Alaska Department of Transportation & Public Facilities

Research & Technology Transfer

Validation and Implementation of AKDOT&PF's Geosynthetic Specifications

FINAL REPORT

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Report # FHWA-AK-RI-4000(102)

December 2014

Technical Report Documentation Page

1. Report No.	2. Government Access No.	3. Recipient's Catalog No.	
FHWA-AK-RI-4000(102)			
4. Title and Subtitle Validation and Implementation of AKDOT&PF's Geosynthetic Specifications		5. Report Date December 2014	
		6. Performing Organization Code	
7. Author Eli Cuelho		8. Performing Organization Report Code	
9. Performing Organization Name and Address Western Transportation Institute PO Box 174250 Montana State University – Bozeman Bozeman, Montana 59717-4250		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. MSU G&C #4W4946 AKDOT&PF Project #60533	
12. Sponsoring Agency Names and Addresses Alaska Department of Transportation and Public Facilities Research, Development, and Technology Transfer 2301 Peger Rd. Fairbanks, AK 99709-5399		13. Type of Report and Period Covered Final Report June 2014 – December 2014	
		14. Sponsoring Agency Code	
15. Supplementary Notes			

16. Abstract

Alaska Department of Transportation and Public Facilities (AKDOT&PF) routinely uses geosynthetics for soil stabilization, soil reinforcement, separation, mechanically stabilized earthen structures, embankments, drainage, erosion control, pavement, and silt fences. Revisions to the department's geosynthetic specifications and design practices were submitted by the Western Transportation Institute in December 2013, but further review from geosynthetic manufacturers was desired prior to full implementation. The main objective of this project was to obtain review comments from geosynthetic manufacturers prior to final revision of the specifications. Work toward this objective began by providing the Geosynthetics Manufacturers Association (GMA) with the draft specifications to review and provide comments. Suggested changes and comments made by GMA will be taken into consideration by AKDOT&PF as they update their geosynthetic specifications.

17. Key Words		18. Distribution Statement	
geosynthetic, specifications, design			
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	143	

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Acknowledgements

The authors gratefully acknowledge the financial support provided by the Alaska Department of Transportation and Public Facilities to fund this research project. The authors also greatly appreciate the contribution and assistance of (in alphabetical order) Anna Bosin, Jeff Curry, Steve McGroarty, Mitch Miller, Carolyn Morehouse, Angela Parsons, Steve Saboundjian and Michael San Angelo throughout the project. Finally, the authors would like to thank the geosynthetic manufacturers of the Geosynthetic Materials Association (GMA) for their review, and Lucie Passus of the Industrial Fabrics Association International (IFAI) for collecting and organizing the comments and suggestions from the various manufacturers.

Executive Summary

Alaska Department of Transportation and Public Facilities (AKDOT&PF) routinely uses geosynthetics for a variety of applications such as soil stabilization, soil reinforcement, separation, mechanically stabilized earthen structures, embankments, drainage, erosion control, pavement, and silt fences. To ensure geosynthetics are used and selected properly, AKDOT&PF desires geosynthetic specifications and construction guidelines that are relevant, accurate and well organized. The main objective of this project was to update Alaska's geosynthetic design guidelines and construction specifications based primarily on review comments and suggestions posed by members of the Geosynthetics Manufacturers Association (GMA) to provide for the most economical geosynthetic selection while minimizing conflicts and promoting competition between manufacturers. Work toward this objective was achieved by submitting draft geosynthetic specifications to the GMA and incorporating their suggestions into the specifications as it made sense to AKDOT&PF.

As part of a previous project completed in 2013 (Cuelho and Perkins, 2013), Alaska geosynthetic specifications were thoroughly reviewed, and modifications to their existing specifications were suggested based on information from multiple sources accumulated from decades of research and experience from manufacturers, designers, researchers and practitioners. During that project, changes were suggested to update the specification to:

1) improve clarity and flow, make formatting and layout consistent with other Alaska specifications, and maintain active voice,
2) update content to make it more consistent with standard practice, design, recent developments in materials and design, and existing state and federal specifications, and
3) make it consistent with the unique Alaska conditions or standard practices.

