vapors from ambient air in the lab

- Replacement air provided through an open window or other opening to achieve specified exchange of air
- Ventilation system capable of exchanging air at rate of 100 ft³/ft²/min (30 m³/m²/min) over entire open door area of each enclosure

NL Scientific

Portland Cement Concrete Plant Laboratory Requirements

The Portland cement concrete plant laboratory shall have the following equipment and facilities:

- Combined office/workspace measuring 300 ft² (28 m²)
- Heating and air conditioning equipment capable of maintaining interior temperature of 70°F (21°C)
- Separate office space with space for a desk and two chairs
- A work table at least 2.5 ft (750 mm) wide, 5 ft (1500 mm) long, and 3 ft (900 mm) high to prepare concrete cylinders for testing
- An outside work area of at least 10 ft × 10 ft (3 m × 3 m) consisting of a concrete slab constructed level and true, with light broom finish

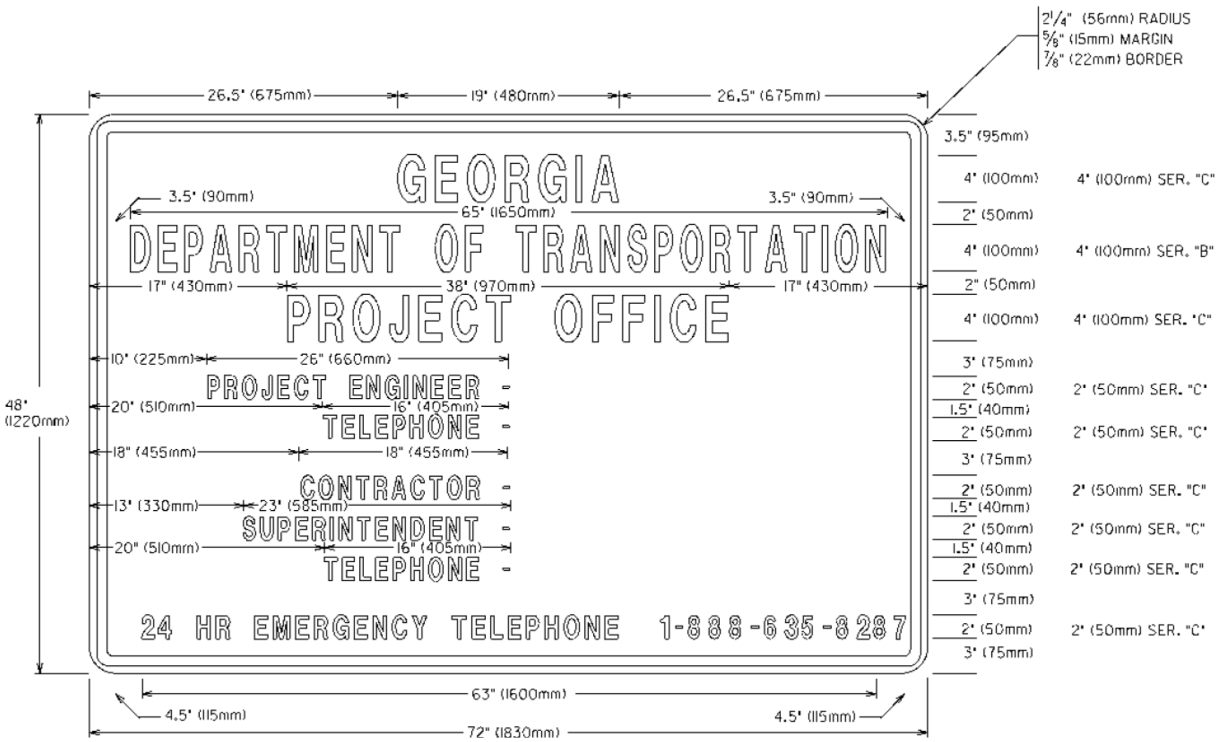
Payment: Contractor Unit Price bid for each laboratory

Related Specifications

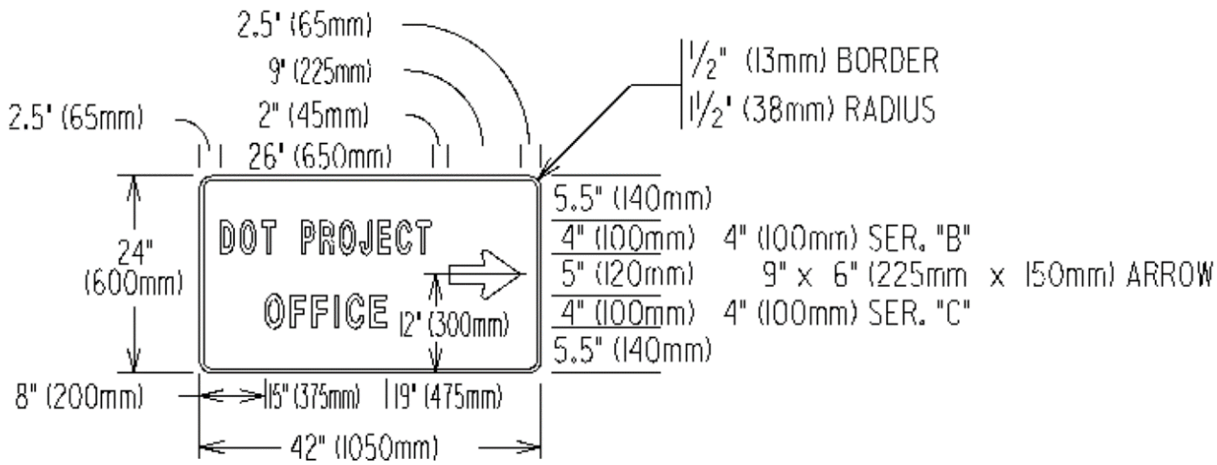
Section	Title
400	Hot Mix Asphaltic Concrete Construction
402	Hot Mix Recycled Asphaltic Concrete
	AASHTO TP4
	AASHTO T166
	AASHTO T209
	AASHTO T309
	GDT 125 “Method for Test for Determining Asphalt Content by Ignition”
	NFPA – 10A

Fabrication

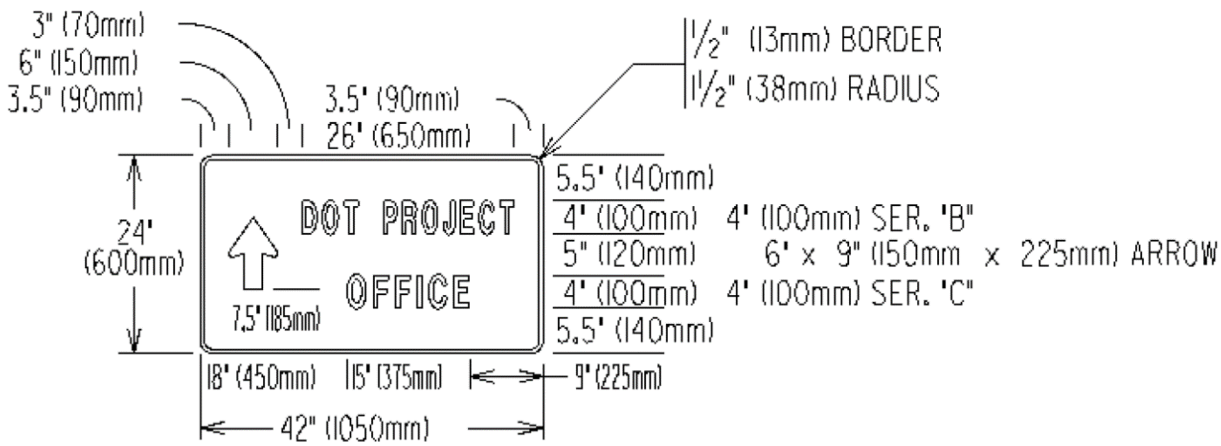
- Install the following sign at the Department of Transportation Project Office:



- Install the sign so it is plainly visible from the Project roadway
- If the Project Office is not adjacent to the roadway, install a second sign as a guide sign
- Submit signage plant to the Engineer for approval of this work
- Follow guide sign specifications as shown in the diagram below:



PROJECT OFFICE
GUIDE SIGN DETAIL



PROJECT OFFICE
GUIDE SIGN DETAIL

Field Engineer's Office Specifications

The field engineer's office shall have the following specifications:

- Office Building Types 1 and 3: Place within or near Project limits as directed by the Engineer
- Place within 1000 ft (300 m) of a power line if possible when electric current is required
- Use a building, house, mobile office, or trailer, if approved
- Meet the requirements in the following table:

1. **Dimensions:** All measurements shown are clear inside dimensions.

	Constructed on Project			Commercially Produced		
	In Linear Feet (Meters)			In Linear Feet (Meters)		
Building	Width	Length	Head-room	Width	Length	Head-room
Type 1	8 (2.44)	10 (3.05)	8 (2.44)	7 ft 6 in (2.29)	9 ft 6 in (2.93)	7 (2.13)
Type 3	12 (3.66)	50 (15.24)	8 (2.44)	11 ft 6 in (3.51)	49 ft 6 in (15.09)	7 (2.13)

<ins>Doors and Windows</ins>

The buildings will meet the following requirements for doors and windows:

- Each building has one standard height solid entrance door (minimum) with lock and self-closing screen door
- Type 3 buildings shall have at least two doors and screens
- Each wall shall have at least one hinged, jalousies, or sliding window that is glazed, screened, or fitted with venetian blinds
- Each window shall measure at least 6.5 ft^2 (0.6 m^2)
- *Window Requirements*: At least 3 for Type 1 and at least 10 for Type 3 buildings

Component	Building Requirement
Roof	• Construct walls and roofs with studs and rafters measuring 2 in. × 4 in. (50 mm × 102 mm) • Make roof watertight with a minimum slope of 1:12 in one direction away from door • Ensure eaves are at least 12 in. (300 mm)
Walls	• Include in walls and ceilings insulated material at least 1¼ in. (32 mm) thick made of rock wool, fiberglass, or other nonflammable material • Ensure material is in all inner wall and ceiling cavities • Cover both sides with ⅜-in. (10 mm) plywood (exterior grade on outside) • Do not permit any open cracks or knotholes
Ceiling	• On all building types, cover inside roof rafters with ⅜-in. (10 mm) plywood, if constructed on Project • Use standard ceiling if the building is commercially produced
Floor	• Require floor to be a minimum of 12 in. (300 mm) above the ground on 2 in. × 6 in. wooden boards (38 mm × 152 mm) • Allow timber with no open cracks or knotholes
Heater	• Provide an oil-fired, gas, or electric heater that can maintain inside minimum temperature of 72°F (22°C) • Properly vent oil and gas units to the outside, provide adequate outside fuel storage, and connect with suitable feed lines • Allow connection of gas units to a commercial gas main if available

Worktable	• Provide a minimum of 3 standard-dimension desks • Provide a minimum of 1⅛-in. (28 mm) wood-grain laminated tops with 23-in. (575 mm) deep files and heavy-duty steel ball bearing drawers and locking center drawer • Provide 1 5-ft × 3-ft (1500 mm × 900 mm), adjustable from 0° to 45°, and 38-in. (950 mm) high drafting table
Stools	• Provide 1 posture stool with supportive backrest, waterfall edge seat, and instant height level (26–30 in. or 650–750 mm) • Provide 4 (minimum) swivel chairs with arms • Provide a minimum of 1⅛-in. (28 mm) wood-grain laminated tops with 23-in. (575 mm) deep files and heavy-duty steel ball bearing drawers and locking center drawer
Storage Shelves	• Provide 6 linear ft (1800 linear mm) of storage shelves for books, etc. • If two 3-ft (900 mm) shelves are furnished, place at least 1 ft (300 mm) apart
Utilities	• Connect all including water, sewage, gas, electricity, and telephone service to sources before the Engineer's occupancy
Fire Extinguisher	• Equip each building with at least 1 approved fire extinguisher that meets the following: (1) Multipurpose dry chemical type extinguisher and (2) Underwriters Laboratories rating 4A-40BC • Mount in a convenient and conspicuous location easily accessible • Maintain according to requirements of NFPA-10A

<u>Additional Type 3 Office Components</u>

- *Locking File Cabinet*: Provide 3 four-drawer, letter size, steel, fireproof, lockable, and 2 keys
- *Plan Racks*: Capable of holding 2 complete sets of Project plans
- *One Enclosed Closet*: At least 3 ft × 3 ft (900 mm × 900 mm) with lockable door and 2 keys
- *Chain Link Fence*: Provide a minimum of 500 ft (150 m) of 6-ft (1.8 m) high chain-link fence with an extension arm and barbed wire (Section 643)
- *Security Light*: Provide two 150-watt high-pressure sodium security lights with photoelectric controls (as directed by the Engineer)
- *Copy Machine*: Furnish and maintain for the life of the Project
- *Aggregate Surface*: Place and spread 200 tons (181 Mg) on the Office grounds and remove (and grass) upon Project completion
- *Alarm System*: Includes SRN-2000 Enforced Bisonic with NAPCO magnum Alert 850 – control box or Honeywell Vista-10P Master Control Panel with Honeywell 615RF keypad or equivalent

Payment

- Payment is for each and is paid 65% when the Field Office is ready for occupancy and 35% when it is no longer needed

Related Specifications

Section	Title
636	Highway Signs
643	Fence
910	Sign Fabrication
911	Sign Posts
912	Sign Blanks and Panels
913	Reflectorizing Materials

Section 155: Insect Control

The Plant Pest Control Division of the US Department of Agriculture and the Georgia State Department of Agriculture restricts movement of certain items from areas infested with Japanese Beetles or Imported Fire Ants.

Construction

- Do not move the following from an infested area into a non-infested area without the approval of the Department of Agriculture Inspector in Charge:
  - Soil
  - Mulch
  - Sod
  - Plants with soil attached
  - Stump wood
  - Timber with soil attached
- Clean soil deposits from earth-moving equipment, including crawler-type tractors, before moving them from an infested area into a non-infested area
- Furnish scraping tools, brooms, water, and labor for cleaning equipment
- Unless otherwise noted, consider a Project an infested area

- Have earth-moving equipment inspected by the Department of Agriculture Inspector in Charge before moving from infested area
- Notify the Department of Agriculture Inspector in Charge in advance concerning movement of infested articles or equipment

- Obtain name, address, and telephone number of the Department of Agriculture Inspector in Charge from:

  Georgia State Department of Agriculture
  Division of Entomology and Pesticides
  Agriculture Building
  State Capitol
  Atlanta, GA
  Phone: (404) 656-3641

  USDA-APHIS
  Plant Protection and Quarantine
  1498 Klondike Road, Suite 200
  Conyers, GA 30094
  Phone: (770) 922-9894

Georgia Department of Transportation Construction Inspection Training

Auxiliary Items Inspection

Section 157: Survey Aids

Materials

- Do not require pre-inspection, sampling, or testing
- Replace, repair, or strengthen defective, worn, deteriorated, corroded, or unsatisfactory material
- Allow timber and piles to be untreated but require that they are peeled
- Consider timber of any commercial grade and species as acceptable
- For triangulation stations, ensure center pile for instrument mounting has a minimum diameter of 1 ft (300 mm) at distance of 4 ft (1.2 m) from the butt
- Require a minimum diameter of other piles in stations of 10 in. (250 mm)

- For survey targets, use marine-type plywood that is 0.75 in. (19 mm) thick
- Paint plywood with coats that meet the requirements of Federal Specifications
- Use galvanized sheet metal caps for pile heads, galvanized large-headed roofing nails to attach caps, and galvanized cable to wrap the pile clusters

Construction

- Identify possible locations of base lines, triangulation stations, and survey targets as shown on the plans
- Base actual and final locations of survey aids on the Contractor’s own procedures and equipment methods
- The Contractor and the Engineer must agree on the most effective means to control the line and distance during construction

- The Engineer places instrument mountings and performs field checks and office calculations necessary to provide locations of survey points
    - Drive pile clusters into underlying firm material to provide instrument mountings and drive into firm material
- The Engineer can determine how high to construct survey aids
    - Construct items above the extreme high-tide mark

> Engineer may require triangulation stations to be built to a higher elevation.

Contractor Warranty and Maintenance

- Promptly replace, repair, or strengthen defective, unduly worn, corroded, deteriorated, or otherwise unsatisfactory material at the Engineer's request
- Maintain survey aids to the Engineer’s satisfaction to ensure they are safe, have longevity, and perform accurately

Payment

- Survey aids are paid at the Contract Unit Price per unit of measurement, complete in place, and when maintained and removed as directed

Georgia Department of Transportation Construction Inspection Training

Auxiliary Items Inspection

Section 158: Training Program

> Contractor’s Employment Program includes on-the-job training aimed at fully qualifying trainees in the trade or job classification involved

General

- The Contractor will submit an acceptable training program to the Department for review and approval within 30 days after the Notice to Proceed is issued
- The number of trainees determine the number the Subcontractor shall train. The Contractor has primary responsibility for meeting training requirements and should provide training for the following: 1) construction crafts, 2) laborers, 3) clerks and 4) secretaries.

Preparation

- Provide each trainee with a copy of the program and certification showing type and length of training satisfactorily completed
- The State will approve or accept the training program before beginning work

Construction

- An employee who completes the training course or is employed as a journeyman cannot receive training in area of expertise
- Include questions in the employee application or by other means to disclose trainee’s status
- Off-site training is permissible

Quality Acceptance

- The selected training program approved by the Department and the Federal Highway Administration establishes the minimum length and type of training for each classification
- Acceptable apprenticeship programs include:
  - Programs registered with the US Department of Labor
  - Programs registered with the Bureau of Apprenticeship and Training
  - Programs registered with a State apprenticeship agency recognized by the Bureau
  - Training programs approved but not necessarily sponsored by the US Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training

References

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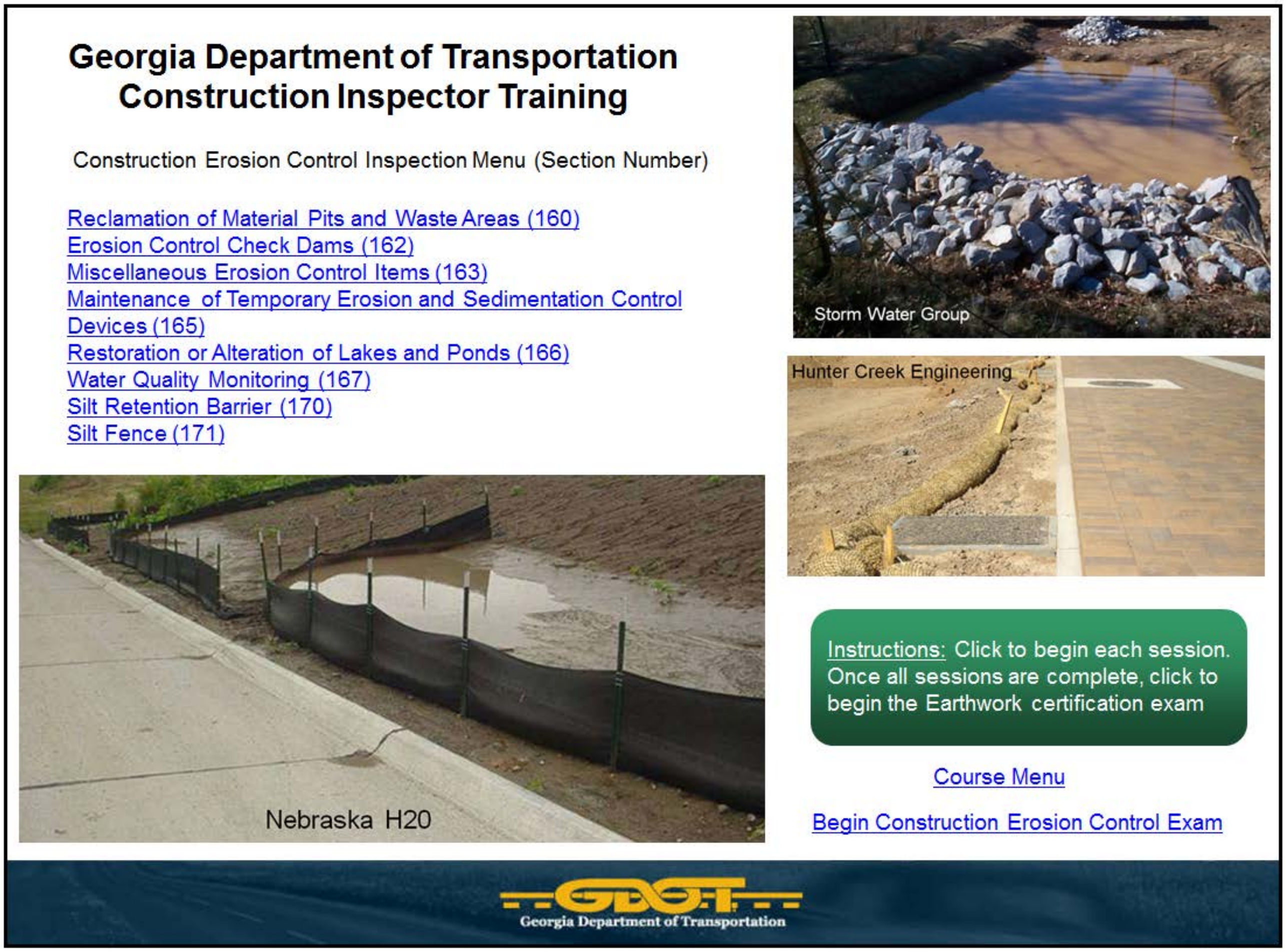
B-3 Construction Erosion Control Training Module



Section 160: Reclamation of Material Pits and Waste Areas

Vegetative requirements apply when Contractor obtains material from source or wastes material on area outside of right-of-way.

General

Reclamation area applies to areas outside of right-of-way

- Plant slopes above water only
- The Engineer may determine areas composed of rock or other materials not satisfactory for permanent vegetative cover

Submittals

- The Engineer must:
  - Approve planting type if the Contractor furnishes a material pit or waste area that requires vegetation
  - Approve all modified mixtures before planting begins

- Property owner may change plant material types specified in the plans to a type not shown in the Planting Table (Section 160.2)

Materials

- The Engineer will select the material type from the Planting Table
- The state is divided into planting zones shown on the Planting Zones Map (Section 700)
- Do not use giant Bermuda seed (Cynodon species), including NK-37
- Do not use Italian rye grass seed (perennial or annual)
- Apply entire combination of seeds specified for each group
- Increase seed quantities 50% on slopes too steep for soil preparation (cannot be dug 6 in. [150 mm] minimum depth)
- Air dry *sericea lespedeza* seed hay and ensure it contains mature seed
- Consult the Planting Table (Section 160.2)

Sample Planting Table (Section 160.2)

	Planting Groups	Species	Rates per Acre/Hectare	Planting Zones			
			lbs. (kg) (except as noted)	Zone 1	Zone 2	Zone 3	Zone 4
Spring Planting	A	Weeping Love Grass	4 (4.5)	3/1-7/15	2/15-7/ 15	2/15-7/ 15	2/1-7/ 15
		Interstate Lespedeza (HS)*	50 (56)	3/1-7/15	2/15-7/ 15	2/15-7/ 15	2/1-7/ 15
	A-1	Interstate Lespedeza (HS)*	60 (67)	3/1-7/15	2/15-7/ 15	2/15-7/ 15	2/1-7/ 15
	B	Tall Fescue	30 (33.5)	3/1-5/1	2/15-5/1		
		Interstate Lespedeza (HS)*	50 (56)	3/1-5/1	2/15-5/1		

Preparation

- Seed or sprig areas subject to erosion
- Grass and mulch areas that require pine seedlings before planting the seedlings

Construction

Item	Construction Note
Ground Preparation	• The Engineer determines areas unsatisfactory for permanent vegetation • Plow areas to be planted to 6 in. (150 mm) depth
Lime and Fertilizer	• Spread agricultural lime uniformly at the rate shown on the plans or determined by the Engineer • Apply fertilizer grade 4-12-12, 6-12-12, or 5-10-15 uniformly at approximately 1200 lb/acre (1350 kg/ha) • Mix in top 2 in. (50 mm) of soil including areas to be planted with pine seedlings • Hydroseed slopes steeper than 2:1
Mulch	• Apply to all seeded and sprigged areas

Plant Pine Seedlings	• Use dibble or other approved planter to dig holes for pine seedlings after seeding or sprigging and mulching • Set plants slightly deeper than they were planted in nursery • Compact bottom of hole before setting plants (for hand planting)
Nitrogen	• Do not apply directly over seedlings
Harvest Sprigs	• Use sod cutter, turning plow, or other approved equipment so at least 3 in. (75 mm) of root system is lifted intact • Immediately load harvested sprigs and cover with wet burlap or canvas • Plant within 48 hours after harvested • Never allow sprigs to dry out or freeze
Apply Sprigs	• Use broadcast or row method • Do not perform broadcast on steep slopes or narrow areas
Broadcast Sprigging	• Apply mechanically or by hand in uniform layer over prepared surface placing 4 viable sprigs (minimum) to each ft^2 (43 viable sprigs to each m^2) • Place 2–3 in. (50–75 mm) deep by disc harrowing or other means
Row Sprigging	• Open furrow spaced at least 1 ft (300 mm) apart and at least 4 in. (100 mm) deep • Immediately place in furrows by hand or machine and overlap in furrows • Do not expose sprigs to 15 minutes (maximum) to outside air before filling furrows

Pine Tree Seedlings

- Considered satisfactory after 85% of growth has survived 90 days after planting with no fail spots exceeding 0.25 acre (0.1 ha)
- Survival rate less than 85% but greater than 75% with fail spots less than 0.25 acre (0.1 ha) are measured for half payment at Contractor price unless deficient area is replanted
- Survival area less than 75% are replanted in full at Contractor’s expense

Payment

- Seeding, sprigging, and pine seedlings are paid per acre (ha) at the Contract Unit Price

Related Specifications

Section	Title
700	Grassing
702	Vine, Shrub, and Tree Planting
890	Seed and Sod

Georgia Department of Transportation Construction Inspection Training

Construction Erosion Control Inspection

Section 162: Erosion Control Check Dams

Materials

- Use commercial type of woven wire (minimum 14½ gauge)
- Place #57 stone at location and depth marked on plans

Check Dam Construction

- Construct check dams before roadway clearing, grubbing, or grading is complete
- Remove trees, logs, brush, etc., within the right-of-way
- Do not disturb other natural ground cover
- Obtain embankment material for earth dams
- Place a layer of #57 stone on the downstream side of dam
- Grass the remaining portions (top/upstream slopes) of earth dams
- Grass or stabilize with straw mulch the roadway cut and fill slopes that drain toward the check dam drainage area
- Leave check dams in place after construction is complete (unless directed otherwise by the Engineer)

Use only rubber-tired equipment to work in affected drainage area until after check dam is completed

Contractor Warranty and Maintenance

- Repair check dams as needed during the Contract life
- Construct additional check dams if necessary and when directed by the Engineer

Measurement

- The number of erosion control check dams measured for the payment is the actual number completed and accepted

Payment

- Erosion control check dams are paid by the Contract Unit Price

Temporary devices will be left in place at Engineer's discretion without a change cost

Georgia Department of Transportation Construction Inspection Training

Construction Erosion Control Inspection

Section 163: Miscellaneous Erosion Control Items

Definition

Retrofit Device: A temporary sediment filter placed in front of an existing or proposed detention pond being used as a temporary sediment basin during the construction of the Project

Materials

- Provide materials shown on plans, including spillways, wood baffles, anti-seep collar, and other accessories
- Materials are the Contractor’s property after removal
- The Engineer approves previously used materials

Construction

- *Silt Control Gates*: If silt control gates are required or are directed by the Engineer, follow these guidelines to construct them:
    - Clear and grade only roadway portion within affected drainage area
    - Construct drainage structure and backfill
    - Install silt control gate at inlet of structure
    - Vary gate height as required as or shown on plans
    - Finish grading roadway in affected drainage area
    - Grass and mulch slopes and ditches that are not paved
    - Construct ditch paving required in affected area
    - Keep gate in place until work is complete and erodible earth is stabilized
    - Remove silt gate assembly by sawing off wood posts flush with concrete apron
    - Leave concrete apron between gate and structure inlet in place

- *Temporary Slope Drains*: Follow these guidelines:
  - Place temporary pipe slope drains with inlets and velocity dissipaters
  - Securely anchor inlet into slope to provide a watertight connection to earth berm
  - Ensure that all connections in pipes are leak proof
  - Place temporary slope drains as shown on Uniform Code System for Erosion and Sediment Control Sheet for temporary items or as directed by the Engineer
  - Keep slope drains in place until permanent grass has grown enough to control erosion
  - Remove slope drains and grass disturbed area with permanent grass
  - Temporary slope drains may remain in place to help establish permanent grass if approved by the Engineer

- *Sediment Basins*:
  - Construct the unit complete as shown, including: (1) grading, (2) drainage, (3) rip rap, (4) spillways, (5) anti-seep collar, (6) temporary mulching and grassing on external slopes,

(7) accessories to complete basin, (8) remove and dispose sediment basin (no longer needed), and (9) mulch and permanently grass disturbed area

- *Baled Straw Erosion Checks*:
  - Construct baled straw erosion checks according to plan details
  - Substitute temporary silt fence Type B with many other options permitted in the specifications

- *Other Temporary Structures*:
  - Plans may show other temporary structures for erosion control with required materials and construction methods
- *Temporary Grass*:
  - Use temporary grass such as rye grass, millet, or a cereal grass
  - Use temporary grass in the following situations:
    - Control erosion where permanent grassing cannot be planted
    - Protect an area for longer than temporary mulch is expected to last (60 days)
    - Use Polyacrylamide (PAM) as stated and required in the specifications
  - Plant temporary grass as follows:
    - Use seeds that conform to Subsection 890.2.01
    - Perform seeding, temporary grass, and lime according to Section 700
    - Prepare areas that require no further grading according to Subsection 700.3.05.A
    - Apply mixed grade fertilizer at 400 lb/acre (450 kg/ha) (Omit Nitrogen)

- *Temporary Mulch*:
  - Apply temporary mulch to control erosion for 60 days or less
  - Use temporary mulch on erodible areas on or off right-of-way as follows:
    - Plant temporary grass on areas stabilized only with temporary mulch
    - Mulch area again after 60 days (mulching and temporary grass required if a period of 60 days has elapsed)
    - Uniformly spread mulch over designated areas 2–4 in. (50–100 mm) thick
    - Walk in mulch by using a tracked vehicle, empty sheepsfoot roller, light disking, or other ways
    - Place temporary mulch on slopes as steep as 2:1 by using a tracked vehicle to imbed mulch into slope
    - Leave mulch in place and plow mulch in soil during seed bed preparation; mulch will become beneficial plant food for newly planted grass
    - Place mulch to protect newly planted grass

- *Miscellaneous Erosion Control Not Shown on Plans*:
  - The Engineer may direct the Contractor to construct temporary devices such as but not limited to: (1) bulkheads, (2) wooden ditch checks, (3) sump holes, (4) half round pipe for use as ditch liners, or (5) UV-resistant plastic sheets to cover cut slopes
  - The Engineer and the Contractor will determine placement to ensure erosion control
- *Diversion Channels*:
  - Construct a diversion channel when building a culvert or other drainage structure in live stream requires diverting a stream
  - Protect the bottom and sides of a channel with plastic sheeting, rip rap, geotextile fabric, or other materials approved by the Engineer

- *Temporary Ditch Checks*:
    - Construct and place temporary ditch checks according to plan details
    - Allow construction of stone plain rip rap
    - Place plastic filter fabric on the ditch section before placing rip rap
    - Allow the temporary ditch check to remain in place until a permanent ditch protection is in place or being installed
    - Allow the temporary one to remain in place to aid in establishing permanent grass in vegetated waterways (if approved by the Engineer)

Temporary ditch shall be cleaned of sediment when half of the height of the ditch is reached (special provisions may direct otherwise)

- *Inlet Sediment Trap*:
    - Inlet sediment traps consist of a temporary device placed around a storm drain inlet to trap sediment
    - An excavated area adjacent to the sediment trap provides additional sediment storage

  - Traps are constructed of Type C silt fence, plastic frame and filter, hay bales, baffle box, or other filtering materials approved by the Engineer
  - Construct inlet sediment traps according to appropriate specification for the material selected for the trap

Payment

- Temporary slope drains are paid by the linear foot (m)
- Temporary grass is paid by the acre
- Temporary mulch is paid by the ton
- Baled straw erosion checks, silt control gates, sediment basins, temporary ditch checks, construction exits, retrofit, and inlet sediment trap are paid by the Contractor Unit Price per each

Related Specifications

Section	Title
109	Measurement and Payment
161	Control of Soil Erosion and Sedimentation
171	Silt Fence
500	Concrete Structures
603	Rip Rap
700	Grassing
715	Bituminous Treated Roving
822	Emulsified Asphalt
860	Lumber and Timber
863	Preservative Treatment of Timber Products
890	Seed and Sod
893	Miscellaneous Planting Materials
	AASHTO M252
	AASHTO M294

Georgia Department of Transportation Construction Inspection Training

Construction Erosion Control Inspection

Section 165: Maintenance of Temporary Erosion and Sedimentation Control Devices

General

- Clean sediment from all temporary erosion control devices (except sediment basins) installed on Project (when half capacity of height, depth, or volume is reached)

> Clean sediment from temporary sediment basins when ⅓ capacity of storage volume is filled

- Handle sediment excavated from erosion of sediment control device by these steps:
  - Remove sediment from immediate area and immediately stabilize
  - Place and mix in roadway embankment, or waste as approved by the Engineer
  - Repair/replace at no cost to the Department any erosion or sediment control devices not functioning properly

Item	Maintenance Notes During Construction
Temporary Silt Fence	• Includes furnishing labor, tools, materials, equipment, and necessary incidentals • Remove and dispose accumulated sediment down to original ground line
Silt Control Gates	• Includes furnishing labor, tools, materials, equipment, and necessary incidentals • Remove and dispose accumulated sediment down to original ground line
Check Dams	• Remove material deposited in sump holes

	• Remove sediment accumulations on fabric by tapping fabric on downstream side or from baled straw by similar means
Temporary Sediment Basins	• Remove sediment from rock filter and restoring rock filter to original specified condition and restore other components to pre-maintenance conditions
Sediment Barrier	• Remove material deposited in sump holes • Remove sediment accumulations on fabric by tapping fabric on downstream side or from baled straw by similar means
Retrofit	• Remove and properly dispose of accumulated sediment in a permanent detention pond being utilized as a temporary sediment basin • Maintain the stone filter by cleaning or replacing
Construction Exit	• Includes additional stone and geotextile fabric to prevent tracking or flow of soil onto public roadways • Includes scarifying existing stone, cleaning existing stone, or placement of additional stone • Clean by scraping and/or brooming
Inlet Sediment Trap	• Includes maintenance required to remove sediment accumulations (filtercake) from material selected to construct inlet sediment trap

Payment

- Temporary silt fence paid by Contractor Unit Price bid per linear ft (m) (Type A, B, or C)
- Sediment barrier, triangular silt barrier, check dams, and silt retention barrier paid by Contractor Unit Price bid per linear ft (m)
- Silt control gates paid by Contractor Unit Price bid per each (Type I, II, III, or IV)
- Temporary sediment basin, retrofit, construction exit, inlet sediment trap, rock filter dams, and stone filter berms paid by Contractor Unit Price bid per each

Section 166: Restoration or Alteration of Lakes and Ponds

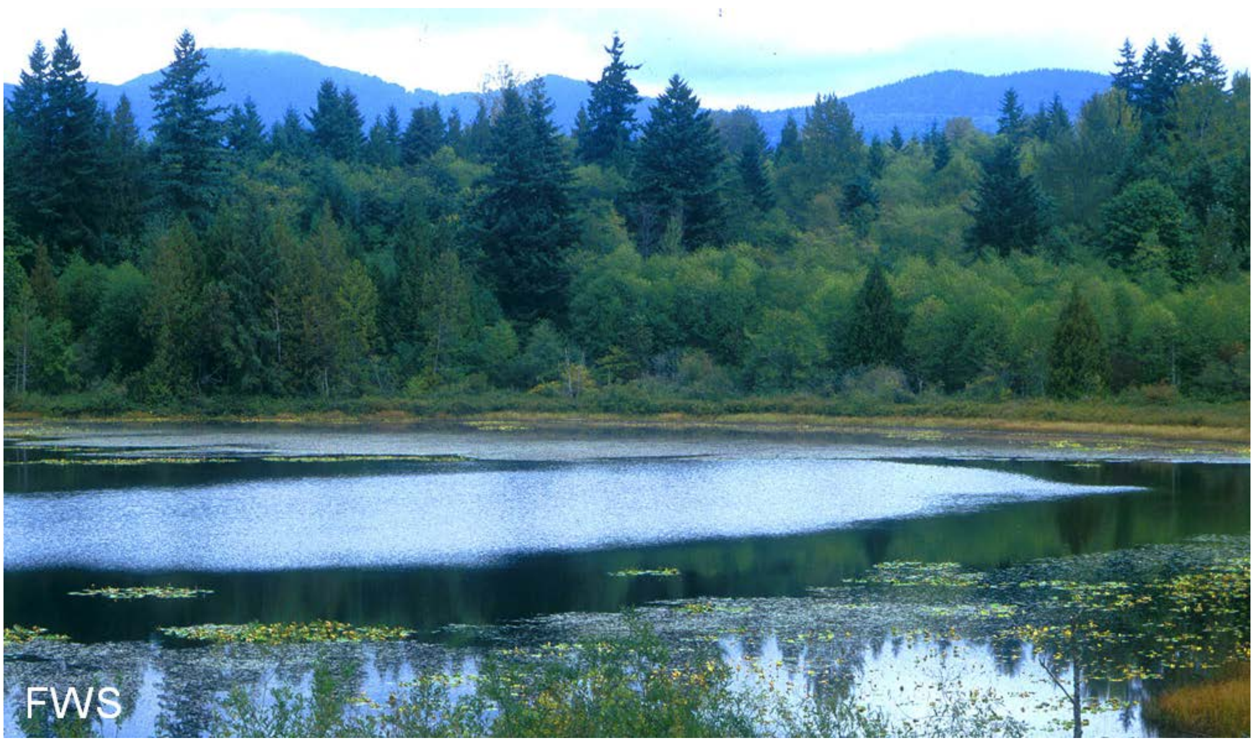
Contractor has responsibility for altering or restoring a lake or pond and adjoining property

Definition

Lake: This term indicates lake or pond regardless of its size or shape

Construction

- Use lake or pond area as a settling basin to contain silt, debris, or other foreign matter during construction
- Only use lakes denoted in the plans in lake restoration
- The Engineer will establish condition of lake and dam and determine existing contours of lake



Restoration of Lakes and Dams

- Remove silt often to avoid polluting downstream area
- Excavate and clean the lake of foreign matter
- Return the lake to its original contour and condition or the proposed contour
- Dispose of material removed in a manner satisfactory to the Engineer
- Grade and grass disturbed areas not under water
- Continue monthly inspections until Notice of Termination (NOT) is submitted

Alteration of Lakes or Ponds

- Work shall include activities to change physical size, shape, or depth of lake
- *Measurement*: Alteration or restoration of a lake is measured by unit
- *Payment*: Contractor Unit Price bid per each or on pro-rata basis of bid amount as work progresses

Restoration of a Lake

Payment

- Ten percent of bid amount paid each time lake or pond is cleaned of silt and debris during the construction period, up to four occurrences
- Remaining amount paid when final cleaning and restoration are complete and accepted

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to the Public

Georgia Department of Transportation Construction Inspection Training

Construction Erosion Control Inspection

Section 167: Water Quality Monitoring

Certified Personnel

- Persons who have successfully completed the appropriate certification course approved by the Georgia Soil and Water Conservation Commission (WECS Certification Course)
- Persons who perform all monitoring, sampling, inspections, and rainfall data collection

General

- Perform inspections, rainfall data collection, sample testing, and reporting results according to requirements in Part IV of the Natural Pollutant Discharge Elimination System (NPDES) Infrastructure permit
- Take samples manually or with automatic samplers, according to permit
- Analyze all according to permit, regardless of the method used to collect samples
- Ensure monitoring results state values of pollutant discharge and are provided through a digital readout of measurements
- Submit bench sheets, work sheets, etc., when using portable turbidimeters
- Perform required inspections and submit required reports within the specified timeframe

Inspections

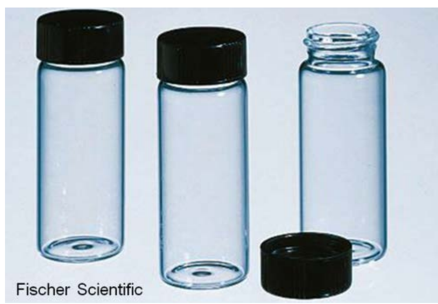
- The Department will provide one copy of the required inspection forms for use and duplication.
  - Inspection forms may change during the Contract
- The Engineer shall inspect the installation and condition of each erosion control device required by the erosion control plan within 7 days after initial installation
- Perform inspection for each stage of construction when new devices are installed
- Document all inspections on the appropriate form provided by the Department, as follows:

Frequency	Inspection
Daily	• Petroleum product storage, usage and handling areas • All locations where vehicles enter/exit site
Weekly and after Rainfall Events	• Rainfall event: 0.5 in. (13 mm) or greater • Inspect disturbed areas not permanently stabilized, material storage areas, structural control measures, and other water quality monitoring locations and equipment • Use EC-1 Form for Best Management Practices (BMP) inspections

Monthly	• Inspect areas where final stabilization has been completed • Look for evidence of sediments or pollutants entering the drainage system or receiving waters • Inspect permanent erosion control devices that remain in place

Inspection Reports

- Summarize results of inspections on the appropriate Daily, Weekly, Monthly, or EC-1 form provided by the Department
- Reports should include:
  - Date(s) of inspection
  - Name of personnel performing inspection
  - Status of devices
  - Observations
  - Action taken
  - Signature of personnel performing inspection
  - Any incidents of noncompliance
- Submit all inspection reports to the Engineer within 24 hours
- The Engineer will review submitted reports and inspect the Project to determine their accuracy
- Correct any items listed in the report requiring routine maintenance within 72 hours of notification



Monitoring Reports

- Submit results to the Engineer within 7 working days of sample date
- Include:
  - Sample date
  - Rainfall amount
  - NTU of sample and analysis method
  - Sample location
  - Water or outfall sample
  - Project number and county
  - Automatic sampler or manually obtained
- Provide monitoring results to the Engineer within 48 hours of analyzing sample

If no qualifying rainfall event occurs prior to submittal of Notice of Termination, submit a report with no samples

Rainfall Data Reports

- Record measurement of rainfall once each 24-hour period
- Measure at the active phase of the construction site
- Rain gauges and those used to trigger automatic samples are emptied after every rainfall event
- Rainfall data supplied by WECS to the Engineer is the official Project rainfall data

Related Specifications

Title
NPDES Infrastructure Permit No. GAR 1000002, Part IV GDOT WECS Seminar
Environmental Protection Divisions Rules and Regulations (Chapter 391-3-26)
Georgia Soil and Water Conservation Commission Certification Level IA Course

Section 170: Silt Retention Barrier

Materials

- Use suitable permeable or impermeable materials
  - Canvas duck, clear or black polyethylene film, or fabric that meets requirements of Type C, temporary silt fence (Section 171)
- Alternate solutions and materials may be used if the Engineer approves
- Use barriers long enough and wide enough to control turbidity

Construction (Floating)

- Confine dredged materials to ponding areas or settlement basins using standpipes or weirs
- Place the barrier approximately 25 ft (7.5 m) outside the affected construction area, and depth within 5 ft (1.5 m) of the bottom
- Place the barrier parallel to the water flow
- Ensure the fabric is permeable
- Vary dimensions and methods to suit conditions and to ensure that silt dispersion is effectively controlled

Construction (Staked)

- Stake or float barriers depending upon current, tides, water depth, and other variables
- Ensure that the fabric:
  - Extends to the bottom of the stream and is weighted
  - Is permeable and not trenched at the bottom
  - Extends 1 ft above normal water from the top of fabric
- Place barrier close to the construction area in smaller streams

Payment

- The Contract Unit Price is paid for each barrier per linear ft (m)

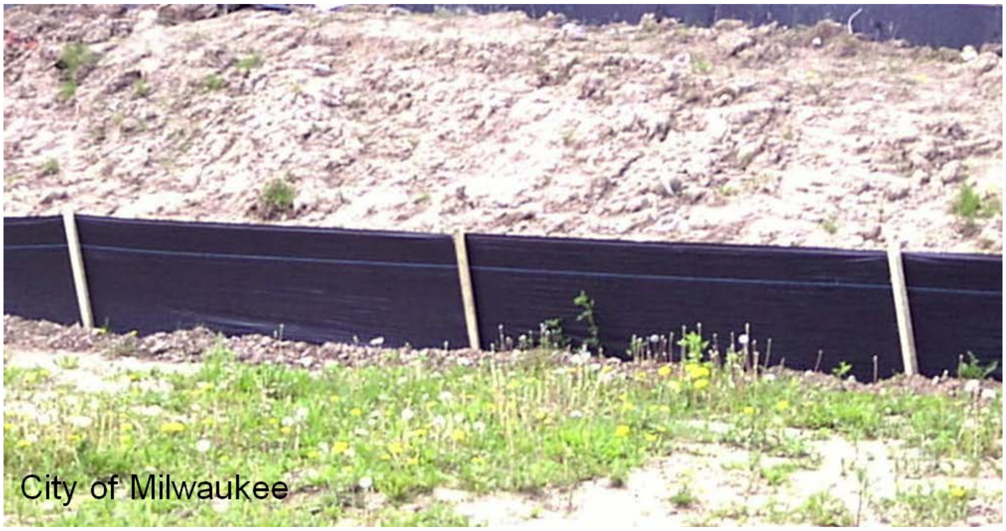
Section 171: Silt Fence

Delivery, Storage, and Handling

- Wrap the fabric in heavy-duty covering that protects cloth from sunlight, dirt, and debris
- Do not expose the fabric to temperatures greater than 140°F
- The Engineer rejects fabric if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage

Excavated Trench Method

- Excavate 4–6 in. (100–150 mm) deep using a trenching machine or motor grader
- Excavate the trench by hand if equipment cannot be operated on site



Soil Slicing Method

- Create a mechanical slice in the soil 8–12 in. (200–300 mm) deep
- Ensure the width of slice is not less than 3 in. (75 mm)
- Mechanically insert the silt fence fabric into the slice in a simultaneous operation

The following items refer to excavated and soil sliced methods:

- Install the first post at the center of the low point
- Space remaining posts a maximum of 6 ft (1.8 m) apart for Types A and B fence and 4 ft (1.2 m) apart for Type C fence
- Bury posts at least 18 in. (450 mm) into the ground
- Secure the posts enough to prevent the fence from overturning from sediment loading if depth cannot be attained
- Evenly space staples or nails with at least five per post for Type A fence and four per post for Type B fence
- Attach fabric to a wood post using at least one additional staple or nail, or to a steel post using wire when pocketed fabric is used
- Allow use of a removed silt fence at other locations if the Engineer approves

Quality Acceptance

- Approved silt fence listed in QPL 36
- The Engineer will reject fabric with defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage

Contractor Warranty and Maintenance

- Maintain the silt fence until the Project is accepted or until the fence is removed
- Remove and dispose of silt accumulations at the silt fence
- Repair or replace any undermined silt fence at no additional cost to the Department

Payment

- Silt fence is paid at the Contract Unit Price bid per linear ft (m)

Related Specifications

Section	Title
700	Grassing
862	Wood Posts and Bracing
881	Fabrics
894	Fencing
	ASTM D 3786
	ASTM D 4355
	ASTM D 4632
	ASTM D 4751

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B-4 Earthwork Training Module

Georgia Department of Transportation Construction Inspection Training

Earthwork Inspection

Section 201: Clearing and Grubbing Right-of-Way

General

- The Contractor will establish right-of-way; construction lines; and trees, shrubs, and plants that should remain per the plans
- Prevent spread of "Introduced Invasive Pest Species" by:
  - Disposing of vegetative parts of plants that reproduce (roots and above ground parts that bear fruit) by burning or burying with minimum 3 ft (1 m) at approved site
  - Engineer must approve other disposal methods per the *GDOT Construction Manual 2-2*
  - Adhere to requirements of Section 155.3.05

Strip grass immediately ahead of grading (*GDOT Construction Manual 8-1*)

Clearing

Clearing includes removing/disposing of fences, bridges, buildings, and other structures within right-of-way.