These specifications were further updated based on continuing reviews presented by AKDOT&PF staff and the comments and suggestions provided by the GMA.

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Introduction

Alaska Department of Transportation and Public Facilities (AKDOT&PF) routinely uses geosynthetics for soil stabilization, soil reinforcement, separation, mechanically stabilized earthen structures, embankments, drainage, erosion control, pavement, and silt fences. AKDOT&PF desires geosynthetic specifications and construction guidelines that are relevant, accurate and well organized so that these products can be efficiently and effectively utilized in appropriate transportation construction projects. The department's geosynthetic specifications and design practices were recently updated by the Western Transportation Institute in 2013, but further approval by from manufacturers was desired prior to full implementation. The main objective of this project was to obtain review comments from geosynthetic manufacturers prior to full implementation. Work toward this objective began by providing the Geosynthetics Manufacturers Association (GMA) with the draft specifications developed by Cuelho and Perkins (2013) to review and comment.

Geosynthetic Applications

The purpose of this section is to briefly highlight and summarize the comments provided by the GMA for each of the applications listed in Table 1. Actual comments and suggestions from the GMA are provided in Appendix A. Several other changes were made by AKDOT&PF staff during this review period and are included in the marked up copy of the specifications in the next section; however, these changes are not delineated from previously-made comments summarized in the review by Cuelho and Perkins (2013).

Table 1: Alaska Construction Specifications Using Geosynthetics

Specification	Title
Section 511	Mechanically Stabilized Earth (MSE) Walls
Section 630	Geotextile for Embankment Separation and Stabilization
Section 631	Geotextile for Subsurface Drainage and Erosion Control
Section 632	Paving Fabric
Section 633	Silt Fence
Section 634	Geogrid Soil Reinforcement
Section 729	Geosynthetics

Mechanically Stabilized Earth (MSE) Walls (Section 511)

Overall, the GMA review suggested relatively major changes to the MSE Walls specification. The special provisions currently used by the Utah Department of Transportation (see Appendix B) were suggested as an example specification by which several missing elements of this

specification could be updated. Specific changes suggested by the GMA for Section 511 were as follows:

- Differentiate between the various types of geosynthetics in terms of their respective resistance to chemical degradation – *accepted by AKDOT&PF*.
- Add a provision to restrict the organic content to a maximum of 1 percent for the backfill material – *accepted by AKDOT&PF*.
- Add a provision to protect the steel reinforcement in areas where there are higher deicing salt concentrations through the use of a geomembrane – *rejected by AKDOT&PF*.
- Remove the reference to Subsection 729-2.04 in the Soil Reinforcement section in 511-2.01 – *accepted by AKDOT&PF*.
- Add a fifth section within 511-2.01 to address design requirements associated with MSE walls – *rejected by AKDOT&PF; however, may be incorporated at a later date*.
- Remove specified method of connecting the vertical portion of the welded fabric forming the face to the next upper level of soil reinforcement in Section 511-3.01 – *accepted by AKDOT&PF*.
- Add the use of geotextile to the list of applicable materials that can be used immediately behind the vertical portion of the soil reinforcement – *accepted by AKDOT&PF*.

Separation and Stabilization (Section 630)

Specific changes suggested by the GMA for Section 630 (Geotextiles for Embankment and Roadway Separation, Stabilization and Reinforcement) were as follows:

- Add "folds" to the list of distortions that must be removed when placing the geotextiles in Section 630-3.01 – *accepted by AKDOT&PF*.
- Further restrict the allowance of geosynthetics to get wet prior to installation – *accepted in part by AKDOT&PF, with modifications.*
- Provide additional detail on how to overlap adjacent pieces of geotextile – *accepted by AKDOT&PF, with modifications*.
- Specify the principal strength direction as the direction of the geotextile for embankment reinforcement perpendicular to roadway centerline – *accepted in part by AKDOT&PF, with modifications, namely, that principal strength be replaced with machine direction.*
- Remove provision for sewing or joining geotextiles in geotextile reinforcement applications, and add sentence stating that no joints or overlaps are permitted in the reinforcement direction of the geotextile – *rejected by AKDOT&PF*.
- Clarify sewn seam direction as "face upward" instead of just "up" in Section 630-3.01 – *accepted by AKDOT&PF*.
- Add clarification to overlap specifications in Section 630-3.01 by adding a parenthetical statement that says, "(shingle in the direction of construction)" – *accepted by AKDOT&PF, with modifications*.
- Add the word "fill" to subsection 5.a. in Section 630-3.01 to clarify what material is being referenced – *accepted by AKDOT&PF, with modifications*.

Subsurface Drainage and Erosion Control (Section 631)

Specific changes suggested by the GMA for Section 631 (Geotextiles for Subsurface Drainage and Erosion Control) were as follows:

- Replace the word "place" with "stretch" to specify how the geotextiles are to be placed – *accepted by AKDOT&PF*.
- Add "folds" to the list of distortions that must be removed when placing the geotextiles – *accepted by AKDOT&PF*.
- Further restrict the allowance of geosynthetics to get wet prior to installation – *accepted in part by AKDOT&PF, with modifications.*
- Add phrase to specify a minimum anchorage depth of 24 inches for the key trenches or aprons in Section 630-3.01 – *accepted by AKDOT&PF*.
- Add clarification to the direction of the placement of the geotextiles in erosion control applications – *needs further review by AKDOT&PF*.

Paving Fabric (Section 632)

Specific changes suggested by the GMA for Section 632 (Paving Fabric) were as follows:

- Consider revising Section 632 based on the Paving Interlayer chart provided by GMA (see Appendix C) – needs further review by AKDOT&PF; ASTM D7239 (Standard Specification for Hybrid Geosynthetic Paving Mat for Highway Applications) may be used to develop an applicable specification for AKDOT&PF.
- Add "Hybrid Paving Mat" to list of approved materials in 632-2.01 – rejected by AKDOT&PF.

Silt Fence (Section 633)

Multiple changes were made to Section 633 by AKDOT&PF staff during this review period based on an updated set of technical drawing sheets (see Appendix D). Appendix D also lists several recommended changes to the drawing set to improve clarity and flow, ensure formatting and layout was similar to other Alaska specification, and to maintain active voice. One specific change suggested by the GMA for Section 633 (Silt Fence) is as follows:

- Replace reference to Subsection 729-2.04 with 729-2.02 in Section 633-2.01 – *accepted by AKDOT&PF*.

Geogrid Soil Reinforcement (Section 634)

Specific changes suggested by the GMA for Section 634 (Geogrid for Embankment and Roadway Stabilization and Reinforcement) were as follows:

- Change name of Section to "Geogrid for Embankment and Roadway Stabilization" to avoid confusion with true reinforcement applications (e.g., MSE walls/slopes) – *rejected by AKDOT&PF*.

- Specify the method of securing overlaps in geogrids used on firm ground – *accepted by AKDOT&PF, with modifications*.
- Remove geogrid reinforcement pay item from Section 634-5.01 – *rejected by AKDOT&PF*.