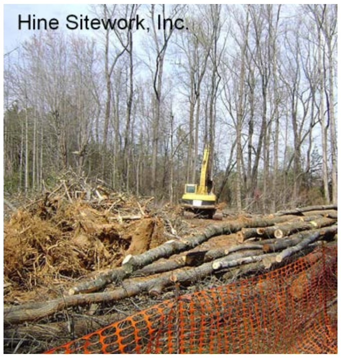
- Choose a method of clearing that prevents damage to property, trees, or retained shrubbery
- Remove stumps as part of the clearing operation
- Cut stumps not grubbed
- Dispose of cleared materials

Required Grubbing Depths for Structures

Structures	Grubbing depth (minimum)
Under Pavements	• 3 ft (1 m) below finished subgrade
Underneath Other Structures	• 3 ft (1 m) below foundation of any proposed structure including guardrail posts and utility poles
Slopes and Shoulders	• 3 ft (1 m) below finished grade and 1 ft (0.3 m) below natural ground outside construction lines
Cracked/Abandoned Concrete Slabs	• Structures within 10 ft (3 m) of finished grade • Break so that no section greater than 10 ft² (1 m²) remains intact

Grubbing procedure:

- Remove stumps and other matter not removed by root rake to a minimum depth of 2 ft (0.6 m) below ground line
- Rake areas with roots to a depth of 6 in. (150 mm) below surface
- Remove other matter (including small roots) by hand
- Backfill stump holes and compact backfill at the density of the surrounding soil
- Use a heavy-duty disc harrow to penetrate the ground at 6 in. (0.15 m) minimum
- Remove matter exposed by harrowing and level with blading equipment
- Leave grubbed areas smooth enough for mowing



Roots for removal include:

- Matted trees and brush roots (regardless of size)
- Individual roots more than 0.75-in. (20 mm) diameter
- Individual roots more than 3 ft (1 m) long regardless of size
- Large quantities of smaller roots present in top 1 ft (0.3 m) of finished subgrade or road surface as determined by the Engineer

Stumps are tree ends with minimum diameter of 4 in. (0.1 m)

Removal and Disposal of Materials

Material	**Inspection Notes**
Merchantable Timber and Buildings	• Department may dispose or allow property owner to remove (prior to Notice to Proceed, *GDOT Construction Manual 1-1*) • Salvaged material becomes the property of the Contractor (unless specified in the plans or Contract)
Combustible	• Abide by federal, state, or local codes when right-of-way is in a burning-restricted area • Allow burning of all material except sawdust piles except when prohibited (if restrictions allow) • Prevent fire from spreading to adjacent areas • Prevent damage to public/private installations within or near right-of-way • Obtain suitable areas for burning/disposing at the Contractor's expense (at the Engineer's approval) • Remove sawdust within construction limits to the approved disposal area • Allow deposit of sawdust on right-of-way in 3-in. (75 mm) maximum layer • Mix sawdust with underlying soil by disking or harrowing
Solid Waste	• Place in an embankment or Department-approved disposal site • The Engineer must approve and record solid waste material used as embankment • The Environmental Protection Division (EPD) of Georgia Department of Natural Resources (GDNR) classifies waste (*GDOT Construction Manual 8-1*)

Non-regulated Solid Waste Material

- Excess soil, rock, brick, concrete (with/without reinforcement), and cured asphalt may be disposed in the right-of-way
- Place common fill (soil, rock, brick, and concrete) in uniform layers of minimum 3 ft (1 m) thick; fill voids with finer material
- Cover the final layer with 2 ft (0.6 m) of soil

Regulated Material

- Dispose of inert waste (organic debris) off the right-of-way
- Dispose of other waste in the construction/demolition municipal landfill
- Dispose oils, solvents, fuels, untreated lead paint residue, and other solid hazardous waste through a properly licensed hazardous waste disposal facility

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to the Public
109	Measurement and Payment
160	Reclamation of Material Pits and Waste Areas
161	Control of Erosion and Sedimentation

Georgia Department of Transportation Construction Inspection Training

Earthwork Inspection

Section 202: Random Clearing and Grubbing

Includes clearing/grubbing borrow pits, material pits, ditch inlets, outlets, channel changes, and easements

Measurement

- Clearing and grubbing is measured in acres (hectares)
- Measure only the area designated on the plans or by the Engineer
- The Department makes no separate payment for removing grass, weeds, debris, small underbrush, other vegetation from cultivated lands, and isolated trees or stumps
  - Include the removal cost in the price bid for other Pay Items

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to the Public

Georgia Department of Transportation Construction Inspection Training

Earthwork Inspection

Section 204: Channel Excavation

Construction

- Coordinate work with grading, construction drainage structures, and performing other Project work
- Maintain adquate drainage until Final Project Acceptance
- Do not deposit material within jurisdictional wetlands
- The Engineer may permit surplus material to be wasted in flushing out slopes of ditch lines, slope stability, and other features
- Do not leave material in unsightly piles
    - Spread in uniform layers, neatly leveled and shaped
- Leave adequate openings in spoil banks to allow adjacent land surfaces to drain
- Apply provisions pertaining to soil erosion and stream pollution

Do not deposit material from channel excavation within 3 ft (1 m) of channel edge

Measurement

- Channel excavation is measured by the method of average ends

Payment

- The Contract Unit Price is paid per cubic yard (meter) per *GDOT Construction Manual 11-1*

Section 205: Roadway Excavation

General Notes

- Includes excavating, hauling, and placing/disposing of materials from within limits of areas designated in Contract
- Temporarily stop excavation operations until directed by the Engineer if artifacts of historical or archaeological signifance are encountered
- Includes ditches (except channels) and filling and/or plugging abandoned wells (dug and drilled)
- Remove paving, aggregates, and ballasts not included in work

Salvaged Materials

- The Department claims salvaged materials unless the Engineer directs that materials be wasted
- Dispose of materials not salvaged
- Stockpile on the Project unless other sites are designated on plans

The Engineer will designate unsuitable materials

Disposal of Surplus Material

- Do not waste excavated material until having satisfied embankment and backfill requirements
- Use suitable material to widen embankments uniformly, flatten fill slopes, or deposit as directed by the Engineer
- Do not leave unsightly material piles
- Do not place waste material on the waste bank edge closer than 10 ft (3 miles) from the top of the cut slope
- Do not deposit waste material within 3 ft (1 m) of the ditch edge

- *Waste Disposal Areas*: When unable to dispose of unsuitable or surplus excavation material on right-of-way, use the following areas:
  - Department-furnished disposal areas shown on plans
  - Other suitable disposal areas not shown on plans
  - Reclamation

General Construction

- Provide adequate openings in spoil banks to allow the adjacent surface to drain
- Cut the surface ditch at the top of cut slopes to carry water from the side hill
- Turn side ditches outward to avoid embankment erosion
- Provide outlets or flumes for roadway ditches when necessary
- Uniformly round the intersection of cut slopes with the natural ground surface
- Dispose of material from slides and overbreaks that occur before Final Acceptance

Construction Item	**Inspection Notes**
Serrated Slopes	• Grade back slope according to Construction Detail • Ensure the first serration is level • Use tilt-control blade dozer to cut steps in alternate directions • Department will not pay additional for serrated slopes
Non-Serrated Slopes	• Leave front and back slopes in roughened condition to provide seed bed for grass

Rock Excavation

- Transition any flattening of cut slope already started when rock is encountered
- Use preslitting to reduce overbreakage and establish free surface or shear place
- Conduct presplitting by drilling appropriately sized holes
- Adhere to Section 107.12 when using explosives, including the submittal of a blasting plan
- Load and stem holes with appropriate light charge explosive
- Detonate explosives simultaneously
- Excavate solid rock and boulders on roadbed at least 1 ft (0.3 m) below finished subgrade
- Backfill excavated space to correct grade with suitable subgrade material
- Remove loose rock on cut slopes immediately after blasting per *GDOT Construction Manual 8-6*

Unsuitable Material Excavation

- Remove material and backfill with properly compacted approved material
- Undercut material to the depth shown on the plans or directed by the Engineer

Final Finishing of Roadway

- Shape the surface of the roadbed and slopes to a reasonably true grade alignment and cross section shown on the plans; finish according to Section 209
- Leave cut slopes in rock reasonably uniform and remove loose overhanging rock
- Open ditches, drains, and culverts constructed to effectively drain roadway
- Maintain excavated areas until final acceptance of Project

Measurement

- Original and final ground surface are measured using conventional methods or photogrammetric means
- Unclassified roadway excavation is computed by method of average end areas, or other means (directed by the Engineer)

Payment

Per *Construction Manual 11-1*:

- Removing paving, aggregates, and ballast are paid at the Contract Price bid per cubic yard (meter)
- The Department withholds a percentage of progress payments for estimated quantity of earthwork (not exceeding 5%) until final dressing, subgrade, and disposal is completed

- Roadway exacavation—unclassified is paid as the Contract Price per cubic yard (meter) and includes: excavating, hauling, placing, compaction, stockpiling, pre-splitting rock, disposal, ditches, subgrades, shoulders, finishing, dressing, and maintaining until Final Acceptance

Related Specifications

Section	**Title**
107	Legal Regulations and Responsibility to the Public
109	Measurement and Payment
411	Asphaltic Concrete Pavement, Partial Removal
610	Removal of Miscellaneous Roadway Items

Earthwork Inspection

Section 206: Borrow Excavation

Submittals

- Fulfill National Historical Preservation Act *GDOT Spec. 106* must be fulfilled
- Approval for environmental considerations and material acceptability required
- Approval for pit investigation, cross sectioning, and staking required

Materials

- Do not use materials containing roots or stumps
- The Engineer must approve borrow excavation materials
- Use selected borrow of Class II B3 or better for subgrade
- Use material within slope stakes or stockpile material for topping roadbed before using borrow areas

Leave borrow pits or waste disposal areas presentable

Construction

- Do not use materials containing roots or stumps
- Prevent water from standing in pits unless directed otherwise by the Engineer
- Machine slope the bottom of the excavated area to smooth surfaces suitable for re-vegetation
- Dispose of material in a manner satisfactory to the Engineer
- Grade boundary slopes of reclaimed areas to 3:1 slope or flatter

Measurement and Payment

Item	Inspection Notes
Measurement	• Borrow pits are measured using the average end method
Payment	• Borrow material is paid at the Contract Price per cubic yard (meter)

Related Specifications

Section	Title
106	Control of Materials
107	Legal Regulations and Responsibility to the Public
160	Reclamation of Material Pits and Waste Areas

Georgia Department of Transportation Construction Inspection Training

Earthwork Inspection

Section 207: Excavation and Backfill for Minor Structures

Construction

- The Engineer determines final structure locations and elevations (plans are approximate)
- The Engineer determines minimum requirements for length and depth of excavation

> Excavate rock or bolder formations at least 1 ft (0.3 m) below bottom of structure

- Backfill with Type I or Type II material to subgrade elevation
- Pipe may be placed incrementally on steep gradients of embankment
- Cut surfaces at structure trenches to prevent damage to the pavement
- Saw pavements to cause the edges to break in straight lines
- Width, depth, and vertical walls of trench meet plan dimensions within 2 in. (50 mm)

Backfill

- Use Type I material in dry structure trenches and Type II material in wet trenches
- Use Type I material as finishing course for Type II material when directed by the Engineer
- Place Type I and Type II materials in layers no more than 6 in. (0.15 m) loose

Material	Compaction
Type I	• 95% of theoretical dry density
Type II	• Satisfactory uniform density as directed by the Engineer

Normal Backfill

- Do not place rock more than 4 in. (0.1 m) in diameter with 2 ft (0.6 m) of drainage structure
- For retaining walls, use pervious material that meets Case I or II:
    - *Case I*: Backfill for retaining walls that support roadbed and parking areas
        - Ensure that the backfill conforms to Section 208
    - *Case II*: Backfill for retaining walls that do not support roadbed and parking areas

Measurement

- Backfill materials (Type I, II, and III) are measured in cubic yards (meters) compacted
- Type III is measured complete in place according to line and grade (uncompacted)
- Lateral measurements are confined to the area bounded by vertical planes lying no more than 1 ft (0.3 m) outside of and parallel to structural limits

Payment

- Type II and III are paid separately by the Department at the Contract Unit Price per cubic yard (meter)
- The Department will not pay for:
    - Excavation of minor structures
    - Excavation of imperfect trench
    - Removal of water

- Excavation and backfill of temporary drainage ditches
- Extra depth excavation

Related Specifications

Section	Title
104	Scope of Work
109	Measurement and Payment
810	Roadway Materials
812	Backfill Materials

Earthwork Inspection

Section 208: Embankments

Use Class I, II, III, V, or VI for embankment material except:

- *Inundated Embankments*:
  - Proposal includes special provision for required gradation
- *Intermittently Inundated Embankments*:
  - Build using any suitable material
- *Embankment at Structures*:
  - Place within 10 ft (3 m) of bridge structure (Class I or II)
  - Ensure rocks are not larger than 3 in. (75 mm) for any dimensions

Benching Excavation for Embankment

- Form benches to increase the bond between the existing ground and proposed embankment
- Require where embankments are placed on hillsides or against existing embankments
- Construct approximately 12 ft (3.7 m) wide unless indicated differently on plans
- Use material removed in during benching operation embankment excavations

Formation

- Deposit material and spread in horizontal layers no more than 8 in. (0.2 m) thick loose measurement
- Keep layers uniform across the cross section
- Compact the layer within the range of optimum moisture content to achieve compaction
- Do not construct successive layers on previous layers that exhibit excessive pumping
- Ensure the moisture content is sufficient for stability and compaction

Construct embankments in parallel layers

Embankment at Structures

- Use Class I or II material for pipes, culverts, arches, and bridges (unless allowed otherwise by the Engineer)
- Place specified material on both sides of the bridge at a minimum distance of 10 ft (3 m)
- Provide sufficient depth of material over and around the structure

Do not place rock larger than 4 in. (0.1 m) diameter within 2 ft (0.6 m) of any drainage structure

Material Handling

Soil Class	Handling Notes
II B3	• Distribute and compact in 8-in. (0.2 m) uniform layers over the embankment width • Use in the top 1 ft (0.3 m) of the roadbed
II B4, V	• Distribute and compact in 8-in. (0.2 m) uniform layers over the embankment width • Do not use in the top 1 ft (0.3 m) of roadbed without adding stabilizing agent
III, IV	• Do not use in embankments unless directed by the plans or the Engineer
VI	• Place rock in uniform layers not over 3 ft (1 m) thick • Distribute to avoid pockets • Fill voids with finer material • Do not use rock larger than 6 in. (0.15 m) in diameter within 3 ft (1 m) of the finished surface

In-Place Embankment

- Use either a hydraulic or conventional dry land construction method
- Obtain material from within construction limits or borrow pits

Embankment Construction Procedure

- Clear and grub the embankment area
- Fill depressions below ground surface and undercut areas with suitable material
- Plow and scarify the entire area upon an area at least 6 in. (0.15 m)
- Re-compact loosened soil to approximate the density of the soil
- Plow or scarify all portions of existing unpaved pavements
- Destroy cleavage planes before placing the embankment

General Embankment Construction

- Use either a hydraulic or conventional dry land construction method
- Allow use of excess material placed outside of prescribed slopes to raise fill
- Dredge material that invades openings or existing channels
- Do not excavate or dredge material within 500 ft (0.15 m) to toe or existing structures
- Construct at the farthest points along the roadway from bridge ends and progress to the end excavation area beyond the slope toe at bridge ends

Final Finishing

- Shape roadbed surface and slopes to true grade and cross sections
- Open ditches, channels, and drainage structures to drain the roadway
- Maintain embankment areas until Final Acceptance of Project

Measurement and* P*ayment

Construction Item	Inspection Notes
Measurement	• Placing embankment is measured using the average end area method • Ground surface is determined by conventional field, photogrammetic, or other methods • Backfill volume is calculated from the cross section on the plans
Payment	• In-place and rock embankments are paid at the Contract Unit Price per cubic yard (meter)

Related Specifications

Section	Title
161	Control of Soil Erosion and Sedimentation
810	Roadway Materials
811	Rock Embankment
813	Pond Sand

Section 209: Subgrade Construction

Subgrade Construction refers to the top 6 in. (0.15 m) or Plan-indicated thickness

Subgrade Construction

- Plow, harrow, and mix the surface of in-place subgrade
- Ensure the subgrade can support construction equipment before placing subsequent layers
- Rework unstable areas of the subgrade to the moisture content providing stability
- Compact using a sheepsfoot roller

Subgrade Stabilization

- Undercut and dispose of subgrade material that is displaced with aggregate or Engineer-selected material
- Leave material off the subgrade in fill sections requiring stabilization
- Incorporate material into existing subgrade to a minimum depth of 6 in. (0.15 m)
- Plow, disk, harrow, blade, and mix with rotary tillers until mixture is uniform
- Finish the stabilized subgrade to plan line, grade, and cross section
- Compact to 100% of maximum laboratory dry density

Shoulder Stabilization

- Spread stabilizer aggregate at the rate and dimensions on the plans
- Mix aggregate with in-place shoulder material at the plan depth

- Compact the area and finish it to plan dimensions
- Prime the stabilized area when paving course is required on the shoulders

Finished Subgrade

- Leave underlying subgrade in cuts and fills low enough to accommodate additional material for stabilization or shoulder stabilization
- Short test sections in curb and gutter areas might be necessary to obtain proper elevation
- Blade the surface to the completed subgrade to a smooth and uniform texture

Measurement and Payment

Item	Measurement	Payment
Subgrade Stabilization	Ton (megagram), cubic yard (meter), or square yard (meter)	Contract Unit Price for cubic yard (meter), per ton (megagram), or per square yard (meter)
Subgrade Material	Cubic yard (meter), ton (megagram), or square yard (meter)	Contract Unit Price per cubic yard (meter), per ton (megagram), or per square yard (meter)
Shoulder Stabilization	Cubic yard (meter) or ton (megagram)	Contact Unit Price per cubic yard (meter), per ton (megagram), or per square yard (meter)

Related Specifications

Section	Title
109	Measurement and Payment
412	Bituminous Prime
803	Stabilizer Aggregate
810	Roadway Materials
815	Graded Aggregate

Section 210: Grading Complete

The Engineer may require the Contractor to remove and replace unsuitable material

Measurement and Payment

Item	Measurement	Payment
Grading Complete	Total	Lump Sum Price bid
Grading Per Mile	Linear miles (kilometers) along centerline	Contract Unit Price per linear mile (kilometer)
Undercut Excavation	Volume of excavation	\$750 per cubic yard (\$9.80 per cubic meter) up to 750 yd^3 (575 m^3)
Shoulder Stabilization	Cubic yard (meter) or ton (megagram)	Contact Unit Price per cubic yard (meter), per ton (megagram), or per square yard (meter)

Section 211: Bridge Excavation and Backfill

Preparation

- Use necessary protection such as cofferdams and sheeting when working in excavations
- Use cofferdams or sheeting to prevent undesirable changes in channels and slopes
- Do not subject the concrete to the action of the water before final setting
- Step the foundation, remove loose fragments, and clean/fill the seams as directed by the Engineer per *GDOT Construction Manual 2-1*

> Provide the Engineer ample opportunity and safe conditions to inspect foundations and measure removed materials

Construction

- Do not place concrete or close the foundation areas from view until the area has been approved
- Bore the foundations in the Engineer's presence per *GDOT Construction Manual 2-1*
- Bore at least 6 ft (1.8 m) deep in rock and 10 ft (3 m) deep in other materials

- Backfill ProcedurePlace backfill in layers not exceeding 1 ft (0.3 m) of loose material
- Backfill around substructures except when located in banks of stream
- Place backfill material to apply only balanced horizontal loads to newly placed structure
- Do not backfill portions of structures that do not have backfill on all sides until the concrete has reached the required strength

Compact layers before placing the next layer

Bents and Piers

- Complete backfilling around substructures not supported by piling on the next workday after placing the lift
- Backfill at least 3 calendar days after placement
- Backfill the footings before beginning form work on the columns
- Backfill around the pile-supported footings and columns after removing the forms
- Complete backfilling within 5 calendar days after placing the concrete

Measurement

- Bridge excavation is measured in cubic yards (meters)
- Each portion of a stepped footing is considered a separate footing

Payment

- The Department will pay for eligible excavation down to 2 ft (0.6 m) below plan foundation elevation at the Contract Price for bridge excavation. There are also payments available for 2 ft through 6 ft, 6 ft through 10 ft, and greater than 10 ft
- Bridge excavation, grade separation, stream crossing, and porous backfill are paid at the Contract Unit Price per cubic yard (meters)

Related Specifications

Section	Title
500	Concrete Structures
525	Cofferdams
540	Removal of Existing Bridge

Section 212: Granular Embankment

Ensure granular material meets Class I A2 soil:

Percent passing No. 200	0–18
Percent Clay	1–10

Construction

- Place embankment at location(s) shown on plans
- The Engineer must approve lift thickness and compaction

Measurement

- Granular embankment is measured by volume in hauling vehicle for pits
    - Weight of material delivered from quarry is converted to volume based on dry loose unit weight
- Average end area is also an approved method

Payment: Granular embankment is paid at Contract Price per cubic yard (meter)

Georgia Department of Transportation Construction Inspection Training

Earthwork Inspection

Section 215: Removal of Solid Waste

Material

- Soil materials used to cover exposed area of removal site may be any noncontaminated earth material approved by the Engineer

> The Contractor must submit a report of disposal from the municipal solid waste landfill to the Engineer

Construction

- Provide engineering and work practice controls to protect employee health and safety
- Give Engineering 2 weeks' notice before removing solid waste
- The Engineer notifies the local governing authority of the proposed work and time schedule
- Excavate to the full depth and width of cut in one continuous operation, leaving minimum exposed surface

- Leave the working faces of the cut near the vertical-slope of soil to safely place the layer over the exposed area in an effort to stabilize the soil.
- Transport solid waste to a permitted municipal solid waste landfill
- Fill the trucks hauling material from the removal site to less than full capacity to prevent spills

- Cover the truck body with waterproof tarpaulin
- Cover exposed areas of removal with a 6-in. (0.15 m) layer of clean earth

Report solid waste discoveries during construction to the Engineer

Odor Control

- The Engineer will cooperate with the local governing authority to determine acceptability of an odor-control chemical
- Keep available a 3-day supply (minimum) of odor-control chemical

M.D. Nursery and Landscaping, Inc.

Measurement

- Removing solid waste from sites shown on plans is measured by cubic yard (meter)
- Volume of material measured for payment is based on cross section measurements using average end area

Payment

- Solid waste removal shown on plans is paid at the Contract Unit Price bid per cubic yard (meter)

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to Public
109	Measurement and Payment

Earthwork Inspection

Section 216: Unpaved Shoulders

Construction

- Shape and compact shoulders in sequence as required for the type of base or pavement
- Repair damage to existing base, surface, or pavement due to shoulder construction
- Compact the shoulder area above subgrade elevations that require grassing or sodding to a firm and stable condition (determined by the Engineer)

Repair areas of excessive erosion to prevent damage to adjacent base or pavement

Maintenance

- Cut weep holes through shoulders constructed prior to flexible bases to prevent impoundment of water on the roadbed or subgrade
- Provide adequate temporary drainage facilities to prevent excessive erosion when the front slopes are subject to concentrated water at weep holes
- Repair and dress adjacent slopes and remove excess material from adjacent ditches when shaping, dressing, and compacting shoulders

Construction Sequence

1) Portland Cement Concrete Bases and Pavements	• Construct, shape, and compact shoulders when curing period is complete on each section
2) Hot Mix Asphalt Concrete Pavement	• Construct shoulders adjacent to hot mix asphaltic concrete pavement
3) Flexible Bases or Pavements	• Place loose shoulder material outside of proposed edge of base or pavement • Use blade grader to pull up shoulder • Use the same number of courses for shoulders, base, or pavement
4) Stabilized Shoulders	• Add stabilizer according to Specifications pertaining to each item
5) Shoulders Constructed with Base Material	• Place and construct shoulder material in the same way as base material
6) Shoulders Constructed under Traffic	• Do not remove existing shoulders or portions of existing shoulders more than 1500 ft (450 m) ahead of paving operations

Measurement

- Shoulders constructed with selected material are measured in cubic yards (meters), loose volume, in vehicles when dumping

Payment

- Roadbed material is paid at the Contract Unit Price per cubic yard (meter)
- Select shoulder material is paid at the Contract Unit Price per cubic yard (meter) or square yard (meter) of specified thickness

Related Specifications

Section	**Title**
106	Control of Materials
817	Shoulder Material

Section 217: Removal of Underground Storage Tanks

Underground tanks include:

- Farm or residential tanks of 1100 gal (4160 L) or less capacity used for storing motor fuel for noncommercial uses
- Tanks used for storing heating oil for consumptive use of premises
- Pipeline facilities

See Specifications 217.01 for more information

Preparation

- Notify the Engineer (in writing) 2 weeks before working on the Underground Storage Tank (UST)
- The Engineer will inspect work with the Office of Materials and Research and District's UST Tank Pull Inspector

> Avoid spilling the contents of the tank and handle or transport the tank to the permitted disposal area

Construction

- The Contractor assumes liability for improperly removing and disposing of UST system
- Immediately contain spills and remove/dispose of contaminated soil
- Dispose of the tank, contents, and contaminated soils according to EPD
- Take soil samples (EPD required) after the tank is removed
- Submit soil samples to a laboratory approved by the Engineer for testing
- Place compact backfill material for tank pit areas within construction limits

Contamination Note: If the tank pit is visually contaminated, remove soils at a maximum of 4 ft (1.2 m) deep per *GDOT Construction Manual 8-1*

Measurement

- Removal of underground storage tanks is measured on a per each basis

Payment

- Removal of underground storage tanks is paid at the Contract Unit Price per each
- See Specifications 217.5B (Discovery during Construction) and 217.5C (Over-excavation of Contaminated Soils)

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to the Public
109	Measurement and Payment

Other Documents

Georgia EPD Rules (Chapter 391-3-15)

EPA Regulation 40 CFR Part 280

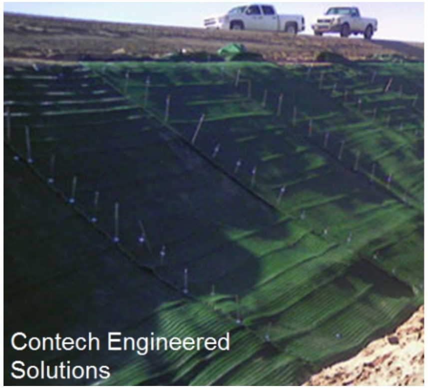
American Petroleum Institute's Recommended Practice 1604 (API 1604)

Earthwork Inspection

Section 218: Blanket for Fill Slopes

Construction

- Remove vegetation, roots, trash, or materials that hinder preparation of bed for grassing
- Place soil shortly before and in conjunction with grassing operations
- Replace material lost from erosion



Measurement

- Material is measured in cubic yards (meters), loose measure, in vehicles at dumping point

Payment

- Blanket for fill slopes is paid per cubic yard (meter)

Section 221: Special Subgrade Compaction and Test Rolling

Includes rolling subgrades using a special roller and repairing weak places discovered during rolling

This work includes:

- Test rolling and performing final compaction and preparation of finished subgrade using special rolling and compaction equipment
- Replacing or repairing weak areas that develop in the finished subgrade from manipulating the test rolling equipment
- Continuing test rolling to compact the repaired areas until the subgrade is firm
- Protect culverts and bridges from damage

Equipment Note

- Use a pneumatic-tired roller with asingle-axle base, 4 wheels, gross weight 35–50 tons (31–45 Mg), free rocking/oscillating wheels, no more than 10 ft (3 m) overall width, maximum turning radius of 15 ft (4.5 m)

Preparation

- Prepare the surface to be test rolled to the proper grade and cross section
- Ensure the top 8 in. (0.2 m) of the surface is within 3 percentage points of the optimum moisture content

Construction

Item	**Notes**
Subgrade Preparation	• Stabilize in specified areas before test rolling
Extent of Rolling	• Test roll on all portions of subgrade under base, subbase, or pavement plus 2 ft (0.6 m) width on each side • Roll frontage roads, spur connections, crossovers, and intersections • Test roll parallel to the centerline with roller speed 2–5 mph (3–8 kph) • Progress uniformly toward the center section until passing over the entire surface twice • Roll the entire width in half-day segments of work • Stop rolling during extreme moisture • Add water if the subgrade moisture content is deficient • The Engineer will mark the extent of weak areas and depressions during rolling
Repairs to Subgrade	• Remove unsatisfactory materials and strengthen or stabilize materials in place • The Engineer will decide which repairs to make • Place and compact materials in the roadbed for embankment or subgrade • Test roll after making repairs until the area is satisfactory per the specifications
Test Rolling at Structures	• Prevent damage to structures during rolling • Do not allow rolling within 10 ft (3 m) of bridge ends and approach slabs • For culverts less than 4-ft (1.2 m) vertical distance from the surface, do not allow rolling within 10 ft (3 m) of the culvert

Measurement

- Test rolling is measured in miles (km) along center of road

Payment

- Special subgrade compaction and test rolling are paid at Unit Price bid per mile (km)
- Repairs to subgrade compaction and test rolling are paid per mile (km)

Earthwork References

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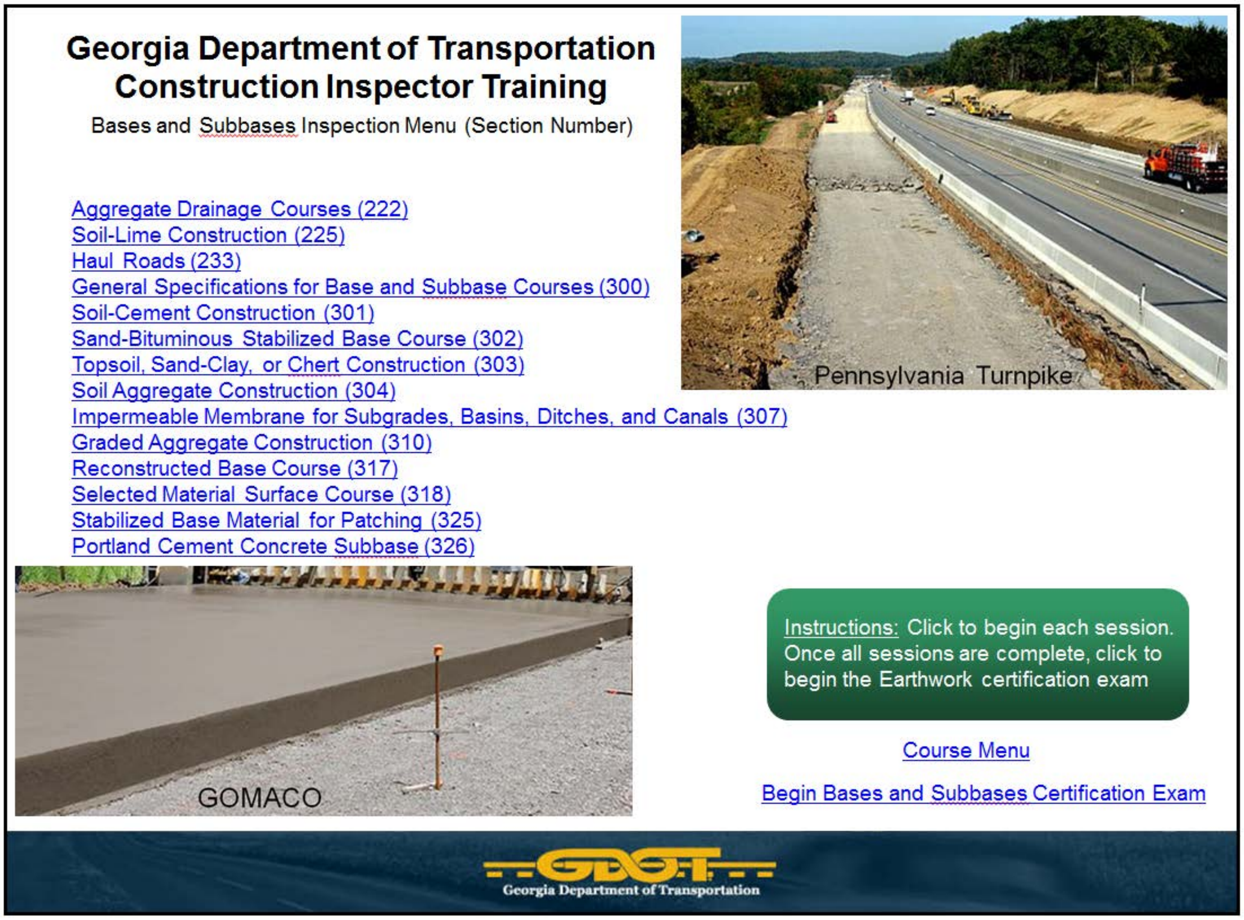
B-5 Bases and Subbases Training Module



Section 222: Aggregate Drainage Courses

Embankment or Subgrades

- Spread a uniform layer of coarse or fine aggregate without segregation and compact to specifications
- Use hauling and spreading equipment approved by the Engineer
- Use trucks for end-dumping and bulldozers/road machines for spreading on wet and unstable areas

Construction

- Construct the roadbed according to lines, grades, and typical cross sections shown on the plans
- Use coarse aggregate, drainage course, and drainage blanket as follows:

Aggregate Drainage Course	Use
Type I	Trench around a pipe or in a shoulder in conjunction with a trench
Type II	Drainage blanket under sidewalks, curbs, gutters, and beneath pavement system or shoulders
Type III	Drainage blanket material as indicated on the plans

Embankments or Subgrades

- Spread material uniformly to a maximum 6-in. (150 mm) thickness
- *Compaction*: Begin rolling on the outer edge of the drainage course and progress toward the center
- *Super-elevated Compaction*: Begin rolling on the lower edge and progress toward the higher
- Compact the final layer with a steel-wheeled roller or vibratory roller

Roll until surfaces or each layer are uniformly compacted

Other Surfaces

- Excavate/trench low areas for positive drainage before placing drainage material
- Spread and compact material as required (until stable)

Payment

- Aggregate drainage course is paid at the Contract Unit Price per ton (megagram) or per cubic yard (meter)

Related Specifications

Section	Title
109	Measurement and Payment
208	Embankments
209	Subgrade Construction
806	Aggregate for Drainage

Section 225: Soil-Lime Construction

Stabilization Materials Information

Material Type	Construction Information
Soil	• Consist of materials found in roadbed, base, subbase, or added materials as directed by the Engineer • Remove from soil: Particles of aggregate too large to pass through 3-in. (75 mm) sieve, roots, stumps, grass turfs, and other vegetable matter
Water	• Without detrimental quantities of oil, salt, acid, or alkalis • Provide test results of nonpotable water to the Engineer prior to use
Lime	• Application rate determined from the laboratory test and provided to the Contractor
Bituminous Prime	• Use prime and blotter material consisting of cutback asphalt of the specified grade

Equipment

- Use mechanical spreaders capable of uniformly distributing bulk lime or slurry to the actual application rate as shown in the plans
- Do not distribute dry lime by pneumatic pressure
- Use rotary-type soil mixers capable of mixing to a 12-in. (300 mm) minimum depth
- Use a type and weight of equipment that will not damage lime-treated soil
- Do not begin construction until the Engineer has approved the proposed equipment

Preparation for Soil-Lime Construction

- Grade/shape the underlying foundation to the required lines, grades, and cross section
- Compact the foundation to the required density
- Dry the foundation, if necessary
- Ensure the foundation can support the construction and compaction equipment
- Stabilize soft or yielding material
- Scarify and partially pulverize each layer of material to be treated
- Remove all detrimental material from the soil

Test Section

- Test the first section of each mixing operation
- Length is the required length to use all the lime of one truck
- If necessary, change equipment, methods, or initial grade elevations based on the test section results

Lime Application

- Apply uniformly so the quantity applied does not vary more than ±10% of the specified quantity
- Apply lime only to areas that are mixed in 1 day
- Do not mix lime with frozen soils or with soils containing frost
- Perform only when air temperature is above 45°F (7°C) and only between April 1 and October 15, unless the Engineer directs otherwise
- Incorporate the material into the soil with mixing equipment
- If necessary, add more water to the mix to accelerate mellowing
- Spread lime on scarified areas at a specific rate
- Distribute material uniformly to avoid excessive loss

Lime application rate is determined by the Engineer

Stabilization Methods

Method	Construction Information
Dry Application with Quicklime	• Adjust the design application rate of hydrated lime for quicklime properties • Do not apply if wind conditions could make blowing lime hazardous for traffic, workers, or adjacent property • Minimize lime pockets by applying to relatively smooth shaped and rolled areas
Slurry of Hydrated Lime	• Create lime slurry by mixing 30% dry lime solids by weight with 70% water • Mix slurry in agitating equipment, and continue to agitate until arriving at the roadbed • Spread slurry on the scarified area with the distributing equipment
Slurry by Slaking Quicklime	• Create lime slurry by slaking quicklime using special equipment at/near Project site • Obtain the Engineer's approval for equipment and procedures

Mix Lime Procedure

- Maintain the moisture content of material at the `specified optimum or not more than 5% over optimum at all times
- Add water during mixing, if necessary
- Incorporate lime and water with rotary mixers until uniform
- Reshape treated course to the approximate line, grade, and typical section
- Seal with a light, pneumatic-tired roller and other approved equipment
- *Mellow Time*: 12–72 hours

Curing Lime

- Keep lime moist for 7 days after lime-treated soil is finished
- Apply bituminous prime material to protect lime-stabilized base, subbase, or shoulder course
- Apply prime as soon as possible—no later than 24 hours after completing finishing operations (unless delayed by wet weather)
- Remove loose and extraneous material on the lime-treated soil surface

Finishing

- Completed lime-stabilized surface layer conforms to lines, grades, and cross sections
- Ensure the layer meets the following requirements:
    - Uniform lime mixture
    - Smooth
    - Dense
    - Well-bonded

- Unyielding
- Free of cracks or loose material

Payment

- Soil-lime material is paid at the Contract Price per square yard (meter) or per cubic yard (meter)
- Soil-lime–treated roadbed base and subbase course is paid at the Contract Price per square yard (meter)
- Pre-mixed soil-lime–treated base and subbase course is paid at the Contract Price per ton (megagram) or square yard (meter)
- Lime is paid at the Contract Price per ton (megagram)

Related Specifications

Section	Title
109	Measurement and Payment
205	Roadway Excavation
209	Subgrade Construction
301	Soil-Cement Construction
412	Bituminous Prime
810	Roadway Materials
814	Soil Base Materials
821	Cutback Asphalt
880	Water
882	Lime

Bases and Subbases Inspection

Section 233: Haul Roads

Haul Roads: Routes used for transporting materials to a Project

General

- Maintain the haul road to the Engineer's satisfaction during hauling
- The Department will determine sources of local materials and commercially produced aggregates for haul roads
- Restore the haul road to a condition equal to what existed before operations started

Related Specifications

Section	Title
109	Measurement and Payment
209	Subgrade Construction
317	Reconstructed Base Course
400	Hot Mix Asphalt Concrete Construction
412	Bituminous Prime
413	Bituminous Tack Coat
424	Bituminous Surface Treatment

Section 300: General Specifications for Base and Subbase Courses

Central Mix Plants

- Check all scales with standard weights for accuracy before the mixture is delivered to the site
- Scales must be accurate within 0.5% of the measured load
- Equip each plant with an approved mixer
- Mix the substance until a homogeneous and uniform mixture is present
- Proportion water by weight (use spray bars to evenly distribute through the mixture)
- Use sampling equipment approved by the Engineer
- Allow use of multiple-pass mixers or traveling-plant mixers (in-place)

Static Rollers

Roller	Information
Trench	• Use at least one for base widening • Must have a guiding roller or wheel that operates in tandem with the compression roller • Must be equipped with an auxiliary wheel or roller • Must compact a minimum width of 15 in. (375 mm)
Steel-Wheeled	• Use 3-wheel or tandem wheels • Use self-propelled rollers equipped with cleaning devices • Have a minimum weight of 10 tons (9 Mg)
Pneumatic Tire	• Must have a minimum contact pressure of 50 psi (345 kPa) • Equip rollers to uniformly distribute loads between all wheels • Operate between 3 and 8 mph (5–13 kph)
Sheepsfoot	• Use vibratory or static compaction rollers of sufficient size and weight to obtain desired compaction

Preparation

- Remove grass, weeds, roots, and other debris from local material pits
- Repair all defective portions of the subgrade before construction
- Prepare the subbase to the requirements of the surface and compaction
- Ensure it is stable enough to support equipment placed on base material without rutting or pumping

Construction

- Mine all the material pits' boundaries and grid depths that are established by the Engineer
- Mine the materials from the top to the bottom
- Mix the material in the pit before hauling it to the roadbed or plant
- Place the materials in windrows or stockpiles with a dragline or backhoe

Placing Materials

- *Mixture Control*: The Engineer will determine proportions of materials needed to compound the base or subbase
- *Moisture Control*: Add water uniformly, allow it to evaporate or aerate, and roll materials often to control moisture content within the limits specified
- *Number of Courses*: Maximum thickness of base or subbase material is subject to the Engineer's approval
- *Widening Work*: Excavate an area that can be completed in the same day
- *Compaction*: Compact the entire thickness of all bases and subbases to the specified maximum dry weight per cubic ft (m)

Base and Subbase courses are paid in accordance with the Specification Section for each item

Related Specifications

Section	Title
106	Control of Materials
107	Legal Regulation and Responsibility to the Public
109	Measurement and Payment
150	Traffic Control
152	Field Laboratory Building
160	Reclamation of Material Pits and Waste Areas
205	Roadway Excavation
206	Borrow Excavation
209	Subgrade Construction
412	Bituminous Prime
831	Admixtures

Section 301: Soil-Cement Construction

The Contractor must submit a construction work plan to the Engineer for approval before construction begins

Construction Requirements

- Mix and place cement-treated base or subbase only when the weather permits the course to be finished without interruption in the specified time (air temperature above 40°F)
- Mix and place materials only when the moisture content of the soil meets the specifications
- Ensure that soil temperature is above 50°F
- Provide equipment in good working condition that can allow continuous prosecution of the work

Category	Information
Soil	• Place and spread additional soil uniformly to the proper depth and thickness
Pulverization	• Loosen roadbed materials to the width and depth to be stabilized without disturbing the underlying subgrade • Add water to assist, if necessary • Remove all roots, sod, and rocks that exceed 3 in. in diameter
Cement	• Uniformly spread the required amount with a cyclone-type mechanical spreader or equivalent • Apply on days when the wind will not interfere with spreading • Pass only the spreading and mixing equipment over the spread cement
Mixing	• Uniformly windrow the aterial if required by the mixing plant • Begin as soon as possible after the cement is spread • Mix until a homogeneous and uniform mixture is produced

Moisture Control

- Ensure uniform moisture content of the mixture is 100–120% of the `optimum moisture content
- Cease operations and make adjustments to bring the moisture content within tolerance
- Do not use materials that “pump” under the construction traffic

Additional Compaction Requirements

- Compact the soil-cement base, subbase, or shoulder to 98% maximum dry density
- Do not perform vibratory compaction on materials more than 1.5 hours old
- Uniformly compact the mixture and fine-grade surface to the desired line, grade, and cross section
- Remove loosened material accumulated during this process
- Use a pneumatic-tired roller to finish the surface until the surface is smooth, closely knit, free from cracks, and conforms to the proper grade line and cross section

Opening to Traffic: No traffic or equipment is permitted to operate on finished base, subbase, or shoulders until the prime has hardened enough to not pick up under traffic

Payment

Item	Payment Method
Soil-Cement Material	Contract Price per cubic yard (meter)
Soil-Cement Stabilized Base, Subbase, and Shoulder Course	Contract Price per cubic yard (meter)
Pre-mixed Soil-Cement Stabilized Base, Subbase, and Shoulder Course	Contract Price per ton (megagram) or square yard (meter)
Portland Cement	Contract Price per ton (megagram)
Fly Ash and Slag	Contract Price per ton (megagram)

Related Specifications

Section	Title
109	Measurement and Payment
205	Roadway Excavation
300	Subgrade Construction
412	Bituminous Prime
814	Soil Base Materials
821	Cutback Asphalt
830	Portland Cement
831	Admixtures
880	Water

Bases and Subbases Inspection

Section 302: Sand-Bituminous Stabilized Base Course

General Construction

- The Engineer determines the suitability of existing roadbed materials for inclusion in the base course
- Do not apply bituminous materials when the air temperature is less than 60°F in the shade or when the subgrade, subbase, or soil is below 50°F
- Remove roots, sod, or rock more than 3 in. (75 mm) in diameter and all other harmful materials from the roadbed

- Blend new materials with the prepared roadbed before adding bituminous material
- Place additional new soil (sand) on the roadbed and spread uniformly to the proper depth and thickness of the compacted base course
- Place materials only on dry, unfrozen subgrade or subbase

Loosen and pulverize material to be stabilized without disturbing the underlying subgrade or subbase

- Add water to the mixture using accurate gauging devices
- Ensure that the moisture is uniformly distributed
- The Engineer will determine the quantity of bituminous material required

Mixing

- Shape the base to the line, grade, and cross section indicated in the plans
- Begin aeration as soon as the prepared base is long enough to permit equipment operation
- Loosen and turn the mixture with harrows, blades, or equivalent until the volatile solvents and water evaporate and the mixture is tacky
- Spread to a maximum compacted lift thickness of 8 in. (200 mm)
- Lay a maximum lift thickness for which the specified compaction is obtained

Compacting and Finishing

Construction Type	Information
Single-Course and Multiple-Course	• Shape course line, grade, and cross section • Roll the surface with a pneumatic-tired roller followed by a steel-wheeled roller to seal the surface • Begin rolling at the edges and work toward the center
Irregular Areas	• Compact areas inaccessible to a roller by using mechanical tampers approved by the Engineer

Payment

Item	Payment Method
Base Course Material	Contract Unit Price per cubic yard (meter)
Sand-Bituminous Stabilized Base Course	Contract Unit Price per square yard (meter)
Sand-Bituminous Stabilized Base Course Pre-Mixed	Contract Unit Price per ton (megagram) or per square yard (meter)
Bituminous Material	Contract Unit Price per gallon (liter)

Related Specifications

Section	Title
105	Control of Work
109	Measurement and Payment
400	Hot Mix Asphaltic Concrete Construction
412	Bituminous Prime
814	Soil Base Materials
821	Cutback Asphalt
822	Emulsified Asphalt
823	Cutback Asphalt Emulsion

Georgia Department of Transportation Construction Inspection Training

Bases and Subbases Inspection

Section 303: Topsoil, Sand-Clay, or Chert Construction

Materials

- *Roadbed*: Use or remove and replace with approved materials as directed by the Engineer
- Handle and place materials carefully to prevent separation of fine and coarse materials
- Spread multiple materials in separate layers to the proper depth
- Place proper proportions of required ingredients on the roadbed and distribute uniformly

Spreading, Mixing, and Stabilizing Base, Subbase, or Shoulder Course

- Spread material lengthwise up to 2500 ft (750 m) on the roadbed—place additional material as the Engineer requires
- Mix material by one of these methods: Plowing, harrowing, blading, or traveling plant
- Spread stabilized aggregate uniformly, if specified in the Contract or plans
- Remix and reshape all sections of the course as needed

Compacting and Finishing a Base, Subbase, or Shoulder Course

- Ensure moisture content is uniformly distributed within 90–120% optimum
- Compact in two courses of equal thickness if the initial thickness is more than 8 in. (200 mm)
- Roll until the course is uniformly compacted to 100% maximum dry density

Complete all courses of any section of construction started in the same day

Payment

Item	Payment Method
Topsoil, Sand-Clay, or Chert Base, Subbase, and Shoulder Course	Contract Unit Price per cubic yard (meter) or per square yard (meter)
Stabilizer Aggregate	Contract Unit Price per ton (megagram)

Related Specifications

Section	Title
106	Control of Materials
202	Random Clearing and Grubbing
205	Roadway Excavation
206	Borrow Excavation
412	Bituminous Prime
803	Stabilizer Aggregate
814	Soil Base Materials
821	Cutback Asphalt
823	Cutback Asphalt Emulsion

Bases and Subbases Inspection

Section 304: Soil Aggregate Construction

Steps for spreading and mixing base, subbase, or shoulder course:

- Uniformly spread the material with an approved mechanical spreader to obtain the desired thickness
- Plow, harrow, and blade the material to full depth without disturbing underlying courses
- Harrow and disc harrow the material
- Plow alternately at edges and center, back and forth, as many times as necessary

Compact and finish surface to 98% maximum dry density

Thickness Tolerances

- Requirements apply to shoulder construction where the plans specify a uniform thickness

Maintenance

- The Contractor maintains the course until the Engineer determines that it has cured sufficiently and is ready to prime

Payment

Item	Payment Method
Soil Aggregate Base Course	Contract Unit Price per square yard (meter)
Soil Mortar	Contract Unit Price per cubic yard (meter)

Related Specifications

Section	Title
105	Control of Work
109	Measurement and Payment
412	Bituminous Prime
816	Soil Aggregate Bases

Section 307: Impermeable Membrane for Subgrades, Basins, Ditches, and Canals

Use the following to construct a waterproofing layer (impermeable membrane):

- Cross-laminated, high-density polyethylene film
- Flexible, self-adhesive, rubberized asphalt

Placement

- Place the membrane on a soil blanket or cushion at least 6 in. (150 mm) thick
- Ensure the membrane contains material fine enough to pass a No. 10 (2 mm) sieve
- Ensure the membrane is at least 4 ft (1.2 m) wide
- Protect the membrane from damage at all times
- Remove and replace sections damaged by sunlight, heat, sharp objects, or other sources

Remove and replace sections damaged by sunlight, heat, sharp objects, or other sources

Payment

- Impermeable membrane for subgrades, basins, ditches, and canals is paid by the Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
888	Waterproofing Membrane Materials

Georgia Department of Transportation Construction Inspection Training

Bases and Subbases Inspection

Section 310: Graded Aggregate Construction

Material Placement

- Use the central plant mix method unless producing aggregates
- Proportion aggregate and water into a homogeneous and uniform mixture when mixing
- Uniformly spread materials to the proper depth with a mixture spreader
- Do not use materials containing frost or frozen particles
- Construct lifts in a maximum thickness of 8 in. (200 mm) compacted

Do not use materials containing frost or frozen particles

Material Compaction

- Ensure the moisture content of materials is uniformly distributed and allows compaction to the specified density
- Uniformly compact the course after shaping the spread material to line, grade, and cross section
- Ensure the compacted base is sufficiently stable to support the construction equipment without pumping

- Dry and rework the underlying subgrade, if necessary
- Finish the subbase surface for portland cement concrete pavement or asphaltic concrete pavement with automatically controlled screed equipment
- Maintain the course until the Engineer determines it has cured sufficiently and is ready to prime

Payment

- Graded aggregate base, subbase, or shoulder course are paid at the Contract Unit Price per ton (megagram)

Related Specifications

Section	Title
105	Control of Work
412	Bituminous Prime
815	Graded Aggregate
821	Cutback Asphalt
823	Cutback Asphalt Emulsion

Bases and Subbases Inspection

Section 317: Reconstructed Base Course

This section includes:

- Reshaping the existing road surface
- Adding the required amount of new material
- Compacting materials to form the foundation course for other base courses, surface courses, or pavements
- Constructing base courses according to the specifications

Methods

- Remove and replace unsuitable material with approved material
- Remove and stockpile the existing base
- Scarify the upper surface of the finished base course to a uniform depth

- Eliminate all depressions and irregularites
- Shape the subgrade or remaining material as directed to add material
- Place stockpiled material, along with any additional new material, on the roadbed
- Thoroughly mix the old and new base course according to requirements
- Compact and finish according to specifications for the type of base being reconstructed

Payment

- Removed and stockpiled material and replaced base material are paid by the Contract Unit Price per cubic yard (meter)
- Base preparation is paid by the Contract Unit Price per mile (kilometer) or per square yard (meter)

Related Specifications

Section	**Title**
109	Measurement and Payment
412	Bituminous Prime

Section 318: Selected Material Surface Course

Material Specifications

Material	Description
Satisfactory	Use in-place roadbed or driveway material when determined to be acceptable by the Engineer
Unsuitable	Remove roadbed materials unsuitable for use as determined by the Engineer
Additional	Use materials approved by the Engineer to add materials to those in the roadbed or to build up the surface course entirely

Maintain the finished surface course to the required cross section until the Project is complete and accepted

Methods

- Spread selected material by the approved method to the thickness prescribed on the plans
- Scarify, mix, and shape the selected material to the required cross section
- Roll until the surface is thoroughly compacted, firm, and unyielding
- Add water to assist with scarifying and compaction

Payment

Item	Payment Method
Selected Material Course Surface	Contract Unit Price per cubic yard (meter)
In-Place Selected Material Surface Course	Contract Unit Price per square yard (meter)
Stabilizer Aggregate	Contract Unit Price per ton (megagram)
Aggregate Surface Course	Contract Unit Price per ton (megagram)

Related Specifications

Section	Title
205	Roadway Excavation
800	Coarse Aggregate
803	Stabilizer Aggregate
814	Soil Base Materials
815	Graded Aggregate

Bases and Subbases Inspection

Section 325: Stabilized Base Material for Patching

General Description

Work includes patching with the soil-cement construction, cement-stabilized graded aggregate construction, or select material-stabilized construction

> Check all labor, equipment, and materials to ensure a continuous patching operation is on hand before patching begins

Preparation

- Trim the sides of areas to be patched and leave them vertical
- Remove all loose material
- Remove unsatisfactory material to the depth shown on plans (at least 6 in. of material)
- Undercut areas of unsatisfactory material 1 ft (300 mm) below the existing surface
- Back the area with subgrade stabilizer-select material to 1 ft (300 mm) below the existing surface

Construction

- Patch during traffic, unless otherwise specified
- Compact the patches at optimum moisture to a minimum 100% of maximum laboratory dry density
- Compact to the required degree with a conventional steel-wheeled, pneumatic-tired roller; mechanical tampers; or other devices
- Lightly spray or mop each patch with bituminous prime
- Sand the primed areas subject to traffic, as directed by the Engineer
- Repair/replace the damaged patch

Payment

Item	Payment Method
Base Material	Contract Unit Price per cubic yard (meter)
Subgrade Stabilizer-Select Material	Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
109	Measurement and Payment
209	Subgrade Construction
412	Bituminous Prime
810	Roadway Materials

Section 326: Portland Cement Concrete Subbase

Equipment

- *Concrete Batching Equipment*: Provide separate bins and weighing hoppers for aggregate and cement in the batching plant
- *Slipform Paver and Spreader*: Use a self-propelled slipform paver equipped with tracks sufficient to prevent slippage and bogging when loaded

> Do not allow workers to walk in fresh concrete with shoes coated with dirt or other foreign substances

Construction

Item	Information
Mixing	• The Engineer will determine design proportions of required material based on mixes prepared in the laboratory or trials performed in construction • Determine the batch weights required to produce the necessary quantity • Continue mixing until producing a homogeneous and uniform mixture
Placing	• Spread the mixture on grade with minimum rehandling • Hand spread with shovels, if necessary • Do not place portland cement concrete on muddy, puddled, or frozen subgrade
Consolidating	• Vibrate the mixture to full length, width, and depth of the section • Ensure the vibration does not produce puddling or excessive ground accumulation
Finishing	• Finish the mixture to the proper cross section • Use equipment that produces a uniform surface free of irregular, rough, or porous areas • Use a tube float or other finishing device approved by the Engineer to provide a smooth surface • Do not add water to the surface to aid finishing

Construction Joints	• Form when the mixture placement is interrupted for more than 1 hour
Curing	• Apply compound for the impervious membrane method at a rate of 200 ft^2/gal (5 m^2/L) or less • Apply a second application of curing compound just before placing the pavement to act as a bond breaker (at the rate of the first application)
Preserving the Subbase	• Maintain the subbase until it is covered by the succeeding pavement course • Place the pavement course on subbase only after the mixture has cured for 7 days • Construct earth ramps and barricades to move traffic across the subbase
Weather Limitations	• Do not place the subbase mixture when the air temperature (in the shade) is less than 40°F and falling • Protect the subbase from rain until the surface has sufficiently hardened to prevent marring

Payment

Item	Payment Method
Portland Cement Concrete Subbase	Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
109	Measurement and Payment
430	Portland Cement Concrete Pavement
500	Concrete Structures
800	Coarse Aggregate
801	Fine Aggregate
815	Graded Aggregate
830	Portland Cement
831	Admixtures
832	Curing Agents

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B-6 Pavements Training Module

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 400: Hot Mix Asphaltic Concrete Construction

Definitions

Segregated Mixture:	Mixture lacking homogeneity in HMA constituents of such a magnitude that there is a reasonable expectation of accelerated pavement distress or performance problems
New Construction:	A roadway section of more than 0.5 mile (800 m) long that is not longitudinally adjacent to the existing roadway
Trench Widening:	Widening no more than 4 ft (1.2 m) in width
Comparison Sample:	Opposite quarters of material sampled by the Contractor
Independent Sample:	(Also called Quality Assurance Sample) A sample taken by the Department to verify an acceptance decision without regard to any other sample that may also have been taken to represent the material in question
Referee Sample:	A sample of the material retained during the quartering process that is used for evaluation if a comparison of Contractor and Departmental split sample test results is outside allowable tolerances

Paving Plan

- Include the following on the paving plan:
    - Proposed starting date
    - Location of plant(s)
    - Rate of production
    - Average haul distance(s)
    - Number of haul trucks

- Paver speed, ft (m)/min, for each placement operation
- Mat width for each placement operation
- Number and type of rollers for each placement operation
- Sketch of typical section showing the paving sequence for each placement operation
- Electronic controls used for each placement operation
- Temporary pavement marking plan

Job Mix Formula

- Include the following in the job mix formula:
  - Specific Project for which mixture will be used
  - Source and description of materials
  - Mixture ID number
  - Proportions of raw materials to be combined in the paving mixture
  - Single percentage of combined mineral aggregates passing each specified sieve
  - Single percentage of asphalt by weight of total mix
  - Single temperature of discharged mixture from plant
  - Theoretical specific gravity of mixture
  - Name of person/agency responsible for quality control

Vehicles for Transporting Mixtures

- Use a required approved releasing agent (QPL 39) for transporting vehicle beds
- Ensure the releasing agent is not detrimental to mixture
- Protect the mixture with waterproof cover that extends over the sides and ends of the bed
- Insulate the front end and sides of each bed with an insulating material
- Mark each transporting vehicle with a clearly visible identification number
- Create a hole in each side of the bed so that the temperature of the loaded mixture can be checked

Equipment Cleaning

- Provide sufficient hand tools and power equipment to clean the roadway surface before placing the bituminous tack coat

Bituminous Paver Requirements

- Ensure the paver meets the following requirements:
  - Capable of maintaining true to line, grade, and cross section
  - Smooth, uniform in density and texture
  - Continuous line and grade reference control
  - Automatic screed control system
  - Transverse slope controller
  - Screed control
  - Spreads and finishes courses to place hot mix asphaltic concrete
  - Automatic grade sensing and slope control
  - Automatic dual grade sensing
  - Combination automatic and manual control
  - Total manual control
  - Paver screed extension

Do not use extendable strike-off devices instead of approved screed extensions. Only use a strike-off device in areas that would normally be fixed by hand

Compaction Equipment

- Accomplish compaction of subgrade by any type of tamping or rolling equipment that will produce the desired results

Material Transfer Vehicle (MTV)

Use an MTV to place asphaltic concrete mixtures on Projects on the State route system with the following conditions:

- ADT is equal or greater than 6000
- Project length is equal to or greater than 3000 linear feet (915 linear meters)
- Total tonnage (megagrams) of mixture is greater than 2000 tons (1815 Mg)

Use an MTV in the following locations:

- Mainline of the traveled way
- Collector/distributor (C/D) lanes on Interstates and limited-access roadways
- Leveling courses at the Engineer's discretion

Existing Surface Preparation

- Clean the existing surface to the Engineer's satisfaction before applying hot mix asphalt concrete on pavement
- Patch and repair minor defects (potholes and broken areas)
- Apply bituminous tack coat using a pressure distributor

Place Patching and Leveling Course

- Bring the surface area to the proper cross section and grade with a leveling course of hot mix asphaltic concrete materials, when the existing course is irregular
- Place leveling at locations and in amounts directed by the Engineer
- For leveling courses, use a motor grader equipped with a spreader box and smooth tires

Provide the Engineer at least 1 day's notice prior to beginning construction

Construction

- Determine the course's maximum compacted layer thickness by type of mix being used
- Do not mix and place asphaltic concrete if the existing surface is wet or frozen
- Unload the mixture into the paver hopper or into a device designed to receive mixture from delivery vehicles
- Spread the mixture to a loose depth for compacted thickness or spread rate except for leveling courses
- Use a mechanical spreader true to line, grade, and cross section specified
- Obtain the Engineer's approval for sequence of paving operations
- Minimize tracking tack onto the surrounding surfaces, including paving the adjoining lanes
- Perform night work with artificial light provided by the Contractor
- Ensure outside edges of pavement being laid are aligned and parallel to centerline
- Remove and replace the mixture placed on roadway that the Engineer determines is unacceptable
- Continue rolling until roller marks are no longer visible

- For new construction and resurfacing containing multiple lifts and courses, arrange the width of individual lifts so that longitudinal joints of the successive lift offsets 1 ft from the previous lift

Environmental Note: Do not use fuel oil or other harmful solvents to clean tools during work

Pavement Protection

- Protect sections of newly finished pavement from traffic until traffic will not mar the surface or alter the surface texture
- Use artificial methods to cool the newly finished pavement to open pavement to traffic more quickly (if directed by the Engineer)

Quality Acceptance

- The Contractor will randomly sample and test mixtures for acceptance on a lot basis
- The Department will monitor the Contractor testing program and perform comparison and quality assurance testing

Payment

Item	Payment Method
Hot Mix Asphaltic Concrete	Contract Unit Price per ton (megagram) or per square yard (meter)

Related References

Section	Title
106	Control of Materials
109	Measurement and Payment
152	Field Laboratory Building
413	Bituminous Tack Coat
424	Bituminous Surface Treatment
802	Aggregates for Asphaltic Concrete
828	Hot Mix Asphaltic Concrete Mixtures
315	AASHTO
209	AASHTO
202	AASHTO
49	AASHTO

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 401: Cold Mix for Patching

General

This section contains requirements for a mixture of mineral aggregates and cutback asphalt suitable for short periods of stockpiling

Composition of Mixtures

- Ensure bituminous cold mixtures are uniform mixtures of aggregate, asphaltic material, and mineral filler, if required

Mixture Stockpiles

- Place finished mixture in small stockpiles to allow proper curing
- After curing, stockpile the mixture in one large stockpile, if possible
- Ensure the stockpile area is clean and well drained

Payment

- Cold mix is paid at the Contract Unit Price per ton (megagram) (see the entire payment section for more information)

Related Specifications

Section	Title
800	Coarse Aggregate
802	Aggregates for Asphaltic Concrete
820	Asphalt Cement
821	Cutback Asphalt
824	Cationic Asphalt Emulsion

Section 402: Hot Mix Recycled Asphaltic Concrete

Definition

Asphalt RAP:	Asphalt Reclaimed Asphalt Pavement and other components (See Standard SPEC PG 304)

Location of Department RAP material stockpiles is given on the plans

Requirements

- Do not use RAP material that contains alluvial gravel or local sand in any mixture placed on Interstate Projects
- See Section 402.1.03 concerning removal of RAP from a stockpile
- Contractors require the submission of an affidavit to the GDOT Materials Testing Laboratory (see Section 402.1.03B)
- When in shoulder construction, limit RAP containing local sand or alluvial gravel
- Asphaltic concrete removed from an existing roadway becomes the Contractor's property unless specified otherwise
- Stockpile RAP at a location specified on the plans
- Ensure that recycled mixture is a homogeneous mixture of RAP or RAS material, virgin aggregate, hydrated lime, and neat asphalt cement
- Erect a sign on each stockpile to identify its source(s)
- The Department may reject by visual inspection stockpiles that are not free of foreign materials

Payment

- RAP materials are paid at the Contract Unit Price per ton (megagram) (see Section 402.5.D for detailed Payment and Measurement information)

Related Specifications

Section	Title
800	Coarse Aggregate
828	Hot Mix Asphaltic Concrete Mixtures

Section 403: Hot In-Place Recycled Asphaltic Concrete

Construction

Follow these steps for hot in-place recycling of the existing surface:

- Soften the existing surface with heat
- Use hot milling to obtain the depth shown in the plan typical section or stated in the Contract
- Apply the tack coat
- Apply the rejuvenating agent
- Add plant-produced asphaltic concrete and virgin aggregate prior to remixing
- Thoroughly remix, level, and relay the recycled mixture

Materials

Material	Specifications
Aggregate	• Add virgin aggregate from an approved source • Use stone size and spread rate specified in the plans
Plant-Produced Hot Mix Asphaltic Concrete	• Add type and amount of plant-produced asphaltic concrete • Allow addition of additional on mixture design analysis
Asphalt Cement Rejuvenating Agent	• Obtain approval from the Office of Materials for source, amount, and type of agent used • Allow addition of additional on mixture design analysis
Bituminous Tack Coat	• Apply with a system equipped with positive start/stop capabilities that prevent tack puddles and uniformly distribute across the full width of the surface being recycled
Asphalt Modifier	• Add at dosage rate specified in the plans • Obtain approval by the OM prior to use in work

Notes:

- Allow the Department 2 weeks to verify the mix design after receiving the proposed mix design and material
- Do not begin recycling operations until the Department has approved the design and accepted the mixture

Equipment (see Specification 403.3.02 A-D)

Material	**Information**
Heating and Milling Units	• Capable of heating asphalt concrete pavement to a temperature high enough to remove excess moisture and allow hot milling
Blending Unit	• Capable of blending the removed material and the rejuvenating agent into a homogeneous mixture
Screed	• Capable of collecting and distributing recycled mixture over variable widths for the entire width being processed
Auxiliary Equipment	• Provide suitable surface-cleaning equipment, hand tools, rollers, and others to perform the work

Surface Preparation

- Clean the surface so as to be free of dirt, vegetation, and other objectionable materials immediately prior to the affected areas being recycled
- Remove all metal raised pavement markers
- Remove thermoplastic paint markings prior to recycling

Heat, Remove, and Blend Materials

- Evenly heat pavement at a full lane width 3-in. (75 mm) minimum overlap onto adjacent pavement materials
- Control heating to ensure uniform penetration without differential softening of surface
- Distribute virgin aggregate across the entire width being recycled prior to the last head application

Ensure the final blended mix in the windrow is uniform

- Hot mill and rework pavement to the width and depth shown in Play typical section
- Control the width of each pass to provide proper longitudinal joint placement
- Ensure the milled material is heated sufficiently to be free of lumps
- Do not use scrapers, scarifiers, or mechanical means of removing softened pavement other than milling heads
- Ensure the aggregate is consistently coated
- Ensure there is no evidence of broken or fractured aggregate in the windrowed material
- Review Section 403.3.05.C for detailed tack coat information

Application

- Control placement of the mixture to produce a surface true to line, grade, and cross slope with a uniform surface texture free of segregation, lumps, or other unacceptable streaks
- Ensure the mixture meets acceptance requirements for mixture quality, compaction, smoothness, and thickness
- Overlay recycled mixture by producing and placing mixture that meets requirements
- Review Section 403.3.06 for Quality Acceptance information

Payment

- Hot in-place recycled asphaltic concrete is paid at the Contract Unit Price per square yard (meter) (see Specification for more detailed payment information)

Related Specifications

Section	Title
800	Coarse Aggregate
828	Hot Mix Asphaltic Concrete Mixtures

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 405: Hot Asphalt–Vulcanized Rubber Seal Treatment

Materials

- *Asphalt Cement*: Before adding rubber and diluent, ensure the asphalt cement conforms to the required specifications
- *Ground Vulcanized Tire Rubber*: Ensure ground vulcanized tire rubber meets the required specifications
- *Diluent*: Use kerosene with a boiling point above 350°F (175°C)
- *Coarse Aggregate*: Ensure the gradation of cover aggregate meets the specification (Section 800) for No. 7 Stone

Equipment

Type	Information
Canvas Cover	Cover exposed material with canvas to help prevent the temperature of exposed material from dropping
Aggregate Spreader	Use an adjustable, self-propelled aggregate spreader to accurately spread amounts given in the plans
Rubber Tire Rollers	Use at least 3 rubber tire rollers loaded to 5000 lb (2275 kg) per tire

Construction

Mixing

- Before adding rubber, ensure the asphalt temperature is no higher than 325°F
- Rapidly combine the rubber with the asphalt
- Mix the rubber until the material approaches a semi-fluid consistency
- Mix the hot asphalt and the rubber for at least 5 minutes

> Ensure the mixing equipment can produce a homogeneous mixture of rubber and asphalt to prevent separation

Spreading

- Immediately begin application when proper consistency is reached
- Never hold the mixture at temperatures over 325°F (160°C) for more than 1.5 hours

Placement

- Place the hot asphalt–rubber mixture only when the ambient temperature is 60°F (15°C)
- Perform at least 4 coverage with the pneumatic rollers
- Roll immediately after application
- Do not permit traffic on the completed surface until approved by the Engineer
- Sweep joint edges clean of overlapping cover aggregate
- Avoid skips and overlaps at joints and protect the surface of adjacent structures
- Use building paper for transverse joints

Payment

- Accept quantity of seal treatment is paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
413	Bituminous Tack Coat
424	Bituminous Surface Treatment
800	Coarse Aggregate
820	Asphalt Cement

Section 407: Asphalt-Rubber Joint and Crack Seal

Definitions

Type M: Used to fill joints and cracks in portland cement concrete or asphaltic concrete pavements when required

Type S: Used to seal joints and cracks in portland cement concrete and asphaltic concrete pavements and shoulders

Materials

- Ensure the mixture contains no water or volatile solvents and cures immediately when cooled to sufficient viscosity to prevent tracking caused by traffic
- Ensure the plastic film used to package units melts at normal application temperatures when placed in installation equipment

Equipment

Type	Information
Field Installation	• Must produce or maintain the specified temperatures even if filled to capacity
Crack Filling	• Seals large cracks from the bottom up • Must fill joints and cracks by directing sealant into the crack
Air Compressor	• Must be considered satisfactory to the Engineer

Preparation

- Use compressed air to clean joints and cracks to be sealed
- Clean the pavement surface and check joints/cracks to ensure they are free of vegetation, dirt, dust, moisture, and other foreign material

Construction

- Do not seal joint cracks if rain is imminent or if air temperature is below 35°F (2°C)
- Place prepackaged sealant mixture in field installation equipment

Apply the mixture at specified application temperature according to the manufacturer's recommendations

- Heat sealant mixture for the proper time/temperature to provide full reaction between the asphalt and rubber
- Fill joints and cracks slightly overfull

Payment

- Asphalt-rubber joint and crack seal is paid at the Contract Unit Price bid

Related Specifications

Section	Title
AASHTO	PP5
ASTM	D 4
ASTM	D 36
ASTM	D 3407
ASTM	D 3583

Section 411: Asphaltic Concrete Pavement, Partial Removal

Sawing the Joint

Saw the joint as follows:

- True to lines shown in the plans or as directed by the Engineer
- To the full depth of the existing asphaltic concrete, unless directed otherwise
- Leave a neat, vertical face for the full depth of the retained portion

Pavement Removal

- Begin removing isolated pavement after sawing the joints
- Use removal methods that will not damage the pavement edges
- Leave a neat, vertical face for the full depth of retained portion

Protection of Remaining Edges

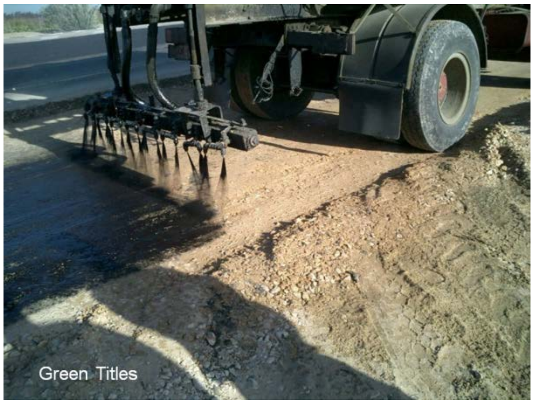
- Do not allow traffic or equipment to cross the remaining edges
- Repair or restore damaged edges to the Engineer's satisfaction

Related Specifications

Section	Title
205	Roadway Excavation

Section 412: Bituminous Prime

Construction



- Use the following equipment:
  - Pressure distributor
  - Power broom and blower
  - Aggregate spreader
  - Pneumatic-tired roller
- Do not apply prime when the surface is wet, rain is imminent, or the air temperature is below 40°F
- Apply prime to the full width of the proposed wearing surface
- Prime the following areas:
  - Cement- or lime-stabilized bases or subbases, regardless of pavement thickness
  - Soil or aggregate bases or subbases
  - ***Not*** on driveways or paved shoulders

Surface Conditions

- Ensure the surface is finished to the line, grade, and cross section specified
- Ensure it is uniformly compacted and bonded
- Remove loose material, dust, caked clay, and other material from the road

Surface irregularities of existing pavement must be corrected

Protection, Curing, and Maintenance

- Close the roadway to traffic
- Roll the surface longitudinally with a pneumatic-tired roller
- Blot sand to the tack places to ensure the tack is not lifted by the equipment
- Open the roadway to traffic after rolling and sanding

Related Specifications

Section	Title
821	Cutback Asphalt

Section 413: Bituminous Tack Coat

Emulsified Asphalt

- Maintain equipment for delivery, storage, and handling of emulsified asphalt to prevent contamination
- Transfer emulsified asphalt directly to the pressure distributor from the transport tanker
- Provide and maintain temperature-measuring devices to monitor during storage (do not allow the asphalt to freeze)

Provide the following equipment: Power broom and blower, pressure distributor, and a dedicated pressure distributor

Application

- Clean the area before applying the tack coat
- Coat the entire areas to be paved with tack coat, unless directed otherwise by the Engineer
- Apply tack coat with distributor spray bars
- The Engineer will determine the application rate of the bituminous tack coat

- Apply only enough tack coat that can be covered with a new pavement course the same working day
- After application, allow the tack coat to break and become tacky
- Do not allow traffic to travel on the tack coat

Payment

- Bituminous material is paid at the Contract Unit Price per gallon (liter)

Related Specifications

Section	**Title**
109	Measurement and Payment
820	Asphalt Cement
822	Emulsified Asphalt
824	Cationic Asphalt Emulsion

Section 424: Bituminous Surface Treatment

Definitions

Single Surface Treatment:	One application of bituminous material that is covered with aggregate
Double Surface Treatment:	A bituminous material application that is covered with aggregate of the size specified in the proposal followed by a second bituminous material application that is covered with a second specified size aggregate
Triple Surface Treatment:	A bituminous material application that is covered with a specified size aggregate followed by subsequent applications of bituminous material that are covered with successively smaller sized nominal aggregates

Materials

Type	**Information**
Bituminous Material	• Select from any type and grade listed in the materials list • Notify the Engineer 10 days before ordering the material
Aggregates	• Size and group are specified in the Proposal • Do not use unconsolidated limerock unless otherwise specified • Use Class B aggregates only where surface treatment is used for shoulder construction

Equipment

Type	Information
Aggregate Spreader	• The Department will annually inspect the spreader before use in the work • Use a self-propelled spreader that can apply aggregate at the desired rate uniformly and accurately without corrugation, overlaps, or excess deficient areas • Provide spreaders that cover the full width of asphalt application
Pressure Distributor	• Mount the distributor on pneumatic tires wide enough to prevent damage to the road surface • Design, equip, maintain, and operate so that material is heated and applied evenly throughout the length of the spray bars • Ensure it maintains constant, uniform pressure on the nozzles • Install screens between the tank and the nozzles and clean them frequently
Heating Equipment	• Ensure it will heat and maintain bituminous material uniformly at the required temperature
Steel-Wheeled Rollers	• Use self-propelled, tandem-type steel-wheeled rollers • Use rollers that weigh 3–8 tons (3–7 Mg) • Ensure it properly seats aggregate without fracturing the aggregate particles • Equip the roller drums with scrapers to prevent pickup of material
Pneumatic-Tired Rollers	• Use self-propelled, two-axle rollers with smooth-tread rubber tires aligned such that no gaps exist on the finished surface • Equip with scrapers and scrubbers to prevent pickup of material
Power Broom and Blower	• Provide one (minimum) of each of a combination that can remove dust or lose material from the road surface

Firmly compact, finish, and prime new bases

Removing Foreign Material

- Use power brooms, power blowers, hand brooms, or other means to remove loose material, dust, dirt, clay, and other materials
- Take special care to clean the outer edges thoroughly
- Use motor grader blade to remove excess material off the paving edge

Condition of Prime

- Ensure prime is cured before placing the mat course
- Require prime if the existing surface is loose, soft, not bonded, removed, or damaged
- Remove concentrations of excess prime
- Perform additional rolling with pneumatic-tired roller as directed

Apply bituminous surface treatment when:

- The date is between April 15 and October 15
- Ambient temperature has ***not*** been less than 45°F (7°C) for 48 hours immediately prior to application
- No forecast is for ambient temperature less than 45°F (7°C) for 48 hours immediately following application
- Ambient temperature and road surface temperature are at least 60°F (16°C) and stable at the time of application

Construction

- After application of the bituminous material, immediately cover that with an application rate of aggregate before beginning the next section
- Do not apply the bituminous material to the full width of the pavement unless the aggregate spreader can immediately cover it
- Never allow bituminous material to chill, set up, dry, or reach a condition that impairs the retention of cover aggregate before application

<u>Spreading Aggregates</u>

- Ensure that aggregates do not contain free moisture when spread
- Apply aggregate immediately after applying bituminous materials
- Uniformly spread the aggregate at the specified rate
- Move the spreader at a uniform speed regardless of the grade
- Ensure the distance of aggregate free fall remains constant during spreading
- Remove corrugations
- Ensure a uniform aggregate spread by hand spotting and brooming

<u>Rolling</u>

- Synchronize the speed of the distributor and aggregate spreader with the rolling operation
- Use a minimum of 2 individual rollers, one of which must be a pneumatic-tired roller
- Use pneumatic-tired rollers only if the steel-wheeled roller fractures the aggregate
- Begin rolling within 1 minute after spreading the aggregate
- Operate rollers at speeds not exceeding 5 mph
- Proceed in a longitudinal direction, beginning at the outside edge of the aggregate application
- A roller pass is defined as one trip in a single direction
- Overlap each roller pass by approximately half the roller width
- Provide a minimum of three (3) roller passes per roller for each layer of aggregate

A roller pass is defined as one trip in a single direction

Brooming

- Use a revolving broom as necessary to redistribute excess stone
- Sweep the surface treatment within the first 3 hours of the next available workday following placement
- Do not unseat bonded stone when sweeping

Traffic Control

- Do not allow traffic on the surface treatment until the bituminous material has cured sufficiently
- Control traffic to speeds not exceeding 25 mph for a minimum of 2 hours after application

Payment

- Surface treatment is paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
105	Control of Work
800	Coarse Aggregate
802	Aggregates for Asphaltic Concrete
820	Asphalt Cement
824	Cationic Asphalt Emulsion

Section 427: Emulsified Asphalt Slurry Seal

Slurry Seal Design

- Submit design samples of each ingredient to be used 2 weeks before the beginning of work
- Include sample information (source, type, and Project number)
- Slurry seal work until the OMR has approved the slurry mix design
- Furnish the Engineer with calibration of the slurry mixing equipment

Materials

Type	Information
Aggregates	• Group II, Class A or B crushed stone or slag with sand equivalent • Must arrive uniform and not require blending or premixing at the site storage area
Water	• Clear and free of oil, salt, acid, alkali, organic, and other harmful substances • The Engineer may require OMR evaluation before work begins
Mixture Composition	• Uniform mixture of aggregate, emulsified asphalt, mineral filler, and water

Asphalt emulsion will not be accepted if transporting vehicles have leaked or spilled during transit

Slurry Mixing Equipment

- Use caution when mixing to ensure the emulsion does not set up prematurely
- Pre-wet aggregate and mineral filler in the machine immediately before mixing
- Use a mechanical squeegee spreader with flexible strike-off that contacts the surface
- Use a spreader equipped with augers, a steering device, and a device to adjust coverage width
- Keep the spreader box clean and free of asphalt and aggregate build-up
- Thoroughly clean cracks in the existing surface
- Remove loose material, silt spots, vegetation, and other objectionable material

Weather Note: Do ***not*** apply slurry seal if the pavement or ambient temperature is below 55°F

Tack Coat Application Steps

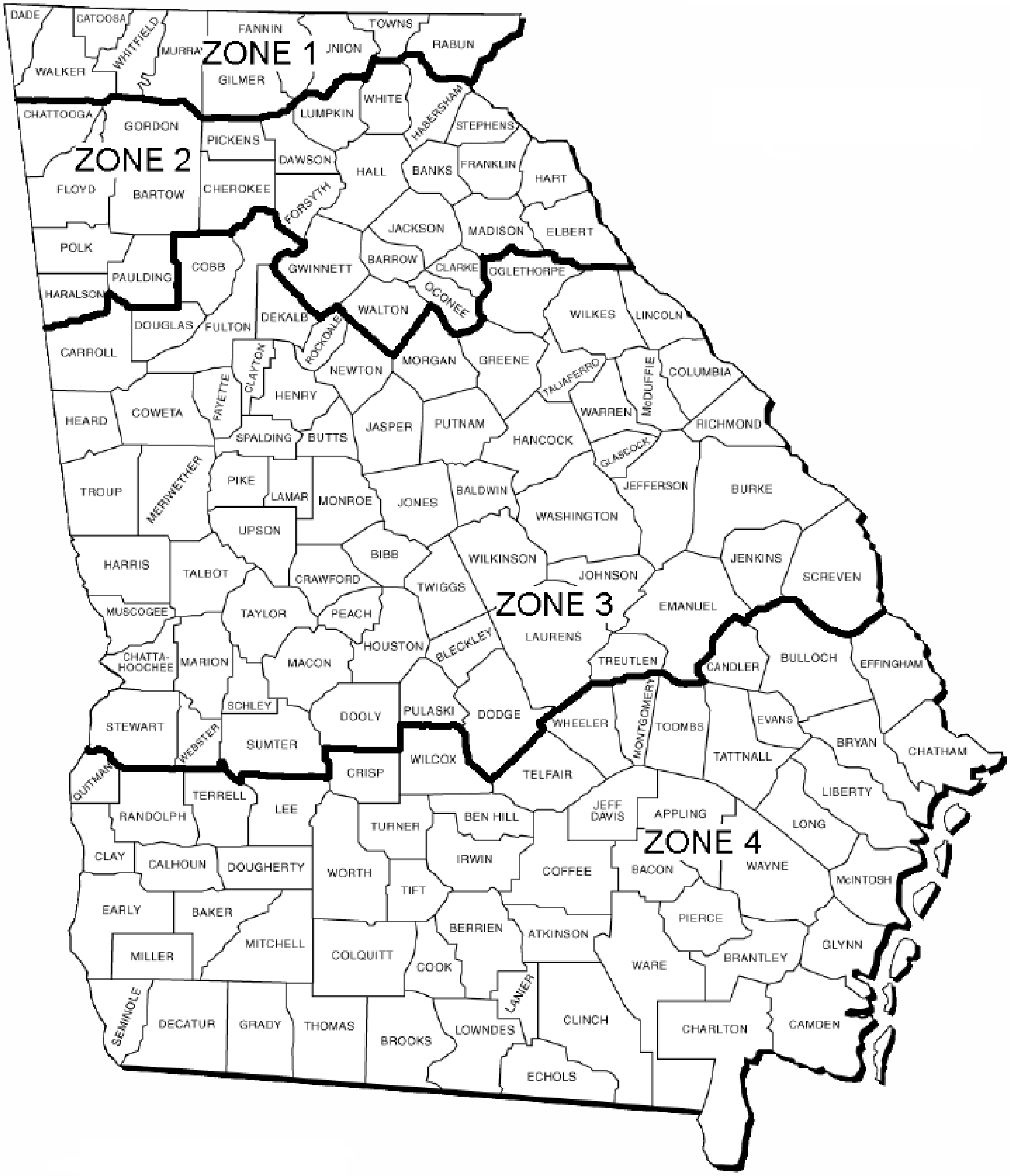
- Apply with the same asphalt emulsion type and grade as used in the slurry seal
- Use an asphalt distributor
- Apply at the application rate specified by the Engineer
- Do not deposit slurry mixture that is not the desired consistency

Traffic Control Note: Do not allow traffic on slurry seal until it has cured enough to withstand marring and tearing

Application Zones and Dates

Dates allowed for application of slurry seal:

Zone	Dates
1	April 15–October 1
2	April 10–October 25
3	April 1–October 31
4	April 1–October 31



Payment

- Emulsified asphalt slurry seal is paid at the Contract Price per square yard (meter)

Related Specifications

Section	Title
413	Bituminous Tack Coat
802	Aggregates for Asphaltic Concrete
822	Emulsified Asphalt
824	Cationic Asphalt Emulsion
830	Portland Cement
882	Lime
883	Mineral Filler

Section 428: Microsurfacing

The maximum test temperature shall not exceed 350°F and the duration shall not exceed 20 minutes

Aggregate Storage

- Store in a manner to prevent segregation, mixing of various materials or sizes, and contamination with foreign materials
- Do not use construction equipment on, or to ramp stockpiled aggregate
- Place aggregate over a scalping screen immediately before transferring to the microsurfacing mixing machine

Bituminous Storage

- Ensure storage meets the requirements of the production rate
- Always keep clean all of the equipment used

Construction

- Produce a finished microsurfacing that has a uniform texture free from excessive scratch marks, tears, or other surface irregularities
- Ensure the cured mixture fully adheres to the underlying surface
- The Engineer may reject any work due to poor workmanship, loss of texture, raveling, or apparent instability
- Ensure the ambient temperature is at least 50°F
- Ensure the weather is not foggy or rainy
- Thoroughly clean all cracks and area to be surfaced before applying mixture

Application

- Pre-wet the surface by spraying water ahead of and outside the spreader box
- Spread the paving mixture on the prepared surface to produce a uniform finished surface
- Fill ruts to restore the designed profile of the pavement cross section
- Do not permit excess crowning or overfilling of the rut area
- Carry a sufficient amount of material in the spreader box to ensure complete coverage
- Provide a smooth, neat seam where two passes meet
- Immediately remove excess material from the ends of each run

Do not allow traffic on the microsurfacing mixture until it is cured sufficiently to prevent pickup or marring of the surface

Payment

- Microsurfacing is paid at the Contract Price per square yard (meter) or per ton (megagram)

Related Specifications

Section	**Title**
412	Bituminous Prime
424	Bituminous Surface Treatment
824	Cationic Asphalt Emulsion

Section 429: Rumble Strips

Construction

- Use nonvibrating hand rollers to compact the strips
- Ensure the form confines and spaces the hot mix according to the plan details

Follow this procedure:

- Tack the entire 20-ft (6 m) strip length
- Place the oiled form, and ensure the first strip coincides with the beginning of the first unit
- Place and level the plant mix
- Roll the strips with the forms in place to the Engineer's satisfaction

> Do not place strips on wet or frozen pavement

Payment

- Rumble strips are paid at Contract price per each

Related Specifications

Section	Title
400	Hot Mix Asphaltic Concrete Construction
413	Bituminous Tack Coat

Section 430: Portland Cement Concrete Pavement

Equipment

Type	Requirements
Scales	• Engineer will inspect and approve scales to weigh concrete materials and devices to measure water
Paving Equipment	• Must have rubber-tired wheels or flat steel wheels • Must wait to operate concrete or shoulder paving until the slab is 14 days old or has 2500 psi compressive strength • May be either slipform or fixed form
Surface Finish Equipment	• Use mechanical equipment to produce surface finish of mainline and transverse plastic concrete grooving • Ensure equipment uses rectangular-shaped steel tines of the same size and uniform length
Mechanical Sprayers	• Provide fully atomizing spraying equipment with tank agitator to place curing compounds

Store aggregate from different sources in separate stockpiles

Preparation

- Prepare the full width of subgrade and subbase according to the plans and specifications
- Ensure the surface immediately under the concrete pavement allows proper pavement thickness and yield
- Trim high areas to the proper elevation
- Ensure the subbase can support the paving equipment without rutting or bogging

Construction

- Combine authorized portions of materials in batches to produce portland cement concrete according to specifications
- Compact the foundation under forms true to grade
- Set the form so that it firmly contacts the foundations for the entire length at the specified grade
- Prevent the forms from settling or springing under the finishing machine
- Clean and oil the forms before placing the concrete
- Provide dowel bars at the transverse joints

Concrete Placement

- Unload concrete into an approved spreading device and mechanically spread it on grade
- Place the concrete continuously between the transverse joints without using intermediate bulkheads
- Hand spread with shovels (not rakes)

Do not allow personnel to walk in freshly mixed concrete with shoes coated with dirt or other materials

- Thoroughly consolidate concrete against the faces of the forms and along the full length and sides of the joint assemblies
- Ensure vibration does not puddle or cause grout accumulation on the surface
- Deposit concrete near formed joints
- Dump or discharge concrete only in the center of the joint assembly
- Take air and slump determination tests at a rate of at least three of each test, evenly distributed during the workday

Place Reinforcement

- Do not insert lane tie bars in the unsupported sides of the fresh concrete
- Ensure the steel placement method does not damage or disrupt the concrete
- Use bent lane tie bars if needed in the longitudinal formed joints construction

Consolidation and Finish

- Perform vibration for the full width and depth of the pavement
- Do not allow vibrators to misalign load transfer devices, or contact forms or base

- Ensure the vibrator amplitude is within the manufacturer's recommendations
- Stop the vibration when the machine cannot go forward
- Obtain uniform consolidation and density throughout the pavement
- Smooth and true the concrete using a float or finishing machine to minimize or eliminate hand finishing
- Perform hand finishing only during irregular dimension areas or if the mechanical equipment does not function after the concrete has been deposited
- Ensure the pavement surface final finish is true to grade, uniform in appearance, and free of irregular, rough, or porous areas
- Use mechanical equipment to produce a surface finish of transverse plastic concrete grooving for the mainline ramps

Forms Removal

- Do not remove forms from freshly placed concrete until it has set for at least 12 hours
- Do not allow vibrators to misalign load transfer devices, or contact the forms or base
- Remove forms carefully to avoid damaging the pavement
- Immediately cure the sides of the slab after the forms are removed
- Remove and replace major honeycombed areas

Joints

Type	Requirements
Longitudinal	• Use unpainted and uncoated deformed steel bars that are the size and length specified on the plans • Place the bars perpendicular to the joint using a mechanical device, or rigidly secure the bars in place with supports
Longitudinal Formed	• Construct while the concrete is in a plastic state • Use methods and equipment that locate joint reinforcement properly without disruption
Longitudinal Sawed Joints	• Cut with a mechanical saw within 3 days after the concrete is placed and before traffic or equipment enters the pavement
Transverse Joints	• Consists of construction joints, contraction joints, or expansion joints at the required locations • Construct in partial width/adjoining lanes to abut to the adjacent lanes • Ensure joints in plain portland cement concrete requiring load transfer devices contain either plastic-coated or epoxy-coated dowels • Secure the dowel bars with supporting assemblies before placing the concrete
Construction	• Construct asphalt pavement when interrupting concreting operations for more than 1 hour • Do not construct within 10 ft (3 m) of an expansion joint, contraction joint, or transverse plane of weakness • Form by securing in place a removable bulkhead or header board • Place the board so that it conforms to the full cross section of the pavement • Secure it flush with the subbase and parallel to normal transverse joints
Contraction	• Create planes of weakness in plain portland cement concrete pavement by cutting joints in the pavement surface • Saw transverse joints before the pavement cracks • Begin sawing when the concrete has hardened enough to prevent surface raveling (4 hours after placement) • Continue sawing day and night regardless of weather conditions
Expansion	• Form by securing a removable bulkhead that conforms to the full cross section of the pavement • Use bulkheads that can construct a vertical expansion wall without offsets, indentations, or burrs • Use expansion joint filler required by the plans • Furnish and install preformed joint filler in lengths equal to the pavement width or the width of one lane • Do not use damaged or repaired joint fillers

<u>Open to Traffic</u>

- Wait to open the pavement slab to traffic until the concrete is 14 days old
- Cure compressive test specimens used for the traffic opening as near as possible to the roadway
- Erect and maintain barricades
- Assign employee watchmen to block traffic from the newly constructed pavement for the period required in this specification
- Arrange barriers away from public traffic on the lanes remaining open
- Maintain signs that clearly indicate the lanes open to public traffic
- Repair or replace pavement damaged by traffic or other causes before Final Acceptance

Payment

- Concrete pavement is paid at the Contract Unit Price per square yard (meter)

Related Specifications

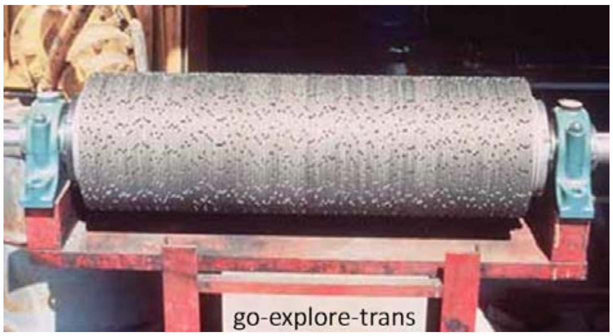
Section	Title
106	Control of Materials
152	Field Laboratory Building
500	Concrete Structures
800	Coarse Aggregate
801	Fine Aggregate
830	Portland Cement
831	Admixtures
832	Curing Agents
833	Joint Fillers and Sealers
853	Reinforcement and Tensioning Steel
880	Water
886	Epoxy Resin Adhesives

Section 431: Grind Concrete Pavement

Grinding Equipment

Use power-driven, self-propelled grinding equipment that has:

- Diamond blades designed to smooth and texture portland cement concrete pavement
- An effective wheel base of at least 12 ft (3.6 m)
- Pivoting tandem bogey wheels at the front of the machine
- Rear wheels arranged to travel in the track of the freshly cut pavement



Operates without encroaching on traffic movement outside the work area

Construction

- Grind the pavement surface areas designated on the plans
- Only grind bridge decks and roadway shoulders when they are indicated on the plans
- Schedule the construction operation to produce a uniform finished surface
- Maintain a constant cross slope between grinding extremities in each lane
- Grind the entire area designated on plans until pavement surfaces of the adjacent sides of the transverse joints and cracks are in the same plane
- Eliminate faulting at the joints and cracks
- Ensure the overall riding characteristics are within the limits specified
- Texture the pavement surface, but do ***not*** grind extra depth to eliminate minor depressions

Payment

- Ground concrete pavement is paid at the Contract Unit Price per square yard (meter)

Section 432: Mill Asphaltic Concrete Pavement

Delivery, Storage, and Handling

- Uniformly stockpile milled material at the plan locations
- Maintain the existing drainage pattern of water from the stockpile storage area
- Dress the reclaimed asphalt area to drain rainwater from the material
- Obtain the Engineer's approval of the stockpile locations and the method used to prevent milled material degradation, segregation, and reconsolidation

Milling Equipment

Use power-driven, self-propelled milling equipment that is:

- Of the size and shape that allows traffic to pass safely through areas adjacent to the work
- Designed to mill and remove a specified depth of the existing asphalt paving
- Equipped with grade and slope controls operating from a string line or ski and based on mechanical or sonic operation
- Furnished with a lighting system for night work, when necessary

> Do not allow dust to restrict visibility of passing traffic or to disrupt adjacent property owners

Milling Operation

- Schedule the construction operation
- Use milling methods that produce a uniform finished surface and maintain a constant cross slope between extremities in each lane
- Provide positive drainage to prevent water accumulation on the milled pavement
- Bevel back longitudinal vertical edges greater than 2 in. (50 mm) that are produced by the removal process and left exposed to traffic
- Remove dust, residue, and loose-milled material from the milled surface
- Do not allow traffic on the milled surface and do not place asphaltic concrete on the milled surface until the removal is complete

Payment

- Milled asphaltic concrete pavement is paid at the Contract Unit Price bid per square yard (meter)

Related Specifications

Section	Title
109	Measurement and Payment

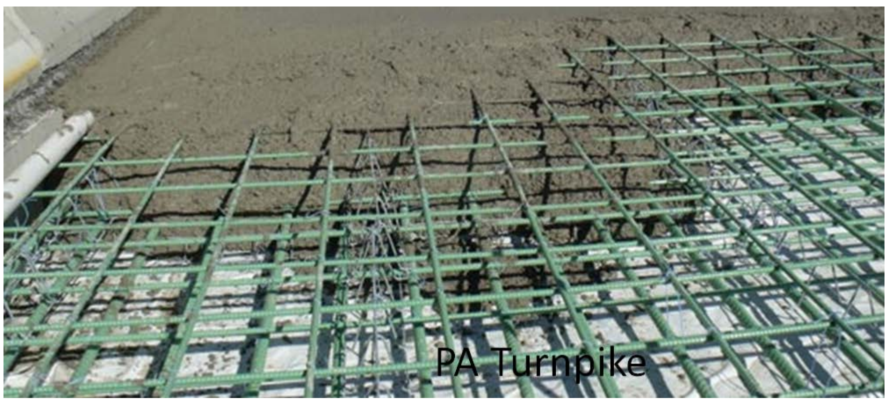
Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 433: Reinforced Concrete Approach Slabs

Construction

- Construct the approach slab before placing the adjacent roadway paving
- Finish, cure, and protect the approach slab as specified
- Construct curbs of dimensions required monolithic with the approach slab when specified on the plans
- Give the concrete a final finish either manually or mechanically before the concrete has hardened



Payment

- Area measured is paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
500	Concrete Structures
511	Reinforcement Steel
621	Concrete Barrier
853	Reinforcement and Tensioning Steel

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 434: Asphalt Paved Ditches

Required Construction Equipment

- Hand-operated roller
- Small power roller
- Vibratory device
- Hand tampers
- Forms

Construction

- Use ditch paving construction methods that allow water to flow continuously
- Protect the ditch paving areas under construction from flowing water, elements, and other disturbances until the materials are fully set

Keep the ditch unobstructed to prevent ponding or standing water

Subgrade Formation

- Form at the required depth below and parallel to the finished surface of the ditch or waterway
- Remove soft, yielding, or otherwise unsuitable material and replace it with suitable material
- Compact the subgrade to 90% maximum dry density
- Finish the subgrade to a smooth, firm surface
- Place and compact subgrade material to the required thickness

Asphalt Mixture Placement

- Place the mixture within temperature limits of 275°F to 325°F (135°C to 160°C)
- Smooth the mixture by raking or screeding
- Thoroughly compact the mixture
- Compact until the surface is smooth and even and texture is dense and uniform
- Remove the forms, and replace them with compacted backfill
- Shape shoulders and slopes and complete them to conform to the required section

Payment

- Asphalt for ditch paving is paid at the Contract Unit Price per ton (megagram)

Related Specifications

Section	Title
802	Aggregates for Asphaltic Concrete
820	Asphalt Cement
828	Hot Mix Asphaltic Concrete Mixtures

Section 435: Rapid Setting Cement Concrete End Dams and Patches

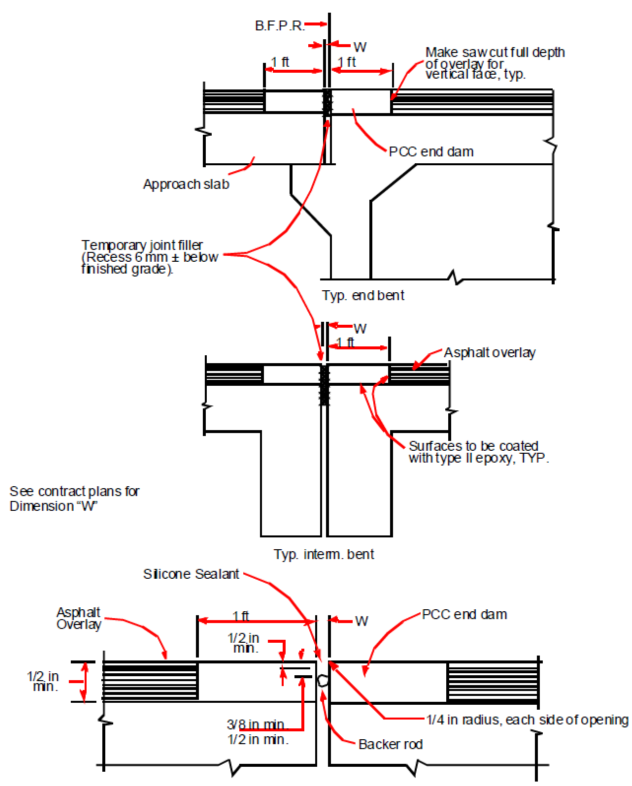
Preparation

- Scarify the surface within the repair area using a concrete scabbler to remove unsound concrete and concrete laitance down to sound coarse aggregate
- Sandblast the surface to remove loose or unsound concrete or other contaminants
- Clean the prepared area with the compressed area
- Completely coat the bottom and vertical side walls of the prepared area with a film of Type II epoxy

> Required minimum depth is 1 in. (25 mm)

Construction

- Repair bridge joint end dams in locations or areas indicated on the plans or designated by the Engineer
- Remove asphaltic concrete from end dams according to the following figure:



Weather Limitations

- Place within a temperature range of 40°F to 100°F (4°C to 38°C)

General Instructions

- Handle, mix, place, and finish rapid-setting cement concrete according to the manufacturer's instructions
- Ensure that the finished rapid-setting cement concrete surface is the same elevation and cross slope as the adjacent pavement
- Deposit rapid-setting cement concrete in the area while the epoxy is still tacky
- Vibrate to completely fill the area of the end dam or patch
- Finish the concrete to the proper grade

Do not allow traffic on end dams or patches until rapid-setting cement concrete obtains a minimum compressive strength of 2500 psi (15 MPa)

Payment

- Joints measured are paid at the Contract Unit Price per cubic ft (m) for bridge joint and end dams, and patches

Related Specifications

Section	Title
500	Concrete Structures
504	Twenty-Four Hour Accelerated Strength Concrete
833	Joint Fillers and Sealers
886	Epoxy Resin Adhesives
934	Rapid Setting Patching Materials for Portland Cement Concrete

Section 436: Asphaltic Concrete Curb

Equipment Requirements

Use an approved self-propelled curbing machine equipped with:

- A hopper
- A power-driven screw
- A mold designed to produce the desired cross section
- The ability to thrust against the asphalt mixture to eliminate objectionable surface voids

Preparation

- Excavate the subgrade for header type curbs to the required depth
- Remove and replace soft or unstable material
- Compact and finish the grade to 90% maximum density
- Shape the subgrade to the required line, grade, and cross section
- Remove dirt and other debris from the area receiving the curb
- Apply tack coat at the rate directed by the Engineer
- Apply tack coat to the full width of the curb being placed
- Place curb sections only after constructing adjoining spillways and drainage outlets

Place curb sections only after constructing adjoining spillways and drainage outlets

Construction

- Determine the working temperature of the asphaltic mixture to achieve the best results
- Do not place curb on an area where the surface temperature is below 40°F (4°C)
- Protect the newly laid curb from traffic by using a barricade or other methods until the mixture has cooled to air temperature
- Once the curb is cool, immediately backfill it

Payment

- Paid at the Contract Unit Price per linear ft (m) for each curb height

Related Specifications

Section	Title
802	Aggregates for Asphaltic Concrete
820	Asphalt Cement

Section 437: Granite Curb

Preparation

- Thoroughly tamp the bottom of the trench
- Remove soft or yielding material to the depth ordered by the Engineer
- Refill the trench with stable material and tamp the material in 4 in. (100 mm) layers or less
- Place granite curb on a dry, firm foundation

Construction

- Thoroughly ram and maul the curbing into place
- Place and compact backfilling in 4-in. (100 mm) layers or less after setting the curb

Use backfilling material approved by the Engineer

- Protect the curb by filling 18 in. (450 mm) horizontal strip of backfill dirt behind the curb
- Divert water away from the trench on steep grades or whenever water can enter the trench
- Lower the curb for driveways and alleys as directed
- Cut and round curb sections adjacent to lowered curbs to 45°
- Provide weep holes and drainage openings