Geosynthetics (Section 729)

Specific changes suggested by the GMA for Section 729 (Geosynthetics) are as follows:

- Add "Embankment" before "Reinforcement" in title – *accepted by AKDOT&PF*.
- Add "Class 2 (default class)" as further clarification to the Subsurface Drainage material specification – *accepted in part by AKDOT&PF, with modifications*.
- Add "Class 1" as further clarification to the Erosion Control material specification – *accepted by AKDOT&PF*.
- Add "Drainage Blanket" and "Geocomposite Drainage Systems" to materials list – *needs further review by AKDOT&PF*.
- Suggest removing "Grab Tensile Strength" from Table 729-1 because it is not a reinforcement property – *needs further review by AKDOT&PF*.
- Consider changing AOS requirement in Table 729-1 to US Sieve #40 to follow AASHTO recommendation – *rejected by AKDOT&PF*.
- Add note to Table 729-1 to specify that seam strength breaking strength is only for sewn geotextiles – *accepted by AKDOT&PF*.
- Add new table for "Enhancement Geotextile Property Requirements" – *needs further review by AKDOT&PF*.
- Add "Class 1" to Section 729-2.03 (Paving Fabric) – *rejected by AKDOT&PF*.
- Consider modifying Section 729-2.03 (Paving Fabric) to include a new Interlayer Chart (see Appendix B) – *needs further review by AKDOT&PF*.
- Recommend title change to Section 729-2.04 to be "Geogrid for Embankment and Roadway Stabilization" – *rejected by AKDOT&PF*.
- Restore the language in Section 729-2.05 back to the 2004 version. Remove installation damage and replace it with ultraviolet stability of 70%. Add Ultimate Tensile at 1300 lb/ft and add percent open area of 50-80%. To address current and future product innovations that are not biaxial, add performance-based approval language after the table. – *rejected by AKDOT&PF*.
- Address the use of multi-axial products by specifying 729-2.04 for biaxial products and creating an additional specification for performance based testing which includes independent full-scale testing and field trials – *rejected by AKDOT&PF; however, if multi-axial products are deemed to be a beneficial substitution for specific applications, their use will be addressed through special provisions.*
- If AKDOT&PF does not adopt the previous two comments, then combine Tables 729-2 and 729-3 into a single table specific to biaxial geogrid, remove Class 2, and increase Class 1 ultimate to 1300 lb/ft. Add note below tables to allow alternate products that

cannot be measured in the traditional machine direction and cross-machine direction to allow for fair inclusion of triaxial geogrid and/or other future products. – *rejected by AKDOT&PF*.

- Remove Class 2 from Table 729-2 – *rejected by AKDOT&PF*.
- Tensile strength and junction strength should specify MARV values in the machine and cross-machine directions in Table 729-2 rather than allowing these values in any direction – *rejected by AKDOT&PF (these values should reflect the physical makeup of the geogrid, so by limiting these values to only the machine and cross-machine directions, products that have strength in off-axis directions will be inadvertently precluded).*

Geosynthetic Specifications

Alaska geosynthetic specifications were thoroughly reviewed by the Western Transportation Institute and GMA and changes were suggested to update the specification to:

1) improve clarity and flow, make formatting and layout consistent with other Alaska specifications, and maintain active voice,

2) update content to make it more consistent with standard practice, design, recent developments in materials and design, and existing state and federal specifications, and

3) make it consistent with the unique Alaska conditions or standard practices.

Highlighted colors associated with each of these changes (i.e., yellow, green and pink) are used to designate the type of modifications or suggested changes that were made in each of the specifications, as respectively illustrated above. Changes and modifications suggested by GMA are highlighted in blue. Each of the modified Alaska specifications is presented below for consideration by AKDOT&PF staff.

SECTION 511

MECHANICALLY STABILIZED EARTH (MSE) WALLS

511-1.01 DESCRIPTION. Furnish and install mechanically stabilized earth wall.

511-2.01 MATERIALS. Meet the following:

Class A Concrete	Section 501
Precast and Cast-in-Place Concrete Panels	Section 501
Reinforcing Steel	Section 503
Structural Steel	AASHTO M 270
Modular Concrete Block Unit	Subsection 704-2.04
Pipe and Perforated Pipe	Section 706
Geotextile for Drainage	Subsection 729-2.02
Geogrid	Subsection 729-2.05
Geocomposite Drainage System	As Specified
Porous Backfill Material	Subsection 703-2.10
Structural Fill	Subsection 703-2.13

1. Structure Backfill and Foundation Fill. Meet Subsection 703-2.13 ~~07~~, Structural Fill ~~Selected Material, Type A~~. Use materials with a sodium sulfate soundness loss less than 15 ~~30~~% after five ~~four~~ cycles as determined by AASHTO T 104 and free of shale or other particles of low durability.