Payment

- Granite curb is paid at the Contract Unit Price per linear ft (m) for straight curbs, radial, or curbed curbs

Related Specifications

Section	Title
805	Rip Rap and Curbing Stone

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 438: Precast Concrete Header Curb

Construction

- Excavate the subgrade to the required grade and cross section
- Remove unsuitable material in the subgrade and backfill as necessary
- Make the precast header curb in tangent sections only
- Provide dowels or dowel holes in poured-in-place portions for tying in precast sections
- Ensure the precast sections conform to the dimensions and details on the plans

Related Specifications

Section	Title
500	Concrete Structures
853	Reinforcement and Tensioning Steel
866	Precast Concrete Catch Basin, Drop Inlet, and Manhole Units

Section 439: Portland Cement Concrete Pavement (Special)

Required Equipment

- Ramp screeds
- Hand finishing tools
- Scales
- Auxiliary vibrator
- Texturing equipment

Subgrade and Subbase

- Prepare the full width of subgrade and subbase according to the plans and specifications
- Ensure the surface immediately under the concrete pavement allows for proper pavement thickness and yield
- Trim high areas to the proper elevation
- Ensure the subbase can support the paving equipment without rutting or bogging

Setting Forms

- Compact the foundation under forms true to grade
- Set the form so it firmly contacts the foundation for the entire length at the specified grade
- Prevent forms from settling or springing under the finishing machine
- Clean and oil forms before placing the concrete

Concrete Placement

- Unload concrete into an approved spreading device and mechanically spread it on grade
- Place concrete between transverse joints without using intermediate bulkheads
- Perform any necessary hand spreading of concrete with shovels (not rakes)

Do not allow personnel to walk in freshly mixed concrete with shoes coated with dirt or other materials

- Thoroughly consolidate concrete on both sides of the joint assemblies
- Ensure vibration does not cause grout accumulation on the surface
- Do not use grout that accumulates ahead of the paver for expansion joints
- Deposit the concrete near the formed joints
- Do not dump or discharge concrete on a joint assembly unless the concrete is centered on the joint assembly
- Keep reinforcing steel free of dirt, oil, paint, mill scale, and loose or thick rust that could impair the bond of the steel to the concrete

Consolidation and Finishing

- Perform vibration for the full width and depth of the pavement
- Allow concrete to be smoothed and trued using a hand float

Protect unhardened concrete from rain

Forms Removal

- Remove forms carefully to avoid damaging the pavement
- Immediately cure the sides of the slab using the same method used to cure the pavement surface
- Remove and replace major honeycombed areas

Joint Construction

- Remove forms carefully to avoid damaging the pavement
- Immediately cure the sides of the slab using the same method used to cure the pavement surface
- Ensure joints are designed, configured, and located as shown on the plans
- Remove and replace plain concrete pavement that cracks during construction
- Seal continuous cracks under movement with sealant
- Saw the vertical face sections to be removed and replace the concrete as a joint with dowels
- Thoroughly clean drilled holes of contaminants and set dowels into the hardened concrete face of the existing pavement
- Uniformly apply a thin coat of heavy grease to epoxy-coated dowels

Joints

Type	Description
Longitudinal	• Shall contain unpainted and uncoated deformed steel bars • Place bars perpendicular to the joint using a mechanical device, or rigidly secure bars in place with supports
Longitudinal Formed	• Construct while the concrete is in a plastic state • Use methods and equipment that locate joint reinforcement properly without disrupting it during construction
Longitudinal Sawed	• Cut with a mechanical saw within 3 days after concrete is placed and before traffic or equipment enters the pavement
Transverse	• Consists of construction joints, contraction joints, or expansion joints constructed at required locations
Construction	• Construct when interrupting concreting operations for more than 1 hour • Do not construct within 10 ft (3 m) of an expansion joint, contraction joint, or transverse plane of weakness

Contraction	• Create planes of weakness in plain portland cement concrete pavement by cutting joints in the pavement surface
Expansion	• Required at location shown on the plans • Furnish and install preformed joint filler in lengths equal to the pavement width or the width of one lane

Cure the entire surface immediately after finishing the concrete

Opening Pavement to Traffic

- Wait to open the pavement slab to traffic until the concrete is 14 days old unless compressive tests show the slab has a compressive strength of 2500 psi (15 MPa)
- Do not allow equipment that exceeds legal load limits on the pavement
- Protect pavement against traffic from the public, employees, and agents

Payment

- Portland cement concrete (special) is paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	**Title**
152	Field Laboratory Building
800	Coarse Aggregate
801	Fine Aggregate
830	Portland Cement
831	Admixtures
832	Curing Agents
833	Joint Fillers and Sealers
853	Reinforcement and Tensioning Steel
880	Water
886	Epoxy Resin Adhesives

Section 440: Plain Portland Cement Concrete Shoulders

Preparation

- Ensure the foundation immediately under the concrete shoulder and areas supporting the paving equipment will not contribute to deficient shoulder thickness or excessive yield losses

Construction

- Deposit concrete on the grade; do not re-handle it if possible
- Unload the concrete into an approved spreading device and mechanically spread it
- Place it continuously between transverse joints without using intermediate bulkheads
- Perform any necessary hand spreading with shovels
- Do not allow personnel to walk in freshly mixed concrete with shoes coated with harmful substances

- Thoroughly consolidate the concrete with vibration against and along the form faces and along the full length and both sides of the joint assemblies
- Do not use grout that accumulates ahead of the paver in construction expansion joints
- Deposit concrete near formed joints
- Do not dump or discharge concrete onto a joint assembly unless the concrete is centered on the joint assembly

Do not allow reinforcement placement to disrupt or damage the concrete

- Vibrate the full width and depth of the shoulder
- Do not allow vibrators to contact the foundation, load transfer devices, side forms, or joints

Concrete Pavement Finishing

- Smooth and true the concrete to the proper cross section with hand floats or mechanical floats
- Ensure the surface conforms to the required cross section and contains no irregular, rough, or porous areas
- Make surfaces flush at the joint between the roadway and the shoulder
- Finish the surface to provide a uniform texture (except on rumble strips)
- Use mechanical equipment for grooving plastic concrete, brooming, or burlap drag

Remove loose material and clean grout from the surface of the adjacent lanes immediately after finishing

Joints

Type	Description
Transverse Contraction	• Saw in shoulder to abut like joints in the roadway
Longitudinal	• Place reinforcement at locations shown on the plans adjacent to the adjoining lane • Secure reinforcement in place with supporting assemblies or by inserting into the supported sides of the fresh concrete
Construction	• From transverse construction joints when concreting operations will be interrupted for more than 1 hour

Permitting Traffic on Shoulders

- Ensure tests show the concrete has developed compressive strength of at least 2000 psi (14 MPa) and is at least 7 days old
- Construct earth ramps to facilitate movement across the shoulder
- Place barricades to prevent traffic encroachment
- Seal joints before permitting vehicles or equipment on the shoulder

Payment

- Concrete shoulders are paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
500	Concrete Structures
815	Graded Aggregate
830	Portland Cement

Section 441: Miscellaneous Concrete

Forms

Use forms that:

- Are subject to the Engineer's approval
- Use wood or metal that is readily available
- Are straight and oiled before each use
- Use metal divider plates and templates
- Use a slipform placement method, when applicable

Provide weep hole drain pockets filled with coarse aggregate to use with weep hole drain pipe or formed openings

Subgrade Preparation

- Compact the subgrade to the same degree as the roadway on which it is placed
- The Roadway Contractor shall complete grading for slope paving if required
- Place any required special materials during roadway construction when placing paving on the front slopes of ditches and shoulders
- Do not excavate for velocity dissipators, spillways, and slow drains below the foundation elevation

- Set specified dowel bars into the pavement when it is laid when fitting spillways on the concrete pavement
- Use metal parting strips to hold the ends of dowels bent into grooves

Do not place concrete on a muddy or frozen surface

Miscellaneous Concrete

Type	Description
Concrete Slope Paving	• Give final finish with a stiff-bristle broom
Concrete Sidewalks	• Give a Type V finish unless otherwise noted • Ensure curb cut (wheelchair) ramps have a rough or textured finish
Concrete Paved Ditches	• Ensure the surface of the bottom and sides of paved ditches are uniform and true to grade and cross section • Do not allow deviation if it reduces the ditch paving thickness • Finish ditch paving by floating with wood or metal floats to bring mortar to the surface to cover the coarse aggregate
Concrete Curbs, Gutters, and Median	• Remove face forms as soon as possible and finish exposed surfaces with a wood float • Use a straightedge to test the edge of the gutter and top of the curb and median • Place using a machine as long as results are satisfactory
Curb Cut Wheelchair Ramps	• Tie ramps into the adjacent paved or unpaved sidewalk and use a rough or textured finish

Slope Paving

- Place paving on slopes in horizontal or vertical courses, but not a mixture of both

Concrete Paved Ditches

- Form joints in concrete paved ditches at 30-ft (9 m) intervals

Concrete Sidewalk

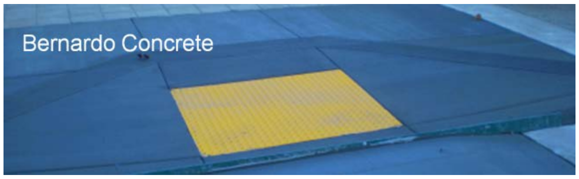
- Form transverse contraction joints using a tool designed to form a groove ⅓ the depth of the sidewalk

Backfilling

- Backfill areas as soon as possible without damaging the work

Clean-Up

- Clean each surface when the concrete work is complete



Payment

- Slope paving, sidewalks, concrete ditches, driveway concrete, drains, and velocity dissipators are all paid at the Contract Unit Price per square yard (meter)
- Concrete headwalls are paid at the Contract Unit Price per cubic yard (meter)
- Curbs, gutters, combination curb and gutters, headers, medians, curb cut wheelchair ramps, and spillways are all paid at the Contract Unit Price per each

Related Specifications

Section	Title
209	Subgrade Construction
500	Concrete Structures
832	Curing Agents
833	Joint Fillers and Sealers
853	Reinforcement and Tensioning Steel

Section 444: Sawed Joints in Existing Pavement

Mechanical Saw

- Use an adequately powered, water-cooled, mechanical saw with a diamond-edge blade or an abrasive wheel that will cut in a straight joint to the required depth

Joints

- Saw the joints true to lines designated by the Engineer
- Saw at least 2 in. (50 mm) deep, or deeper if the Engineer directs to remove pavement
- Do not dry saw with abrasive blades (use diamond blades)

Pavement Removal

- Begin removing the pavement
- Protect the edge of pavement that will remain
- Do not use removal methods that may damage these edges

> Do not allow traffic or other equipment to cross exposed edge of remaining pavement until new pavement is constructed in its place

Payment

- Sawed joints are paid at the Contract Unit Price per linear ft (m)

Section 445: Waterproofing Pavement Joints and Cracks

Preparation

- Place bituminous tack coat on:
  - Portland cement concrete
  - Old asphaltic concrete surfaces
- Prime the surface according to the manufacturer's recommendations
- Correct spalls greater than 3 in. (75 mm) in diameter
- Place primer on the surface at the rate specified by the primer manufacturer
- Cover sections that are primed with membrane within the same day or repriming will be required

Membrane Placement

- Place the membrane only when the temperature is above 40°F (4°C) and the pavement surfaces are dry and free of debris
- Center the membranes over the joint or crack within a 2-in. (50 mm) tolerance
- Seal transverse joints and cracks first, starting at the outside edge of the pavement
- Seal longitudinal joints, placing membrane in the direction that the Project will be paved

- Install the membrane straight and wrinkle-free with no curled or uplifted edges
- Press the membrane against the concrete or asphalt surface using a hand roller
- Bond edges and corners of the strips securely to the surface
- Place vasphaltic concrete overlay when the membrane surface is dry

Traffic will be allowed to enter the section between the time of placing the membrane and placing the paving, for 7 calendar days (maximum)

- Fill joints or cracks flush with the pavement
- Clean the joint and remove dirt and debris before filling the joint

Payment

- Waterproofing membrane materials are paid at the Contract Unit Price per linear ft (m)

Related Specifications

Section	Title
150	Traffic Control
888	Waterproofing Membrane Materials

Section 446: Placement of Pavement Reinforcement Fabric

Equipment

- Use a template or other method satisfactory to the Engineer to apply the bituminous tack coat uniformly when using fabric strips
- Use a mechanical device approved by the Engineer when placing fabric full width on the pavement to ensure the fabric is placed smooth, free of wrinkles, and with no uplifted edges
- Place the fabric in total contact with the underlying pavement
- Roll the fabric with a static drum or pneumatic roller to ensure adequate adhesion to the pavement surface

Preparation

- Mark joint and crack locations with an offset reference so they can be located after milling has been completed
- Clean the pavement surface to remove rocks, dirt, debris, and other materials that may prevent a clean bonding surface

> Repair potholes, spalls, or cracks greater than $^3/_{16}$ in. (5 mm) wide

Construction

- Mark joint and crack locations with an offset reference so they can be located after milling has been completed
- Do not install reinforcement fabric when ambient temperatures are less than 45°F (7°C)
- Use a bituminous tack coat when temperatures are between 45°F (7°C) and 70°F (21°C) for all reinforcement fabric types

- Use bituminous tack coat when fabric is placed on the milled surface, regardless of temperature
- Remove the release liner of the fabric and place the adhesive side to the pavement
- Place the self-adhesive reinforcement fabric no more than 24 hours in advance of the paving operation to ensure proper adhesion of the fabric to the pavement
- Place the fabric on the pavement immediately after the bituminous tack coat is applied to the pavement
- Place the nonwoven polyester side of the fabric on the pavement

Fabric Overlap

- Ensure that seams created butt or are lapped if more than one strip is required
- Make all lapped seams in one direction of the paving operation
- Make joint overlaps to prevent pickup by the paving train that places the asphaltic concrete

Fabric Protection

- Schedule work so that the fabric will be covered with asphaltic concrete prior to reopening the section to traffic
- Do not allow traffic on the unprotected fabric
- Allow traffic to use a section of applied fabric strips for a maximum of 7 days
- Ensure fabric is completely dry before the overlay is placed

Overlay Placement

- Apply bituminous tack coat over the fabric at the rate determined by the Engineer
- Milling may be required to provide minimum thickness (2 in.)

Payment

- Reinforcement fabric is paid at the Contract Unit Price per square yard (meter) or per linear ft (m) of reinforcement fabric

Related Specifications

Section	Title
150	Traffic Control
881	Fabrics

Section 449: Bridge Deck Joint Seals

Preparation

Issue	Description
Surface Preparation	• Ensure compressed air used to sandblast debris is free of moisture and oil • Use air compressors for cleaning joints equipped with suitable traps capable of removing surplus water and oil • Check compressed air daily for contamination
Preparation for Headers	• Remove loose, eroded, and unsound concrete from the surface within the joint • Provide horizontal bonding areas by cutting angular areas of concrete blockouts • Sandblast concrete surfaces or abrade free of oil, dust, dirt, traces of asphaltic concrete, or other contaminants
Preparation for Joint Seal	• If necessary, use a saw-cut concrete deck to provide an acceptable attachment surface for the joint seal
Joint Fabrication	• Have the joint fabricated the full width of the bridge deck

Construction

- Use an installer trained by the manufacturer to install the bridge deck joint sealing system
- Ensure the surface is completely dry before applying adhesive or primer
- Ambient temperature must not be less than 55°F (13°C) during installation of the epoxy concrete material

> Do not perform any part of installation in rainy weather or when rain is expected within 1 hour of installation

<u>Handling, Mixing, Finishing, and Curing</u>

- Fill blockout to the correct grade
- Cure the material according to the manufacturer's instructions
- Thoroughly mix the resin and hardener of epoxy mortar
- Prime the surface of the concrete in accordance with the manufacturer's recommendations
- Place and finish epoxy concrete within ½ hour of mixing

<u>Preformed Elastomeric Neoprene Profile Joint Seal Application</u>

- Remove the temporary joint filler and thoroughly clean the joint faces of all joint filler
- Lightly sandblast the joint to remove all residue
- Apply adhesive according to the manufacturer's recommendations
- Promptly remove all surplus residue on the bridge deck

Do not permit traffic to drive over sealed joints until epoxy or elastomeric concrete has hardened enough to resist displacement. Allow epoxy concrete to cure for at least 2 hours before opening to traffic

Payment

- Bridge deck joint seal is paid at the Contract Price per linear ft (m)

Related Specifications

Section	Title
106	Control of Materials
501	Steel Structures
ASTM	A 36
ASTM	D 395
ASTM	D 570
ASTM	D 588
ASTM	D 624
ASTM	D 638
ASTM	D 1299
ASTM	D 2240
ASTM	D 2628
ASTM	D 4070

Section 450: Pressure Grouting Portland Cement Concrete Pavement

Equipment

Type	Description
Batching Equipment	• Includes weight hoppers and scales for each dry material or calibrated volumetric batch hopper • Equip conveyor belts with windproof covers if belts convey dry materials into the mixer
Mixing Equipment	• Use a watertight, batch-type mixer or high-speed colloidal mixer capable of blending materials into a homogeneous mixture • Use a high-speed colloidal mixer various mix types
Grout Pumping Equipment	• Use grout pumping equipment with a positive displacement plunger or piston-type pump or a screw-type worm pump • Equip the end of the discharge line with a nozzle or device that remains secure in the drilled holes and is free of leaks • Furnish a blow pipe with enough air pressure to dislodge loose debris • Provide an auger of proper size and length to open clogged holes
Drilling Equipment	• Provide air compressors with enough capacity to operate pneumatic hammers or drills • Provide pneumatic or hydraulic drills equipped with bits • Operate equipment so as to prevent damage to the pavement being drilled • Do not create excessive down pressure to force the bit through the concrete rapidly
Slab Stabilization Testing Equipment	• Furnish a two-axle truck with dual rear wheels • Load rear axle to evenly distribute between the two sides
Slab Lift Measuring Equipment	• Ensure the equipment used to measure the slab lift can simultaneously detect movement of the two outside slab corners adjacent to the joint and the adjoining shoulder

Begin grouting operations when the air temperature in the shade is at least 35°F and rising

Drilling Holes

- Use the hole pattern and pumping sequence shown on the plans with modifications to use as many holes from previous undersealing work as possible
- The Engineer may alter the hole pattern
- Drill holes 1½ in. (38 mm) in diameter or another size if approved by the Engineer
- Ensure holes provide a positive seal for the pumping nozzle
- Drill holes approximately 8 in. (200 mm) deep beneath the bottom of the concrete
- Be careful during operations to not break or crack the slabs
- Repair slabs that have cracks that extend through the drill hole

Insert a pipe with enough air pressure in each hole to remove debris and provide passage for grout

Underseal Grout Pumping

- Pump grout holes designated by the Engineer
- Have the Engineer determine the time of day to perform pressure grouting
- The Engineer may require pressure grouting during late night and early morning hours
- Watch the lift measuring device to prevent excessive pumping pressures, rapid lifting of slabs, or substantial rising of adjacent shoulders
- Stop pumping in the hole when cavities or voids are filled within the range of the hole being grouted

Do not crack the slabs by differential lifting

- Secure the discharge hose nozzle in the hole to provide a seal that will maintain grout pressure underneath the slab
- Continue pumping in the hole until a clear flow of grout comes out the other holes, joints, or cracks, or until the slab begins to lift excessively
- Repeat this procedure in other holes until voids are filled
- Take precautions to minimize the amount of grout that flows into the edgedrain system

Traffic Note: Do not permit traffic on grouted slabs until the grout has taken an initial set (4–6 hours)

Payment

Type	Payment Method
Holes	Contract Until Price per each
Portland Cement Pressure Grout Slurry	Contract Unit Price bid per 94-lb (42.6 kg) bag of cement
Preliminary Testing	Contract Price bid per linear mile (kilometer) horizontal measure

Related Specifications

Section	Title
609	Removal of Portland Cement Concrete Roadway Slabs
801	Fine Aggregate
830	Portland Cement
831	Admixtures
880	Water
882	Lime
883	Mineral Filler
884	Chlorides

Section 451: Patching Portland Cement Concrete Pavement (Spall Repair)

Equipment

- Use air compressors equipped with traps that can remove surplus water and oil in compressed air
- Ensure the compressor can deliver compressed air at a continuous pressure
- Do not use contaminated air

Repair Area Removal and Preparation

- "Sound" each transverse joint and longitudinal joint with a visual defect to determine the limits of damaged or defective areas
- Strike the pavement surface along the sides of each joint with a hammer, chair drag, or similar tool to detect unsound concrete that sounds flat or hollow
- Mark the limits of defective areas on pavement by marking 2 in. (50 mm) beyond the outer limits of unsound concrete area

- Mark spalled areas less than 2 ft (600 mm) from each other along a joint as one spall area
- Remove unsound material within the sawed area using a chipping hammer
- Before placing patching material, saw the face of existing transverse or longitudinal joints bordering the repair areas
- Thoroughly clean surfaces within repair areas by sandblasting and air blasting to remove oil, dust, dirt, traces of asphaltic concrete, slurry from saw operation, and other contaminants

> Do not "over-cut" pavement beyond marked areas, whenever possible

Concrete Patching

- Accomplish the work with other operations in progress within an area if possible
- Complete the work before grinding operations begin
- Remove and replace completed concrete patches that contain cracks, shrinkage, or compression failures

<u>Repair Method 1: 24-hour Accelerated Strength Concrete</u>

- Completely coat concrete surface areas within the repair area with a film of Type II epoxy
- Mix the concrete on site in a portable mixer
- Deposit the concrete in the repair area while the epoxy is still tacky
- Vibrate it to form a dense, homogeneous mass of concrete that completely fills the patch
- Screed the concrete to the proper grade and do not disturb it until the water sheen disappears from the surface
- Cover the concrete with wet burlap or membrane-curing compound

<u>Repair Method 2: Rapid Setting Patching Material for Portland Cement Concrete</u>

- Perform patching material handling, mixing, placing, consolidating, screeding, and curing according to the manufacturer’s instructions
- Continue curing for 1 hour (minimum) and until opening the section to traffic

<u>Special Requirements</u>

- Place a form to the full depth of the repair area to maintain a true, straight shoulder joint
- Protect traffic in adjacent lanes during sandblasting
- Thoroughly clean the area to be repaired with compressed air

- Remove sand from the sandblasting operation from the roadway and shoulders
- Remove saw slurry and other contaminants from over-cutting

Payment

- Spall repair is paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	**Title**
504	Twenty-Four Hour Accelerated Strength Concrete
800	Coarse Aggregate
801	Fine Aggregate
833	Joint Fillers and Sealers
886	Epoxy Resin Adhesives
934	Rapid Setting Patching Materials for Portland Cement Concrete

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 452: Full Depth Slab Replacement

Preparation

- Use wire brushes or other methods to clean exposed faces
- Remove existing silicone or other joint sealant from exposed concrete faces
- Remove debris and standing water from the base
- Thoroughly compact loose base material by hand tamping before placing concrete

Dowel Installation

- Use a pneumatic or hydraulic drill to drill holes into the existing concrete faces
- Drill a hole no greater than 1½ in. (38 mm) diameter to insert dowel bars
- Prevent damage to the pavement being drilled
- Thoroughly clean drilled holes of contaminants
- Set the type and size of dowels into hardened concrete face from existing pavement with Type VIII epoxy bonding compound
- Place dowels with one-half of the dowel protruding out of the pavement
- Place dowels at the correct horizontal and vertical alignment
- Place enough epoxy in the back of the hole to completely fill the entire cavity around the dowel
- Allow epoxy to harden before placing concrete to prevent the dowels from moving

Never drive dowels into the dowel hole with a sledge hammer or other device

Setting Forms

- Place the form the full depth of the replaced slab or joint area to maintain a true, straight shoulder joint
- Compact the foundation under the form true to grade
- Clean and oil the forms before placing the concrete
- Wait 4 hours to remove the forms from the freshly placed concrete
- Carefully remove forms to avoid damaging the pavement
- Repair the shoulder to the Engineer's satisfaction

Coated dowels will be rejected if they cannot be freely inserted into a dowel hole

Concrete Placement and Finishing

- Deposit concrete within the slab replacement area in a way that requires as little rehandling as possible
- Minimize hand spreading as much as possible

Do not allow workmen to walk in fresh concrete with shoes coated with earth or other foreign substances

- Fill the replaced slab area with concrete and thoroughly consolidate by rodding, spading, and using vibration to form a dense homogeneous mass throughout the area
- Ensure the final surface area has a uniform appearance and is free of irregularities and porous areas

Sawing and Sealing Joints

- Saw and seal joints with silicone sealant
- Ensure the width of the sawed joints is ⅜ in. (10 mm)
- Saw and seal joints as soon as possible, but not more than 60 days after placing the slab

Rain Protection

- Keep materials to protect the concrete surface available at all times
- When rain in imminent, stop paving operations and begin covering the surface of the unhardened concrete with a protective covering

> Provide lighting for work performed at night for safety, traffic control, and work control and completion

Opening to Traffic

- Schedule slab replacements so that concrete will cure for 4 hours (minimum)
- Complete the work and open the lanes to traffic before sunset

Payment

- Slab replacement is paid at the Contract Unit Price per cubic yard (meter)

Related Specifications

Section	**Title**
504	Twenty-Four Hour Accelerated Strength Concrete
609	Removal of Portland Cement Concrete Roadway Slabs
833	Joint Fillers and Sealers
853	Reinforcement and Tensioning Steel
886	Epoxy Resin Adhesives

Georgia Department of Transportation Construction Inspection Training

Pavements Inspection

Section 455: Filter Fabric for Embankment Stabilization

Preparation

- Prior to placing filter fabric, remove logs, stumps, and other objects from the ground surface
- Leave grasses that formed root mats in place to provide support for the fabric placement

Section 456: Indentation Rumble Strips

Definitions

Skip Ground-In-Place Rumble Strips:	Rumble strips placed with 28 ft (8.5 m) of strips and 12 ft (3.7 m) of clear space between
Continuous Ground-In-Place Rumble Strips:	Rumble strips placed continuously
Edge Line Rumble Strips:	Rumble strips placed continuously on the edge-line traffic stripe
Centerline Rumble Strips:	Rumble strips placed continuously on the centerline traffic striping

Cutting Tool

Use a cutting tool that:

- Has independent suspension from the power unit to allow the tool to self-align with the slope of the shoulder
- Is equipped with guides to provide consistent alignment of each line of indentations in relation to the roadway
- Houses a single rotary-type milling/grinding head in line in the direction of travel

Indentations

- Install indentations within 10 calendar days for traveled ways opened to traffic
- Ensure finished indentations have a concave circular shape and are spaced 12 in. (300 mm) center to center

Excess waste material resulting from operation may be swept to grassed shoulder and spread where applicable

Payment

- Rumble strips are paid at the Contract Unit Price bid per gross linear mile (kilometer)

Equipment

Type	Description
Air Compressors	• Equipped with traps to remove surplus water and oil in compressed air • Do not use contaminated air • Ensure the compressor can deliver compressed air at a continuous pressure
Silicone Sealant Pump	• Apply silicone by pumping only • Use a caulking gun with cartridge for touch-up work or small applications • Use a pump with sufficient capacity to deliver the necessary volume of silicone to completely fill the joint in a single pass
Caulking Gun	• Use for touch up work • Use to place vertical runs of Type A silicone in the bridge deck joint when Type B, C, or D silicone is used in horizontal runs • Seal voids and cracks with Type A silicone • Use for sealing small cracks in concrete

Ensure joint is clean and dry before installing a bond breaker or sealant

Resealing Existing Joints

- Remove existing sealant in joints
- Determine the depth of existing joint
- Thoroughly clean the joint of all foreign material

Sealing New Joints

- Saw transverse and longitudinal joints
- Make the initial cut and wait for the concrete to harden enough to prevent spalling or raveling
- Make the second cut to the required width and depth
- Clean the freshly cut sawed joints
- Install bond breakers
- Install silicone sealant
- Clean the pavement
- Open to traffic

The Engineer will determine all cracks that should be resealed

Payment

- Sealed joints are paid at the Contract Unit Price bid per linear ft (m)

Related Specifications

Section	Title
500	Concrete Structures
833	Joint Fillers and Sealers
886	Epoxy Resin Adhesives

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B-7 Bridges Training Module

Georgia Department of Transportation Construction Inspector Training

Bridges Inspection Menu (Section Number)

Instructions: Click to begin each session. Once all sessions are complete, click to begin the Earthwork certification exam

Course Menu

Begin Bridges Certification Exam

Georgia Department of Transportation

Section 500: Concrete Structures

Contractor is responsible for all concrete mix designs

Specifications Note: Use the applicable method in Section 500 of the *Sampling, Testing, and Inspection Manual*

General Construction Notes

- The Contractor must submit all concrete mix designs to the Office of Materials
- The Department will approve mixes that contain materials from approved sources and that produce concrete by the Department that meets the GDOT Standard Specifications
- The concrete plant must transmit delivery tickets with each load of concrete delivered to the site
- Required information on each delivery ticket: (1) project designation, (2) date, (3) time, (4) class, (5) quantity of concrete, (6) batch proportions, (7) free moisture content of aggregates, (8) quantity of water withheld, and (9) concrete mixing revolutions
- Discuss the following before beginning a bridge deck placement:
    - Reinforcing steel support method
    - Final screed setting check
    - Anticipated placement rate
    - Equipment type

- Curing methods
- Adverse weather placement procedures
- Emergency procedures
- Other work-related details

Cold and Hot Weather Concrete

- Secure the Engineer's approval of a "Cold Weather Concrete Curing and Protection Plan" for bridges and structures
- Ensure protection for the underside of bridge decks for metal forms
- Provide protection procedures to keep concrete above 50°F for 72 hours after placement and above freezing for 6 days after placement
- Keep concrete at no more than 90°F
- Cool aggregates by fogging or other means that do not affect moisture content
- Do not "splash on" water to aid screeding or finishing operations

Materials

- Use either Class A or B coarse aggregate (except for limestone or dolomite in bridges)
- Use Type I or II portland cement or Type IP portland–pozzolan cement
- Do not use air entraining cement
- Construct bridge sections with duct enclosures with a maximum stone size of No. 7
- Stockpile aggregates separately by type and source
- Keep stockpile areas firm, reasonably level, well-drained, and clean

The Engineer may reject improperly formed stockpiles

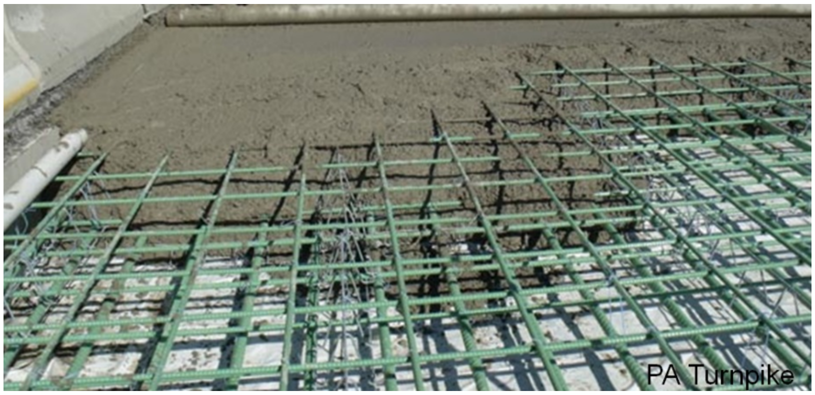
Concrete Handling and Preparation

- Ensure concrete reaches its final position within 1 hour after adding cement to aggregates
- Use the following to transport the concrete from the truck to the forms: (1) buckets, (2) buggies, (3) pumps, or (4) other approved means
- Place the concrete without delays

- Manipulate the delivery unit to avoid vibration damage to partially set concrete
- Thoroughly clean and wet forms before placement

> Use pipes or tubes to place concrete requiring dropping of the concrete more than 5 ft vertically

- Do not use equipment that leaks grout, water, oil, or gas
- Operate pumping equipment (if used) so that the concrete is produced in a continuous stream without air pockets
- Have enough production and placement capacity to continuously mix, place, and finish the concrete in each pour
- Form an approved construction joint if the pour cannot be completed in 1 day
- Construct and maintain in mortar-tight condition
- Must be easily removed without damaging concrete
-



- Repair defects using approved methods
- Reuse forms in good condition as determined by the Engineer
- Use acceptable formwork materials:
  - Lumber
  - Plywood
  - Metal
  - Plastic
  - A combination of these

Concrete Placement

- Work concrete around reinforcement bars without displacing them
- Compact the concrete using tools and vibration
- Do not disturb the forms or projecting reinforcing bars after placement
- Do not drive, pile, blast, or perform other operations before concrete is 3 days old

Curing Concrete

- Continue curing for 5 days after applying surface finish
- Cure formed surfaces after removing forms
- Cure surfaces exposed to air using methods that prevent premature curing or moisture loss
- Use cotton mats, burlap, sand, hay, or straw coverings
- Keep coverings moist continuously

Open a structure to traffic other than haul traffic after all concrete in the decks, parapets, or curbs (sidewalks) reaches its 28-day cylinder strength and is at least 14 days old

Payment

- Concrete structures are paid at the Contract Price per cubic yd (m), per Lump Sum, or per linear ft (m), each complete in place and accepted

Related Specifications

Section	Title
104	Scope of Work
211	Bridge Excavation and Backfill
431	Grind Concrete Pavement
621	Concrete Barrier
800	Course Aggregate
801	Waterproofing Fabrics
824	Cationic Asphalt Emulsion
836	Special Surface Coating for Concrete
838	Graffiti-Proof Coating for Concrete
853	Reinforcement and Tensioning Steel
865	Manufacture of Prestressed Concrete Bridge Members

Section 501: Steel Structures

Preparation

- The Engineer must verify the Contractor's installation method
- Use straightening methods that do not injure the metal
- Reject metal that has sharp kinks and bends
- Apply heat no hotter than 1150°F to adjust deviations
- Ensure each steel piece is marked with:
  - Mill test report number
  - Heat number
  - Color code (if applicable)

Bolts

- Before reaming, drilling, or bolting, ensure forming members are: (1) straight; (2) close-fitting; (3) clean; (4) true to the required dimensions; (5) free from twists, bends, and burrs; (6) well-pinned; and (7) firmly drawn together
- Fit up connections securely before placing bolts
- Ream or drill unfair holes (holes that prevent the bolt from entering)

Welded Construction

- Ensure welded construction conforms to specification requirements
- Do not allow electroslag welding; it is prohibited
- Repair, remove, or replace welds that do not meet specifications

If welds are unacceptable, Engineer will reject the entire piece

Straightening Material (Heat Straightening)

- Ensure all parts are free of stress and external forces
- Heat metal to the temperature given by the specifications
- Cool metal slowly after heating

Payment

- Steel structures are paid at the Contract Price per pound (kilogram) of structural steel or per Lump Sum, each complete in place

Related Specifications

Section	Title
109	Measurement and Payment
851	Structural Steel
852	Miscellaneous Steel Materials
854	Castings and Forgings
857	Bronze Bushings, Bearings, and Expansion Plates
870	Paint
881	Fabrics
885	Elastomeric Bearing Pads

Section 502: Timber Structures

Material Handling and Storage

- Handle timber carefully without dropping, breaking outer fibers, bruising, or piercing with tools
- Place all stored material in well-drained locations and keep it free from weeds and rubbish

The following hardware must be galvanized: bolts, nuts, washers, special couplings, dowels, nails, and spikes

Construction

- Repair and apply treatments to treated timber
- Treat bolt holes with creosote oil and an approved pressure bolt hole treater
- Treat countersunk holes with hot creosote oil before placing bolts
- Cut and frame the lumber and timber to a close fit so the joints will have an even bearing over the entire contact surface
- Countersink holes wherever smooth faces are required

Timber Superstructure Construction

- Install stringers
- Lay single plank floors
- Lay laminated or strip floors
- Frame and erect hub guards and railings

Payment

- Structural metal is paid at the Contract Price according to quantity of structural metal
- Lumber and timber are paid at the Contract Unit Price bid per thousand feet board measure, complete in place and accepted

Related Specifications

Section	Title
645	Repair of Galvanized Coatings
852	Miscellaneous Steel Materials

Section 504: Twenty-Four Hour Accelerated Strength Concrete

The Contractor must provide enough labor and equipment to place, consolidate, and screed each batch of concrete within 1 hour after introducing the cement and first mixing water into the mix

Batch and Mix Materials

- The Engineer must approve the method of adding the acceleration admixture
- The Contractor shall measure admixture into the concrete with an accuracy of ±3%
- The Contractor shall not add accelerating admixture to concrete that has attained an age of 45 minutes as measured from the beginning of the initial mixing at the plant
- Mix the concrete for 40 additional revolutions at mixing speed

Payment

- Accelerator admixtures are paid at the Contract Unit Price bid either by cubic yard (meter) or square yard (meter)

Section 505: Corrugated Steel Bridge Plank

Plank Installation

- Place plank as shown on the plans
- Ensure the bottom corrugations have full bearings on the supporting members
- Hold the bottom corrugations in full contact with the supporting members until they are securely connected

In-Shop Fabrication Requirements

- Shop-pump holes for the welded attachment to the beams and space the holes as shown on the plans
- Ensure shop painting is of the paint type and number of coats shown on the plans

All welds shall be of the type and size, and be placed at locations shown on the Plans

Payment

- Corrugated steel bridge planks are paid at the Contract Price per square ft (m) for corrugated steel bridge plank, complete in place

Related Specifications

Section	Title
852	Miscellaneous Steel Materials
870	Paint

Section 506: Expanded Mortar

Mortar Placement

- Use expanded mortar for the shear keys
- Completely fill the shear key with mortar
- Rod the mortar into a dense, homogeneous mass
- Float the mortar off flush with the surface of the precast decks
- Moist cure the mortar continuously for a minimum of 3 days

Do not allow traffic on bridge decks until 5 days after expanded mortar is placed

Payment

- Expanded mortar is paid at the Contract Price for concrete of the same Class as the concrete the mortar accompanies

Related Specifications

Section	Title
800	Coarse Aggregate
801	Fine Aggregate
830	Portland Cement
835	Aluminum Powder
880	Water

Prestressed Concrete (PSC) Bridge Members Erection

- Erect the beams in conformity with true longitudinal alignment and transverse placement as shown on the plans or as directed by the Engineer
- Align and grade the caps according to the plans
- Drift the caps to the timber pile heads according to the plans
- Erect PSC deck units that bear directly on the caps so sections have a smooth and uniform bearing on the caps

Pouring Expanding Mortar into Shear Keys Between Deck Units

- Erect the entire bridge
- Ensure all units are in final alignment
- Pour mortar in the shear keys
- Continuously moist cure the keys for at least 3 days
- Keep traffic off the structure for at least 5 days

Tightening Diaphragm Bars

- Bring diaphragm bar nuts to a snug fit against the beams
- Pour the diaphragm
- Allow the diaphragm concrete to age at least 5 days and reach at least 1500 psi
- Tighten the nuts fully
- Cut off the excess bar length
- Place an approved grout in the recessed area provided for the bar’s nuts and washer

Use Type III coating on prestressed members as required by the chart in Specifications 500AB.3.

Payment

- Beams are paid at the Contract Price per linear ft (m)
- PSC box beams are paid at the Contract Price per linear ft (m)
- Deck units are paid at the Contract Price per span of each different nominal span length
- Caps are paid at the Contract Price per each

Related Specifications

Section	Title
109	Measurement and Payment
865	Manufacture of Prestressed Concrete Bridge Members

Section 508: Asphalt Plank Bridge Floor

Concrete Base Construction

- Ensure the concrete is dry and free from dust and rubbish
- Remove surplus talc and other powder from the base
- Apply approximately 1 gal (1 L) of cold cutback asphalt to each 100 ft^2 (9 m^2) of surface
- Brush the cutback asphalt coat out well and allow it to dry
- Mop the surface with hot-applied asphalt cement
- Lay the plank straight and smooth with staggered joints
- Ensure the plank is free of irregularities

Timber Base Construction

- Securely spike the wooden floor upon which the plank will be laid
- Remove nails, dirt, and rubbish before laying the asphalt plank

Payment

- Asphalt plank bridge floor is paid at the Contract Price per square yard (meter)

Section 509: Prestressing Concrete by Post Tensioning

Contractor Options

- *Alternative Prestressing Systems*: The Contractor may use post-tensioning systems other than those shown on the plans
- *Alternative Stressing or Anchorage Blocks*: Stressing or anchorage blocks for the structure may deviate from those shown on the plans

Duct Installation

- Support the ducts at intervals of no more than 2 ft
- Join rigid duct sections using positive metallic connections
- Use waterproof tape at the connections
- Make duct splices so the nose of the tendon being pushed into the duct goes from a male end into a female end
- Stagger splices in ducts to prevent splices in the same location in a row of ducts
- Carefully cut and deburr the ends of the ducts
- Place continuous-draped longitudinal ducts in the web in one vertical row at the center of the web
- Tie the ducts securely to the saddles
- Ensure a clear distance between the ducts
- Do not bundle the ducts
- Ensure the vents are mortar tight, taped as necessary, sealable, and capable of allowing grout to be injected into them

Steel Installation Reinforcement

- Fabricate reinforcing steel and place it according to the plans and shop drawings
- Do not cut and remove reinforcing steel to align stressing ducts properly
- Replace bars that cannot be fabricated to clear ducts with bars with an adequate lap length

Post-Tension Install Anchorages

- Secure post-tensioned prestressing steel at ends using permanent anchoring devices

Post-Tension the Tendons

- Ensure the deck slab thickness and deck reinforcement cover comply with the plan requirements
- Wait to prestress cast-in-place concrete until the compressive strength of all the concrete placed reaches the required 28-day strength and the concrete is at least 14 days old
- Conduct the tensioning process so that the applied tension and elongation can be measured
- Tension the prestressing steel using hydraulic jacks

Grout the Duct

- Open the grout and vent openings
- Ensure that the pumping pressure at the tendon inlet does not exceed 250 psi
- Allow grout to flow from the first vent after the inlet pipe to remove residual flushing water or entrapped air
- Once water or air is removed, cap or otherwise close the vent

Do not use sand in grout used for prestressing concrete bridge members

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 510: Protective Platforms

Construction

- Construct and maintain a protective platform so that no object or liquid will fall from the bridge superstructure or platform to the roadway below
- Place protective platforms under spans that pass over pedestrian or vehicular traffic lanes

> Place platforms immediately after setting beams and before working on the span

Platform Specifications

Use platforms that:

- Extend at least 3 ft (1 m) beyond each side of the outside limits
- Completely cover the length of the spans over the traveled ways
- Maintain the minimum vertical clearance over the traffic lanes

Protective Platforms Construction and Removal

- Post signs stating (MUTCD:W 12-2) for approaching traffic
- Remove the protective platforms when the superstructure worker is complete
- Stop operations and take remedial actions if the platforms fail to provide required protection
- Remove the protective platforms and signs when complete

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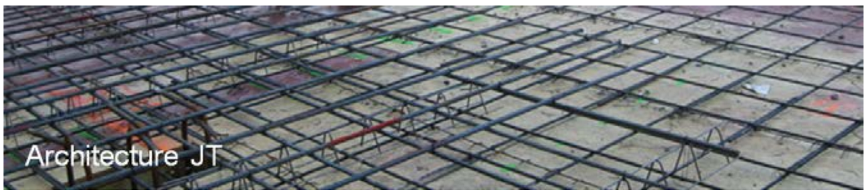
Bridges Inspection

Section 511: Reinforcement Steel

Handling

- Load, transport, unload, and handle reinforcement steel in a way that prevents damage
- Block unloaded reinforcement steel off the ground and store it in piles separated by size and type
- Protect reinforcement steel from weather if prolonged exposure is expected
- Clean off loose mill scale, rust scale, and coatings that will destroy the bond



Construction

- Tie the mat steel at each intersection on the outer edges and at alternate intersections within the mat
- Support the mat steel using precast blocks fastened with cast-in wires

Do not use rocks or random pieces of broken concrete to support steel

- Position dowel bars so that the column bars or vertical wall bars can be spliced and tied in the location the plan specifies
- Support the mat steel using precast blocks fastened with cast-in wires
- Construct a rigid template across the top of the footing to support the dowel bars
- Attach the dowel bars to the template so they cannot move during concrete placement
- Do not push the dowel bars into the wet concrete after placing
- Space steel off the side forms using precast blocks
- Tie hoop ties at intersections with dowel bars and corner vertical bars
- Ensure bundled bars have at least 3 ties per bundle for beam and cap steel ties

Payment

- Reinforcement steel is paid at the Contract Price per Lump Sum or per pound (kilogram) of bar reinforcement steel

Related Specifications

Section	Title
853	Reinforcement and Tensioning Steel

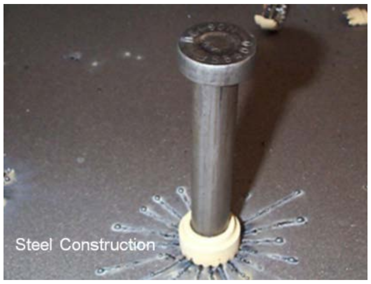
Section 512: Shear Connectors

Materials

- Use stud-type shear connectors of the size or diameter and length specified in the plans
- Do not paint or galvanize studs

Construction

- Fabricate channel-type shear connectors as denoted in the specifications and plans
- Fabricate stud-type shear connectors of the correct length after welding
- Allow shear connectors to be welded in the girder flanges' beam either in the shop or onsite
- Before welding, clean the shear connectors and base of rust, scale, oil, and paint
- Wire-brush, peen, prick-punch, or grind base metal where shear connectors will be welded



Channel-Type Shear Connectors Defective Welds Repair

- Repair undersized but otherwise sound welds by bringing the weld up to size with additional welding
- Repair undercut caused by the welding process by filling with additional weld metal

Repair unsound welds by chipping

Payment

- Shear connectors of the specified type are paid at the Contract Price per pound (kilogram), complete in place

Section 513: Precast Reinforced Concrete Box Culverts Barrel Sections and End Sections

Material Requirements

- Ensure precast wingwalls and aprons are built so that corrugations of pipe sleeve inserts lock into concrete and have reinforcement steel maintained around the pipe sleeve inserts
- Use modified connector boxes of the type required for connections to precast ends or cast-in-place ends
- Use pipe sleeves rigid enough to withstand concrete placement, anchoring, and construction loads without damage or excessive deformation

Excavation, Bedding, and Backfill

- Place bedding between graded forms set at least 18 in. (450 mm) outside each wall of the boxes or from the edge of the precast apron sections
- Shape bedding material to fit the bottom of the precast sections
- Screed off graded forms

- Ensure bedding is level in the plane perpendicular to the culvert centerline
- Check the grade of the bedding surface on both sides before installing precast sections
- After placing precast sections on the graded bedding, remove the forms
- Install barrels according to the manufacturer's recommendations

Make all joint sections between aprons and barrels water tight

- Ensure all concrete is set up before installing the wingwalls
- Use cast-in-place ends at the ends of precast box culvert barrels
- Use cast-in-place ends of the same design as cast-in-place box culverts
- Repair spalled areas around the holes
- Fill lift holes with mortar or concrete

Related Specifications

Section	Title
207	Excavation and Backfill for Minor Structures
834	Masonry Materials
843	Concrete Pipe
848	Pipe Appurtenances
852	Miscellaneous Steel Materials

Section 514: Epoxy-Coated Steel Reinforcement

Handling

- Use a system for handling coated bars that have padded contact areas for bars whenever possible
- Use padded bundling bands
- Lift bundles with multiple supports or a platform bridge
- Do not drop or drag bars

Repair damaged areas within 12 hours and before visible rusting appears between aprons and barrels are not permeable

Construction

- During and after installing bars into their deck locations, repair any cuts, nicks, and abrasions in the bar coating with epoxy repair material
- Repair damaged reinforcing steel and metallic accessories with epoxy repair material supplied by the powdered epoxy resin manufacturer
- Thoroughly remove rust by sandblasting or other approved methods before repairing
- To prevent subsequent rusting, provide a rust-free and completely coated steel reinforcement system before placing concrete in the deck

- Keep coated bars free from dirt, paint, oil, grease, or other foreign substance
- Place the deck concrete using methods and equipment that will not damage the coated materials
- Do not expose coated bars to fire or flame

Related Specifications

Section	Title
853	Reinforcement and Tensioning Steel

Section 515: Handrail—Ferrous Metal and Pipe

Handrails Construction

- Set anchor bolts according to the plan details and ensure that bolts have the correct spacing and projection
- If the projection is too short, lengthen or replace the bolt as directed by the Engineer
- Remove all concrete protrusions and fill all depressions before placing posts
- Finish concrete with Type IV—Floated Surface Finish

Handrails Erection

- Make all rails parallel to grade
- Set the handrail posts normal to grade when the bridge rails are supported on a concrete parapet

- Tighten the set screws as detailed on the plans
- Tighten the anchor bolt nuts to a snug fit with full bearing on the base of the post

Ensure posts and rails are true to line and grade

Payment

- Metal or pipe handrail is paid at the Contract Price per linear ft (m), complete in place

Related Specifications

Section	Title
645	Repair of Galvanized Coatings

Section 516: Aluminum Handrail

All cast posts for any one structure shall be produced by the same manufacturer

Construction

- Set anchor bolts according to the plan details and ensure that the bolts have the correct spacing and projection
- Remove all concrete protrusions and fill all depressions for bearing areas
- Ensure that bearing areas for posts are true to grade
- Separate contact surfaces with neoprene pads
- Do not place aluminum alloys in direct contact with copper, copper base alloys, lead, nickel, iron, steel, or wood

Handrail Erection

- Make all rails parallel to grade
- Set handrail posts normal to grade where the bridge rails are supported on a concrete parapet
- Tighten the anchor bolt nuts to a snug fit with full bearing on the post base
- When posts and rails are completely bolted into place, ensure they are true to grade

Payment

- Aluminum handrail is paid at the Contract Price per linear ft (m), complete in place

Related Specifications

Section	Title
645	Repair of Galvanized Coatings

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 520: Piling

Definitions

Plan Driving Objective (PDO):	A statement on the plans specifying the minimum requirements during pile driving
Minimum Tip Elevation:	The elevation the pile tip cannot stop above
Long Pile:	A pile more than 50 ft (15 m) in length

Handling

Pile Type	Handling Description
Timber	• Handle carefully using only non-metallic slings • Do not drop or damage piling • Store on skids above the supporting surface
Prestressed Concrete	• Handle carefully to prevent fracture by impact or by excessive bending stress • Do not place other materials on piling during storage or transport • Load and unload piles using embedded pick-up points placed during manufacturing
Metal Shell	• Do not deform or dent during handling and storage • Keep shells fully drained
Sheet H-Piling	• Do not deform or bend flanges during handling and storage • Keep the piling fully drained

Preparation

- Remove or cut out portions of obstacles that interfere with attaining the PDO
- Make the embankment at the bridge ends full depth to the subgrade template except for the stage of construction providing a bench of the end bent
- Thoroughly compact the embankment as provided in the specifications

Construction

- Determine pile length (always use full-length timber piling)
- Drill pilot holes when required
- Test the piling
- Evaluate the bearing capacity (determine the driving resistance and perform a loading test)
- Drive the piling
- Excavate and re-drive
- Jet and spud unless otherwise noted in the Contract
- Cut off, splice, and extend the piling
- Weld the steel piling splices and sway-bracing attachments
- Repair and treat the timber piling
- Bolt the timber bracing
- Coat and paint the piling

Payment

- Piling is paid at the Contract Prices, complete in place

Related Specifications

Section	Title
104	Scope of Work
109	Measurement and Payment
636	Highway Signs
855	Steel Pile
865	Manufacture of Prestressed Concrete Bridge Members

Section 522: Shoring

Shoring Design

- Ensure the shoring is structurally adequate to withstand forces from pressures resulting from excavation and pressures of surcharge loads from adjacent structures, roadbeds, tracks, slopes, and equipment
- Ensure the work conforms to the sequence of construction outlines on the plans and in the special provisions

Payment

- Shoring is paid at the Contract Price, complete in place, maintained, and removed

Section 525: Cofferdams

Cofferdam Design

In the design of cofferdam, consider the following:

- Use forces and pressures from an excavated depth of not less than 6 ft (1.8 m) below the elevation of the bottom of the footing
- Use forces and pressures from surcharge loads from adjacent structures, roadbeds, tracks, slopes, and equipment

Cofferdam Construction

- Correct to the Engineer's satisfaction cofferdams that tilt or move laterally during construction
- Use all reasonable methods to provide a dewaterable enclosure
- Unless otherwise specified, completely remove all cofferdam material

Cofferdam material shall remain the property of the Contractor

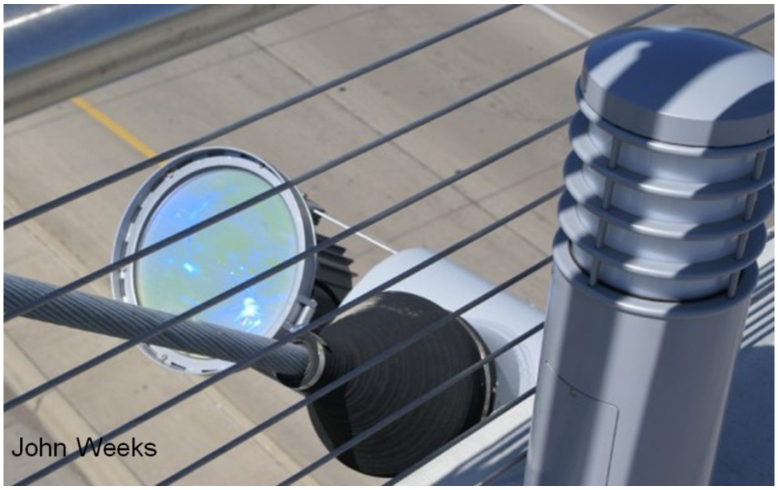
Payment

- Cofferdams measured for separate payment are paid at the Contract Price per each, complete in place, maintained, dewatered, removed, and disposed of
- Cost of cofferdams not measured for separate payment will be included in the Contract Price for bridge excavation

Section 529: Navigation Lighting

Conduit, Boxes, Fittings, Wiring, and Supports

- Ensure conduit connections are waterproof
- Use flexible conduit when going from bridge superstructure to substructure, from bridge fender system, and in transition areas between rigid members
- Use nonmetallic conduit for the underground conduit between the service riser and the bridge

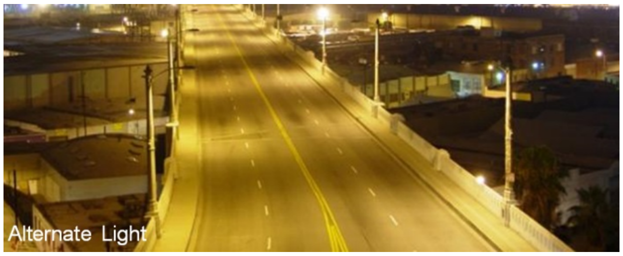


- Use flexible conduit to connect the rigid galvanized steel conduit located on the faces of the pier or bent columns to the conduit located on the finder system walkway
- Install conduit perpendicular to or parallel with the principal structural members
- Fit conduit terminals at the junction boxes with bushings
- Allow use of powder-actuated galvanized studs and clamps to fasten items to the concrete

Ensure the Qualified Electrician possesses evidence of classification

Power Supply and Wiring

- Require a service pole at least 30 ft (9 m), Class 5, or as shown on the plans
- Use a metallic service riser with a weatherhead
- Use a weatherproof enclosure containing a fusible disconnect switch of the appropriate voltage and ampere rating or as shown on the plans
- Mount the photoelectric control near the top of the service pole
- Direct the photoelectric control toward the north sky
- Enclose the wiring to and from the photoelectric control in rigid galvanized conduit
- Mount the disconnect switch, magnetic contactor, and transformer to the service pole
- Install the weatherproof enclosure so that it is accessible from the ground



Payment

- Each navigation lighting system completed and accepted at the location specified is paid at the Lump Sum Price bid for each system

Related Specifications

Section	Title
645	Repair of Galvanized Coatings
852	Miscellaneous Steel Materials
863	Preservative Treatment of Timber Products
921	Luminaires
922	Electric Wire and Cable
923	Electrical Conduit
924	Miscellaneous Electrical Materials

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 528: Epoxy Pressure Injection of Concrete Cracks

Preparation

- Prepare concrete surfaces next to the cracks by exposing the clean and sound concrete
- Ensure procedures must comply with any traffic handling and construction sequencing requirements for the Project

Seal Injection

Seal concrete cracks as follows:

- Prepare the concrete surfaces
- Seal cracks at the surface with epoxy
- Thoroughly penetrate voids on the surface
- Clean the sealed cracks to the original concrete surface
- Remove devices and surface sealers over the injection holes

Payment

- Epoxy pressure injection of concrete cracks is paid at the Lump Sum Price bid

Related Specifications

Section	Title
886	Epoxy Resin Adhesives

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 530: Waterproofing Fabrics

Concrete Preparation

- Fill all hole cracks and depressions in the concrete surface flush with the mortar
- Chip or grind smooth all high spots, sharp points, and edges
- Thoroughly clean and dry the concrete surface

Construction

- Seal openings and structure edges; construct a seal to prevent water from passing between the waterproofing and surface
- Require a double thickness of waterproofing membrane over properly sealed expansion, construction, or control joints
- Ensure edge and end seams overlap at least 4 in. (100 mm) on all applications
- Rub membrane firmly as soon as possible to minimize bubbles caused by air outgassing or water vapor from the concrete

Payment

- Waterproofing is paid at the Contract Price per square yard (meter), complete in place

Section 531: Dampproofing

Surface Preparation

- Thoroughly clean and dry the surface to be dampproofed
- Spray at least two applications of primer, allowing primer to be thoroughly absorbed before the next application

Concrete surfaces shall cure at least 5 days before dampproofing

Construction

- Evenly apply a seal coat having a temperature of 300°F to 350°F and 200°F for pitch
- Allow the seal coat to dry at least 2 days or longer
- The seal coat shall be hard before any water or earth contacts it
- Protect the seal coat from the weather during the drying period

Payment

- Dampproofing is paid at the Contract Price per square yard (meter), complete in place

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 533: Bridge Deck Waterproofing Membrane

Methods

Method A: A waterproofing membrane system placed directly on a portland cement concrete bridge deck surface

Method B: A waterproofing membrane system placed directly on a specified grade and thickness of freshly placed asphaltic concrete on the bridge deck

Surface Preparation

Method A

- Chip or grind smooth the high spots, sharp points, and edges on the deck surface
- Fill holes and depressions in the concrete surface flush with the mortar
- Allow the mortar to cure
- Clean and remove all traffic paint and other harmful materials from the deck by sandblasting the entire deck surface
- Remove all sandblasting residue with compressed air

Do not use water to clean the deck

Method B

- Place a strip of preformed sheet membrane transversely across deck joints
- Apply a mastic at the face of the curb and at the joints to ensure the membrane uniformly adheres to the concrete
- Apply the asphaltic concrete

Waterproofing

<u>Method A</u>

- Observe weather conditions
- Prime the surface
- Place the waterproofing membrane
- Place the pavement

> Do not allow construction traffic over the membrane before placing the surface pavement

<u>Method B</u>

- Place the waterproofing membrane directly on asphaltic concrete using guidelines specified in Method A
- Do not require tack coat or primer on the asphaltic concrete beneath the membrane

Bituminous Overlay Application

<u>Methods A and B</u>

Apply bituminous overlay in either Method A or Method B as follows:

- Apply a bond coat of adhesive (bituminous tack coat) to the surface of the waterproofing membrane
- Overlay the waterproofing membrane with the thickness or quantity and the type of asphaltic concrete specified on the plans
- Dump the asphalt concrete directly into the receiving hopper of the paving machine
- Have trucks pull forward and avoid contacting the paving machine while it is moving
- Do not permit the mixture to be dumped onto the deck ahead of the paving machine
- Spread and roll the asphalt concrete such that the membrane will not be damaged
- Compact the asphaltic concrete to the satisfaction of the Engineer
- Place a final surface course of Open Graded Surface Mixture

Payment

- Preparing the surfaces and furnishing and applying the waterproofing system are paid at the Contract Unit Price per square yard (meter)

Related Specifications

Section	Title
400	Hot Mix Asphaltic Concrete Construction
413	Bituminous Tack Coat

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 535: Painting Structures

Health and Safety Responsibilities

- Comply with all relevant Environmental Protection Agency (EPA) regulations and all other regulatory agencies
- Personnel involved with lead paint removal operations must have received the required training
- Provide test results from an OSHA Certified Laboratory showing blood lead levels of employees that may be exposed to lead during the Project
- Do not allow the containment system of equipment to violate the minimum bridge clearances shown on the plans
- Submit to the Engineer for review and approval an emergency contingency plan for cleaning up spills from failure of the containment system
- Submit Material Safety Data Sheets (MSDS) on abrasive and paint materials used

Preparation

- Clean new and existing steel structures before painting
- Clean structures under or over the railroads
- Prepare steel piling, sway bracing, and concrete piling surfaces for special protective coatings

Construction

- Provide protection to the structure, adjoining property, and public from the dangers of cleaning and painting
- The Contractor must meet the general painting requirements (including weather conditions, oxidation requirements, paint thinning, application methods, properly drying, and cracks/cavities)

Painting New Steel Structures

- Use the correct paint system
- Use one shop prime coat, one field touch-up coat, and two field weather coats
- Apply the type and color of paint coats as required by the system number shown on the plans
- Do not paint advertising on structural steel

Painting Existing Steel Structures

- Prevent paint overspray by using containments
- Adhere to the same weather conditions as when painting new steel structures
- Give steel one full prime coat and two weather coats, all of the color and type required by the special provisions or plans

Do not thin or dilute pile paints

Painting Steel H-Piling, Metal Shell Piling, and Steel Sway Bracing

- Paint in open yards or on erected structures
- Do ***not*** paint metal when freezing weather is forecast
- Apply a thick application of paint to be plastered or troweled onto steel surfaces
- Brush out paint only as required to obtain uniform thickness
- Ensure that each coat is thoroughly dry before the next coat is applied

Related Specifications

Section	**Title**
107	Legal Regulations and Responsibility to the Public
647	Traffic Signal Installation
870	Paint

Bridges Inspection

Section 540: Removal of Existing Bridge

Sequence of Operations

- Do ***not*** remove or close to traffic any existing structure until traffic has been satisfactorily provided for as required by the plans or the Engineer

Extent of Removal

- Remove portions of the existing bridge (including piling) within the area of a proposed culvert to a minimum depth of 5 ft (1.5 m) below the flow line
- Remove the entire substructure down to the streambed or natural ground line unless plans require that old substructures or parts are used as parts of the new structure
- Leave abutments or end bents in place that do not interfere with stream flow or new work if the plans indicate

Care of Removal

- For reuse of existing structures, if possible, remove parts from each unit without blasting
- Clean, straighten, or bend reinforcement to the required dimensions and cut it as an incidental part of this work
- Arrange for the salvaging method according to the parts designated on the plans

Disposal

- Salvage only the material designated on the plans for salvage
- Disassemble the material and neatly stockpile it near the bridge site and above high water
- Do not use any materials stockpiled for the Department without written permission from the Engineer

Payment

- Removal of existing bridge is paid at the Contract Price per Lump Sum

Related Specifications

Section	Title
201	Clearing and Grubbing Right-of-Way

Georgia Department of Transportation Construction Inspection Training

Bridges Inspection

Section 541: Detour Bridges

Safety Features

- *Guardrail*: Construct according to the Construction Detail shown in the plans
- *Precast Median Barrier*: Use on both sides and both ends of the detour bridge unless otherwise directed by the Engineer
- Ensure the barrier extends at least 40 ft (12 m) from the bridge ends unless plans show otherwise

Detour Bridge Removal

- Remove the bridge after permanent construction is open to traffic
- Material salvaged from the detour bridge remains the property of the Contractor

Payment

- Detour bridges are paid at the Contract Price per each, complete in place, maintained, and removed

Related Specifications

Section	Title
104	Scope of Work
105	Control of Work

Section 542: Contractor Proposed Alternate to Reinforced Concrete Deck Girder

Design and Construct Team

- *Contractor*: Responsible for engineering design, drawing, detailing, plan preparation, printing, and other work necessary
- *Design Engineer*: Remains a part of the team and is available to discuss the Project with the Department at any time during the Project

Proposed Alternate Requirements

Contractor-proposed alternates are subject to the following:

- Comply with traffic handling and sequence of operation schemes
- Do not change the following: horizontal/vertical alignments, beginning and ending bridge stations, minimum horizontal clearance, and span lengths
- Reduce vertical clearances from those indicated on the plans

Related Specifications

Section	Title
105	Control of Work

Section 543: Bridge Complete

Plans Note: The prestressed concrete pile order lengths shown on the plans are the estimated pile lengths

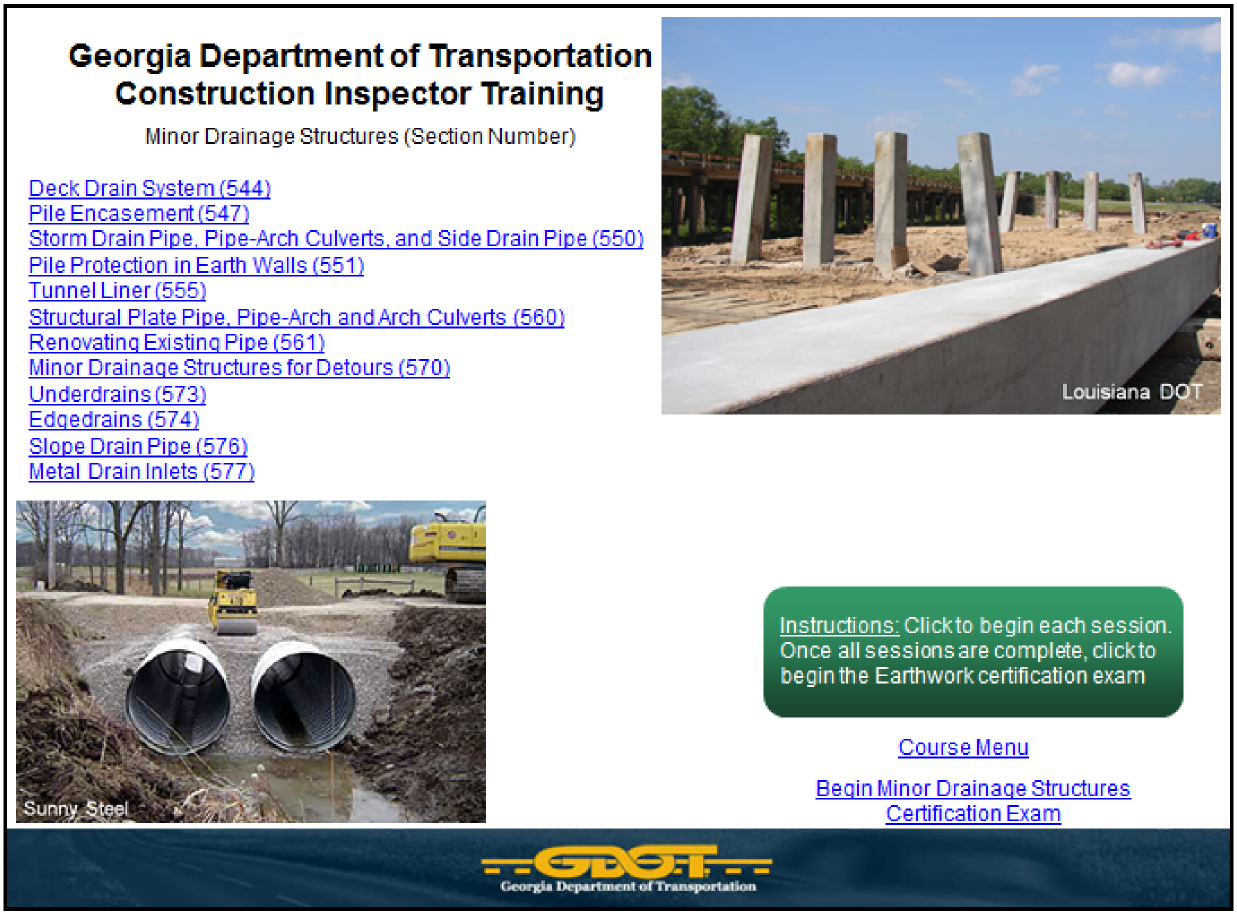
Estimated Pile Lengths

- Estimated pile lengths shown on plans with more than 4 bents apply to the first 4 bents constructed
- The Engineer will adjust pile order lengths for the remaining bents based on pile driving for the first 4 bents constructed
- The Contractor may order lengths by furnishing and driving a test pile in a permanent pile location

Related Specifications

Section	Title
211	Bridge Excavation and Backfill

B-8 Minor Drainage Structures Training Module



Georgia Department of Transportation Construction Inspection Training

Minor Drainage Structures Inspection

Section 544: Deck Drain System

General Construction Notes

- Use materials that meet the plan requirements
- Use commercial-grade steel hardware (clips, brackets, bars, etc.) unless otherwise noted on the plans
- Use galvanizing repair compound
- Shop drawings are required for review and approval

Install deck drain systems according to the Plans

Related Specifications

Section	Title
645	Repair of Galvanized Coatings
870	Paint

Georgia Department of Transportation Construction Inspection Training

Minor Drainage Structures Inspection

Section 550: Storm Drain Pipe, Pipe-Arch Culverts, and Side Drain Pipe

Types of Pipe

Use any of the following types of pipe:

- Reinforced concrete
- Nonreinforced concrete
- Corrugated steel or aluminum
- Smooth-lined corrugated high density polyethylene (HDPE)
- Ductile iron
- Polyvinyl chloride (PVC) profile wall drain pipe
- Polyvinyl chloride (PVC) corrugated smooth interior drain pipe
- *Review Qualified Products List (QPL)*: See standards 1030, 1401, 9031U, and detail 149.C
- For imperfect trenches see Specifications 207 and 210

Preparation and Backfill

- Shape the foundation material as shown on the plans
- Use graded aggregate material for cross-drain applications
- Use Class II B2 soil or better for longitudinal and side drains

Construction

- Periodically remove any debris or silt constricting the pipe flow to maintain drainage throughout the life of the Contract
- Protect the structure by providing sufficient depth and width of compacted backfill
- Repair damage or displacement from traffic or erosion that occurs after installation and backfilling

Contractor must provide the necessary temporary drainage

Installation

- Check vertical and horizontal alignment of the pipe culvert and drain pipe barrel by sighting along the crown, invert, and sides of the pipe
- Check for sagging, faulting, or invert heaving
- Repair any issues involving incorrect horizontal and/or vertical alignment before backfilling pipe

<u>Pipe Installation</u>

Type	**Installation Notes**
Concrete	• Lay sections in a prepared trench • Join sections using either a rubber gasket or preformed flexible sealant
Ductile Iron	• Lay pipe sections in a prepared trench, with bells pointing upstream
Corrugated Aluminum or Steel Pipe and Pipe-Arches	• Lay sections in a prepared trench with outside laps of circumferential joints pointing upstream and longitudinal joints at the sides
Smooth-Lined Corrugated HDPE Pipe	• Use a fitting and coupling that comply with ASTM 2321

Payment

- Pipe installations, complete in place and accepted, are paid at the Contract Price for linear ft (m)

Related Specifications

Section	Title
205	Roadway Excavation
207	Excavation and Backfill for Minor Structures
208	Embankments
645	Repair of Galvanized Coatings
815	Graded Aggregate
834	Masonry Materials
840	Corrugated Aluminum Alloy Pipe
841	Iron Pipe
843	Concrete Pipe
844	Steel Pipe
845	Smooth Lined Corrugated Polyethylene (PE) Culvert Pipe
846	Polyvinyl Chloride (PVC) Drain Pipe
847	Miscellaneous Pipe
848	Pipe Appurtenances

Georgia Department of Transportation Construction Inspection Training

Minor Drainage Structures Inspection

Section 555: Tunnel Liner

Required Equipment

- *Pumping Equipment*: Use a pump with enough horsepower and grouting line pressure to completely fill voids without buckling or shifting liner plates or damaging the roadway
- *Water Control*: Operate well points or other drainage systems in the vicinity of the tunnel construction limits

Tunnel Excavation

Use any of the following procedures to excavate the tunnel:

- Full face
- Heading and bench
- Multiple drift
- Poling plates
- Breast boards
- Shields
- Soil solidification
- A combination of these methods

Liner Plate Installation

- Install self-supporting steel liner plates according to the manufacturer's recommendations
- Seal all segments between the liner plates and the surrounding soil before grouting tunnel liner segments
- Repair damaged spelter coating
- Begin tunneling at one end of a pit that has been sheeted and shored as necessary
- Perform the work below the level of the roadbed

Complete tunneling at one location before beginning work at another

- Stop tunneling if the Engineer determines it is endangering the overpassing roadway
- Perform the work below the level of the roadbed

Payment

- Tunneling is paid at the Contract Price bid per linear ft (m) of liner for each diameter and plate thickness

Related Specifications

Section	Title
608	Brick Masonry
615	Jacking or Boring Pipe
645	Repair of Galvanized Coatings
834	Masonry Materials
844	Steel Pile

Minor Drainage Structures Inspection

Section 560: Structural Plate Pipe, Pipe-Arch, and Arch Culverts

Construction

- Provide necessary temporary drainage
- Immediately remove debris or silt that constricts the flow through a structural plate pipe, pipe-arch, or arch culvert to maintain drainage throughout the Contract's life
- Repair and correct damage or displacement from traffic, erosion, or negligence
- Erect structural plate pipe-arches and arches in the sequence recommended by the manufacturer
- Set bolts using drift pins or bars to line up the holes
- Review Standards 1017, 2010, 2011B, and Details 18 and 34

Tighten bolts only after erecting the entire structure

Payment

- Structural Plate Pipe, Pipe-Arch, and Arch Culverts are paid at the Contract Price bid per linear ft (m)

Related Specifications

Section	Title
205	Roadway Excavation
207	Excavation and Backfill for Minor Structures
208	Embankments
645	Repair of Galvanized Coatings
840	Corrugated Aluminum Alloy Pipe
844	Steel Pipe

Section 561: Renovating Existing Pipe

Required Equipment

- *Batching*: Use weight hoppers and scales for each dry material or calibrated volumetric batch hopper
- *Mixing*: Use a water-tight batch-type mixer capable of blending various materials into a homogeneous mixture
- *Grout*: Use a positive-displacement, piston-type pump and a screw-type worm pump
- *Pulling*: Provide equipment capable of pulling a newly helically corrugated metal pipe

Construction

- Clean and inspect the existing pipe before pulling or pushing the new pipe through
- Ensure the nose cone has enough strength to withstand the pulling/pushing of the new liner
- Weld or bolt the nose cone to the end of the liner
- Use a nose cone that includes a ring for attaching the pulling cable
- Plug the space between pipes at both ends with concrete or mortar
- Remove the grout pipe caps after the pipe plugs have been placed long enough to develop strength to withstand pressure grouting
- After pumping is complete, replace the grout pipe caps

Use a nose cone on all pipe liners

Payment

- Exhibit pipe renovation is paid at the Contract Price bid per linear foot (m)

Related Specifications

Section	Title
801	Fine Aggregate
830	Portland Cement
831	Admixtures
844	Steel Pipe
845	Smooth Lined Corrugated Polyethylene (PE) Culvert Pipe
880	Water
882	Lime
883	Mineral Filler

Georgia Department of Transportation Construction Inspection Training

Minor Drainage Structures Inspection

Section 570: Minor Drainage Structures for Detours

Construction

- Have the Engineer approve the selected construction methods
- Use structures that have adequate openings and are suitable for the purpose intended
- Provide for an uninterrupted flow of traffic over the existing highway or the completed detour
- See Specification 149

Payment

- Drainage structures are paid at the Lump Sum price bid for each structure

Section 573: Underdrains

Construction

- Schedule work so that underdrain installations coincide with operations on the Project
- Excavate according to details and elevations on the plans to intercept water-bearing strata
- Remove unstable material at the bottom of the trench
- Add and compact approved granular material for a stable pipe foundation
- Lay pipe according to plan details with perforations on the pipe's underside
- Lay bell, spigot, and tongue-and-groove pipe with the bell or grooved end upstream and the bells embedded in the foundation material
- Review Standard 9029B

Firmly connect the joints

- Connect the pipe and butt joints securely
- Install the following miscellaneous items as indicated on the plans: pipe screens, caps, plugs, ells, wyes, tees, and markers

Do not disturb pipe alignment during backfilling

- Mark each outlet end of the drainage system according to plan details
- Protect the filter material from contamination by foreign matter

Payment

- Each size of underdrain pipe is paid at the Contract Price per linear ft (m)

Related Specifications

Section	Title
806	Aggregate for Drainage
839	Corrugated Polyethylene Underdrain Pipe
840	Corrugated Aluminum Alloy Pipe
844	Steel Pipe

Georgia Department of Transportation Construction Inspection Training

Minor Drainage Structures Inspection

Section 574: Edgedrains

Preparation

Pressure grout and cure the pavement slabs in the immediate area

Do not begin work until the Engineer determines pavement slabs are stable

Construction

- Complete any opened trenches (including asphalt cap) each working day
- Install edgedrains with other operations on the Project
- Remove and replace contaminated or damaged materials
- Lay pipe with perforations on the pipe's underside
- Lay bell, spigot, and tongue-and-groove pipe with bell or grooved end upstream and bells embedded in the foundation material
- Connect butt joint pipes securely using the appropriate size and type of band or coupling
- Review Detail 32

Payment

- Edgedrains are paid at the Contract Price per linear ft (m)

Related Specifications

Section	Title
400	Hot Mix Asphaltic Concrete Construction
800	Coarse Aggregate
839	Corrugated Polyethylene Underdrain Pipe
840	Corrugated Aluminum Alloy Pipe
843	Concrete Pipe
881	Fabrics

Section 576: Slope Drain Pipe

Construction

- Place the slope drain in an open trench, excavated to the line and grade shown on the plans or as directed
- Lay pipe sections that have circumferential joints with the outside laps of the circumferential joints uphill
- Review Detail 26

Post-Installation

After installing the pipe:

- Immediately backfill the trench with excavated materials or other approved materials
- Place backfill in 8 in. (200 mm) thick or less
- Compact each layer until firm and stable

Payment

- Slope drain pipe is paid at the Contract Price per linear ft (m) for the size specified

Related Specifications

Section	Title
840	Corrugated Aluminum Alloy Pipe
844	Steel Pipe
845	Smooth Lined Corrugated Polyethylene (PE) Culvert Pipe

Georgia Department of Transportation Construction Inspection Training

Minor Drainage Structures Inspection

Section 577: Metal Drain Inlets

> Locate inlets to avoid future installations such as guardrail posts and lighting standards

Stage Construction

Stage 1

- Install metal drain inlets where shown on the plans or as directed by the Engineer
- Install concrete aprons or rip rap as required by the Engineer
- Crown the roadbed and construct a roll of embankment material at the shoulder line
- Keep gutters, pipes, and inlets open
- Review Standards 1019A and 1019B

Stage 2

- Complete the second-stage operation immediately after paving the shoulders
- Remove each adjacent inlet from its position placed under Stage 1
- Field cut a section of slope drain pipe to the required length to connect existing slope drain pipe to the metal inlet in its new position
- Compact embankment material around the inlet including the subgrade under the asphaltic concrete spillway
- Finish to a smooth, firm surface
- Place asphaltic concrete mixture for a spillway on the prepared subgrade

Payment

- Metal drain inlets are paid at the Contract Price per each

Related Specifications

Section	**Title**
400	Hot Mix Asphalt Concrete Construction
436	Asphaltic Concrete Curb
441	Miscellaneous Concrete
603	Rip Rap
645	Repair of Galvanized Coatings
844	Steel Pipe

B-9 Incidental Items Training Module

Georgia Department of Transportation
Construction Inspector Training

Incidental Items (Section Number)

Course Menu

Begin Incidental Items Certification Exam

Georgia Department of Transportation

Incidental Items Inspection

Section 581: Pot Bearing

Assembly

- Have each pot bearing assembled at the plant, marked for identification, and delivered to the site as a complete unit
- Ensure each bearing is marked with permanent match-marks to indicate the normal position of the bearing
- Includes furnishing and installing pot bearings (see Sections 581.1.03.A and B)

Handling Pot Bearing

- Protect each pot bearing from dust and moisture
- Store the surface in the shade to avoid the damaging effects of ultraviolent rays
- Protect from damage during construction and prevent contamination of the various components of pot bearings

Responsibilities of the Bearing Manufacturer Skilled Representative

- Give aid and instruction during the pot bearing installation
- Be present during the initial bearing installation
- Be present during welding of the pots to the masonry plats
- Remain on the job until the bearing installation proceeds without trouble
- Have each bearing assembled at the manufacturer’s plant, marked for identification, and delivered to the construction site as a complete unit
- Ensure the bearings have permanent match-marks to indicate the normal position of the bearing

Construction

- Install pier tops horizontal at the correct elevation
- Inform the Construction Inspector to assist in inspecting the requirements of this section
- Collaborate with the Offices of Bridge Design and Materials and Testing Inspection Services as required
- Cast anchor bolts in concrete or set them in preformed holes
- Insert anchor bolts to the prescribed depth
- Set masonry plates to the proper elevation on the previously finished concrete pads
- Place bearings at predetermined locations when erecting the superstructure
- Adjust bearings as required
- Refer to Section 581.05 for more information

Place additional grout as required in the annular space around anchor bolts until the grout is well packed and flush with the top surface of the concrete

Payment

- Refer to Specification 581.3 for payment information

Related Specifications

Section	Title
501	Steel Structures
506	Expanded Mortar
535	Painting Structures
851	Structural Steel
852	Miscellaneous Steel Materials
885	Elastomeric Bearing Pads
886	Epoxy Resin Adhesives
887	Bearing Plates with Polytetrafluoroethylene Surfaces

Section 600: Controlled Low Strength Flowable Fill

Construction

Assure correct alignment of the pipe by using straps, soil anchors, or other approved means of restraint

> Protect flowable fill from freezing for 36 hours after placement

Payment

- Flowable fill is paid at the Contract Unit Price per cubic yard (meter)

Related Specifications

Section	Title
500	Concrete Structures
801	Fine Aggregate
830	Portland Cement
831	Admixtures
880	Water

Incidental Items Inspection

Section 603: Rip Rap

Foundation Preparation

- Prepare the ground surface where rip rap will be placed to conform with correct lines and grades before beginning the placement
- Compact new material with hand or mechanical tampers when filling depressions

> Ensure toe ditch is 2 ft (600 mm) deep in original ground and the side next to the fill or cut has the same slope

- Begin placing rip rap in a toe ditch constructed in the original ground around the toe of the fill or cut slope
- Compact new material with hand or mechanical tampers when filling depressions
- Backfill the toe ditch and spread excess dirt neatly within the right-of-way as an incidental part of the work after placing rip rap

Stone Rip Rap Placement

Rip Rap Type	**Placing Description**
Stone Plain	• Dump and handle stone into place to form a compact layer to design thickness
Stone Dumped	• Place course at least 2 ft (600 mm) thick • Use recycled concrete only when materials do not contain steel after processing
Stone Grouted	• Prevent earth from filling the spaces between the stones • Fill spaces between 1:3 grout composed of portland cement and sand mixed thoroughly with enough water to make a thick, creamy consistency • Place grout beginning at the toe • Finish by sweeping with a stiff-bristle broom

Filter Placement

- Prepare the surface to receive fabric until it is smooth and free from obstructions, depressions, and debris
- Place the fabric with its long dimension running up the slope
- Place strips to provide the width at least 1 ft (300 mm) of overlap for each joint

Do not drop stones more than 3 ft (1 m) during construction

- Anchor filter fabric in place with securing pins of the type recommended by the fabric manufacturer
- Place fabric so that the upstream strip will overlap the downstream strip
- Loosely place fabric to prevent stretching and tearing during stone placement
- Always protect fabric during construction from clogging due to clay, silts, or chemicals
- Remove contaminated fabric or fabric damaged during installation or rip rap placement

Payment

- Rip rap is paid at the Contract Price per square yard (meter) of material complete in place

Related Specifications

Section	Title
800	Coarse Aggregate
801	Fine Aggregate
805	Rip Rap and Curbing Stone
815	Graded Aggregate
830	Portland Cement
832	Curing Agents
880	Water
881	Fabrics

Section 607: Rubble Masonry

Shaping the Stone

- Roughly square the stones on joints, beds, and faces
- Use selected stone roughly squared and pitched to line at angles and ends of walls
- If specified, finish corners or angles in exterior surfaces with a chisel draft
- Shape and dress it before laying stone in the wall

No dressing or hammering the stone after it is placed

Laying the Stone

- Decrease stone thickness from the bottom to the top of the wall
- Ensure headers in the wall are the same size as shown in the face
- Ensure that headers in walls 2 ft (600 mm) or less in thickness extend through the wall
- Headers shall occupy at least 20% of the wall's face

- Lay masonry to line and in roughly leveled courses
- Lay courses with leaning beds parallel to the natural bed of the material
- Regularly diminish the thicknesses of the courses

Do not lay masonry in freezing weather or when the stone contains frost, except with permission

Weep Holes

- Provide adequate drainage for retaining walls with weep holes as shown on the plans or required by the Engineer
- Build chimneys and French drains extending through parts to be filled and drained when backfilling weep holes

Copings

- Use copings, bridge seats, and back walls made from materials shown on the plans
- Use Class A concrete

Payment

- Masonry is paid at the Contract Price per cubic yard (meter) for mortar rubble masonry or dry rubble masonry, complete in place

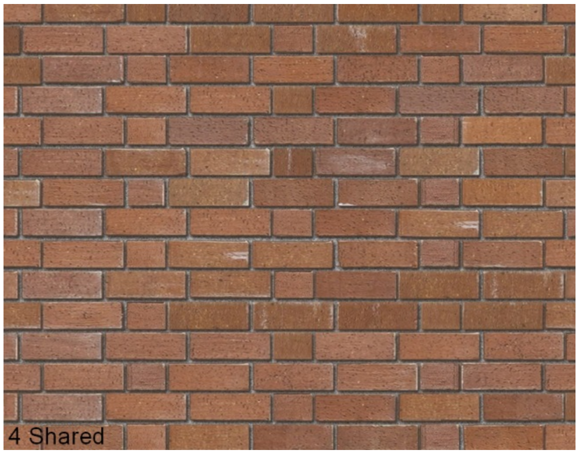
Incidental Items Inspection

Section 608: Brick Masonry

Select brick for exposed surfaces, corners, etc. from brick approved as to color and uniformity

Concrete Handling and Placement

- Ensure concrete reaches its final position within 1 hour after adding cement to the aggregates
- Use the following to transport concrete from truck to forms:
  - Buckets
  - Buggies
  - Pumps
  - Other approved means
- Place concrete without delays



Laying Brick

- Saturate brick with water before laying it
- Lay brick using the shove-joint method to bond into the mortar
- Arrange headers and stretchers to bond mass thoroughly
- Ensure at least 1 course in 7 is a header course
- Finish joints properly as the work progresses

Do not lay brick in freezing weather or when bricks contain frost

Payment

- Brick masonry is paid at the Contract Price per cubic yard (meter), or per thousand (M) bricks, for brick masonry complete

Section 609: Removal of Portland Cement Concrete Roadway Slabs

The Engineer will determine which slabs to remove and replace and whether to use full or partial slab replacement

Partial Slab Replacements

- Saw the slab full depth longitudinally along the center-line joint and shoulder joint and transversely along the area marked for removal
- Remove saw slurry and other contaminants from the over-cutting beyond the limits of the removal area
- Remove the damaged slabs by lifting

- Drill holes in each slab section to accommodate the expanding type lift anchors
- Repair the damaged shoulder area to the Engineer's satisfaction
- Enlarge the removal area to include damaged sections of adjacent concrete
- Remove loose underlying base material to produce a sound, well-compacted base
- Tamp the material loosened in the removal process to the Engineer's satisfaction
- Dispose of slabs and underlying base material removed during this work
- Obtain the disposal site and necessary permits and agreements

Note: Avoid damaging the pavement base, shoulder, or sides that will not be removed

Payment

- Removal of concrete slabs is paid for at the Contract Unit Price bid

Related Specifications

Section	Title
886	Epoxy Resin Adhesives

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 610: Removal of Miscellaneous Roadway Items

Protection of Remaining Structures

- Do not use explosives, equipment, or devices that may endanger structures, facilities, or other property to remain in place
- If parts of structures are to remain in place, protect those parts from damage during construction
- Protect and preserve the salvage value of materials to be salvaged

Separate and remove existing structures with their attached parts and connections

Inlets, Catch Basins, Manholes, and Culverts

- Remove gratings, traps, and other metal casting of inlets, catch basins, and manholes without damaging them
- Remove old culverts down to the ground level or to the adjacent water level
- Remove the bottom slabs of inlets, catch basins, manholes, and culverts

Removing Pipe

- Uncover the pipe to remove it without damage
- Exercise care in removing the pipe
- Replace pipe sections damaged by negligence
- Clean removed pipe and neatly stack it at points directed by the Engineer along the line of work

Backfilling

- Use approved materials in the backfill
- Compact backfill in layers no more than 6 in. (150 mm) thick with proper moisture content
- Use pneumatic tampers or other approved equipment

Raised Edge Curb

- Remove the raised edge curb to a reasonably true line at elevation of normal finished pavement
- Do not shatter pavement that will be retained

Removal of Existing Building Structures

- Demolish, remove, and dispose of all building structures within the right-of-way and easement areas, including concrete slabs, footings, and foundations
- Grade all disturbed ground to a reasonably smooth and pleasing appearance
- Provide a copy of all inspection reports of structures to demolish to the Georgia Environmental Protection Division (EPD)

Inspect all building structures for the presence of asbestos

Payment

- Miscellaneous roadway items are paid at the Contract Unit Price

Related Specifications

Section	Title
201	Clearing and Grubbing Right-of-Way
202	Random Clearing and Grubbing
205	Roadway Excavation
208	Embankments
540	Removal of Existing Bridge

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 611: Relaying, Reconstructing, or Adjusting to Grade of Misc. Roadway Structures

Miscellaneous Roadway Items Construction

- Remove existing structures to be rebuilt
- Clean material salvaged for use in the rebuilt structure and stockpile it in convenient places
- Dispose of portions of structures not suitable for reuse
- Relay or rebuild structures
- Adjust to the required grade miscellaneous structures specified in the proposal or on the plans by raising or lowering the upper portion of the fixture
- Furnish materials such as mortar, sand–cement grout, sand cushion, bituminous filler, brick, castings, and other materials to excavate, trench, prepare earth foundation, and backfill

Capping an Existing Structure

- Remove the improvements to expose only the portion of the structure to be modified
- Replace the removed improvements to the Engineer's satisfaction
- Remove enough existing masonry to lower the top elevation to a point not less than the thickness of the cap plus 3 ft
- Cap the remaining portion of the structure with a fitted reinforced concrete cover

Resetting Guardrail

- Reset guardrail that was removed
- Furnish materials, including additional hardware, offset blocks, and posts
- Replace posts that do not conform to the plans

Raising Manholes

- Adjustments may be made by using adjustable extension rings that do not require removal of the existing manhole frame

- Ensure that the extension device locks to the existing frame and permits height and diameter adjustment
- Choose an extension ring compatible with the existing casting and cover

Ensure that the extension ring and cover are machine ground to reduce contact irregularity

Payment

- Reconstructing or adjusting miscellaneous roadway structures is paid at the Contract Unit Price

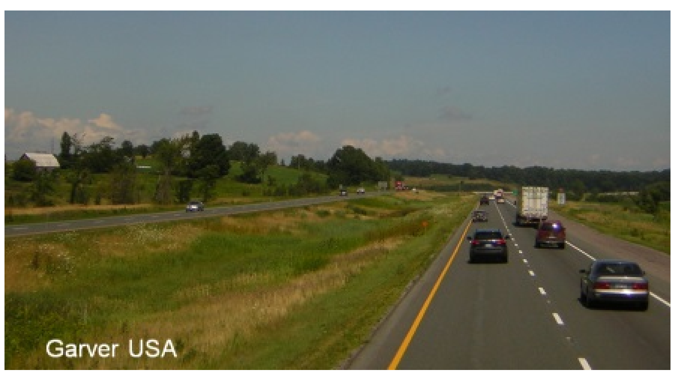
Related Specifications

Section	**Title**
854	Castings and Forgings

Section 612: Construct, Maintain, and Remove Median Crossover

Construction

- Place materials to construct each crossover according to the applicable specifications and as directed by the Engineer
- Place and remove barricades and warning signs as directed by the Engineer
- Remove and dispose of materials when the Engineer determines that the crossover has served its purpose
- Reshape the area where the crossover was removed to comply with the appropriate typical section



Substitute loose sod if the Engineer approves

Payment

- Crossovers measured as shown above are paid at the Unit Price for each crossover constructed, maintained, and removed

Related Specifications

Section	Title
700	Grassing

Incidental Items Inspection

Section 613: Docks

Construction

- Ensure the dock is suitable for its intended purpose
- Select construction methods as approved by the Engineer
- Drive the pile deep enough to provide a safe dock under weather and construction conditions

Related Specifications

Section	Title
863	Preservative Treatment of Timber Products

Section 615: Jacking or Boring Pipe

Pipe Jacking

- Excavate suitable pits or trenches for the jacking operation and for placing the end joints of the pipe
- Avoid interfering with facility operation and weakening of roadbed or structure during construction
- Use a jack with a head constructed to apply uniform pressure around the ring of the pipe
- Set the pipe to be jacked on guides, braced together properly to support the pipe section and to direct it to the proper line and grade

- Excavate the roadbed material just ahead of the pipe
- Force the pipe through the roadbed into the excavated space
- Use an approved mix to pressure grout any voids that develop during installation
- Ensure that the excavation does not extend beyond the pipe more than 2 ft (600 mm)
- Jack the pipe from the low or downstream end
- Use a cutting edge around the head end
- Remove and replace pipe damaged in the jacking operations
- After completing the jacking, immediately backfill the excavated pits or trenches

Pipe Boring

- Excavate for pits and shoring installation as outlined above
- Locate the pit at the Engineer's approval
- Bore holes mechanically using a pilot hole approximately 2 in. (50 mm) in diameter that is bored the entire length of the installation
- Place excavated material near the top of the working pit and dispose of it as required
- Ensure the diameter of the excavation conforms to the outside diameter of the pipe as closely as possible

Payment

- Jacking and boring pipe is paid at the Contract Price per linear ft (m) of the pipe type, size, and class specified

Related Specifications

Section	Title
205	Roadway Excavation
208	Embankments
550	Storm Drain Pipe, Pipe-Arch Culverts, and Side Drain Pipe
841	Iron Pipe
847	Miscellaneous Pipe

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 617: Permanent Anchored Walls

Definition

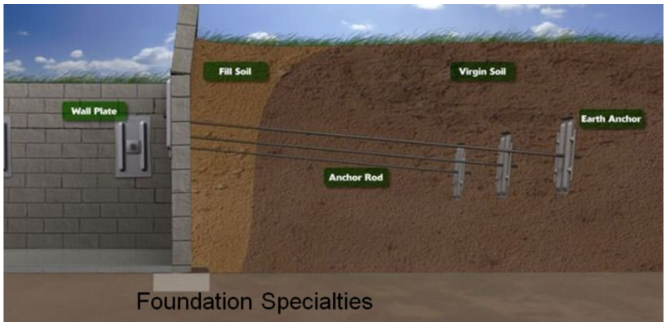
Anchor: Synonymous with the terms tie-back, tie-down, soldier piles, lagging, facing, and drainage

Design Engineer Requirements

- Be registered as a Professional Engineer in the state of Georgia
- Have considerable knowledge and experience in anchored walls
- Be available anytime during the Contract

Equipment

- Anchorage and hardware
- Anchor nut and plate for bars



Preparation

- Survey the condition of the adjoining properties
- Keep records and photograph any settlement or cracking of adjacent structures
- Deliver the report to the Department before beginning work at the site

Tendons Fabrication

- Keep the tendons free of dirt, rust, or other harmful substances
- Use a plastic sheath that is a single piece without splices
- Install the sheath at the fabrication drilled location
- Handle and store tendons so as to avoid corrosion and physical damage before installation
- Repair damaged coatings in the field at the Engineer's approval

Payment

- Anchored walls are paid per Lump Sum

Related Specifications

Section	Title
500	Concrete Structures
511	Reinforcement Steel
853	Reinforcement and Tensioning Steel

Incidental Items Inspection

Section 620: Temporary Barrier

Definitions

Method 1:

- Method of furnishing, placing, maintaining, moving, and reusing where required and removing temporary barrier of the proper length and at proper locations
- Not suitable on bridges where the distance from the centerline of the barrier to the free edge of the bridge deck is less than 6 ft (1.8 m)

Method 2:

- Used on bridge and bridge approaches where the distance from the centerline of the barrier to the free edge of the bridge deck is less than 6 ft (1.8 m)

Construction

Method 1

- Ensure that units are complete and in acceptable condition
- Interconnect all barrier sections within each single run of barrier

Handle and transport units to prevent damage

Method 2

- Rigidly attach the barrier to the bridge deck and extend it off the bridge a transition distance
- Use nonshrink grout to fill any holes remaining in the permanent bridge decks after the barrier is removed

Payment

- Temporary barrier is paid at the Contract Price per linear ft (m) of barrier Method 1 or barrier Method 2

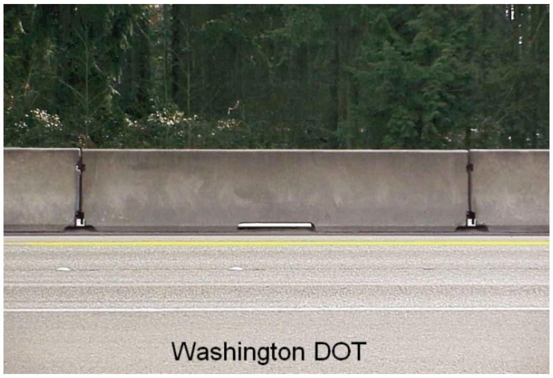
Related Specifications

Section	Title
500	Concrete Structures
501	Steel Structures
511	Reinforcement Steel

Section 621: Concrete Barrier

Preparation

- Finish the subgrade to the required lines, grade, and cross section
- Compact the subgrade to 100% of the maximum laboratory density
- Determine the maximum laboratory dry density from representative samples of the material compacted



Formed or Slipformed Barriers

- Place the concrete using conventional forms or an approved self-propelled extrusion machine
- Construct joints of the type and at the locations specified on the plans
- The Engineer will decide whether to allow a construction joint and will direct where and how to construct the joint
- The outside vertical face of the side barrier or parapet may be battered

Slipformed Barriers

- Use extrusion machines designed to place concrete barrier or parapet without using forms
- Conform the barrier or parapet to the established shape, line, grade, and dimensions
- Obtain the proper density and cross section by forcing an approved concrete mix through a mold of the proper cross section
- Ensure the extrusion machine consolidates the freshly placed concrete in one complete pass

Use a steel trowel to repair and correct the concrete surface

Payment

- Concrete barrier is paid at the Contract Unit Price per linear ft (m) for each barrier type

Related Specifications

Section	Title
433	Reinforced Concrete Approach Slabs
500	Concrete Structures
833	Joint Fillers and Sealers
853	Reinforcement and Tensioning Steel

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 623: Pneumatically Applied Concrete

Personnel

- Have qualified machine, nozzle, and re-bound operators prepare and apply pneumatically applied concrete under the supervision of qualified superintendents

Equipment

- Use equipment in good operating condition on the Project

Earth Foundation Preparation

- Compact and finish the area upon which the pneumatically applied concrete will be placed to the lines and grades shown on the plans
- Ensure the foundation contains enough moisture to provide maximum density and to avoid absorbing water from the concrete

Bonding Foundation Preparation

- Remove unsound or deteriorated concrete, loose particles, dust, and dirt
- Clean steel members by sandblasting loose rust, scale, or other deleterious material
- Keep the bonding surface wet for at least 1 hour before applying the concrete
- Remove any free water immediately before placing

Construction

<u>Earth Foundation Construction</u>

- Use gauging wires to establish finish grade lines, surface planes, and plan thickness
- Place joints, side forms, shooting strips, weep holes, and reinforcement

Bonding Foundation Construction

- Reinforce and form concrete according to plan details
- When sloping, vertical, or overhanging work surfaces require successive layers or thickness, allow enough time between application of layers to permit an initial set

Placing Reinforcement

- When dowels or anchor bolts are specified, securely fasten the reinforcing steel to them
- Lap the welded wire fabric at least 4 in. (100 mm) and firmly tie the full area of mesh or fabric in position with wire ties
- Place welded wire fabric around the top of slab-carrying beams and girders before pouring the slab
- Place the reinforcement at least ½ in. (15 mm) from the surface on which the concrete is to be placed

Finishing

- Screed the surface and check it with a 10-ft (3 m) straightedge
- Remove and replace loose areas of pneumatically applied concrete at the Contractor's expense
- Protect the adjacent areas that are not to be covered and clean them after application if necessary

The Contractor is responsible for all concrete mix designs

Payment

- Pneumatically applied concrete is paid at the Contract Price per square yard (meter) of paving or per ton (megagram) of cement, as specified

Related Specifications

Section	Title
441	Miscellaneous Concrete
500	Concrete Structures
800	Coarse Aggregate
801	Fine Aggregate
830	Portland Cement
832	Curing Agents
833	Joint Fillers and Sealers
853	Reinforcement and Tensioning Steel
880	Water

Section 624: Sound Barriers

Wall Types

Type B Wall

- Install steel noise barrier walls
- Repair cut, scratched, or marred surfaces

Type C Wall

- Concrete precast concrete panels
- Cast them in a precasting facility approved by the Engineer
- Cast the panels on a steel surface with steel side forms

Type D Wall

- Construct the wall of tongue-and-groove panels placed in a horizontal configuration