   ~~When using backfill material with 80% passing the 3/4 inch sieve, the minimum angle of internal friction on the portion of the backfill select material finer than the No. 10 sieve must not be less than 34 degrees, as tested by AASHTO T 236.~~

   When using polyester geosynthetic reinforcement, use backfill material with a pH range between 3 and 9 as determined by AASHTO T 289. When using polyolefin geosynthetic reinforcement, use backfill material with a pH of 3 or greater as determined by AASHTO T289. When using steel soil reinforcement, use backfill material meeting the following electrochemical requirements:
   - pH of 5 to 10 (AASHTO T 289)
   - Resistivity not less than 30 ohm-meters (AASHTO T 288)
   - Chlorides not greater than 100 ppm (AASHTO T 291)
   - Sulfates not greater than 200 ppm (AASHTO T 290)
   - Organic content of 1% max (AASHTO 267)

2. Wall Members. Provide facing consisting of precast concrete panels, modular concrete block units, cast-in-place concrete, or welded wire fabric, as specified.

   Manufacture concrete panels with a minimum 28-day concrete compressive strength of 4,000 psi and thickness of 5.5 inch. Finish the exposed face with a smooth ~~ordinary~~ finish or as detailed on the Plans. For the face not exposed to view, provide a uniform surface finish free of open pockets of aggregate or surface distortions in excess of 1/4 inch and a minimum concrete cover of 1.5 inch over concrete reinforcing steel. Locate soil reinforcement connection hardware during concrete placement to avoid contact with the panel reinforcing steel. Shop-fabricate welded wire fabric reinforcement from cold-drawn wire meeting AASHTO M 32 and conforming to the specifications for welded wire fabric in accordance with ~~the finished fabric meeting~~ AASHTO M 55.

3. Soil Reinforcement.

Use approved geogrid reinforcement that meets the requirements as specified on the Plans or accepted wall design.

Galvanize all steel soil reinforcement and any steel connection hardware to meet AASHTO M 111. Manufacture steel strip reinforcement by hot rolling to meet ASTM A 572, Grade 450, or approved alternate.

4. Working Drawings. Submit all working drawings and design calculations, sealed by licensed Engineer, including:
   a. Earthwork requirements including specifications for material and compaction of backfill.
   b. Details and ~~of~~ revisions or additions to drainage systems or other facilities required to accommodate the system.
   c. Existing ground elevations verified by the Contractor for each location involving construction wholly or partially in original ground.
   d. Complete design calculations substantiating that all proposed designs satisfy the design parameters in the Contract documents. List all design parameters, assumptions, and design life in design calculations.
   e. Complete details of all elements required for the proper construction of the system, including complete material specifications.
   f. Complete plan and elevation sheets including dimensions, details and cross-sections necessary to construct the wall.
   g. Details of the facing treatments and connections between facing elements and soil reinforcement.

   Prohibit work on earth retaining systems for which working drawings are required until such drawings have been approved.

511-3.01 CONSTRUCTION.

1. Excavation and Backfill. Excavate and backfill earth retaining systems to meet Section 205. Compact the material as specified under Subsection 203-3.04. Do not use studded rollers (i.e., sheeps foot, pad foot) for compacting the backfill material atop soil reinforcement.