Type F Wall

- Do not install walls with burns, discolorations, or cracks

Type G Wall

- Cast PAAC panels in a precasting facility approved by the Engineer

Construction Steps for Type C Wall

- Ensure the curing period is at least 72 hours under normal temperature conditions
- Protect panels from freezing from the time the concrete is placed until curing is complete
- Mark each panel with the date cast and the Inspector’s approval stamp

Wall Construction

- Protect the final ground elevations established in the field for the duration of the Project
- Install sound barriers according to the plans and shop drawings approved by the Engineer
- Secure joints and connections to be structurally sound with no visible openings
- Repair marred, chipped, scratched, or spalled barrier areas
- Place trench backfill for sound barrier construction
- Dispose of excess excavation to the Engineer's satisfaction
- Leave the disturbed area in a finished condition at the Engineer's direction, and plant grass or sod

Apply the graffiti-proof coating in weather recommended by the manufacturer

Related Specifications

Section	Title
106	Control of Materials
201	Clearing and Grubbing Right-of-Way
205	Roadway Excavation
206	Borrow Excavation
208	Embankments
210	Grading Complete
500	Concrete Structures
520	Piling
865	Manufacturing of Prestressed Concrete Bridge Members
885	Elastomeric Bearing Pads

Section 626: Mechanically Stabilized Embankment Retaining Walls

Wall Crew Supervisor

- Ensure that the wall crew supervisor has previous satisfactory experience in erecting mechanically stabilized walls

Wall Erection

- Adjust the batter to allow for the effect of backfill type, equipment, and construction method on panel movement
- Place panels in successive horizontal lifts as backfill is placed
- Maintain a panel in a vertical position when backfilling
- Use external bracing for the initial lift
- Place cast-in-place concrete on top of the wall panel to bring the precast coping elements on top of the wall to the proper grade

Joint Fillers

- Cover joints that are located in a flood plain or other intermittently inundated areas
- At other locations, cover joints between panels with a woven or nonwoven plastic filter fabric sheet
- Caulk the openings on either side and between the pads
- Ensure that the minimum width based on the manufacturers recommendations of the plastic filter fabric sheets is used.
- Overlap the filter fabric with the joint at least 4 in. (100 mm)
- Glue the filter fabric to the panels

MSE Wall Backfill

- Place backfill lift to a uniform thickness and place it from the back face of the wall to 1 ft (300 mm) beyond the end of the soil-reinforcing device level
- Compact the backfill to the full length of the reinforcing devices at each soil-reinforcing device level and slope it to drain away from the wall
- Level the compacted backfill with the connecting device before connecting the reinforcing device
- Repair damaged soil-reinforcing devices or panels before attaching and backfilling the reinforcing devices
- Place soil-reinforcing devices at 90° to the face of the wall
- Ensure maximum lift thickness is 8 in. (200 mm) loose and closely follows panel erection
- Compact embankment backfill material to at least 100% of maximum laboratory dry density
- Compact the embankment backfill material without disturbing or displacing the reinforcing devices and panels

Storm Drains

- Provide precast panels that have the appropriate storm drain openings into panels at elevation and locations indicated on drainage profiles
- Place catch basins so that pipes will enter perpendicular (plan view) to the panels or below the leveling pads as shown on the plans
- Coordinate the catch basin construction and the storm drain placement with the wall construction

Related Specifications

Section	Title
106	Control of Materials
208	Embankments
500	Concrete Structures
511	Reinforcement Steel
514	Epoxy Coated Steel Reinforcement
535	Painting Structures
645	Repair of Galvanized Coatings
809	Geogrid Materials
812	Backfill Materials
848	Pipe Appurtenances
865	Manufacture of Prestressed Concrete Bridge Members
867	Epoxy Coated Reinforcement Strips
870	Paint

Section 627: Mechanically Stabilized Embankment Retaining Wall—Contractor Design

Contractor Requirements

The Contractor must meet the following requirements:

- Be experienced in the construction of mechanically stabilized embankment (MSE) walls
- Have a supervising engineer for the Project with at least 5 years of experience in MSE walls
- Have evidence of the successful completion of at least 5 Projects similar in concept and scope to the proposed wall

Wall Envelope

The Department's plans will include a wall envelope that will show:

- Existing and proposed ground line
- Maximum elevation of the top of the leveling pad
- Proposed top of coping or proposed gutter line elevations
- Soil parameters for the wall design
- Location of any internal walls required
- Location of other appurtenances
- Backfill design conditions
- Depth of wall embedment
- Location of drainage structures and other obstructions in the wall backfill

The Engineer must approve any changes to the wall envelope

Related Specifications

Section	Title
106	Control of Materials
208	Embankments
500	Concrete Structures
511	Reinforcement Steel
514	Epoxy Coated Steel Reinforcement
535	Painting Structures
812	Backfill Materials
848	Pipe Appurtenances
865	Manufacture of Prestressed Concrete Bridge Members
870	Paint

Section 632: Portable Changeable Message Signs

Portable Changeable Message Sign (PCMS) Equipment

PCMS equipment must:

- Have a control system with a keyboard to allow programming of user-defined messages
- Have primary and backup power sources
- Be capable of adjusting its brightness from daylight to nighttime conditions
- Be capable of displaying 3 lines of legend
- Have a minimum reliability for its primary power supply for a minimum of 14 days for solar units

Gasoline-powered units are not allowed

- Have a message displayed on the sign that is visible for 3000 ft (915 m) and legible for not less than 650 ft (198 m) during both daytime and nighttime operation
- Have a self-contained unit that includes a control system with keyboard, primary and backup power source, and mounting and transporting equipment
- Be capable of raising the bottom of the message sign panel a minimum of 7 ft above the roadway

Utilization Requirements

- Utilize PCMS whenever any condition(s) exists that requires extra emphasis in warning motorists of a situation
- The Engineer should determine the location of the PCMS

- Use PCMS on Interstate, limited-access, and multi-lane divided highways if requirements are met
- Use on all other types of roadways according to the traffic control plan or as directed by the Engineer

Payment

- Changeable message signs, complete with appurtenances, are paid at the Contract Unit Price per each

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 634: Monuments and Road Markers

Construction

- Set the monuments and road markers in the ground to the depth shown on the plans
- Use backfilling material of the selected earth or gravel
- Carefully tamp it in place so that the monument is stable and secure
- Use a level to set it plumb in all directions

Payment

- Monuments and road markers are paid at the price bid for each, complete in place

Related Specifications

Section	Title
500	Concrete Structures

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 635: Barricades

Construction

- Use timber barricades to warn and alert drivers of the terminus of a road, street, or highway in a nonconstruction or nonmaintenance area
- Install timber barricades where called for on the plans or directed by the Engineer
- Ensure barricade rails are marked with alternate red and white stripes
- Have stripes slope downward in both directions from the center of the barricade if traffic may turn right or left

- Make the entire red-and-white striped area of retroreflectorized sheeting materials
- Make other barricade components white
- Ensure that the barricade has 3 rails as long as specified on the plans
- Promptly clean, repair, or replace barricades that are damaged or defaced

The Contractor is responsible for all concrete mix designs

Payment

- Barricades are paid at the Contract Unit Price per linear ft (m) of barricade

Related Specifications

Section	Title
860	Lumber and Timber
862	Wood Posts and Bracing
863	Preservative Treatment of Timber Products
870	Paint
913	Reflectorizing Materials

Section 636: Highway Signs

Sign Erection

- Drive posts in place or place in prepared holes
- Backfill holes with damp, clean, friable soil and 8% by volume of portland cement
- Thoroughly tamp the mixture in place around the posts
- Erect steel posts for mast arm assemblies in a concrete foundation
- Securely fasten the specified signs into place on the mast arm after curing the concrete foundation for at least 24 hours

- Erect supporting members of ground-mounted panel-type signs where shown on the plans
- Securely fasten the panels into place
- Erect milepost signs including posts
- Use delineator posts made of galvanized steel, aluminum, or an alloy
- Mount reflectors for galvanized steel or aluminum posts on the flange side of the post

Ensure that the finished signs are clear cut and that the lines of letters and details are true, regular, and free of waviness, unevenness, furry edges or lines, scaling, cracking, blistering, pitting, dents, or blemishes

Steps to Erect Signs

- Excavate for the footing to the lines and elevations shown on the plans or established by the Engineer
- Do not disturb or loosen the foundation below these elevations
- Use forms of the necessary shape and dimensions to construct the footings to the lines and elevations shown on the plans
- Cure the concrete foundations at least 7 days before erecting the sign
- Ensure that the minimum lengths of steel H piling used in the foundations of ground-mounted signs are accepted
- Furnish a list of proposed pile lengths to the Engineer before driving the piles
- Place required backfilling in layers no greater than 6 in. (150 mm) thick and thoroughly compact to the approximate density of the undisturbed soil in the area

Payment

- Highway signs are paid at the Contract Unit Price for the various items

Related Specifications

Section	Title
500	Concrete Structures
830	Portland Cement
855	Steel Pile
870	Paint
910	Sign Fabrication
911	Sign Posts
912	Sign Blanks and Panels
913	Reflectorizing Materials
914	Sign Paint
915	Mast Arm Assemblies
916	Delineators
917	Reflectors and Nonreflective Characters

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 637: Illuminated Sign System

Power Control

- The photoelectric control operates the lighting conductor that supplies power to the lighting circuit
- Furnish and install a weatherproof transformer to provide a 120 V control voltage
- Enclose the wiring to and from the photoelectric control in rigid galvanized conduit

Grounding Rods

- Install grounding rods adjacent to each structural support foundation where the supply voltage enters, and adjacent to the service pole
- Solidly connect the grounding conductor sign framework and metallic, noncurrent-carrying material in the lighting system
- Ensure the neutral/grounding conductor is continuous and connected to the luminaire housing
- Drive the single ground rods vertically until the top of each rod is at least 12 in. (300 mm) below the finished ground

Externally Illuminated Signs

- Ensure the lighting system provides on the face of the signs at least 30 foot-candles
- Mount luminaires so that the top of the luminaire is at least 18 in. (450 mm) below the bottom edge of the sign and at a horizontal distance to provide uniform luminaires
- Support the luminaires and conduit runs with a framework of aluminum or hot-dipped galvanized steel channel solidly fastened to the structural support with galvanized steel or aluminum clamps

Do not drive holes in the structures

- Ensure luminaires are accessible from the maintenance walkway for lamp replacement
- Use ballasts when using multiple circuits when operating at voltages shown on the plans
- Provide a light shield plate made of a specified material is at least 0.10 in. (2.54 mm) thick
- Erect the shield below the signs at an elevation that will eliminate glare from the luminaires to motorists traveling in the opposite direction from the face of the sign

Payment

- Illuminated signs are paid at the Lump Sum Price bid for each system

Related Specifications

Section	Title
150	Traffic Control
500	Concrete Structures
863	Preservative Treatment of Timber Products
911	Sign Posts
923	Electrical Conduit

Section 638: Structural Supports for Overhead Signs

Protection of Metal

- Protect all metal components to prevent damage of galvanized coatings
- Handle galvanized steel components with rope slings
- Do not use metal slings, chains, or hooks on galvanized surfaces

Metal components will be rejected if they have extensive damage to the galvanizing

Foundations

- Chamfer the edges of the stems ¾ in. (19 mm)
- Ensure stems have a Type III finish to at least 6 in. (150 mm) below the finished ground surface
- The Engineer must inspect the anchor bolt assembly installation before placing concrete
- Do not remove the temporary template until the footing and stem concrete have been in place at least 24 hours

Erection

- Place and level a leveling nut on each anchor bolt
- Use a washer with each leveling nut
- Set the column on the washers without the horizontal structure and tighten a washer and secure a nut on each anchor bolt
- Inspect the connections to ensure full bearing of the top and bottom of the washers on the base plate
- No structure will be accepted if this dimension is greater than 4 in. (100 mm)

Grounding

- Vertically drive a single, 8-ft (2.4 m) long ground rod until the top of the rod is at least 12 in. (300 mm) below the finished ground
- Attach a length of #6 bare copper, 7-strand wire to the ground with suitable ground rod clamps
- Connect the wires to the grounding nut of the column

Payment

- Structural supports for overhead signs are paid at the Lump Sum Contract Unit Price bid

Related Specifications

Section	Title
207	Excavation and Backfill for Minor Structures
500	Concrete Structures
501	Steel Structures
511	Reinforcement Steel
833	Joint Fillers and Sealers
852	Miscellaneous Steel Materials

Section 639: Strain Poles for Overhead Sign and Signal Assemblies

Timber Poles Construction

- Excavate the hole to the proper diameter and depth
- Erect the pole to an out-of-plumb position with its base resting on the bottom of the hole
- Hold the pole in its out-of-plumb position until the cavity around the pole is filled and compacted

Prestressed Concrete Poles Construction

- Do not disturb the natural ground adjacent to the foundation more than necessary to construct the foundation
- Excavate to the lines and elevations shown on the plans
- Dispose of the excavated materials as directed
- Regrade and grass the disturbed areas to match the contiguous area
- Backfill according to the plans
- Furnish and place Class A concrete
- Burn off and patch lifting eyes or loops on the pole that facilitate handling

<u>Ground Rod</u>

- Use exothermic weld or ground rod clamps to attach the length of copper wire to the ground rod
- Place 3 parallel ground rods at least 6 ft (1.8 m) center-to-center in a horizontal pattern and at least 12 in. (300 mm) below the finished ground

Cable Erection

- Install the top cable 6 in. (150 mm) from the top of the pole
- Install the bottom cable no more than 5 ft (1.5 m) from the pole’s top
- Secure the cable to each pole
- Use preformed cable grips instead of cable clamps
- Apply enough tension to pull the timber poles toward each other past the plumb position by one degree

Minimum sag of a cable attached to a timber pole is 2.5%

Related Specifications

Section	Title
500	Concrete Structures
852	Miscellaneous Steel Materials
861	Piling and Round Timber
863	Preservative Treatment of Timber Products
865	Manufacture of Prestressed Concrete Bridge Members
915	Mast Arm Assemblies

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 640: Retroreflectorized Railroad Cross Buck Sign

Setting a Steel Post

- Set each steel post for a sign assembly in a concrete foundation
- Securely hold each post vertically until the concrete is strong enough to hold the post and sign without support
- Replace cracked bases
- Carefully tamp the backfill in place

Setting a Wood Post

- Place each post in the prepared dry hole of at least 6-in. (150 mm) diameter
- Backfill the hole with a mixture of Portland cement and damp and clean soil using 8% cement by volume
- Thoroughly tamp the resultant mixture into place around the post
- Erect the post vertically to a depth and angle provided in the project specifications to the roadway
- Ensure the post penetrates the ground at least 4 ft (1.2 m)

Backfill around the bases with satisfactory material

Payment

- Retroreflectorized railroad cross buck signs are paid per each

Related Specifications

Section	Title
500	Concrete Structures

Section 641: Guardrail

Guardrail Post Erection

- Do ***not*** allow use of wood posts at any location except as required for guardrail anchorage
- Set posts in post holes or drive them vertically at the positions, depth, spacing, and alignment shown on the plans
- Install posts for guardrail on bridges or other structures as detailed on the plans
- Backfill post holes to the ground line with approved material tamped in place
- Protect the tops of posts with a suitable driving mat or cap

> Do not cut posts that are too high—drive them to the proper elevation.

- Backfill post holes that are drilled in rock
- Remove and reset posts that are out of alignment or too low in grade
- Fit posts with an offset block
- Set additional posts and appurtenances according to requirements of the GDOT Standard Specifications and project plan details

Guardrail Construction

- Erect rails to attain a smooth, continuous rail line that conforms to the line and grade of the highway
- Use bolts long enough to extend at least ¼ in. (6 mm) beyond the nuts after they are firmly tightened

- Install reflectorized washers on guardrail and anchorages
- Install reflectorized washers only on the side that is nearest traffic

Payment

- Guardrail, of the type specified, complete in place including posts, offset blocks, and hardware, are paid at the Contract Price per linear ft (m)
- Guardrail anchorage assembly is paid at the Contract Price per each

Related Specifications

Section	Title
205	Roadway Excavation
208	Embankments
859	Guardrail
870	Paint

Incidental Items Inspection

Section 643: Fence

General Fencing Requirements

- Construct fence (except field fence) within the right-of-way line
- Do not allow permanent installation to encroach on adjacent property
- Construct fence to follow the contour of the ground
- Place the bottom of the fence fabric at least 1 in. (25 mm) from the ground surface

Connect existing cross fences to new fencing

- Clean the fence line a maximum of 8 ft (2.4 m) wide and grade where necessary
- Use longer posts to maintain ground clearance when the ground profile changes
- Place corner or end posts at the junction with existing fences and fasten wires in the new and existing fences to the posts
- Install corner or pull posts for new fencing without placing tension on existing posts

Post and Appurtenance Construction

- Place and install posts as shown on the plans
- Encase concrete line posts installed in marshy or swampy areas
- Encase the corner, end, and pull posts in concrete
- Replace posts damaged by driving
- Fill the entire hole around a post with Class A or B concrete
- Add additional approach posts for greater stability
- Fill space around the post with molten lead or a cement filler
- Repair posts after cutting or drilling
- Treat timber posts and braces with a preservative coating

Gates

- Ensure gate assemblies are the length, height, and type designated on the plans (must provide a 180-degree swing)

Temporary Barrier Fence

- Use suitable metal, wood, or composite posts
- Ensure the posts are long enough to be embedded to a depth that will provide stability to a fence
- Allow a maximum post spacing of 10 ft (3 m)
- Attach the fence to the posts with nails, staples, or wire ties spaced every 6 in. (150 mm) along the posts
- Do not allow the method of attachment to create a safety hazard

Payment

- Fence is paid at the Contract Unit Price per linear ft (m) of the specified type and height of fence

Related Specifications

Section	Title
500	Concrete Structures
862	Wood Posts and Bracing
863	Preservative Treatment of Timber Products
894	Fencing

Section 645: Repair of Galvanized Coatings

Construction

- Apply repair compound smoothly and evenly with a moderately filled paint brush
- Apply when the temperature of the steel compound and surrounding air is above 45°F
- Ensure a minimum dry film thickness is 2 mils (0.05 mm) on smooth surfaces
- The Engineer may require one coat on rough and pitted surfaces

Do not brush over partly dried applications

Payment

- Repair of galvanized coatings is performed at the Contractor's expense

Related Specifications

Section	Title
870	Paint

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 647: Traffic Signal Installation

> Do not modify the signal equipment, design, and operation without the District Traffic Operations Engineer's written approval

General

- Return to the District Traffic Signal Shops all traffic signal equipment removed or replaced
- Provide an inventory list and arrange a mutually agreeable delivery time with the District Signal Engineer a minimum of 24 hours in advance

Traffic Signal Equipment Modification and Removal

- Remove existing signal equipment that is not used in the final installation when the new signal equipment is operational
- Carefully remove equipment to minimize damage and retain it in its original form
- Replace traffic signal equipment that the District Signal Engineer determines has been damaged or destroyed during installation, modification, or removal of the traffic signal
- If the Engineer finds that the existing material shown in the plans to be relocated is unsatisfactory, replace it with new material
- Remove old signal heads by the end of the day
- Remove other signal equipment within 7 days after operation of the installed equipment

Signal Controller Installation

- Identify the controller and other auxiliary equipment by model and revision numbers
- Assemble the controller, cabinet, and auxiliary equipment to provide the operational sequence shown in the plans and future operations specified
- Ensure controller and auxiliary equipment are provided AC power from receptacles marked for controller power
- The Department will provide controller firmware
- The Contractor shall deliver signal controllers 30 days prior to installation

Cabinet Assembly

- Locate the cabinet in accordance with the plan location
- Install and level traffic signal controller cabinets at locations shown in the plans
- Do not allow the cabinet base to extend more than 9 in. above final grade

Signal Monitors

- Mount signal monitors in a rack with appropriate connectors to attach to the wiring harness
- Program the monitor according to the signal operation indicated in the signal plans
- Configure and equip the signal monitor to monitor all red signal indications

Power Disconnect

- Install a box at each intersection
- Ensure the power disconnect is installed at the top of the cabinet or as indicated on the plans
- Program the monitor according to the signal operation indicated in the signal plans
- Install service cables from the disconnect box and terminate

Related Specifications

Section	Title
106	Control of Materials
107	Legal Regulation and Responsibility to the Public
108	Prosecution and Progress
150	Traffic Control
500	Concrete Structures
501	Steel Structures
535	Painting Structures
755	Electrical Work
800	Coarse Aggregate
801	Fine Aggregate
832	Curing Agents
833	Joint Fillers and Sealers
850	Aluminum Alloy Metals
852	Miscellaneous Steel Materials
853	Reinforcement and Tensioning Steel
854	Castings and Forgings
861	Piling and Round Timber
870	Paint
886	Epoxy Resin Adhesives
910	Sign Fabrication
911	Sign Posts
912	Sign Blanks and Panels
913	Reflectorizing Materials
915	Mast Arm Assemblies
922	Electrical Wire and Cable
923	Electrical Conduit
924	Miscellaneous Electrical Materials
925	Traffic Signal Equipment
926	Wireless Communication Equipment
927	Wireless Communication Installation
935	Fiber Optic System
936	Closed Circuit Television (CCTV)
937	Detection Systems
939	Communication and Electronic Equipment
940	NaviGator Advanced Transportation Management System Integration

Incidental Items Inspection

Section 648: Traffic Impact Attenuator

Definitions

Gating: A gating end treatment allows a vehicle impacting the nose or the side of the unit at an angle near the nose to pass through the device

Non-Gating: A non-gating end treatment is capable of redirecting a vehicle impacting the nose or the side of the unit along the unit's entire length

Construction

- Field locate the position of the attenuator nose as shown on the plans
- Increase the length of the concrete transition section or length of the longitudinal barrier as needed to provide a proper beginning point for the attenuator nose
- Consider the length of the system to be the combined length of the attenuator unit/array, the back-up system, and any required transition
- Ensure the length of the system is not excessive to the extent that it intrudes appreciably within the clear offset distance as shown on the plans
- Ensure temporary portable units/arrays are installed, moved, reinstalled, and maintained as required

Payment: Impact attenuator units/arrays will be paid per each type specified

Section 649: Concrete Glare Screen

Glare Screen Alternatives

Construct the glare screen using one of the following:

- *Alternative One*:
    - Cast the median barrier and insert “D” bars into the fresh, plastic concrete
    - Wait until the median barrier concrete has reached a compressive strength of 2000 psi on an age of 7 days

- *Alternative Two*:
    - Wait until the median barrier concrete has reached a compressive strength of 2000 psi, then drill and place “D” bars
    - Construct the second course of barrier on top of the first course

Payment

- Concrete glare screen is paid at the Contract Unit Price per linear ft (m) for each specified height

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 651: Raised Traffic Bars

Construction

- Use concrete materials, and mix and place Class A, air-entrained concrete
- Make forms accessible for tamping and vibrating concrete
- Do not use curing compound on the bottom surfaces

Cement Bar Installation to the Pavement

- Sandblast the highway surface of dirt, curing compound, grease, oil, moisture, loose or unsound layers, and other material that would prevent the bar adhesive from bonding
- Use epoxy resin type IR or IS
- Place enough adhesive on the cleaned pavement, or on the bottom of the bar, to completely cover the area of contact with no voids
- Position the bar and press firmly into the pavement

> Do not use thinners or solvents to remove the adhesive

Payment

- Raised traffic bars are paid at the Contract Unit Price per linear ft (m)

Related Specifications

Section	Title
500	Concrete Structures
886	Epoxy Resin Adhesives

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 652: Painting Traffic Stripe

Definitions

Painted Stripes: Solid or broken (skip) lines

Skip Traffic Stripes: Painted segments with unpainted gaps

Construction

- Ensure accurate stripe location by establishing control points at spaced intervals
- Apply the traffic stripe paint by machine
- Change the minimum rate proportionately for varying stripe widths
- Do not paint areas of pavement when the air temperature in the shade is below 50°F
- Apply a layer of glass spheres and reflective composite optics immediately after laying the paint

Protective Measures

- Control and protect traffic with warning and directional signs during painting
- Set up warning signs before beginning each operation, and place signs well ahead of the painting equipment

Protect freshly painted stripe using cones or drums

Payment

- Painting stripes is paid at the Lump Sum Contract Unit Price bid

Related Specifications

Section	**Title**
870	Paint

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 653: Thermoplastic Traffic Stripe

Definitions

Thermoplastic Marking Compound: A heated compound extruded or mechanically sprayed on the pavement that cools to pavement temperature

Short Lines: Crosswalks, stop bars, arrows, symbols, and crosshatching

General Application

- Clean the pavement areas to be striped
- Use hand brooms, rotary brooms, air blasts, or scrapers to clean
- Remove all vegetation and road film from the striping area
- Apply the material only when the pavement temperature in the shade is above 40°F

Lay the stripe with continuous uniform dimensions

- Ensure the new striping paint material bonds on top of the old line (if applicable) without splitting or cracking
- Remove 100% of the existing traffic stripe
- Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry determined by visual inspection.

Section 654: Raised Pavement Markers

Adhesive Types

Type I-R Epoxy:	Use when the pavement temperature is above 50°F or when traffic conditions require a rapid-setting system
Type I-S Epoxy:	Use when the pavement temperature is above 60°F and traffic conditions permit a slower setting system
Bituminous Adhesive:	Use when the pavement temperature is above 40°F or when traffic conditions require a rapid-setting material

Placement of Markers

- Clean the pavement of dirt, curing compound, grease, oil, paint, moisture, or unsound layers
- Use either sandblasting or grinding equipment to clean

- Do not place markers when the pavement temperature is below 40°F
- When possible, wait 60 to 90 days before placing markers using epoxy adhesive on newly constructed asphaltic concrete pavements

Do not use thinners to clean epoxy from the marker

Placing Marker Using Epoxy Adhesives

- Place enough adhesive on the cleaned pavement or the bottom of the marker to completely cover the contact area of the marker
- Press the marker firmly to the pavement
- Allow a slight bead of epoxy adhesive to extrude from under the marker edges
- Remove adhesive on the face of the marker

Payment

- Raised pavement markers are paid at the Unit Price for each Unit of each type

Related Specifications

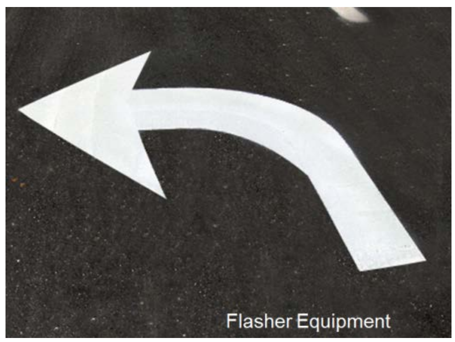
Section	**Title**
868	Bituminous Adhesive for Raised Pavement Markers
886	Epoxy Resin Adhesives
919	Raised Pavement Markers

Incidental Items Inspection

Section 655: Pavement Arrow with Raised Reflectors

Thermoplastic Arrow Application

- Apply thermoplastic 125 mils (3.18 mm) thick
- Screed or level the thermoplastic
- Immediately embed the raised reflector in the molten thermoplastic



Payment

- Each arrow is paid per Unit placed

Related Specifications

Section	Title
868	Bituminous Adhesive for Raised Pavement Markers
870	Paint
886	Epoxy Resin Adhesives
913	Reflectorizing Materials
919	Raised Pavement Markers

Section 656: Removal of Pavement Markings

Remove pavement markings before changing the traffic pattern

Construction

- Utilize blasting, such as sandblasting or water blasting, or grinding to remove pavement markings without damaging the pavement surface
- Do not allow sand and other debris to accumulate and interfere with drainage
- Immediately remove residue and dust from the blast cleaning
- Use a vacuum attachment operating simultaneously with the blast cleaning

Payment

- Markings removal is paid at the Contract Unit Price per Unit

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to the Public
150	Traffic Control
804	Abrasives for Blast Cleaning

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 657: Preformed Plastic Pavement Markings

Pre-Conditions for Marking Application

- Ambient temperature is 40°F and rising
- New asphaltic pavement temperature is at least 120°F
- The plastic can be applied to new asphaltic pavement immediately before the new surface is rolled for the final time
- No significant rainfall occurred 24 hours prior to the plastic's application

Marking Application

- Thoroughly clean the pavement with compressed air, hand brooms, or rotary brooms
- Remove all vegetation and road film
- Mechanically wire brush or abrasive blast clean all new portland cement concrete
- Apply an adhesive activator according to the manufacturer's recommendations
- Position markings according to the plans
- Press positioned markings firmly onto the pavement
- Offset longitudinal lines at least 2 in. (50 mm) from construction joints of portland cement concrete pavements

Related Specifications

Section	Title
107	Legal Regulations and Responsibility to the Public
150	Traffic Control
804	Abrasives for Blast Cleaning

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 658: Polyurea Traffic Stripe

Definitions

Painted Stripes:	Solid or broken (skip) lines
Skip Traffic Stripes:	Painted segments between unpainted gaps on a designated sequence with a ratio of 1:3

General Construction

- Apply pavement markings only during conditions of dry weather and subsequently dry pavement surfaces
- Ensure that the pavement surface temperature and the ambient temperature at the time of installation are both greater than 40°F and that the relative humidity is less than 85%
- Ensure that the traffic stripe is the specified length, width, and placement

Pavement Marking Application

- Apply the liquid marking material by spray method and according to the manufacturer's installation instructions
- Ensure marking configurations are in accordance with the *Manual on Uniform Traffic Control Devices*
- Place the reflectorized pavement markings only on properly prepared surfaces and at the widths and patterns designated on the plans

Air-blast the surface first, to remove any dirt and residues from the pavement

- Apply the pavement markings as a continuous operation
- Heat Component A and Component B to the manufacturer's recommended temperatures
- Ensure that mixing of the two components occurs in a static tube or impingement chamber prior to reaching the application spray nozzle
- Immediately following application, drop the glass spheres and/or reflective composite optics onto the liquid marking

Section 659: Hot Applied Preformed Plastic Pavement Markings

Pre-Conditions for Applying Markings with Heat

- Apply markings when the ambient temperature is 35°F or above
- Apply markings when the pavement is clean, dry, and free of debris
- Apply drop-on glass beads to the entire surface of preformed markings that do not have factory pre-applied surface beads
- Apply the drop-on glass beads to the preformed marking material while it is in a liquid state

Section 666: Vertical Drainage Wicks

Install to the depth shown on the Plans, or where reasonable efforts to further penetrate fail

Drain Installation

- Ensure the mandrel of the sleeve completely encloses and protects the drainage wick
- Force the mandrel containing the wick vertically into the ground at the required depth
- Cut the mandrel neatly at its upper end after installation
- Ensure that a 4–8 in. (100–200 mm) length of wick protrudes from the ground
- If necessary, drill through the dense upper soils before installing the prefabricated drains
- Do not drill more than 2 ft (600 mm) into the underlying compressible soils, as determined by the Engineer

Payment

- Vertical drainage wicks are paid at the Contract Price for the accepted quantity of drilled holes and vertical drainage wicks

Related Specifications

Section	Title
106	Control of Materials

Section 668: Miscellaneous Drainage Structures

Poured-in-Place Concrete Units

- Allow use of Class B concrete for the throat or other nonreinforced portions of catch basins
- Use Class A concrete for the top slab

Pre-Cast Reinforced Concrete Units

- Cast each unit with the number and dimensions of pipe holes necessary to incorporate the unit into the drainage system
- Use mortar or Class A concrete to connect pipe to units
- Set units to within ½ in. (15 mm) of grade on a bed of compacted sand between 2 in. to 3 in. thick

Castings: Hold the frame securely in place to the proper line and grade, which makes it an integral part of the complete structure

Sanitary Sewer Manholes

- Shape invert channels to lines and grades as shown on plans
- Ensure the channel surfaces are smooth
- Directly place the invert channel in the concrete base of the manhole
- Construct the invert channel of brick and mortar
- Lay half-round tile in the concrete base of the manhole
- Lay round sewer pipe through the manhole and cut out the top half of the pipe after the concrete base has set

Related Specifications

Section	Title
207	Excavation and Backfill for Minor Structures
500	Concrete Structures
607	Rubble Masonry
608	Brick Masonry
801	Fine Aggregate
830	Portland Cement
834	Masonry Materials
843	Concrete Pipe
853	Reinforcement and Tensioning Steel
854	Castings and Forgings

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 680: Highway Lighting

Conduit Installation

- Cut metallic conduit threads and then ream the ends
- Ream other conduit as necessary
- Cut conduit ends square
- Ensure that conduit ends butt solidly in the joints to form a smooth raceway for cables

Conduit on Structures

- Run conduit parallel to beams, trusses, supports, pier caps, etc., as directly as possible
- Install horizontal runs in a slight grade without forming low spots that may prevent proper drainage
- Run conduits with smooth, easy bends
- Hold conduit in boxes with locknuts
- Do not clamp or attach conduit to the beam flanges
- Use bushings to protect the conductors

Pull and Junction Box Construction

- Construct concrete boxes from Class A concrete
- Ensure that precast concrete boxes follow the same requirements
- Provide cast iron, steel, or reinforced concrete covers with each pull or junction box according to the plans
- Ground the cast iron or steel covers to the electrical junction or pull boxes

Light Standard and Tower Installation

- Install the specified design, kind, and size of light standards or towers at plan-specified locations

- Install these structures, complete with specified supporting assembly and luminaires, to the mounting heights shown on the plans
- Consider transformer bases to be an integral part of the lighting standard

> Never attempt to realign the anchor bolts after placing the foundation

Luminaires

- Mount or install the specified design and size of luminaire shown on the plans
- Level according to the manufacturer's recommendations and plan details, and as approved by the Engineer
- Provide glare shields on luminaires if required by the plans
- Where a lighting unit illuminates a roadway portion on a grade, rotate the luminaire on its major axis to bring the minor axis parallel to the roadway
- Clamp cables into the proper terminals on the luminaire's terminal board
- Leave enough slack in the cables to check or replace the fuse outside of the handhole
- Leave slack in the cables for future maintenance
- Attach a suitable identification tag to each phase cable, using white for the neutral grounding wire

Power Source

- Make prior arrangements for furnishing power to operate the lighting system
- Notify the power company at least 30 days before needing to connect to the power source
- Connect the lighting system to the secondaries of the local power supplier's overhead or underground distribution system
- Install the service pole, metallic conduit riser, weatherproof circuit breaker, and weatherhead with enough wire to connect to the power source

Related Specifications

Section	Title
205	Roadway Excavation
500	Concrete Structures
800	Coarse Aggregate
801	Fine Aggregate
832	Curing Agents
853	Reinforcement and Tensioning Steel
854	Castings and Forgings
870	Paint
920	Lighting Standards and Towers
921	Luminaires
922	Electrical Wire and Cable
923	Electrical Conduit
924	Miscellaneous Electrical Materials

Section 682: Electrical Wire, Cable, and Conduit

Construction

- Furnish and install electrical cables, conduit, and power service necessary to make the system fully operational
- Identify all conductors of all cables by color and number

Do not splice any cable, shield, or conductor used for power

- Identify the conductor function in the as-built documentation
- Install telephone service cable directly to or into the equipment cabinet in accordance with telephone company procedures
- Install electrical conduit to provide enclosures for electrical cables at the terminating junction
- Make all aboveground electrical conduit and conduit bodies of rigid metal
- Terminate all aboveground conduit in either a weather head or in a cabinet

- Require that all conduits entering a pole-mounted equipment cabinet enter through the bottom with at least one conduit body with a sealable, removable cover for pulling access
- Require that all conduits entering in a base-mounted cabinet enter through the foundation and the base-mount adapter

Related Specifications

Section	Title
205	Roadway Excavation
208	Embankments
922	Electrical Wire and Cable
923	Electrical Conduit

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 685: Blast Cleaning Portland Cement Concrete Structures

Blast Cleaning Methods

Use any of the following methods:

- Dry abrasive blasting with compressed air, blast nozzles, and abrasive
- Recirculating dry abrasive blasting with compressed air, blast nozzles, abrasive, and a recovery system
- Wet abrasive blasting with compressed air, blast nozzles, abrasive, and a water injection system

Blast Cleaning Operation

- Provide and maintain traps to prevent contaminating the blasted substrate with oil or grease
- Immediately remove residue to prevent a traffic hazard when blasting within 10 ft (3 m) of a lane occupied by traffic
- Control dust to protect motorists from reduced visibility or damage to passing vehicles

Payment

- Blast cleaning is paid at the Contract Unit Price bid

Section 690: Static Scale System

Reinforced Concrete Scale Pit Construction

- Install the scale pit concrete including sleeves, piping, conduits, anchors, and frames
- Use deformed billet steel bars for bar reinforcement steel
- Make the top of the pit and aprons flush and level with the adjoining pavement
- Furnish and install a pit drain connected to a 4-in. (100 mm) drain line

Enclose each scale platform and pit with steel coping

- Provide a float-controlled high-water alarm system in the scale pits that automatically activates a red warning light to the operator
- Install an alarm buzzer with the high-water alarm system in the operator's tower
- Provide scale pits with an access cover and manhole

Payment

- Scale pits are paid at the Lump Sum Contract Unit Price bid

Related Specifications

Section	Title
105	Control of Work
108	Prosecution and Progress
109	Measurement and Payment
500	Concrete Structures
511	Reinforcement Steel
853	Reinforcement and Tensioning Steel

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 691: Weigh-in-Motion Scale System

Scalepit and Weighing Platform

- Install a drain line to an outlet beyond the shoulder pavement
- Make the entire weigh-in-motion scales flush with the pavement
- Ensure that the completed scales do not rock or hammer
- Hermetically seal and treat the load cells to prevent moisture penetration and corrosion under normal pit conditions

Inductive Loops

- Saw cut the pavement, install the loop wires, and seal the saw cuts
- Provide a loop detector in the bypass lane that detects a vehicle that was directed by the automatic sorting system to proceed to the static axle scales but has incorrectly proceeded to the bypass lane

Equip the loop detector to activate a buzzer at the operator's console

Control Signs and Indicators

- Provide a high-intensity light on the back of each overhead signal head that will illuminate at the same time the green arrow is illuminated
- Install two repeater pin lights at the weigh-in-motion console that indicate the vehicle has been directed to the static scales or the bypass lane
- Provide a manual switch in the operations office to override the automatic mode of the overhead signs

Payment

- Weigh-in-motion scale systems are paid at the Contract Lump Sum Price

Related Specifications

Section	Title
105	Control of Work
108	Prosecution and Progress
109	Measurement and Payment
500	Concrete Structures
511	Reinforcement Steel
680	Highway Lighting
923	Electrical Conduit

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 700: Grassing

The Engineer has the authority to alter the planting dates as set forth by a period of 2 weeks

General Inspection Notes

- Obtain the Engineer's approval before changing the ground cover type
- Do not use annual rye grass seeds with permanent grassing
- Follow the planting zones indicated on the Georgia State Planting Zone Map
- Sod may be installed throughout the year (weather permitting)

Ground Preparation

- On slopes 3:1 or flatter, plow shoulders and slopes to between 4 in. and 6 in. deep
- Plow front and back slopes in cuts to no less than 6 in. deep
- Serrate slopes steeper than 3:1 according to plan details when required
- Remove boulders, stumps, large roots, large clods, and other objects
- Spread topsoil stockpiled during grading evenly over cut and fill slopes
- Push topsoil from the top over the serrated slopes
- Do not operate equipment on the face of the completed serrated cuts

Seed Preparation and Sowing

- Inoculate each kind of leguminous seed separately with the appropriate commercial culture according to the manufacturer's instructions for the culture
- Sow seed within 24 hours after preparing the seed bed and applying fertilizer and lime
- Sow seed uniformly at the rates specified in the seeding tables

- Allow temporary grass areas that were prepared to be overseeded using the no-till method
- Use Riparian seed mix when specified in the plans

Sod Requirements and Preparation

- Use only common bermudagrass or a specified bermudagrass variety
- Ensure that sod is nursery-grown and accompanied with a Georgia Department of Agriculture Live Plant License Certificate or Stamp
- Furnish either a big roll or block sod
- Apply lime and fertilizer within 24 hours prior to installing sod

No dwarf Bermuda types shall be used

Related Specifications

Section	Title
160	Reclamation of Material Pits and Waste Areas
163	Miscellaneous Erosion Control Items
718	Wood Fiber
822	Emulsified Asphalt
882	Lime
890	Seed and Sod
891	Fertilizers
893	Miscellaneous Planting Materials
895	Polyacrylamide (PAM)

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Section 701: Wildflower Seeding

Ground Preparation

- Plow 4–6 in. (100–150 mm) deep
- After plowing, thoroughly disk the area until it is pulverized and then smooth the surface
- Remove large clods, boulders, stumps, rocks, and other foreign particles that will interfere with the work and seedling growth
- Wait 2 weeks after preparation and then spray new growth with 1 gal per acre of herbicide

Seeding

- Sow seed within 24 hours of applying the fertilizer and lime to the seed bed
- Sow seed uniformly according to the specified rate
- Use approved mechanical seed drills or mix the seed with dry sand and spread it with either a drop spreader or rotary spreader
- Cover the seed to no more than ⅛ in. deep
- Roll the area with a cultipacker or similar equipment to ensure good soil contact for seedling germination
- Apply 1 ton per acre of wood fiber mulch after rolling the seed bed

Related Specifications

Section	Title
882	Lime
890	Seed and Sod
891	Fertilizers

Section 702: Vine, Shrub, and Tree Planting

Planting Operations

- Install plants as straight/upright as possible
- Continuously water, mulch, guy, provide tree guards, and stake as indicated on the plans and details until completing the last operation
- After completing planting, provide a method for retaining water adjacent to the plant according to the details shown on the plans or as directed by the Engineer
- Protect marsh restoration areas from vehicles and machinery
- Do not use typical protective barriers in tidal areas
    - Stakes that remain secure and are taller than the highest tide, flagged with highly visible flagging tape, are required to mark the area to be protected and off-limits for vehicles and machinery

Landscape Mulching for Pit Plantings

- Where the distance between plants is 8 ft (2.4 m) or less, spread mulch throughout and 3 ft (900 mm) beyond the outermost plants
- Where plants are more than 8 ft (2.4 m) apart, apply mulch in a circular fashion around each plant, forming a ring 5 ft (1.5 m) in the outside diameter
- If plant pits are greater than 5 ft (1.5 m) in diameter, ensure that the mulch extends out to cover the berm as shown in the planting details on the plans
- Within 3 days of planting, apply mulch at least 4 in. (100 mm) to obtain a compacted depth of at least 3 in. (75 mm)
- Check compaction at least two months after spreading and exposing the mulch to the elements

Do not wrap the trunks of a tree unless otherwise specified

Watering

- Apply water in a manner to prevent erosion
- Water plants deeply and thoroughly at the time of planting
- Water after applying fertilizer and as necessary to maintain enough moisture to promote plant growth
- Apply enough water to wet the soil to a depth slightly below the roots

Related Specifications

Section	**Title**
108	Prosecution and Progress
214	Mitigation Site Construction
882	Lime
891	Fertilizers
893	Miscellaneous Planting Materials

Section 703: Tree Wells, Tree Walls, and Root Protection

Foundation Excavation and Filling

- Avoid unnecessarily injuring root systems when excavating for tree wells and tree walls
- Excavate and fill foundations to the elevations shown on the plans or as directed
- Backfill the foundation area with broken stone or coarse gravel where the soil under the tree wells or tree walls is unstable
- Ensure that foundations firmly and uniformly support masonry

Provide adequate well drainage using weep holes, pipe drains, drain tile, or porous material

Tree Root Protection

- Spread porous material loosely to the extent and depths indicated on the plans
- Before spreading porous material, clean the tree root protection area of vegetation
- Before backfilling over a tree or plant that will be preserved, place porous material above its roots

Payment

- Rubble masonry for tree wells and walls and porous material for tree root protection are paid at the Contract Unit Price per cubic yard (meter)
- Clay drain pipe or drain tile is paid per linear ft (m)

Related Specifications

Section	Title
834	Masonry Materials
842	Clay Pipe
893	Miscellaneous Planting Materials

Section 705: Transplanting Trees

Trunk and Branch Protection

- Protect trunks and branches from breaks or bruises
- Spray trees in leaf with an approved antidesiccant before digging

Pruning

- Prune trees before transplanting as directed by the Engineer
- Remove broken or badly bruised branches with a clean cut

Securing Roots

- Dig trees to secure as many roots as possible
- Maintain a tight, firm ball during the moving operations

Excavating

- Excavate trees and tree pits
- Use the excavated material to backfill the pits from which the existing trees were removed

Placing Trees in Pits

- Place transplanted trees into the new pits
- Backfill voids between the ball and the pit with clean, washed sand and then tamp
- Thoroughly water the sand with a root feeder or water needle

Applying Topsoil and Mulch

- Apply plant topsoil to the transplanted tree according to plan details
- Mulch a minimum 6-ft diameter tree pit with 3 in. (75 mm) of mulching material

Stake or anchor trees according to planting details

Payment

- Transplanting trees is paid at the Contract Unit Price

Related Specifications

Section	Title
891	Fertilizers
893	Miscellaneous Planting Materials

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 708: Plant Topsoil

General Requirements

- Only plant topsoil on slopes where the gradient is 3:1 or flatter
- Scarify the designated areas 6–8 in. deep
- Place the soil shortly before the grassing operations
- Mix the plant topsoil, lime, and first application of fertilizer with the underlying soil
- Spread and smooth the topsoil uniformly

Place topsoil and complete the grassing within specified seasonal limits

Plant Topsoil Obtained from the Work

- Strip and stockpile the topsoil in suitable locations in advance of grading operations
- Just before grassing, remove the plant topsoil from the stockpile and spread it over the designated areas

- Use the surplus material as additional plant topsoil material if directed by the Engineer
- Use the surplus material left in the stockpiles to maintain the Item or to fill washes that occur within a reasonable haul distance
- Remove or dress down the remaining material as directed by the Engineer

Payment

- Plant topsoil, eligible for payment, is paid at the Contract Unit Price per cubic yard (meter)

Related Specifications

Section	Title
106	Control of Materials
107	Legal Regulations and Responsibility to the Public
893	Miscellaneous Planting Materials

Section 711: Turf Reinforcement Matting

Turf Reinforcement Matting (TRM) Installation

- Do not use in areas where rock crops out
- Install mainly in ditches
- Cut a transverse trench 6-in. wide × 9-in. deep at the ends of the TRM
- Cut longitudinal, 4-in. deep anchor slots along each side of the TRM along the full length of the ditch

- Bury the edges
- Roll out the center strip of TRM starting at the lower end of the ditch
- Overlap the ends of each TRM roll 3 ft (1 m) with the upslope mat on top
- Backfill, compact, and dress the longitudinal anchor slots

Payment

- TRM is paid at the Contract Price per square yard (meter)

Related Specifications

Section	Title
700	Grassing

Georgia Department of Transportation Construction Inspection Training

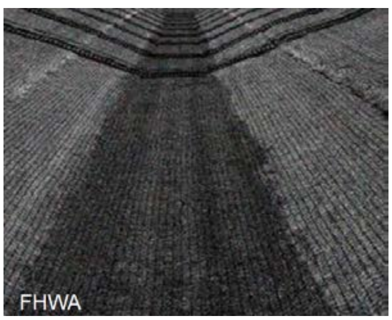
Incidental Items Inspection

Section 712: Fiberglass Blanket

Mat Placement

- Dig a 9-in. deep anchor slot across the upgrade end of the site
- Place the initial 12 in. of blanket in the anchor slot
- Backfill and solidly tamp the slot
- Unroll the blanket in the direction of water flow, keeping the blanket in contact with the soil over the entire area
- Overlap adjacent strips at least 2 in.
- Overlap adjoining ends at least 6 in., with the upstream section on top

Place the mat or blanket within 24 hours after the area has been planted but before any rain or watering



Mat Stapling

- Drive staples vertically into the ground approximately 1 yd (1 m) apart on each side of the blanket
- Drive one row in the center alternately spaced between each side staple
- Place the edge staples in the 2-in. (50 mm) overlap
- At the end of each mat, place staples in a row spaced approximately 12 in. apart

The Engineer may specify additional staples or check slots in waterways

Note: The Contractor may apply an asphalt emulsion instead of staples to anchor the blanket

Payment

- Fiberglass blanket is paid at the Contract Price per square yard (meter)

Related Specifications

Section	**Title**
700	Grassing
822	Emulsified Asphalt

Section 713: Organic and Synthetic Material Fiber Blanket

Definitions

Straw Blanket:	A machine-produced blanket of clean, weed-free, consistently thick straw from agricultural crops
Excelsior Blanket:	A machine-produced mat of curled wood excelsior
Coconut Fiber Blanket:	A machine-produced blanket of 100% coconut fiber evenly distributed over the entire blanket
Wood Fiber Blanket–Type 1:	A machine-produced blanket manufactured with reprocessed wood fibers to a consistent thickness
Wood Fiber Blanket–Type 2:	A hydraulically applied bonded fiber matrix that, upon drying, adheres to the soil in a form of a continuous 100% coverage, biodegradable erosion control blanket
Synthetic Fiber Blanket:	A machine-produced uniform blanket of ultraviolet degradable polypropylene staple fibers reinforced with ultraviolet degradable polypropylene netting

Blanket Placement

- Place vertically on slopes beginning at the top of the slope and extending to the bottom
- Place the blanket within 24 hours after planting and before rain or watering
- Unroll the blanket with the netting on top and the fibers contacting the soil over the slope
- Overlay the joint 4 in. and staple through the joint

- Overlap the ends of the blanket at least 6 in. with the upgrade section on top, and staple through the overlap

Horizontal installation of the blankets is not permitted

Stapling

- Drive staples vertically into the ground to anchor the plastic mesh
- Place the staples approximately 2 yd (2 m) apart on each side of the blanket and add one row in the center alternately spaced between each side staple
- Where the blankets lay side to side, place each staple so that half of the staple anchors mesh from each blanket

Payment

- Material fiber blankets are paid at the Lump Sum Contract Unit Price bid

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 714: Jute Mesh Erosion Control

Mesh Placement

- Roll the mesh out in the direction of flow unless the downstream end section connects to a drainage structure or paved ditch
- Anchor the mesh in a 6-in. deep trench adjacent to the structure
- Overlap adjacent strips by at least 6 in.
- Overlap adjoining ends by at least 6 in.

- For all overlaps, place the upstream section on top
- Use a Type 2 check slot at the downstream end of the jute mesh that does not connect
- Apply the jute mesh without stretching
- Do not allow workers to walk directly on the seedbed before or after applying the mesh
- Bury the up-channel end of each installation in a narrow, 6-in. deep trench
- After burying the mesh, backfill, tamp, and staple the trench

Lay the mesh evenly but loosely on the soil surface

Mat Stapling

- Staple along each edge
- Staple each row along the middle
- Space staples no more than 3 ft (1 m) apart in each row
- Space the staples in the middle row alternately with those at the edges
- Ensure that staples remain flush with the ground

Rolling

- Firmly embed the mesh in the soil by tamping or rolling
- Secure mesh that bridges over soil surface irregularities with extra staples to provide overall contact with the soil

Related Specifications

Section	**Title**
106	Control of Materials

Georgia Department of Transportation Construction Inspection Training

Incidental Items Inspection

Section 716: Erosion Control Mats (Slopes)

Construction

- The Contractor may use either Fiberglass Blanket (Section 712), Organic and Synthetic Material Fiber Blanket (Section 713), or Jute Mesh Erosion Control (Section 714) on slopes
- Place blankets or mats vertically on the slopes beginning at the top of the slope and extending to the bottom

- Do not permit horizontal installation of the blankets or mats
- Do not require mulch when mats or blankets are placed on grassed slopes within 24 hours of planting

Section 718: Wood Fiber

Construction

- Apply enough materials to cover the ground evenly and thoroughly as directed by the Engineer
- Use hydraulic equipment to apply a homogeneous water slurry that includes the proper amounts and kind of seed and fertilizer
- Mix the slurry during application

Section 719: Silt Filter Bag

Construction

- Place a silt filter bag on a #57 stone gravel bed sloped to ensure that the filtered water will exit at the desired location
- Extend the pump hose past the inlet opening to ensure that the silt-laden water will discharge in the center of the bag
- Ensure that the seal between the inlet and hose is watertight
- When the filter bag is full of silt and cannot readily pass more water, use a new filter bag
- If approved by the Engineer, bury the full filter bag on site or remove the top section of fabric and then seed the exposed filtrate

Choose an exit location to prevent erosion

Payment

- Silt filter bags are paid at the Contractor Unit Price per each

Incidental Items Inspection

Section 720: Triangular Silt Barrier

Construction

- Excavate a trench 4–6 in. deep using equipment such as a trenching machine or motor grader; or, if equipment cannot be operated on site, excavate by hand
- Secure the edge of the fabric into the trench with wire staples
- Install the fabric in the trench so that 4–6 in. of fabric is against the side of the trench with 2–4 in. of fabric across the bottom in the upstream direction

- Backfill the trench and compact it so that no flow can pass under the barrier
- Where the individual sections of triangular silt barrier meet, fix the fabric to the ground with wire staples at each joint location and at each end of the barrier
- The Engineer may increase, decrease, or eliminate the quantity of triangular silt barrier

> Triangular silt barrier may be substituted for baled straw

Related Specifications

Section	Title
106	Control of Materials

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APPENDIX C: CONSTRUCTION INSPECTION TRAINING MODULE EXAM QUESTIONS

C.1 General Provision Training Module Exam Questions

Easy

1. Which of the following is the correct definition for a bid advertisement?

    a) A defined method of taking and evaluating measurements for the purpose of determining the acceptability of a lot of material or construction
    b) A public announcement as required by law, inviting bids for work to be performed or materials to be furnished
    c) Any calendar day exclusive of Saturdays, Sundays, and Legal Holidays
    d) A structure, including supports, erected over a depression or an obstruction

2. When "the Work" is specified in the Contract, it refers to all the following *except* **_____**?

    a) Labor
    b) Materials
    c) Equipment
    d) Bidding Qualifications

3. Which of the following is *not* considered a Structure?

    a) Bridges
    b) Signs
    c) Culverts
    d) Retaining Walls

4. Which of the following is *not* a requirement of a bidder?

    a) Examine proposed worksite
    b) Examine the Proposal
    c) Examine other Contractor bids
    d) Examine Supplemental Specifications

5. Which of the following is *not* true of the bidding process?

    a) The bidder should submit their Proposal on their own company forms
    b) The bidder should show unit prices and quantities
    c) Blank spaces on the Proposal should be filled in correctly for each pay item
    d) The unit prices will govern the bid and be recalculated in an event of discrepancy of any figures

6. Which of the following is considered an acceptable bidding practice?

   a) Submitting bid amount by calling the Department
   b) Proposals are submitted in a sealed envelope unless submitted electronically
   c) Submitting after the bid closing time
   d) Submitting an incomplete Proposal

7. Which of the following may result in a rejected bid?

   a) Unit prices are balanced and calculations are correct
   b) Bids submitted by prequalified bidders
   c) Bids that list Disadvantage Business Enterprise (DBE) information
   d) If the Department believes collusion exists among bidders

8. If a discrepancy between unit bid prices exists, which of the following will govern?

   a) Performed calculations
   b) Unit prices
   c) Total bid sum
   d) Bid is automatically rejected

9. Who is responsible for damage to the work until Final Acceptance?

   a) Engineer
   b) The Department
   c) Contractor
   d) The General Public

10. Who is responsible for constructing and maintaining detours outside of the construction site's right-of-way?

    a) Engineer
    b) The Department
    c) Contractor
    d) The General Public

11. Who shall retain ownership of salvaged materials?

    a) Engineer
    b) The Department
    c) Contractor
    d) The General Public

12. Who must approve all working drawings?

   a) Engineer
   b) General Contractor
   c) Subcontractors
   d) Material Suppliers

13. Which of the following is the correct governing order of documents?

   a) 1) Special Provisions, 2) Project Plans, 3) Supplemental Specifications, 4) Standard Plans, 5) Standard Specifications, 6) Calculated Dimensions
   b) 1) Special Provisions, 2) Project Plans, 3) Supplemental Specifications, 4) Calculated Dimensions, 5) Standard Specifications, 6) Standard Plans
   c) 1) Special Provisions, 2) Standard Specifications, 3) Supplemental Specifications, 4) Standard Plans, 5) Project Plans, 6) Calculated Dimensions
   d) 1) Standard Plans, 2) Project Plans, 3) Supplemental Specifications, 4) Special Provisions, 5) Standard Specifications, 6) Calculated Dimensions

14. Which of the following is a duty of a Construction Inspector?

   a) Responsible for Contract administration and engineering details
   b) Participate in the bidding process
   c) Alter or waive provisions of the Contract
   d) Inspect all work done and materials furnished

15. Which of the following is *not* true of the Final Inspection?

   a) General Contractor will determine if the Project is ready for Final Inspection
   b) Engineer will schedule the Final Inspection
   c) Engineer will provide Contractor with a written punch-list with necessary instructions
   d) Contractor shall immediately comply and execute the punch-list

Medium

1. The length of a bridge measures the following:

   a) The overall length of a structure measured along the edge of the roadway between back of the abutment backwalls or between ends of the bridge floor
   b) The overall length of a structure measured along the edge of the roadway between front of the abutment backwalls or between ends of the bridge floor
   c) The overall length of a structure measured along the center of the roadway between front of the abutment backwalls or between ends of the bridge floor
   d) The overall length of a structure measured along the center of the roadway between back of the abutment backwalls or between ends of the bridge floor

2. Which of the following is defined as an Available Day in a contract?

   a) Any calendar day exclusive of Saturdays or Sundays on which the Engineer determines that the Contractor is not prevented from accomplishing at least 8 hours of productive work
   b) Any calendar day exclusive of Saturdays, Sundays, or Legal Holidays on which the Engineer determines that the Contractor is not prevented from accomplishing at least 8 hours of productive work
   c) Any calendar day exclusive of Saturdays, Sundays, or Legal Holidays on which the Engineer determines that the Contractor is not prevented from accomplishing at least 5 hours of productive work
   d) Any calendar day exclusive of Saturdays or Sundays on which the Engineer determines that the Contractor is not prevented from accomplishing at least 5 hours of productive work

3. Which of the following terms describes the calendar date by which the Contractor's work shall be completed when such data is shown in the Proposal?

   a) Holiday
   b) Construction Schedule
   c) Start Date
   d) Completion Date

4. Which of the following describes the number of available days or calendar days allowed for completion of the Contract?

   a) Contract Time
   b) Construction Schedule
   c) Start Date
   d) Completion Date

5. What type of bond is described in the following: The approved form of security executed by the Contractor and his Surety which guarantees complete execution of the Contract and all Supplemental Agreements?

   a) Bid Bond
   b) Contract Bond
   c) Performance Bond
   d) Construction Bond

6 Which of the following is *not* true concerning the competency of bidders?

a) The Department may limit the amount of work awarded to any Contractor
b) The Department may limit the aggregate amount of work awarded to any nonprequalified Contractor
c) The Department may refuse Contractor Proposals to bid on additional work if the Contractor is behind schedule
d) The Department may limit the number of Contractors allowed to bid on a Contract

7. Which of the terms is defined by the following: All parts of the bridge structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, including backwalls, wingwalls, and wing protection railings?

a) Superstructure
b) Substructure
c) Bridge Span
d) Culvert

8. Which of following is *not* true concerning the interpretation of estimates?

a) Estimates are quantities of work to be performed and materials to be furnished to complete construction
b) Department guarantees quantities indicated on plans or given in the proposal
c) Contractor shall not plead deception or misunderstanding due to variation in quantities
d) Payment to the Contractor made only for actual quantities performed

9. Stations measured in the plans are typically at what intervals?

a) 10 ft
b) 20 ft
c) 50 ft
d) 100 ft

10. Which of the following is classified as a culvert?

a) Any structure under the roadway with a clear opening of 20 ft or less measured along the center of the roadway
b) Any structure under the roadway with a clear opening of 20 ft or more measured along the center of the roadway
c) Any structure above the roadway with a clear opening of 20 ft or less measured along the center of the roadway
d) Any structure above the roadway with a clear opening of 20 ft or more measured along the center of the roadway

11. Which of the terms is defined by the following: The fixed charges assessed against the successful Bidder or the Contractor for failure to execute the Contract or to complete the Contract with the Contract time?

    a) Addenda
    b) Force Account
    c) Change Order
    d) Liquidated Damages

12. Which of the following is *not* included in the Contract definition of the plans?

    a) Profiles
    b) Typical Cross Sections
    c) Working Drawings
    d) Contract

13. Which of the following is *not* true of value engineering proposals?

    a) Must provide a life-cycle cost analysis
    b) Must provide a detailed estimate of cost of performing the proposed work
    c) Must provide predictions of any effect of proposed changes on the Department
    d) Must be submitted after the value engineering proposal work is constructed

14. Which of the following does *not* fall under the authority of the Engineer?

    a) Decides all questions that may arise as to the quality and acceptability of materials furnished
    b) Determines quantities of several kinds of work performed and materials furnished
    c) Determines the construction methods used by the General Contractor
    d) Decides all questions that may arise to the rate of progress of the Work

15. Which of the following is *not* required on a construction material invoice?

    a) Date shipped
    b) Quantities
    c) Unit prices
    d) Delivery driver’s name

Hard

1. Which of the following accurately describes the bridge roadway width measurement?

    a) The clear width of a structure measured at right angles to the center of the roadway between the top of curbs or at the ends of the inner faces of the parapet or railing
    b) The clear width of a structure measured at right angles to the center of the roadway between the top of curbs or between the inner faces of the parapet or railing
    c) The clear width of a structure measured at right angles to the center of the roadway between the bottom of curbs or between the inner faces of the parapet or railing
    d) The clear width of a structure measured at 30-degree angles to the center of the roadway between the bottom of curbs or between the inner faces of the parapet or railing

2. A Calendar Day specified in a Contract starts at what time?

    a) 12:00 a.m.
    b) 12:00 p.m.
    c) 9:00 a.m.
    d) 9:00 p.m.

3. A Chief Engineer specified in the Contract is which of the following?

    a) The Engineer Executive appointed by the State Transportation Board, or other authority as may be provided by the law, and acting for the Department within the authority and scope of duties assigned
    b) The Engineer Executive appointed by the State Transportation Board, or other authority as may be provided by the law, and acting for the General Contractor within the authority and scope of duties assigned
    c) The Engineer Executive appointed by the General Contractor which acts within the authority and scope of duties assigned
    d) The Engineer Executive appointed by the General Contractor which acts within the authority and scope of duties assigned by the State Transportation Board

4. Which of the following terms is defined in the following: A method of payment for Extra Work when a Supplemental Agreement is *not* arrived at between the Engineer and General Contractor?

    a) Change Order
    b) Extra Work
    c) Supplemental Tasks
    d) Force Account

5. Companies must be prequalified to bid on a Project if they submit a bid in excess of how much?

   a) $500,000
   b) $1,000,000
   c) $2,000,000
   d) $5,000,000

6. How often must bidders intending to consistently submit Proposals prequalify?

   a) Every year
   b) Every two years
   c) Every five years
   d) Only need to prequalify once

7. In general, the Contract is awarded ____ calendar days after the opening of Proposals.

   a) 10
   b) 20
   c) 50
   d) 100

8. Which of the following is the difference of bidding requirements between Georgia and non-Georgia resident construction companies?

   a) Nonresident Georgia construction companies must have aggregate bond amounts equaling 50% of the full Contract sum
   b) Nonresident Georgia construction companies must have aggregate bond amounts equaling 100% of the full Contract sum
   c) Nonresident Georgia construction companies must have aggregate bond amounts equaling 210% of the full Contract sum
   d) No differences exist

9. Changes in the Contract cannot decrease more than what amount?

   a) 20%
   b) 40%
   c) 60%
   d) No limit exists

10. Which of the following is *not* true with regard to maintenance during construction?

    a) Contractor shall maintain Project from beginning of operations until maintenance acceptance or final Project acceptance
    b) Shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces
    c) Includes signing, pavement markings, and traffic control devices
    d) The Department shall provide all maintenance throughout the duration of the Contract

11. What is the maximum interval at which the Contractor must remove debris from the site?

    a) 1 month
    b) 2 months
    c) 4 months
    d) 6 months

12. Who is responsible for taking material samples?

    a) General Contractor
    b) The Department
    c) Subcontractor
    d) Material Supplier

13. Which of the following is an acceptable place to store construction materials?

    a) Anywhere within the construction site's right-of-way
    b) Private property without the owner's consent
    c) On the right-of-way when approved by the Engineer
    d) Storing of materials is not permitted

14. Who should furnish, install, and maintain necessary barricades, signs, and other traffic control devices required within the Project limits?

    a) Engineer
    b) The Department
    c) General Contractor
    d) Traffic control devices are not required within the Project limits

15. Construction of drainage facilities shall be carried out in conjunction with which construction activity?

    a) Clearing and grubbing and earthwork operations
    b) Structural construction
    c) Pavement construction
    d) After final Project acceptance

C.2 Auxiliary Items Training Module Exam Questions

Easy

1. Which of the following is *not* true about mobilization?

   a) Mobilization includes preparatory work, operations, and moving personnel, equipment, supplies, and incidentals to the Project site
   b) Mobilization is measured separately for payment
   c) Contract Unit Price amount is used for payment
   d) None of the above

2. Mobilization includes:

   a) Preparatory work, operations, moving personnel, equipment, supplies, and incidentals
   b) Direct work performed during the Project
   c) All General Provision items in the Contract
   d) None of the above

3. Which of the following is *not* true about field laboratory building or trailer requirements?

   a) Each unit shall be floored, roofed, and weathertight
   b) Entrance door securely locks
   c) Built-in work table with at least two drawers (one lockable)
   d) Must be permanent buildings that can be used after Project completion

4. Which of the following is *not* a requirement for an asphaltic concrete plant laboratory?

   a) Enclosures shall be provided for procedures where extracting solvent vapors are emitted
   b) Samples shall be dried under enclosure or inside the oven that is vented outside the lab
   c) Enclosure must have hood, glass, or other doors capable of enclosing extracting solvent vapors from ambient air in the lab
   d) None of the above

5. Which of the following is *not* true about the doors and windows of the Field Engineer's office?

   a) Each building must have one standard-height solid entrance door (minimum) with lock and self-closing screen door
   b) Type 3 buildings shall have at least two doors and screens
   c) Each wall shall have at least one hinged, jalousies, or sliding window that is glazed, screened, or fitted with venetian blinds
   d) None of the above

6. Which of the following can be moved from a pest-infected area into a non-infected area without the approval of the Department of Agriculture Inspector in Charge?

   a) Soil
   b) Mulch
   c) Tree stumps
   d) None of the above

7. Earth-moving equipment shall be inspected by the ______ Inspector in Charge before moving from an infested area.

   a) Department of Agriculture
   b) Owner
   c) Project manager
   d) Georgia Department of Health

8. Which of the following can be used for pile heads, galvanized large-headed roofing nails to attach caps, and galvanized cable to wrap the pile clusters in survey aids?

   a) Galvanized sheet metal caps
   b) Wood caps
   c) PK nails
   d) Steel reinforcement bars

9. Actual and final locations of survey aids are based on the _______’s own procedures and equipment methods.

   a) Engineer
   b) Project manager
   c) Contractor
   d) Superintendent

10. Who is responsible for placing instruments mountings and performing field checks and office calculations necessary to provide locations of the survey points?

   a) Engineer
   b) Contractor
   c) Project manager
   d) Foremen

11. Which of the following is *not* true about the Contractor warranty and maintenance of survey aids?

    a) Promptly replace, repair, or strengthen defective, unduly worn, corroded, deteriorated, or otherwise unsatisfactory material at the Engineer's request
    b) Survey aids should be maintained to the Engineer's satisfaction to ensure they are safe, have longevity, and perform accurately
    c) Survey aids are paid at the Contract Unit Price per unit of measurement, complete in place, and when maintained and removed as directed
    d) Survey aids do not need to be replaced after initial installation

12. The Contractor will submit an acceptable training program to the Department for review and approval within ________ after the Notice to Proceed is issued.

    a) 1 week
    b) 10 days
    c) 30 days
    d) 60 days

13. What should be the minimum diameter of all piles (except the center pile) used for survey aids at stations?

    a) 5 in. (125 mm)
    b) 10 in. (250 mm)
    c) 15 in. (375 mm)
    d) 20 in. (500 mm)

14. Which of the following is *not* true about the installation of Project information signs?

    a) Sign shall be plainly visible from the Project roadway
    b) If the Project Office is not adjacent to roadway, a second guide sign must be installed
    c) Signage plant shall be submitted to the Engineer for this work
    d) Project information signs are optional on all Projects

15. The roof of the Field Engineer's office must be watertight and have minimum slope of _______ in one direction away from door.

    a) 1:8
    b) 1:10
    c) 1:12
    d) 1:16

Medium

1. The surface area of a hinged or sliding window must be at least _____ in a field laboratory building.

   a) 4 ft^2 (0.4 m^2)
   b) 6.5 ft^2 (0.6 m^2)
   c) 10 ft^2 (0.9 m^2)
   d) 13 ft^2 (1.2 m^2)

2. Which of the following is *not* a requirement for a field laboratory building?

   a) Heating with necessary fuel
   b) Equip each building with one approved fire extinguisher
   c) Each building or trailer shall be 7 ft (2.1 m) wide and 7 ft (2.1 m) high inside and contain 120 ft^2 (11 m^2) minimum floor space
   d) At least one hinged or sliding window on each window having at least 15 ft^2 (1.4 m^2) of openings

3. Portland cement concrete plant laboratories must have combined office/workspace measuring ____________.

   a) 100 ft^2 (9 m^2)
   b) 200 ft^2 (18 m^2)
   c) 300 ft^2 (28 m^2)
   d) 400 ft^2 (36 m^2)

4. Portland cement concrete plant laboratories must have heating and air conditioning equipment capable of maintaining an interior temperature of _________.

   a) 32°F (0°C)
   b) 50°F (10°C)
   c) 70°F (21°C)
   d) 86°F (30°C)

5. What is the minimum height of a table used for preparing concrete cylinders for testing at portland cement concrete plant laboratories?

   a) 2 ft (600 mm)
   b) 3 ft (900 mm)
   c) 4 ft (1200 mm)
   d) 5 ft (1500 mm)

6. The Field Engineer’s office should be placed within _______ of power lines if possible when electric current is required.

   a) 100 ft (30 m)
   b) 500 ft (150 m)
   c) 1000 ft (300 m)
   d) 2000 ft (600 m)

7. In a Field Engineer’s office, each window should have a minimum surface area of:

   a) 6.5 ft^2 (0.6 m^2)
   b) 10 ft^2 (0.9 m^2)
   c) 12.5 ft^2 (1.2 m^2)
   d) 16 ft^2 (1.5 m^2)

8. What is the window requirement for the Field Engineer’s offices?

   a) At least 3 for Type 1 and at least 3 for Type 3
   b) At least 3 for Type 1 and at least 10 for Type 3
   c) At least 10 for Type 1 and at least 3 for Type 3
   d) At least 10 for Type 1 and at least 10 for Type 3

9. For the ceiling of the Field Engineer’s office, the roof rafters should be covered with ______ plywood.

   a) 1.9 in. (5 cm)
   b) 3.9 in. (10 cm)
   c) 5.9 in. (15 cm)
   d) 7.9 in. (20 cm)

10. Oil, gas, or an electric heater shall be provided for the Field Engineer’s office and shall maintain an inside minimum temperature of _____.

   a) 32°F (0°C)
   b) 50°F (10°C)
   c) 72°F (22°C)
   d) 86°F (30°C)

11. The Type III security lights in the Field Engineer’s office must have two _____ high-pressure sodium security lights with photoelectric controls.

   a) 50-watt
   b) 100-watt
   c) 150-watt
   d) 200-watt

12. Plan racks of Type III Field Engineer offices should be capable of holding ______ complete sets of Project plans.

    a) 1
    b) 2
    c) 3
    d) 4

13. Which of the following Field Engineer office types shall have at least two doors and screens?

    a) 1
    b) 2
    c) 3
    d) It doesn’t depend on the building type

14. Which of the following is true about the stool in the Field Engineer’s office?

    a) Must have a supportive backrest, waterfall edge seat, and instant height level (26–30 in. or 650–750 mm)
    b) Provide 4 (minimum) swivel chairs with arms
    c) Provide a minimum of 1⅛ in. (28 mm) wood-grain laminated tops with 23-in. (575 mm) deep files and heavy-duty steel ball bearing draws and locking center drawer
    d) All of the above

15. Which of the following is *not* true about the training program?

    a) Contractor will submit an acceptable training program to the Department for review and approval within 60 days after the Notice to Proceed is issued
    b) Employee who completes the training course or is employed as journeyman cannot receive training in an area of expertise
    c) Off-site training is permissible
    d) None of the above

Hard

1. The interior dimensions of each field laboratory building or trailer should be:

    a) 5 ft (1.5 m) wide and 5 ft (1.5 m) tall
    b) 5 ft (1.5 m) wide and 7 ft (2.1 m) tall
    c) 7 ft (2.1 m) wide and 7 ft (2.1 m) tall
    d) 9 ft (2.1 m) wide and 9 ft (2.1 m) tall

2. Portland cement concrete plant laboratories must have a worktable at least ______ wide and ______ long to prepare concrete cylinders for testing.

   a) 2.5 ft (750 mm) / 2.5 ft (750 mm)
   b) 2.5 ft (750 mm) / 5 ft (1500 mm)
   c) 5 ft (1500 mm) / 5 ft (1500 mm)
   d) 5 ft (1500 mm) / 7.5 ft (2250 mm)

3. The floor of the Field Engineer's office must be a minimum of ____ above the ground.

   a) 12 in. (300 mm)
   b) 12 in. (300 mm)
   c) 24 in. (600 mm)
   d) 30 in. (762 mm)

4. A minimum thickness of ________ wood-grain laminated tops of the worktables in the Field Engineer's office.

   a) 1⅛ in. (28 mm)
   b) 1⅛ in. (28 mm)
   c) 2¼ in. (56 mm)
   d) 3 in. (76 mm)

5. The worktable in the field Engineer's office shall be ______.

   a) 5 ft × 3 ft (1500 mm × 900 mm), 19 in. (475 mm)
   b) 10 ft × 6 ft (3000 mm × 1800 mm), 19 in. (475 mm)
   c) 5 ft × 3 ft (1500 mm × 900 mm), 38 in. (950 mm)
   d) 10 ft × 6 ft (3000 mm × 1800 mm), 38 in. (950 mm)

6. For triangulation stations in survey aids, the center pile for instrument mounting must have a minimum diameter of ________ at distance of _______ from the end.

   a) 0.5 ft (150 mm) / 2 ft (0.6 m)
   b) 0.5 ft (150 mm) / 4 ft (1.2 m)
   c) 1 ft (300 mm) / 2 ft (0.6 m)
   d) 1 ft (300 mm) / 4 ft (1.2 m)

7. Asphaltic concrete plant laboratories must have a ventilation system that can maintain a temperature between __________ with the windows and doors closed.

   a) 45°F and 80°F (7°C and 27°C)
   b) 45°F and 100°F (7°C and 38°C)
   c) 65°F and 80°F (18°C and 27°C)
   d) 65°F and 100°F (18°C and 38°C)

8. Asphaltic concrete plant laboratories must be capable of exchanging an air rate of _________ over the entire open door area of each enclosure.

   a) 50 $ft^3/ft^2/min$ (15 $m^3/m^2/min$)
   b) 100 $ft^3/ft^2/min$ (30 $m^3/m^2/min$)
   c) 150 $ft^3/ft^2/min$ (45 $m^3/m^2/min$)
   d) 200 $ft^3/ft^2/min$ (60 $m^3/m^2/min$)

9. Portland cement concrete plant laboratories must have an outside work area of at least ________ consisting of a concrete slab constructed level and true, with a light broom finish.

   a) 5 ft × 10 ft (1,5 m × 3 m)
   b) 10 ft × 10 ft (3 m × 3 m)
   c) 10 ft × 15 ft (3 m × 4.5 m)
   d) 15 ft × 15 ft (4.5 m × 4.5 m)

10. Marine-type plywood shall be used for survey targets that are __________ thick.

    a) 0.75 in. (19 mm)
    b) 1 in. (25 mm)
    c) 1.25 in. (32 mm)
    d) 1.5 in. (38 mm)

11. Each field laboratory building or trailer shall contain _______ minimum floor space.

    a) 120 ft^2 (11 m^2)
    b) 160 ft^2 (15 m^2)
    c) 200 ft^2 (18 m^2)
    d) 240 ft^2 (22 m^2)

12. Which of the following is true about portland cement concrete plant laboratories?

    a) Office space shall be separated with space for a desk and two chairs
    b) The payment is done by Contractor unit price bid for each laboratory
    c) It must have a work table at least 2.5 ft (750 mm) wide, 5 ft (1500 mm) long, and 3 ft (900 mm) high to prepare concrete cylinders for testing
    d) All of the above

13. Which of the following is *not* required for the roof of a Field Engineer's office?

    a) Walls and roofs shall be constructed with studs and rafters measuring 2 in. × 4 in. (38 mm × 89 mm)
    b) Eaves are at least 12 in. (300 mm)
    c) It must be watertight and have minimum slope of 1:12 in one direction away from door
    d) All of the above

14. Which of the following is *not* required for the walls of a Field Engineer’s office?

a) Must include in walls and ceilings insulated material at least 1¼ in. (32 mm) thick made of rock wool, fiberglass, or other nonflammable material
b) Must ensure material is in all inner wall and ceiling cavities
c) Both sides shall be covered with ⅜ in. (10 mm) plywood (exterior grade on outside)
d) Open cracks or knotholes are permitted only if it is not wider than ½ in. (16 mm)

15. Which of the following is *not* true about survey aids?

a) Actual and final locations of survey aids are based on the Contractor’s own procedures and equipment methods
b) Contractor and Engineer must agree on most effective means to control the line and distance during construction
c) Engineer can determine how high to construct survey aids
d) Contractor may require triangulation stations to be built to a higher elevation

C.3 Erosion Training Module Exam Questions

Easy

1. Which of the following is *not* true regarding the reclamation of material pits and waste areas?

   a) Reclamation areas apply to areas outside of right-of-way
   b) Only slopes above water will be planted
   c) The Engineer may determine areas composed of rock or other materials not satisfactory for permanent vegetative cover
   d) None of the above

2. In reclamation of material pits and waste areas, the Engineer must:

   a) Approve planting type if the Contractor furnishes a material pit or waste area that requires vegetation
   b) Approve all modified mixtures before planting begins
   c) Property owner may change plant material types specified in the plans to a type not shown in the Planting Table
   d) All of the above

3. Which of the following is *not* true about the materials used in reclamation of material pits and waste areas?

   a) The Contractor will select material type from Planting Table
   b) Giant Bermuda seed (Cynodon species) including NK-37 shall not be used
   c) Italian rye grass seed (perennial or annual) shall not be used
   d) Seed quantities shall be increased 50% on slopes too steep for soil preparation (cannot be dug 6 in. [150 mm] minimum depth)

4. Which of the following is *not* true about the erosion control check dams?

   a) Check dams shall be constructed before roadway clearing, grubbing, or grading is complete
   b) A layer of #57 stone shall be placed on the downstream side of dam
   c) Check dams shall not be left in place after construction is complete
   d) Roadway cut and fill slopes that drain toward check dam drainage area shall be grassed or stabilized with straw mulch

5. Which of the following is *not* true?

   a) For reclamation of material pits and waste areas, vegetative requirements apply when the Contractor obtains material from a source or wastes material on the area outside of the right-of-way
   b) For erosion control check dams, only rubber-tired equipment shall work in the affected drainage area until after the check dam is completed
   c) For erosion control check dams, temporary devices will be left in place at the Engineer’s discretion without a change cost
   d) All of the above

6. Which of the following guidelines is true about constructing silt control gates?

   a) Only roadway portion within the affected drainage area shall be cleared and graded
   b) A silt control gate should be installed at the inlet of a structure
   c) Slopes and ditches that are not paved shall be grassed and mulched
   d) All of the above

7. Which of the following grass types can be used as temporary grass for erosion control?

   a) Rye grass
   b) Millet grass
   c) Cereal grass
   d) All of the above

8. Which of the following is *not* true about constructing silt retention barriers?

   a) Dredged materials shall be confined to ponding areas or settlement basins using standpipes or weirs
   b) Barrier shall be placed approximately 25 ft (7.5 m) outside affected construction area, and a depth within 5 ft (1.5 m) of bottom
   c) Fabric shall be impermeable
   d) Barrier could be placed close to construction area in smaller streams

9. Which of the following can be used for protecting the bottom and sides of a diversion channel?

   a) Plastic sheeting
   b) Rip rap
   c) Geotextile fabric
   d) All of the above

10. Which of the following is *not* paid by Contractor Unit Price per each?

    a) Baled straw erosion checks
    b) Sediment basins
    c) Temporary mulch
    d) Retrofit

11. The __________ has responsibility for altering or restoring a lake or pond and adjoining property.

    a) Contractor
    b) Project manager
    c) Owner's engineer
    d) All of the above

12. Who has the responsibility to establish the condition of lake and dam and determine the existing contours of a lake while restoring or altering of lakes and ponds?

    a) Contractor
    b) Project manager
    c) Engineer
    d) None of the above

13. Which of the following is true about altering lakes and ponds?

    a) Work shall include activities to change physical size, shape, or depth of lake
    b) Alteration or restoration of a lake is measured by unit
    c) Payment is made by Contractor Unit Price bid per each or on pro rata basis of bid amount as work progresses
    d) All of the above

14. Which of the following shall be monitored by the certified personnel weekly or after a rainfall event?

    a) Disturbed areas not permanently stabilized
    b) Material storage areas
    c) Structural control measures
    d) All of the above

15. Which of the following needs to be inspected only monthly by the certified personnel as a part of the water quality control program?

    a) Petroleum product storage, usage, and handling areas
    b) All locations where vehicles enter/exit the site
    c) Disturbed areas that are not permanently stabilized, material storage areas, structural control measures
    d) Areas where final stabilization has been completed

Medium

1. Seed quantities shall be increased ______ on slopes too steep for soil preparation (cannot be excavated greater than 6 in. [150 mm]).

    a) 25%
    b) 50%
    c) 75%
    d) 100%

2. Which of the following is *not* true about the construction operations of "ground preparation" and "liming and fertilizing" for reclamation of material pits and waste areas?

    a) The Engineer determines areas unsatisfactory for permanent vegetation
    b) Areas to be planted 12 in. (300 mm) depth shall be plowed
    c) Slopes steeper than 2:1 shall be hydro-seeded
    d) Mix fret and lime into the top 2 in. of soil including pine seedlings

3. Which of the following is *not* true about the construction operations of "Broadcast Sprigging" and "Row Sprigging" for reclamation of material pits and waste areas?

    a) They shall be applied mechanically or by hand in a uniform layer over the prepared surface, placing 4 viable sprigs (minimum) to each ft^2 (43 viable sprigs to each m^2)
    b) They shall be placed 2–3 in. (50–75 mm) deep by disc harrowing or other means
    c) Furrows shall be opened such that they are spaced at least 1 ft (300 mm) apart and at least 4 in. (100 mm) deep
    d) None of the above

4. Which of the following is true about pine tree seedlings?

   a) It is considered satisfactory after 85% of growth has survived 90 days after planting with no fail spots exceeding 0.25 acre (0.1 ha)
   b) Survival rates less than 85% but greater than 75% with fail spots less than 0.25 acre (0.1 ha) are measured for half payment at the Contractor price unless deficient area is replanted
   c) Survival areas less than 75% are replanted in full at the Contractor's expense
   d) All of the above

5. Which of the following is true about planting temporary grasses?

   a) Seeds that conform to Subsection 890.2.01 shall be used
   b) Seeding, temporary grass, and lime shall be performed according to Section 700
   c) Mixed grade fertilizer shall be applied at 400 lb/acre (450 kg/ha) (Omit Nitrogen)
   d) All of the above

6. Temporary mulch shall be placed on slopes as steep as _______ by using a tracked vehicle to imbed mulch into the slope.

   a) 4:2
   b) 3:1
   c) 2:1
   d) It does not depend on the steepness of the slope

7. Which of the following is *not* true about the payment of materials and items used for erosion control?

   a) Silt control gates are paid at the Contract Unit Price per each
   b) Temporary slope drains are paid by linear ft (m)
   c) Sediment basins are paid at the Contractor Unit Price per each
   d) Temporary grass is paid by the ton

8. A person who has successfully completed the appropriate certification course approved by the _______ (WECS Certification Course) can perform all monitoring, sampling, inspections, and rainfall data collection.

   a) Georgia Soil and Water Conservation Commission (GSWCC)
   b) Environmental Protection Agency (EPA)
   c) Georgia Department of Agriculture
   d) Any of these choices

9. Which of the following do certified personnel need to perform more than once a month as a part of water quality control program?

    a) Inspecting petroleum product storage, usage, and handling areas
    b) Inspecting areas where final stabilization has been completed
    c) Inspecting permanent erosion control devices that remain in place
    d) Looking for evidence of sediments or pollutants entering drainage system or receiving waters

10. Which of the following is performed by the certified personnel for water quality monitoring?

    a) Inspections, rainfall data collection, testing samples, and reporting results according to requirements in Part IV of the NPDES Infrastructure permit
    b) Taking samples manually or with automatic samplers, according to permit
    c) Submitting bench sheets, work sheets, etc., when using portable turbidimeters
    d) All of the above

11. Which of the following is true about restoring lakes and dams?

    a) Silt shall be removed often to avoid polluting downstream area
    b) Lake shall be returned to the original contour and condition or proposed contour
    c) Removed material shall be disposed in a manner satisfactory to the Engineer
    d) All of the above

12. In which of the following situations can temporary grass be used?

    a) Control erosion where permanent grassing cannot be planted
    b) Protect an area for longer than temporary mulch is expected to last (at least 60 days)
    c) Both choices a) and b)
    d) Temporary grass shall not be used for erosion control

13. Which of the following is true about an inlet sediment trap?

    a) Excavated area adjacent to a sediment trap provides additional sediment storage
    b) Inlet sediment traps consist of a temporary device placed around a storm drain inlet to a trap sediment
    c) It is constructed of a Type C silt fence, plastic frame and filter, hay bales, baffle box, or other filtering materials approved by the Engineer
    d) All of the above

14. Which of the following guidelines is *not* true about constructing temporary slope drains?

a) Temporary pipe slope drains shall be placed with inlets, but velocity dissipaters are optional and can be installed if Contractor determines
b) Inlets are securely anchored into a slope to provide a watertight connection to an earth berm
c) Temporary slope drains shall be placed as shown on the Uniform Code System for Erosion and Sediment Control Sheet for temporary items or as directed by the Engineer
d) Slope drains and areas with permanent grass shall be removed

15. Which of the following do certified personnel need to perform more than once a month as a part of a water quality control program?

a) Inspecting petroleum product storage, usage, and handling areas
b) Inspecting areas where final stabilization has been completed
c) Inspecting permanent erosion control devices that remain in place
d) Look for evidence of sediments or pollutants entering drainage system or receiving waters

Hard

1. Which of the following is *not* true about temporary mulch for erosion control?

a) Temporary mulch could be applied to control erosion for 120 days or less
b) Mulch shall be uniformly spread over designated areas from 2–4 in. (50–100 mm) thick
c) Mulch shall be walked in with a tracked vehicle, empty sheepsfoot roller, light discing, or other ways
d) Temporary mulch shall be placed on slopes as steep as 2:1 by using a tracked vehicle to imbed mulch into slope

2. Which of the following is *not* true about temporary ditch checks?

a) They may be constructed of stone plain rip rap
b) Plastic filter fabric is placed on the ditch section after placing rip rap
c) They remain in place until permanent ditch protection is in place or during installation
d) They may remain in place to aid in establishing permanent grass in vegetated waterways (if approved by the Engineer)

3. Temporary ditch checks shall be cleaned of sediment when _____ of the height of the check is reached.

a) ¼
b) ⅓
c) ½
d) ¾

4. Sediment shall be cleaned from temporary sediment basins when _____ capacity of storage volume is filled.

   a) ¼
   b) ⅓
   c) ½
   d) ¾

5. Which of the following is *not* true about the payment of maintenance of temporary erosion and sedimentation control devices?

   a) Temporary Silt Fence: Contractor Unit Price bid per linear ft (m) (Type A, B, or C)
   b) Silt Retention Barrier: Contractor Unit Price bid per linear ft (m)
   c) Temporary Sediment Basin: Contractor Unit Price bid per linear ft (m)
   d) Silt Control Gates: Contractor Unit Price bid per each (Type I, II, III, or IV)

6. For restoration of a lake, the payment schedule is _____ of bid amount paid each time a lake or pond is cleaned of silt and debris during the construction period, up to four occurrences.

   a) 5%
   b) 10%
   c) 15%
   d) 20%

7. Water quality shall be tested and monitored by the certified personnel every time the rainfall is more than __________.

   a) 0.5 in. (13 mm)
   b) 0.75 in. (21 mm)
   c) 1 in. (26 mm)
   d) 1.5 in. (40 mm)

8. In water quality monitoring, all inspection reports made by the certified personnel need to be submitted to the Engineer within ________.

   a) 12 hours
   b) 24 hours
   c) 48 hours
   d) 7 days

9. In water quality monitoring, all samples made by the certified personnel need to be submitted to the Engineer within ________ of sample date.

   a) 12 hours
   b) 24 hours
   c) 48 hours
   d) 7 days

10. For constructing a silt retention barrier, it should be placed approximately ______ outside the affected construction area, and at a depth within _______ of bottom.

    a) 25 ft (7.5 m) / 5 ft (1.5 m)
    b) 25 ft (7.5 m) / 10 ft (3 m)
    c) 50 ft (15 m) / 5 ft (1.5 m)
    d) 50 ft (15 m) / 10 ft (3 m)

11. For constructing silt retention barrier, it should be assured that the fabric extends _______ above the normal water line from the top of the fabric.

    a) 1 ft (300 mm)
    b) 1.5 ft (450 mm)
    c) 2 ft (600 mm)
    d) 3 ft (900 mm)

12. When delivering and storing a silt fence, the fabric shall *not* be exposed to temperatures greater than _______.

    a) 110°F
    b) 140°F
    c) 160°F
    d) 170°F

13. When constructing a silt fence, the soil shall be excavated to a depth between _____ using trenching machine, motor grader, or by hand (if equipment cannot be operated on site).

    a) 2–4 in. (50–100 mm)
    b) 4–6 in. (100–150 mm)
    c) 8–12 in. (200–300 mm)
    d) 12–16 in. (300–400 mm)

14. A mechanical slice shall be created in soil with ________ depth and width *not* more than _______ during soil slicing when constructing a silt fence.

    a) 4–6 in. (100–150 mm) / 3 in. (75 mm)
    b) 4–6 in. (100–150 mm) / 6 in. (150 mm)
    c) 8–12 in. (200–300 mm) / 3 in. (75 mm)
    d) 8–12 in. (200–300 mm) / 6 in. (150 mm)

15. Staples or nails shall be evenly spaced with at least _____ per post for Type A fence and ______ per post for Type B fence when using the soil slicing method of constructing a silt fence.

    a) 4 / 4
    b) 4 / 5
    c) 5 / 4
    d) 5 / 5

C.4 Earthwork Training Module Exam Questions

Easy

1. Vegetative parts of plants (roots and above ground bearing fruit parts) should be ____ to prevent spreading of “Introduced Pest Species.”

   a) Re-planted near subgrade
   b) Burned or buried at approved site
   c) Undisturbed during construction
   d) Plowed or harrowed

2. Which of the following is *not* a recommended procedure for clearing and grubbing?

   a) Remove grass after grading
   b) Remove stumps
   c) Cut stumps not grubbed
   d) Dispose of cleared materials

3. Which of the following is *not* considered a root that should be removed?

   a) Matted trees and bushes
   b) Individual roots more than 0.75 in. in diameter
   c) Individual roots more than 3 ft long, regardless of size
   d) Roots not located on the roadway subgrade

4. When disposing of combustible materials, the Contractor should ____.

   a) Burn sawdust on right-of-way
   b) Dispose in other areas without Department approval
   c) Obtain suitable areas for burning at Department’s expense
   d) Remove sawdust within construction limits of approved disposal area

5. Which of the following is a regulated solid waste material?

   a) Rock
   b) Brick
   c) Concrete
   d) Solvents

6. Which of the following is a good practice for excavating channels?

   a) Leave piles near the excavated channel after final grading
   b) Deposit material in jurisdictional wetlands
   c) Spread in uniform layers, neatly leveled and shaped
   d) Close openings in spoil banks to minimize drainage

7. When historical artifacts are discovered during excavation, ____________.

   a) Continue excavation
   b) Dispose of artifacts outside of the subgrade
   c) Temporarily stop excavation operations until directed by the Engineer
   d) Stop all construction on the Project for a 1-week minimum

8. Which Project stakeholder retains salvaged materials?

   a) Contractor
   b) Department
   c) Adjacent property owners
   d) Material must be immediately disposed

9. All of the following must be submitted for borrow excavation *except* _____.

   a) Construction equipment used to perform excavation
   b) National Historical Preservation Act
   c) Approval for environmental considerations
   d) Approval for pit investigation, cross sectioning, and required staking

10. Use borrow material containing ______.

    a) Roots
    b) Stumps
    c) Contaminated soil
    d) Class II B3 or better for subgrade

11. All of the following are recommended practices for bridge excavation and backfill *except*:

    a) Key center of foundation throughout area equal to column dimensions
    b) Subject concrete to action of water before final setting
    c) Step foundation, remove loose fragments, and clean/fill seams
    d) Use cofferdams or sheeting to prevent undesirable changes in channels and slopes

12. Granular embankment is paid by:

a) Lump Sum
b) Unit Price per linear foot
c) Unit Price per square yard
d) Unit Price per cubic yard

13. Which of the following is *not* a recommended practice for removing solid waste?

a) Give Engineer 2 days' notice before removing solid waste
b) Provide engineering and work practice controls to protect employee health and safety
c) Engineer notifies local governing authority of proposed work and time schedule
d) Excavate to full depth and width of cut in one continuous operation leaving minimum exposed surface

14. Which of the following is *not* a recommended practice for constructing unpaved shoulders?

a) Shape and compact shoulders in sequence as required for type of base or pavement
b) Do not repair damage to existing base, surface, or pavement due to construction
c) Compact shoulder area above subgrade elevation that requires grassing or sodding to firm and stabilize area
d) Compact shoulders adjacent to flexible pavement at least 18-in. wide on each side

15. Ungrassed shoulder areas should have a minimum resultant density of ___ of maximum laboratory dry density.

a) 75%
b) 80%
c) 95%
d) 100%

Medium

1. What grubbing procedure is required for concrete slabs?

a) Slabs can remain as part of the subgrade
b) All slabs must be removed off the right-of-way
c) Grub 10 ft below finished grade
d) Break such that no section greater than 10 ft^2 remains intact

2. Heavy-duty disc harrows should penetrate the ground by a minimum of…

   a) 6 in.
   b) 5 ft
   c) 8 ft
   d) 10 ft

3. Stumps are tree ends with a minimum diameter of ____.

   a) 4 in.
   b) 2 ft
   c) 4 ft
   d) 8 ft

4. Which of the following is *not* an accepted procedure for disposing sawdust?

   a) Deposit on right-of-way in 3 in. maximum layer
   b) Mix with underlying soil by discing or harrowing
   c) Dispose in approved area outside of construction limits
   d) Pile on sides of subgrade

5. Unless noted otherwise, clearing and grubbing is paid by:

   a) Unit price
   b) Lump Sum
   c) Cubic yard of embankment
   d) Department does not pay

6. Which of the following is *not* recommended for serrated slopes?

   a) Grade back slope according to Construction Details
   b) First serration should be level
   c) Deposit regulated material in slope
   d) Use tilt-control blade dozer to cut steps in alternate directions

7. Which of the following is *not* a recommended practice for rock excavation?

   a) Backfill excavated space to correct grade with suitable subgrade material
   b) Presplit periphery plane to excavation depth before blasting
   c) Remove loose rock on cut slopes after blasting
   d) Detonate explosives individually at 2-minute intervals

8. Which of the following is *not* a recommended practice for backfilling a minor structure?

    a) Use Type I backfill material
    b) Use Type II backfill material
    c) Use large boulders as backfill material
    d) Cut surfaces at structure trenches to prevent damage to pavement

9. Which of the following is the Contractor’s responsibility for backfilling minor structures?

    a) Selection of construction method and equipment
    b) Determination of final structure locations and elevations
    c) Determination of minimum requirements for length and depth of excavation
    d) Selection of type of backfill material

10. Backfill material is paid by:

    a) Lump Sum
    b) Plan quantity
    c) Cubic yard
    d) Department does not pay

11. All of the following are true of benching for embankments *except*:

    a) Must have width of 12 ft
    b) Must not be constructed in parallel layers
    c) Increase bond between existing ground and proposed embankment
    d) Use material removed in embankment excavation

12. All of the following are recommended for constructing embankments *except*:

    a) Plow and scarify entire area at least 2 ft
    b) Clear and grub embankment area
    c) Plow and scarify all portions of existing unpaved pavements
    d) Re-compact loosened soil to approximate density of soil

13. Which of the following is *not* used to measure subgrade stabilization?

    a) ton
    b) cubic yard
    c) square yard
    d) linear feet

14. Backfill for bridges should be placed in layers *not* exceeding ___ of loose material.

   a) 1 ft
   b) 3 ft
   c) 5 ft
   d) 10 ft

15. Bridge bents and piers should be backfilled at least ____ after placement.

   a) 1 calendar day
   b) 1 work day
   c) 3 calendar days
   d) 3 work days

Hard

1. What is the minimum grubbing depth below finished grade for existing pavements?

   a) 1 ft
   b) 2 ft
   c) 3 ft
   d) 10 ft

2. Remove stumps and other matter *not* removed by a root rake to minimum depth of ____ below the grade.

   a) 1 ft
   b) 2 ft
   c) 3 ft
   d) 5 ft

3. Material from channel excavation should be deposited at least ___ away from the channel edge.

   a) 1 ft
   b) 3 ft
   c) 5 ft
   d) 10 ft

4. Channel excavation is typically paid by:

   a) Unit price
   b) Lump Sum
   c) Plan quantity
   d) Department does not pay

5. Allow ____ offset in slope to between the pavement and drilling operators for rock excavation.

   a) 6 in.
   b) 18 in.
   c) 3 ft
   d) 5 ft

6. Do *not* pre-split rock slopes flatter than ____.

   a) 1:1
   b) 2:1
   c) 3:1
   d) 4:1

7. Excavate rock or bolder formations near minor structures at least ____ below the bottom of the structure.

   a) 1 ft
   b) 3 ft
   c) 5 ft
   d) 10 ft

8. Which class of material should *not* be used in embankment material?

   a) I
   b) II
   c) III
   d) IV

9. Under what condition is pond sand used for embankment material?

   a) Fill slope steeper than 2:1
   b) Fill thickness less than 7 ft
   c) Fill cover of greater than 2 ft
   d) Fill height exceeding 30 ft

10. Which of the following is *not* required for embankment compaction near bridge structures?

   a) Minimum of 100% of maximum laboratory dry density
   b) Compact top 6 in. of embankment to at least 100% of maximum laboratory dry density
   c) Full-depth compaction beginning at toe of slope, extending 100 ft from bridge end
   d) Minimum 95% maximum laboratory dry density within 1 ft at embankment top

11. Which of the following is *not* a recommended practice for class VI soil in embankments?

a) Use only in top 1 ft of the roadbed
b) Place rock in uniform layers not over 3 ft thick
c) Fill voids with finer material
d) Do not use rock larger than 6 in. in diameter within 3 ft of finished surface

12. Subgrade refers to the top ___ or plan-indicated thickness.

a) 6 in.
b) 1 ft
c) 2 ft
d) 5 ft

13. Key center of foundation by ___ depth throughout area equal to dimensions of column to be placed.

a) 6-in.
b) 1-ft
c) 2-ft
d) 5-ft

14. Bore at least ___ deep in rock and ____ deep in other material for bridge excavation.

a) 1 ft / 2 ft
b) 3 ft / 5 ft
c) 6 ft / 10 ft
d) 12 ft / 20 ft

C.5 Bases and Subbases Training Module Exam Questions

Easy

1. Which of the following is true for constructing embankments or subgrades?

    a) Spread a uniform layer of course or fine aggregate without segregation and compact to specifications
    b) Use any trucks or bulldozers available
    c) Allow course and fine aggregate to segregate during installation
    d) Do not compact embankments or subgrades

2. Which of the following is *not* a stabilization method?

    a) Dry application with quicklime
    b) Slurry of hydrated lime
    c) Slurry by slaking quicklime
    d) Slurry of dry lime

3. Which of the following is *not* a requirement for finishing a lime-stabilized surface?

    a) Uniform lime mixture
    b) Rough surface
    c) Unyielding
    d) Well-bonded

4. Who should determine sources of local materials and commercially produced aggregates for haul roads?

    a) The Department
    b) General Contractor
    c) Subcontractor
    d) Material Supplier

5. Which of the following is *not* an acceptable type of roller for compacting asphalt bases and subbase courses?

    a) Pneumatic tire roller
    b) Steel-wheeled roller
    c) Sheepsfoot roller
    d) All of the above are acceptable

6. Which of the following is *not* a requirement for steel-wheeled rollers?

   a) Must use 3-wheel or tandem wheels
   b) Must use self-propelled rollers equipped with cleaning devices
   c) Must have a minimum weight of 10 tons
   d) Must be equipped with an auxiliary wheel

7. Who decides to remove and replace materials within the roadbed?

   a) Engineer
   b) General Contractor
   c) Subcontractor
   d) Material Supplier

8. Which of the following is *not* an approved mix method to spread mix and stabilize the base, subbase, or shoulder course?

   a) Plowing
   b) Harrowing
   c) Blading
   d) Scarifying

9. Membranes on a soil blanket or cushion should be at least ____ thick.

   a) 2 in.
   b) 4 in.
   c) 6 in.
   d) 8 in.

10. Which of the following is *not* a required practice when placing material for graded aggregate construction?

    a) Use central plant mix methods unless producing aggregates
    b) Do not use materials containing frost or frozen particles
    c) Construct lifts in maximum of 12 in. compacted layers
    d) Uniformly spread materials to a proper depth with a mixture spreader

11. Which of the following is *not* an acceptable practice for compacting material for graded aggregate construction?

    a) Ensure moisture content of materials is uniformly distributed and allows compaction to specified density
    b) Uniformly compact course after shaping the spread material to line, grade, and cross section
    c) Apply water to underlying subgrade, if necessary
    d) Maintain course until the Engineer determines it has cured sufficiently and is ready to prime

12. Which of the following is *not* an acceptable practice for reconstructing the base course?

    a) Remove and replace unsuitable material with approved material
    b) Remove and stockpile existing base material
    c) Scarify upper surface of finished base course to a uniform depth
    d) Cover unstable materials with other base course material

13. Which of the following is an unacceptable practice for constructing the surface course?

    a) Spread selected material by approved method to thickness prescribed on the plans
    b) Scarify, mix, and shape selected material to required cross section
    c) Roll until surface is thoroughly compacted, firm, and unyielding
    d) Always keep material dry, even during compaction

14. Which of the following is an acceptable method for preparing base material for patching?

    a) Trim sides of areas to be patched and leave them vertical
    b) Remove all loose material
    c) Undercut areas of unsatisfactory material 1 ft below the existing surface
    d) All of the above

15. Which is an acceptable practice for patching with stabilized base material?

    a) Patch during traffic unless otherwise specified
    b) Do not compact patching material
    c) Do not spray any liquid material on the patch
    d) Fill patch to half of depth of the eroded area

Medium

1. Embankment or subgrade material should be spread uniformly at what maximum thickness?

   a) 6 in.
   b) 8 in.
   c) 10 in.
   d) 1 ft

2. Which of the following practices should be followed when compacting embankments or subgrades?

   a) Compact final layer with sheepsfoot roller
   b) For super-elevated compaction, begin rolling on the upper edge and progress toward the lower end
   c) Begin rolling from the center of the drainage course
   d) Begin rolling on the outer edge of the drainage course

3. How are application rates for lime installation into the soil determined?

   a) Determined from laboratory tests
   b) Rates from previous Projects are used
   c) At the discretion of the General Contractor
   d) There is no standard for these application rates

4. Which of the following is a required capability of a mechanical spreader used for soil stabilization?

   a) Weight of the equipment must penetrate the ground surface by at least 3 ft
   b) Rotary-type mixers capable of mixing to a 6 in. depth
   c) Uniformly distribute bulk lime or slurry to the required application rate
   d) Distribute lime using pneumatic pressure

5. Which of the following is *not* a step to prepare soil-lime for construction?

   a) Always keep foundation moist
   b) Compact foundation to required density
   c) Stabilize soft or yielding material
   d) Remove all detrimental material from the soil

6. Which of the following is *not* true concerning installation of lime for soil stabilization?

   a) Apply lime onto areas that can be mixed in 1 day
   b) Mix lime with frozen soils or soils containing frost
   c) Incorporate the material into the soil with mixing equipment
   d) Distribute the material uniformly to avoid excessive loss

7. Thickness of bases and subbases should be compacted to which of the following?

   a) Number of roller passes determined by the General Contractor
   b) Until material starts to segregate
   c) Maximum dry weight per cubic foot
   d) At the General Contractor's discretion

8. Which of following is *not* true concerning pulverization during soil-cement construction?

   a) Loosen roadbed materials to a width and depth to be stabilized without distributing underlying subgrade
   b) Do not add water
   c) Remove all roots that exceed 3 in. in diameter
   d) Remove sod and rocks

9. What is the acceptable range of moisture content for soil–cement construction?

   a) 50–100%
   b) 70–100%
   c) 100–120%
   d) 120–140%

10. Do *not* perform vibratory compaction on materials more than ___ old.

    a) 1.0 hours
    b) 1.5 hours
    c) 2.0 hours
    d) 2.5 hours

11. For soil aggregate construction, compact and finish the surface to ____ maximum dry density.

    a) 75%
    b) 80%
    c) 90%
    d) 98%

12. Which of the following is *not* an approved material for a waterproofing layer (impermeable membrane)?

    a) Cross-laminated, high-density polyethylene film
    b) Flexible, self-adhesive, rubberized asphalt
    c) Polyvinylpyrrolidone (PVP) plastic coating
    d) All of the above

13. How long should the subbase cure before placing portland cement pavement as the surface layer?

    a) 1 day
    b) 5 days
    c) 7 days
    d) 28 days

14. Which of the following is an unacceptable practice for placing Portland cement concrete subbase?

    a) Spread mixture on grade with minimum re-handling
    b) Hand spread with shovels if necessary
    c) Place portland cement concrete on muddy, puddled, or frozen subgrade
    d) Continue mixing until aggregate and cement segregate

15. For curing portland cement concrete subbases, apply a compound with an impervious membrane at a rate of ______.

    a) 50 ft^2/gal
    b) 100 ft^2/gal
    c) 150 ft^2/gal
    d) 200 ft^2/gal

Hard

1. Which of the following accurately describes construction for a Type II aggregate drainage course?

   a) Trench around a pipe or in a shoulder in conjunction with a trench
   b) Drainage blanket under sidewalks, curbs, gutters, and beneath pavement system or shoulders
   c) Drainage blanket material is indicated for special use on the plans
   d) None of the above

2. What sieve size must soil particles pass to be used for soil-stabilization material?

   a) 2-in. sieve
   b) 3-in. sieve
   c) 4-in. sieve
   d) 5-in. sieve

3. Apply lime uniformly so that the quantity applied does *not* vary more than ____ from the specified quantity.

   a) 10%
   b) 20%
   c) 25%
   d) 30%

4. What are the proper mixture amounts when creating slurry of hydrated lime?

   a) 10% dry lime solids by weight with 40%
   b) 10% dry lime solids by weight with 70%
   c) 30% dry lime solids by weight with 40%
   d) 30% dry lime solids by weight with 70%

5. What is the adequate range of time for mellowing lime?

   a) 12 to 24 hours
   b) 12 to 48 hours
   c) 12 to 72 hours
   d) 12 to 84 hours

6. What is the proper amount of time to keep lime moist during the curing time?

   a) 1 day
   b) 3 days
   c) 5 days
   d) 7 days

7. How quickly should prime be applied to curing lime?

   a) No later than 12 hours after finishing
   b) No later than 24 hours after finishing
   c) No later than 36 hours after finishing
   d) No later than 48 hours after finishing

8. Scales at central mix plants must be with ____ accuracy of a measured load.

   a) 0.5%
   b) 1.5%
   c) 3.5%
   d) 5.0%

9. What is the acceptable operating speed range for pneumatic tire rollers when compacting base and subbase courses?

   a) 3 to 8 mph
   b) 5 to 10 mph
   c) 5 to 15 mph
   d) No limit exists

10. What is the required minimum width of compaction for trench rollers?

   a) 10 in.
   b) 15 in.
   c) 20 in.
   d) 25 in.

11. What is the minimum contact pressure for pneumatic tire rollers for base and subbase course compaction?

   a) 20 psi
   b) 30 psi
   c) 40 psi
   d) 50 psi

12. What is the minimum temperature for conducting soil–cement construction?

    a) 25°F
    b) 50°F
    c) 60°F
    d) 70°F

13. To what depth should undercut areas of unsatisfactory material be removed before constructing stabilized base material for patching?

    a) 1 ft
    b) 2 ft
    c) 3 ft
    d) 4 ft

14. Base patching with stabilized material should be compacted to a minimum of ____ maximum laboratory dry density.

    a) 85%
    b) 90%
    c) 95%
    d) 100%

15. Portland cement concrete subbase should be placed when the air temperature is greater than which of the following?

    a) 20°F
    b) 30°F
    c) 40°F
    d) 50°F

C.6 Pavements Training Module Exam Questions

Easy

1. Which of the following is *not* included on the paving plan?

    a) Weather conditions
    b) Proposed starting date
    c) Average haul distances
    d) Number of haul trucks

2. Trench widening is defined as widening no more than ____.

    a) 2 ft
    b) 4 ft
    c) 6 ft
    d) 8 ft

3. Which of the following is *not* a requirement for the job mix formula?

    a) Source and description of materials
    b) Number of employees on the paving crew
    c) Single percentage of combined mineral aggregates passing each specified sieve
    d) Single temperature of discharged mixture from the plant

4. What is a requirement of vehicles for transporting hot mix asphalt?

    a) Approved releasing agent
    b) Waterproof cover that extends over the sides and ends of the bed
    c) Insulation on front end and sides of each bed
    d) Releasing agent that is detrimental to the mixture

5. Which of the following is *not* required for a bituminous paver?

    a) Must be capable of maintaining true to line, grade, and cross section
    b) Automatic screed control system
    c) Transverse slope controller
    d) All of the above are acceptable

6. Which of the following is *not* a requirement for using a Material Transfer Vehicle?

    a) Mainline of the traveled way
    b) Collector and distributor lanes on Interstates and limited-access roadways
    c) If total Project tonnage is greater than 1000 tons
    d) Leveling courses at the Engineer’s discretion

7. Who is responsible for monitoring the asphalt testing program and performing comparison and quality assurance testing?

   a) The Department
   b) General Contractor
   c) Subcontractor
   d) Material Supplier

8. Which of the following is an approved practice for the composition of pavement mixtures?

   a) Ensure bituminous cold mixtures are uniform mixtures of aggregate, asphaltic material, and mineral filler
   b) Ensure constituents are segregated and unevenly proportioned to produce mixtures that meet requirements
   c) Do not mix materials of pavement mixture until material has arrived on the site
   d) None of the above

9. Which of the following is *not* an acceptable practice for stockpiling cold mix for patching material?

   a) Place finished mixture into small stockpiles to allow proper curing
   b) After curing, stockpile the mixture into one large pile
   c) Mix with hot mix asphalt on site to ensure curing time
   d) Ensure the stockpile area is clean and well drained

10. What does the acronym RAP stand for with regard to asphalt?

    a) Reclaimed Aggregate Pavement
    b) Reclaimed Asphalt Pavement
    c) Rough Aggregate Pavement
    d) Rough Asphalt Pavement

11. Which of the following is *not* an acceptable practice for using RAP?

    a) Use RAP material that contains alluvial gravel or local sand for Interstate Projects
    b) Stockpile at the location specified on the plans
    c) Erect a sign on each stockpile to identify sources
    d) The Department may reject by visual inspection stockpiles that are not free of foreign materials

12. Which of the following is the correct construction sequence when placing hot in-place recycled asphalt mix?

    a) 1) Soften existing surface with heat; 2) mill to obtain proper depth; 3) apply tack coat; and 4) remix, level, and re-lay recycled mixture
    b) 1) Soften existing surface with heat; 2) remix, level, and re-lay recycled mixture; 3) mill to obtain proper depth; and 4) apply tack coat
    c) 1) Apply tack coat; 2) soften existing surface with heat; 3) mill to obtain proper depth; and 4) remix, level, and re-lay recycled mixture
    d) 1) Apply tack coat; 2) soften existing surface with heat; 3) remix, level, and re-lay recycled mixture; and 4) mill to obtain proper depth

13. Which of the following is an *unacceptable* practice for asphalt-rubber joint and crack sealing?

    a) Material should contain water
    b) Material should not contain volatile solvents
    c) Material should cure immediately when cooled to a sufficient viscosity to prevent tracking caused by traffic
    d) Ensure the plastic film used to package the units melts at normal application temperatures

14. Which of the following is an *acceptable* method for preparing asphalt-rubber joint and crack seal construction?

    a) Use compressed air to clean joints
    b) Do not clean cracks to be sealed
    c) Apply water to all surfaces to be sealed
    d) Vibratory roll all surfaces to be sealed before application

15. Which is an acceptable practice for partial removal of asphalt concrete pavement using a saw cut joint?

    a) Lines are established by the General Contractor
    b) Saw to a depth half of the desired removal depth
    c) Excavation buckets on construction equipment can be substituted for saw cutting a joint
    d) Leave neat, vertical face for full depth of the retained portion

Medium

1. Which term is defined by the following: A sample of material retained during the quartering process which is used for evaluation if a comparison of Contractor and Department split sample test results is outside allowable tolerances?

   a) Independent sample
   b) Referee sample
   c) Comparison sample
   d) Random sample

2. Which of the following practices should be followed when preparing the existing surface for hot mix asphalt?

   a) Scarify existing surface
   b) Spread coarse aggregate across existing surface
   c) Prime or tack coat area after being cleaned
   d) Compact with rollers after applying prime or tack coat

3. What is an acceptable practice for placing a patching and leveling course?

   a) Bring surface area to proper cross section and grade with leveling course
   b) Place at locations and amounts as directed by the General Contractor
   c) Use a motor grader lacking a spreader box
   d) None of the above

4. Which of the following is *not* an acceptable practice for hot mix asphalt placement?

   a) Spread mixture to loose depth for compacted thickness and spread rate
   b) Use fuel and other solvents to clean tools on the site
   c) Minimize tracking tack onto surrounding surfaces
   d) Continue rolling until roller marks are no longer visible

5. Which of the following is true for screens on asphalt paving equipment?

   a) Should be capable of blending removed material and rejuvenating agent into a homogeneous mixture
   b) Should be capable of collecting and distributing recycled mixture over variable widths for the entire width being processed
   c) Should be capable of heating asphalt concrete pavement to a temperature high enough to remove excess moisture and allow hot milling
   d) Should provide a suitable surface for cleaning equipment

6. Which of the following is *not* true concerning surface preparation for hot mix asphalt?

   a) Surface should be free of dirt and vegetation
   b) Remove thermoplastic paint markings prior to recycling
   c) Individually remove all painting lines and marking on the existing surface
   d) Remove all metal raised pavement markers in place

7. When applying hot mix recycled asphalt, the Contractor should do all of the following *except*:

   a) Control placement of mixture to produce surface true to line, grade, and cross slope with uniform texture free of segregation, lumps, or unacceptable streaks
   b) Ensure mixture meets acceptable requirements for mixture quality, compaction, smoothness, and thickness
   c) Provide a maximum of one roller behind the asphalt paver
   d) Overlay recycled mixture by producing and placing mixture that meets the requirements

8. Which of following is true concerning heating, removing, and blending hot mix recycled asphalt materials?

   a) Evenly heat pavement at full lane width at a 2-in. minimum overlap on the adjacent paving materials
   b) There should be evidence of broken or fractured aggregate in the windrowed material
   c) Aggregate should be inconsistently coated
   d) Control heating to ensure uniform penetration without differential softening of the surface

9. To which of the following areas should bituminous prime *not* be applied?

   a) Cement-stabilized bases
   b) Cement-stabilized subbases
   c) Lime-stabilized subbases
   d) Driveways and paved shoulders

10. Which of the following is *not* a step for protecting, curing, and maintaining bituminous prime?

    a) Close roadway to traffic
    b) Roll surface across the width (laterally) with a steel drum roller
    c) Blot sand to tack places so tack is not lifted by the equipment
    d) Open roadway to traffic after rolling and sanding

11. Which of the following should *not* be completed when applying bituminous tack coat?

a) Clean area before applying tack coat
b) Coat entire areas to be paved with tack coat
c) General contact will determine application rate of the bituminous tack coat
d) After application, allow tack coat to break and become tacky

12. Which class of aggregates is used for bituminous pavement when surface treatment is used for shoulder construction?

a) Class A
b) Class AA
c) Class B
d) Class C

13. Which of the following terms is described in the following: A bituminous material application that is covered with aggregate of the size specified in the proposal followed by a second bituminous material application that is covered with a second specified size aggregate?

a) Single surface treatment
b) Double surface treatment
c) Triple surface treatment
d) None of the above

14. Which of the following should *not* be used to remove foreign material from the existing surface before asphalt paving?

a) Hand brooms
b) Power broom
c) Power blowers
d) Cleaning existing surface is not required

15. In general, bituminous surface treatment should be applied within which of the following date range?

a) April 15 to October 15
b) May 15 to September 15
c) June 15 to November 15
d) July 15 to November 15

Hard

1. Material Transfer Vehicles (MTV) should be used when the ADT is equal to or greater than ____, the Project length is equal to or greater than ____, and the total tonnage of the mixture is greater than ______.

   a) 2000 vehicles / 1000 linear feet / 1000 tons
   b) 2000 vehicles / 1000 linear feet / 2000 tons
   c) 4000 vehicles / 3000 linear feet / 2000 tons
   d) 6000 vehicles / 3000 linear feet / 2000 tons

2. The General Contractor should notify the Engineer at least __ before beginning construction with hot mix asphalt.

   a) 12 hours
   b) 1 day
   c) 2 days
   d) 3 days

3. For the diluent material of hot asphalt–vulcanized rubber seal treatment, use kerosene with a boiling point above what temperature?

   a) 200°F
   b) 250°F
   c) 300°F
   d) 350°F

4. When using rubber tire rollers for hot asphalt–vulcanized rubber steel treatment, the tire rollers should be loaded at a minimum of what weight for each tire?

   a) 1000 lb
   b) 2000 lb
   c) 3500 lb
   d) 5000 lb

5. Hot asphalt and rubber should be mixed for at least what time period when used for hot asphalt–vulcanized rubber seal treatment?

   a) 5 minutes
   b) 10 minutes
   c) 15 minutes
   d) 18 minutes

6. What is the minimum amount of coverage rolls required of pneumatic rollers when placing hot asphalt–vulcanized rubber seal treatment?

   a) 1
   b) 2
   c) 3
   d) 4

7. Which type of asphalt–rubber joint and crack seal is used to fill joints and cracks in portland cement concrete or asphaltic concrete pavements when required?

   a) Type A
   b) Type B
   c) Type M
   d) Type S

8. Do *not* apply prime when the surface is wet, rain is imminent, or the air temperature is below what temperature?

   a) 5°F
   b) 10°F
   c) 30°F
   d) 40°F

9. What is the acceptable minimum temperature for applying bituminous surface treatment?

   a) 45°F
   b) 50°F
   c) 55°F
   d) 60°F

10. Rollers should operate at what maximum speed when compacting bituminous surface treatment?

    a) 5 mph
    b) 8 mph
    c) 10 mph
    d) 12 mph

11. Do *not* apply slurry seal if the pavement or ambient temperature is below what value?

    a) 45°F
    b) 50°F
    c) 55°F
    d) 60°F

12. Which of the following conditions is *not* correct for microsurfacing?

   a) Weather is not foggy or rainy
   b) Ambient temperature is at least 40°F
   c) Thoroughly clean all cracks and area to be surfaced before applying mixture
   d) Ensure the cured mixture fully adheres to the underlying surface

13. What width should be covered with tack coat before constructing a rumble strip?

   a) 5 ft
   b) 10 ft
   c) 15 ft
   d) 20 ft

14. When removing forms after placing concrete for a portland cement concrete pavement, the forms should remain for a minimum of what time period?

   a) 6 hours
   b) 12 hours
   c) 18 hours
   d) 24 hours

15. While constructing joints in portland cement concrete pavement, they should be spaced at a minimum of what distance from an expansion joint, contraction joint, or transverse joint?

   a) 5 ft
   b) 10 ft
   c) 15 ft
   d) 20 ft

C.7 Bridges Training Module Exam Questions

Easy

1. Which of the following is *not* required on a concrete delivery ticket?

   a) Driver name
   b) Quantity of concrete
   c) Class of concrete
   d) Concrete mixing revolutions

2. Which of the following is *not* an acceptable material for concrete formwork?

   a) Fiberglass
   b) Lumber
   c) Plywood
   d) Metal

3. Which of the following should *not* be used for a covering when curing concrete?

   a) Plastic
   b) Burlap
   c) Sand
   d) Straw

4. Which of the following is true when using bolts for steel structures?

   a) Leave unfair holes as they are
   b) Fit up connections securely after placing bolts
   c) Ensure members are open-fitting and close to required dimensions
   d) Ensure members are free from twists, bends, and burrs

5. Which of the following is *not* required for straightening material?

   a) Ensure all parts are free of stress
   b) Ensure some parts have external forces
   c) Heat metal to temperature given by the Specifications
   d) Cool metal slowly after heating

6. Which of the following Contractor options for prestressing concrete by post-tensioning is defined in the following: Contractor may use post-tensioning systems other than those shown in the plans?

   a) Alternative prestressing systems
   b) Alternative stressing
   c) Anchorage blocks
   d) None of the above

7. Which of the following is *not* an acceptable practice when handling reinforcement steel?

   a) Load, transport, unload, and handle reinforcement steel in way that prevents damage
   b) Lay reinforcement steel on the ground surface and store in piles
   c) Protect reinforcement steel from weather if prolonged exposure is expected
   d) Clean off loose mill scale, rust scale, and coatings that will destroy the bond

8. To which of the following locations should reinforcement steel be tied?

   a) Each intersection on the outer edges
   b) Alternating intersections on the outer edges
   c) Each intersection within the mat
   d) Every third intersection within the mat

9. Which of the following should be used to support the mat steel from touching the ground?

   a) Random pieces of broken concrete
   b) Large rocks
   c) Mounds of dirt
   d) Precast blocks fastened with cast-in wires

10. Which of the following is an acceptable practice when placing steel dowels?

    a) Position dowel bars so that the column bars or vertical wall bars can be spliced and tied into location
    b) Push dowel bars into wet concrete after placing
    c) Space steel off side forms using random pieces of broken concrete
    d) Attach dowel bars to the template loosely so they can move during concrete placement

11. Which of the following is *not* an acceptable practice for erecting aluminum handrails on bridges?

    a) Make all rails perpendicular to the bridge grade
    b) Set handrail posts normal to grade where bridge rails are supported on a concrete parapet
    c) Tighten anchor bolt nuts to a snug fit with full bearing on the post base
    d) When posts and rails are completely bolted into place, ensure they are true to grade

12. A minimum tip elevation is defined by which of the following?

   a) Final elevation of the pile
   b) Elevation that the pile tip cannot stop above
   c) Plan elevation of the top of the pile
   d) None of the above

13. Which of the following is *not* a type of piling used for bridges?

   a) Timber
   b) Prestressed concrete
   c) Sheet H-Piling
   d) Plastic

14. Which of the following best describes the extent of removing an existing bridge structure?

   a) Remove portions of the existing bridge except the piling
   b) Remove entire substructure higher than the streambed or natural ground line
   c) Remove abutments or end bends in place
   d) Do not interfere with stream flow or new work if the plans indicate

15. Barriers for detour bridges must extend what minimum value from the bridge ends unless the plans show otherwise?

   a) 10 ft
   b) 20 ft
   c) 30 ft
   d) 40 ft

Medium

1. Which of the following should be used in concrete structures?

   a) Class A and Class B coarse aggregate
   b) Limestone
   c) Dolomite
   d) Wood material

2. Which of the following is *not* a type of cement used for concrete structures?

   a) Type I portland cement
   b) Type II portland cement
   c) Type III portland cement
   d) Type IP portland–pozzolan cement

3. Which of the following is *not* an acceptable practice when placing concrete for structures?

   a) Ensure concrete reaches the final position within 3 hours after adding cement to aggregates
   b) Place concrete without delays
   c) Manipulate delivery unit to avoid vibration damage to partially set concrete
   d) Thoroughly clean and wet forms before placement

4. Which of the following is an acceptable practice when placing concrete for structures?

   a) Use equipment that leaks grout, water, oil, or gas
   b) Operate pumping equipment so that concrete is produced in a segregated stream with air pockets
   c) Have enough production and placement capacity to continuously mix, place, and finish concrete in each pour
   d) Segregate course and fine aggregate in concrete before placing

5. Steel pieces used for structures should be marked with the following *except*:

   a) Delivery company
   b) Color code
   c) Mill test report number
   d) Heat number

6. Which of the following does *not* need to be galvanized when constructing timber structures?

   a) Bolts
   b) Nuts
   c) Dowels
   d) None of the above

7. Which of the following gives the correct steps to construct timber superstructures?

   a) 1) Install stringers, 2) frame and erect hub guards and railings, 3) lay single-plank floors, and 4) lay laminated or strip floors
   b) 1) Lay single-plank floors, 2) frame and erect hub guards and railing, 3) install stringers, and 4) frame and erect hub guards and railings
   c) 1) Frame and erect hub guards and railing, 2) install stringers, 3) frame and erect hub guards and railings, and 4) lay single-plank floors
   d) 1) Install stringers, 2) lay single plank floors, 3) lay laminated or strip floors, and 4) frame and erect hub guards and railings

8. Which of following is *not* a step to tighten diaphragm bars?

a) Bring diaphragm bar nuts to a snug fit against the beams
b) Allow the diaphragm concrete to age at least 1 day
c) Allow the diaphragm concrete to reach at least 1500 psi
d) Cut off the excess bar length

9. Which of the following is *not* an acceptable practice for excavating, bedding, and backfilling precast reinforced concrete box culverts barrel sections and end sections?

a) Place bedding between graded forms at least 12 in. outside each wall of the boxes from the edge of precast apron sections
b) Shape bedding material to fit the bottom of the precast sections
c) Screed off graded forms
d) None of the above

10. Which of the following is *not* an acceptable practice for dampproofing a bridge?

a) Evenly apply a seal coat having a temperature of 300°F to 350°F and 200°F for pitch
b) Allow the seal coat to dry at least 1 day
c) Seal coat shall be hard before any water or earth contacts it
d) Protect the seal coat from the weather during the drying period

11. Which method of bridge deck waterproofing membrane is described in the following: A waterproofing membrane system placed directly on a portland cement concrete bridge deck surface?

a) Method A
b) Method B
c) Method C
d) Method D

12. Which of the following is *not* an acceptable practice for painting bridge structures?

a) Comply with all relevant regulations of the Environmental Protection Agency (EPA) and all other regulatory agencies
b) Material Safety Data Sheets (MSDS) are not required for abrasive and paint materials
c) Do not allow containment system of equipment to violate the minimum bridge clearances shown on the plans
d) Submit to the Engineer for review and approval of an emergency contingency plan for cleaning up spills from a failure of the containment system

13. Which of the following is an acceptable practice for preparing a bridge structure for painting?

a) Do not clean new and existing steel structures until after painting
b) Clean structures under or over the railroads
c) Special protective coating is not required for steel piling, sway bracing, and concrete piling surfaces
d) None of the above

14. Which of the following gives the correct number of paint coats for bridge structures?

a) One shop prime coat and one field touch-up coat
b) One shop prime coat, one field touch-up coat, and one field weather coat
c) One shop prime coat, one field touch-up coat, and two field weather coats
d) One shop prime coat, and two field weather coats

15. Waterproofing fabric material should be overlapped a minimum of what value on all applications?

a) 2 mm
b) 4 mm
c) 6 mm
d) 8 mm

Hard

1. Protection procedures should keep concrete above what temperature for 72 hours after placement?

a) 30°F
b) 40°F
c) 50°F
d) 60°F

2. Concrete should *not* exceed what temperature?

a) 60°F
b) 70°F
c) 80°F
d) 90°F

3. What is the maximum stone size allowed when constructing bridges with duct enclosures?

   a) 5
   b) 6
   c) 7
   d) 8

4. How old must concrete be before a Contractor can drive, pile, blast, or perform other operations around the concrete?

   a) 1 day
   b) 2 days
   c) 3 days
   d) 4 days

5. Concrete should be cured for a minimum of how many days after applying the surface finish?

   a) 5 days
   b) 10 days
   c) 12 days
   d) 15 days

6. When adjusting deviations in steel structures, apply heat no hotter than which of the following temperatures?

   a) 500°F
   b) 800°F
   c) 1000°F
   d) 1150°F

7. When placing expanded mortar, traffic should be allowed on the bridge deck no sooner than what time period?

   a) 1 day
   b) 3 days
   c) 5 days
   d) 7 days

8. Which of the following is *not* a step when placing mortar?

   a) Expand mortar for shear keys
   b) Completely fill shear key with mortar
   c) Float mortar off flush with surface of precast decks
   d) Moist cure mortar continuously for a minimum of 2 days

9. Which of the following is a step to pouring expanded mortar into shear keys between deck units?

   a) Ensure all units are in final alignment before pouring mortar
   b) Pour mortar directly below the shear keys
   c) Continuously moist cure the keys for at least 2 days
   d) Keep traffic off the structure for at least 3 days

10. When prestressing concrete by post-tensioning, place support ducts at a maximum of what interval?

    a) 1 ft
    b) 2 ft
    c) 3 ft
    d) 4 ft

11. When prestressing concrete by post-tensioning, ensure the pumping pressure at the tendon inlet does *not* exceed which value?

    a) 250 psi
    b) 500 psi
    c) 750 psi
    d) 1000 psi

12. Reinforcing steel must have at least how many ties per bundle for beam and cap steel ties?

    a) 2
    b) 3
    c) 4
    d) 5

13. Piles must be what length to be categorized as a long pile?

    a) 10 ft
    b) 25 ft
    c) 30 ft
    d) 50 ft

14. When designing cofferdams, measure forces and pressures from what minimum excavated depth?

    a) 6 ft
    b) 8 ft
    c) 10 ft
    d) 15 ft

15. Service poles for power supply and wiring on bridge should be at what minimum length?

a) 10 ft
b) 20 ft
c) 30 ft
d) 40 ft

C.8 Minor Drainage Structures Training Module Exam Questions

Easy

1. Which of the following is true about the deck drain system for constructing minor drainage structures?

   a) Materials used shall meet plan requirements
   b) Commercial-grade steel hardware (clips, brackets, bars, etc.) shall be used unless otherwise noted on the plans
   c) Galvanizing repair compound shall be used
   d) All of the above

2. For performing pile encasement for minor drainage structures with Class A concrete deposited in water and epoxy-coated steel reinforcement, the Department ……

   a) Will not require cofferdams
   b) Will require cofferdams if concrete is deposited in water
   c) Will not require cofferdams only if concrete is not deposited in water
   d) None of the above

3. For performing pile encasement for minor drainage structures with the Fabriform Pile Jacket system or an approved equal, mortar shall be pumped into the fabric jacket using ____ tremie hoses extending to the jacket's bottom.

   a) 1
   b) 2
   c) 4
   d) It depends on the specifications

4. For constructing storm drain pipe in minor drainage structures, the structure shall be protected by _____.

   a) Periodically removing any debris or silt constricting the pipe flow
   b) Providing sufficient depth and width of compacted backfill
   c) Repairing damage or displacement from traffic or erosion occurring after backfilling
   d) All of the above

5. Who is responsible for providing the necessary temporary drainage while constructing storm drain pipe, pipe-arch culverts, and side drain pipe in minor drainage structures construction?

    a) Contractor
    b) Owner
    c) Engineer
    d) All of the above

6. Which of the following is true about smooth-lined corrugated HDPE pipes used for storm drain pipe in minor drainage structures construction?

    a) Sections shall be laid in a prepared trench with bells pointing upstream
    b) Section shall be joined using either rubber gasket or preformed flexible sealant
    c) Fitting and coupling that comply with ASTM 2321 shall be used
    d) None of the above

7. In constructing and installing storm drain pipe, pipe-arch culverts, and side drain pipe in minor drainage structures construction, payment is done at the Contract Price per _________.

    a) Each item
    b) Linear feet (meter)
    c) Cubic feet (meter)
    d) None of the above

8. Which of the following is *not* true about the structural plate pipe, pipe-arch, and arch culverts in minor drainage structures construction?

    a) Necessary temporary drainage shall be provided
    b) Damage or displacement from traffic, erosion, or negligence shall be repaired and corrected
    c) Structural plate pipe-arches and arches shall be erected in the sequence recommended by the Contractor
    d) None of the above

9. For the structural plate pipe, pipe-arch, and arch culverts in minor drainage structures construction, bolts shall be tightened ______.

    a) Only after erecting each segment of the structure
    b) Only after erecting the entire structure
    c) It depends on the specifications and manufacture's recommendations
    d) None of the above

10. For the structural plate pipe, pipe-arch, and arch culverts in minor drainage structures construction, payment is done at the Contract Price bid per _____.

   a) Segment
   b) Volume of liner
   c) Linear ft (meter)
   d) Linear ft (meter) for each diameter and plate thickness

11. Which of the following pumps could be used for grouting for renovating existing pipes in minor drainage structures construction?

   a) Positive-displacement pump
   b) Piston-type pump
   c) Screw-type worm pump
   d) All of the above

12. Which of the following is *not* true about minor drainage structures for detours?

   a) The Engineer shall approve selected construction methods
   b) Only structures that have adequate openings and are suitable for the purpose intended shall be used
   c) An uninterrupted flow of traffic over the existing highway or the completed detour shall be provided
   d) None of the above

13. For minor drainage structures for detours in minor drainage structures construction, the work is paid at the __________ price bid for each structure.

   a) Lump Sum
   b) Unit price
   c) Cost plus
   d) All of the above

14. Which of the following is *not* true about underdrains in minor drainage structures construction?

   a) Work shall be scheduled so that underdrain installations coincide with operations on the Project
   b) Unstable material at the bottom of the trench shall be removed
   c) Approved clay material shall be added and compacted for a stable pipe foundation
   d) None of the above

15. For underdrains in minor drainage structures construction, each size of underdrain pipe will be paid at the ___________.

a) Contract Price per linear ft (meter)
b) Contract Price per item
c) Lump Sum price
d) Cost plus price

Medium

1. Deck drain systems shall be installed according to the …

a) Plans
b) Professional Engineer
c) Standards
d) None of the above

2. Which of the following is *not* true about the cleaning of the pile encasement for minor drainage structures?

a) Piles on existing structures to be encased shall be sandblasted to remove loose dirt, rust, scale, and other deleterious material
b) They shall be rinsed thoroughly with clean water
c) They shall be cleaned with a wire brush if necessary
d) None of the above

3. Piles to be used on new construction for minor drainage structures shall ________.

a) Be always sandblasted before usage
b) Be sandblasted only if they are not clean
c) Not be sandblasted
d) It depends on the plans

4. In performing pile encasement for minor drainage structures, payment is done at the Contract Price per ________ for the pile size indicated, complete in place as specified.

a) Linear foot (meter)
b) Unit weight
c) Structure
d) None of the above

5. Which of the following cannot be used for storm drain pipe, pipe-arch culverts, and side drain pipe in minor drainage structures construction?

   a) Reinforced concrete
   b) Nonreinforced concrete
   c) Polyvinyl Chloride (PVC) Profile Wall Drain Pipe and Polyvinyl Chloride (PVC) Corrugated Smooth Interior Drain Pipe
   d) None of the above

6. Which of the following is *not* true about installing storm drain pipe, pipe-arch culverts, and side drain pipe in minor drainage structures construction?

   a) Vertical and horizontal alignment of the pipe culvert and drain pipe barrel shall be checked by sighting along the crown, invert, and sides of the pipe
   b) They shall be checked for sagging, faulting, or invert heaving
   c) Any issues involving incorrect horizontal and/or vertical alignment shall be repaired before backfilling pipe
   d) None of the above

7. Which of the following is true about concrete pipes used for storm drain pipe in minor drainage structures construction?

   a) Sections shall be laid in a prepared trench with bells pointing upstream
   b) Section shall be joined using either rubber gasket or preformed flexible sealant
   c) Fitting and coupling that comply with ASTM 2321 shall be used
   d) None of the above

8. In linear plate installation for tunnel liner in minor drainage structures construction, self-supporting steel liner plates shall be installed according to the________.

   a) Manufacturer's recommendations
   b) Plans
   c) Standards
   d) Contractor decision

9. For tunnel liner in minor drainage structures construction, payment is done at the Contract Price bid per _____.

   a) Segment
   b) Volume of liner
   c) Linear foot (meter) of liner
   d) Linear foot (meter) of liner for each diameter and plate thickness

10. Which of the following is *not* true about renovating existing pipes in minor drainage structures construction?

   a) The existing pipe shall be cleaned and inspected before pulling or pushing the new pipe through
   b) The nose cone shall have enough strength to withstand pulling/pushing of the new liner
   c) The space between pipes at both ends shall not be plugged with concrete or mortar
   d) None of the above

11. Which of the following is true about renovating existing pipes in minor drainage structures construction?

   a) Grout pipe caps shall be removed before pipe plugs have been placed long enough to develop strength to withstand pressure grouting
   b) Before pumping is complete, the grout pipe caps shall be replaced
   c) The space between pipes at both ends shall be with concrete or mortar
   d) The nose cone shall not be welded to the end of the liner

12. For renovating existing pipes in minor drainage structures construction, payment is done at the Contract Price bid per _______.

   a) Segment
   b) Linear foot (meter) of new pipe
   c) Linear foot (meter) for each diameter and metal thickness of new pipe
   d) None of the above

13. For edgedrains in minor drainage structures construction, work shall *not* begin until the _________ determines pavement slabs are stable.

   a) Owner
   b) Contractor
   c) Engineer
   d) Any of the above

14. Which of the following is *not* true about constructing edgedrains in minor drainage structures construction?

   a) Any opened trenches (including an asphalt cap) shall be completed each working day
   b) Contaminated or damaged materials shall be removed and replaced at the end of each working day
   c) Pipes shall be laid with perforations on the pipe's underside
   d) Belt, spigot, tongue, and groove pipe shall be laid with bell or grooved end upstream and bells embedded in foundation material

15. For edgedrains in minor drainage structures construction, the work is paid at the ______.

a) Contract Price per linear foot (meter)
b) Contract Price per item
c) Lump Sum price
d) Cost plus price

Hard

1. Which of the following is *not* true about the deck drain system for constructing minor drainage structures?

a) Materials used shall meet plan requirements
b) Commercial-grade steel hardware (clips, brackets, bars, etc.) shall be used only if noted on the plans
c) Galvanizing repair compound shall be used
d) None of the above

2. For performing pile encasement for minor drainage structures with Fabriform Pile Jacket system or an approved equal, mortar shall be pumped into the fabric jacket at a rate to provide a rise of approximately _______ per minute.

a) 6 in. (150 mm)
b) 9 in. (225 mm)
c) 12 in. (300 mm)
d) 15 in. (375 mm)

3. For constructing storm drain pipe in minor drainage structures construction, ______ or better shall be used for longitudinal and side drains.

a) Class II B1 soil
b) Class II B2 soil
c) Class II B3 soil
d) Any of the above

4. For tunnel liner in minor drainage structures construction, the pump shall have enough horsepower and grouting line pressure to ______.

a) Completely fill voids
b) Not buckle or shift liner plates
c) Not damage the roadway
d) All of the above

5. Which of the procedures could be used for tunnel liner in minor drainage structures construction?

   a) Heading and bench
   b) Poling plates
   c) Breast boards
   d) All of the above

6. For slope drain pipe in minor drainage structures construction, after installing the pipe, the trench shall be backfilled in __________ thick or less.

   a) 4 in. (100 mm)
   b) 8 in. (200 mm)
   c) 12 in. (300 mm)
   d) 16 in. (400 mm)

7. For slope drain pipe in minor drainage structures construction, the work is paid at the ______.

a) Contract Price per linear ft (m) for the size specified
b) Contract Price per item
c) Lump Sum price
d) Cost plus price

8. Which of the following is *not* true about metal drain inlets construction in minor drainage structures construction?

   a) Embankment material around the inlet including the subgrade under the asphaltic concrete spillway shall be compacted
   b) Gutters, pipes, and inlets shall be kept open
   c) Asphaltic concrete mixture for spillway shall be placed on the prepared subgrade
   d) None of the above

9. For metal drain inlets in minor drainage structures construction, the work is paid at the _______.

   a) Contract Price per weight
   b) Contract Price per length
   c) Contract Price per each
   d) Lump Sum price

10. Which procedure should *not* be used to excavate a tunnel?

   a) Heading and bench
   b) Multiple drift
   c) Blasting
   d) Soil solidification

11. When tunneling, the Contractor should begin at what location?

   a) At one end of the pit that has been sheeted and shored as necessary
   b) At one end of the pit before sheeting or shoring
   c) At both ends of the pit that have been sheeted and shored as necessary
   d) At both ends of the pit before sheeting and shoring

12. Which of the following is *not* required by the Department to perform encasement?

   a) Class A concrete
   b) Cofferdams
   c) Epoxy-coated steel reinforcement
   d) Deposit concrete in water

13. Which of the following steps are required for stage 1 construction of metal drain inlets?

   a) Install metal drain inlets where shown on plans or directed by the Engineer
   b) Install concrete aprons or rip rap as required by the Engineer
   c) Crown the roadbed and construct a roll of embankment material at the shoulder line
   d) All of the above

14. Which of the following does *not* need to remain open during construction of metal drain inlets?

   a) Gutters
   b) Storm sewers
   c) Pipes
   d) Inlets

15. Which of the following is *not* a required step in stage 2 construction of metal drain inlets?

   a) Complete the second stage immediately after paving shoulders
   b) Remove each adjacent inlet from its previous position
   c) Finish to a smooth, firm surface
   d) Place soil mixture for spillway on the prepared subgrade

C.9 Incidental Items Training Module Exam Questions

Easy

1. Which of the following is *not* required to be furnished by the Contractor?

    a) Mortar
    b) Sand cushion
    c) Bituminous filler
    d) None of the above

2. Which of the following is *not* allowed to transport concrete from trucks to the formwork?

    a) Shovels
    b) Buckets
    c) Buggies
    d) Pumps

3. Which of the following is true for cutting slabs for partial replacement?

    a) Saw slab to half of the full depth
    b) Cut along the center-line joint and shoulder joint
    c) Backfill over broken slabs
    d) Leave slurry and other contaminants within the limits of the removal areas

4. Which of the following is *not* a step in capping an existing structure?

    a) Remove the improvements to expose only the portion of the structure to be modified
    b) Replace and remove improvements to the Engineer's satisfaction
    c) Remove enough existing masonry to lower the top elevation to a point not less than the thickness of the cap plus 3 ft
    d) Leave the remaining portion of structure uncapped

5. Which of the following is a step for raising a manhole?

    a) Must always remove the existing manhole frame
    b) Extension device does not need to lock to the existing frame
    c) Choose an extension ring compatible with the existing casting and cover
    d) None of the above

6. Which of the following is true when placing a grass median crossover?

   a) Contractor can substitute loose sod if allowed by the Engineer
   b) Leave crossover materials in the median location
   c) Do not reshape the area where the crossover was removed
   d) Place and remove barricades as instructed by the Contractor

7. Which of the following is true when building a dock for construction?

   a) The dock should be suitable for its intended purpose
   b) Only the Contractor is required to approve construction methods
   c) Drive pile to a minimum depth for limited stability
   d) None of the above

8. Which of the following is *not* true when constructing sound barrier walls?

   a) Install sound barriers according to the plans and shop drawings approved by the Engineer
   b) Marred, chipped, or scratched areas on the wall do not need to be repaired
   c) Trench backfill should be placed around the sound barrier construction
   d) Dispose of excess excavation to the Engineer's satisfaction

9. Which of the following is *not* included in the wall envelope description of an MSE wall?

   a) Existing and proposed ground line
   b) Elevation to only the bottom of the leveling pad
   c) Proposed top of coping
   d) Soil parameters for the wall design

10. A Portable Changeable Message Board should have at least ___ lines of horizontal text.

   a) 1
   b) 2
   c) 3
   d) None of the above

11. Which of the following is *not* required for a Portable Changeable Message Board?

   a) Control system with a keyboard to allow programming of user-defined messages
   b) Wireless and internet capabilities
   c) Primary and backup power sources
   d) Capable of adjusting its brightness from daylight to night-time conditions

12. Which of the following is true for installing guardrail posts?

    a) Wood posts should only be used when required by a guardrail anchor
    b) Backfill post holes to the ground line
    c) Primary and backup power sources
    d) Set post in holes and drive in the ground horizontally

13. Which of the following is *not* true for installing fencing?

    a) Use longer posts to maintain ground clearance when the ground profile changes
    b) Do not allow permanent installation to encroach on adjacent property
    c) Construct fence to follow the contour of the ground
    d) Construct fence outside of the right-of-way line

14. Which of the following is *not* a step for modifying or removing traffic signal equipment?

    a) Remove existing signal equipment that is not used in the final installation
    b) Carefully remove equipment to minimize damage and retain it in its original form
    c) Remove old signal heads by the end of the week
    d) Remove other signal equipment within 7 days after operation of the installed equipment

15. Which of the following is *not* a step for installing a signal controller?

    a) Identify the controller and other auxiliary equipment by model and revision numbers
    b) The Contractor must furnish the controller firmware
    c) Assemble the controller, cabinet, and auxiliary equipment to provide the operational sequence shown in the plans
    d) Contractor shall deliver controllers to the project site 30 days prior to installation

Medium

1. Which of the following is an acceptable condition to lay brick?

    a) When the weather is below freezing
    b) When the brick contains frost
    c) If the temperature is above 85°F
    d) None of the above

2. Which of the following is *not* a step in handling pot bearings?

    a) Submerge in water until time of placement
    b) Protect each pot bearing from dust and moisture
    c) Store the surface in the shade
    d) Protect from damage during construction and prevent contamination of various components

3. Which of the following is *not* a type of rip rap?

   a) Stone plain
   b) Stone dumped
   c) Stone grouted
   d) Stone placed

4. Who will determine which slabs should be removed and replaced?

   a) Contractor
   b) Concrete supplier
   c) Engineer
   d) Concrete foreman

5. Which of the following is *not* used to correctly align the pipe during construction of controlled low strength flowable fill?

   a) Straps
   b) Soil anchors
   c) Wood formwork
   d) Other Engineer-approved methods

6. When laying rubble masonry, which of the following steps should be followed?

   a) Decrease stone thickness from top to bottom of the wall
   b) Ensure headers in the wall are a difference size than as shown in the face
   c) Ensure the headers in the walls are 2 ft or less in thickness
   d) Headers shall occupy at least 10% of the wall's face

7. Which type of concrete should be used for placing copings?

   a) Class A
   b) Class AA
   c) Class B
   d) Flowable fill

8. Which of the following terms are *not* synonymous with "anchors"?

   a) Tie-backs
   b) Block piles
   c) Lagging
   d) Tie-down

9. Which of the following is *not* a step in placing reinforcement for pneumatically applied concrete?

    a) Securely fasten the reinforcing steel on dowels or anchor bolts
    b) Lap the welded wire fabric and firmly tie the full area of mesh
    c) Place welded wire fabric around the bottom of the slab-carrying beams
    d) Place reinforcement at least 0.5 in. from the surface on which the concrete is to be placed

10. What is the minimum curing period for Type C sound barrier walls under normal temperature?

    a) 24 hours
    b) 36 hours
    c) 48 hours
    d) 72 hours

11. Which of the following is true for construction of Mechanically Stabilized Embankment (MSE) wall backfill?

    a) Compact the backfill to half the length of reinforcing devices
    b) Level the compacted backfill with the connecting device
    c) Repair damaged soil reinforcing devices or panels
    d) Place soil reinforcing devices at 90° to the face of the wall

12. Which of the following is true for erecting a highway sign?

    a) Erect steel posts for mast arm assemblies in a concrete foundation
    b) Drive posts in place or prepared holes
    c) Backfill hole with dry, dirty soil
    d) Backfill hole with soil and 8% volume of Portland cement

13. Which of the following is *not* a step for erecting highway signs?

    a) Excavate the footing to the lines and elevations determined by the Contractor
    b) Do not disturb or loosen the foundation below the foundation elevations
    c) Use forms of the necessary shape and dimensions to construct the footings to the lines and elevations shown on the plans
    d) Furnish a list of proposed pile lengths to the Engineer before driving the piles

14. Which of the following is *not* a step for erecting structural supports for overhead signs?

    a) Use a washer with each leveling nut
    b) Inspect connections to ensure full bearing of the top and bottom of washers on the base plate
    c) Set column on washers without a horizontal structure and place and tighten a washer and secure a nut on each anchor bolt
    d) Shall include placing and leveling a leveling nut on every fifth anchor bolt

15. Which type of concrete is required for prestressed concrete poles?

    a) Class A
    b) Class AA
    c) Class B
    d) Flowable fill

Hard

1. Which of the following is required for the brick header course?

    a) Ensure at least 1 course in 7 is a header course
    b) Ensure at least 1 course in 9 is a header course
    c) Ensure at least 1 course in 11 is a header course
    d) Ensure at least 1 course in 15 is a header course

2. What is the minimum depth of a toe ditch from the original ground surface for rip rap?

    a) 1 ft
    b) 2 ft
    c) 5 ft
    d) 10 ft

3. What is the minimum fill space between components of Portland cement grout around stone grouted rip rap?

    a) 1:1
    b) 1:2
    c) 1:3
    d) 1:4

4. When constructing rubble masonry, what step is required when shaping the stone?

   a) Roughly square stones on joints and on centers
   b) Use selected stone roughly squared and pitched to line angles and end of walls
   c) Shape and dress after laying stone in the wall
   d) Finish corners and angles using a jack hammer

5. When jacking a pipe, ensure the excavation does *not* extend beyond the pipe more than ___?

   a) 1 ft
   b) 2 ft
   c) 5 ft
   d) 10 ft

6. Which of the following is *not* a step for boring a pipe?

   a) Excavate for pits and show installations
   b) Place excavated material near the top of the working pit and dispose of it as required
   c) Ensure the diameter of the excavation conforms to the outside diameter of the pipe
   d) Locate the pit at the Contractor’s approval

7. “Method 2” for temporary barriers should be used on a bridge and bridge approaches where the distance from the centerline of the barrier to the free edge of the bridge deck is less than what distance?

   a) 2 ft
   b) 4 ft
   c) 6 ft
   d) 8 ft

8. The barrier or parapet from slipform concrete barriers should be aligned with all of the following *except*:

   a) Shape
   b) Line
   c) Grade
   d) Drainage system

9. The barrier or parapet from slipform concrete barriers should be aligned with all of the following *except*:

   a) Shape
   b) Line
   c) Grade
   d) Drainage system

10. Backfill should be placed at a uniform thickness of ____ for Mechanically Stabilized Embankment (MSE) walls.

a) 1 ft
b) 2 ft
c) 3 ft
d) 5 ft

11. Provide a light shield plate at least ____ thick for externally illuminated signs.

a) 0.10 in.
b) 0.20 in.
c) 0.30 in.
d) 0.5 in.

12. Drive a single ground rod vertically until the top of the rod is at least ____ below the finished ground for externally illuminated signs.

a) 6 in.
b) 12 in.
c) 2 ft
d) 4 ft

13. While constructing structural supports for overhead signs, the temporary template for the footing and stem should remain for a least how long?

a) 12 hours
b) 24 hours
c) 36 hours
d) 48 hours

14. What is the minimum sag of a cable attached to a strain pole for an overhead highway sign?

a) 2.5%
b) 5%
c) 7.5%
d) 10%

15. What is the minimum distance a wooden post must penetrate the ground for a railroad cross buck sign?

a) 2 ft
b) 4 ft
c) 6 ft
d) 8 ft