2. Drainage. Provide a drainage system at the base of the wall along its back-face with outlet works at sags in the profile and at the low ends of the system ~~gutter~~.

   a. Weep Holes. Place a minimum of 2 cubic feet of porous backfill material encapsulated with geotextile at each weep hole. Cover joints between retaining wall facing elements ~~panels~~, which function as weep holes, with geotextile meeting the requirements in subsection 729-2.01 for Subsurface Drainage and as specified in the Working Drawings. Dry and thoroughly clean the face panels that are to receive the geotextile.

   b. Drainage Blankets. Construct drainage blankets consisting of porous backfill material encapsulated in geotextile, collector pipes, outlet pipes, or ~~and~~ cleanout pipes. Construct and compact the subgrade to receive the geotextile so it is free of loose or extraneous material and sharp objects that may damage the geotextile. Stretch, align, and place the fabric in a wrinkle-free manner. Overlap adjacent borders of the fabric from 12 to 18 inches. Repair torn or punctured fabric by covering the damaged area with a piece of fabric large enough to cover the damaged area and meet the overlap requirement.

      Place the porous backfill material in horizontal layers and thoroughly consolidate by the ~~same~~ methods specified in Subsection 205-3.03. Prohibit ponding or jetting of porous backfill material or structural ~~back~~fill material. Maintain a minimum of 6 inches of porous backfill material, ~~structural~~ backfill select material, or embankment material between the fabric and the equipment during material spreading and compaction ~~of the porous backfill material~~.

Place perforated collector pipe, when required, within the porous backfill material to the flow line elevations shown. Place outlet pipes at sags in the flow line and at the low end of the collector pipe. Construct rock slope protection, when required, at the end of outlet pipes, as shown on the Plans. Place cleanout pipes at the high ends of collector pipes.

c. Geocomposite Drainage Systems. Place and secure the geocomposite drainage material tightly against the excavated face, lagging or back of wall. Protect the drainage material against physical damage and grout leakage when concrete is to be placed against geocomposite drainage material. Use geocomposite material as specified in the Working Drawings.

3. Retaining Wall Construction. Construct mechanically stabilized earth walls consisting of a facing system to which steel or geosynthetic ~~polymeric~~ soil reinforcement is connected. Provide facing consisting of precast concrete panels, cast-in-place concrete, modular concrete blocks or welded wire fabric.

Install geosynthetic ~~polymeric~~ soil reinforcement in accordance with ~~under~~ Section 634.

When constructing cast-in-place concrete facing, embed soil reinforcement which extends beyond the temporary facing into the facing concrete.

Form welded wire facing by bending the horizontal soil reinforcement 90 degrees upward to form the wire face. ~~Connect the vertical portion of the welded fabric forming the face to the next upper level of soil reinforcement.~~ Place a separate backing mat and hardware or geotextile cloth immediately behind the vertical portion of soil reinforcement.

Provide a precast reinforced or cast-in-place concrete leveling pad at each panel foundation level. Place panels or wire fabric and support to achieve the final position.

Place and compact structural fill ~~structure backfill~~ material at the same time as placement of facing and soil reinforcement, without distortion, damage, or displacement of the facing or soil reinforcement. Use light compaction equipment within 3 feet of the back face of the wall and compact in thinner layers if necessary to achieve specified levels of compaction. Backfill to an elevation approximately 1-1/4 inch above the facing connection level before placing the next level of soil reinforcement. Roughly level the structural fill material before placing the soil reinforcement. Uniformly tension all soil reinforcement to remove any slack in the connection or material prior to placing the next lift of structural fill. At the end of the day, place the final layer of structural fill sloping away from the wall face to provide rain and runoff drainage away from the face of the wall.

Where required, install joint filler, bearing pads, and joint-covering material concurrently with face panel or modular concrete block placement.

Furnish and install instrumentation for monitoring corrosion, where specified.

511-4.01 MEASUREMENT. Measure by the square foot of wall face (Section 109). The vertical height of each section is measured on the outer face from the bottom of the lowermost face element to the top of the wall.

511-5.01 PAYMENT. Payment will be made at the contract unit price per square foot of wall.

Excavation and backfill are paid for under Section 205.

Payment will be made under:

Pay Item	Pay Unit
511(1) Mechanically Stabilized Earth Wall	Square Foot

703-2.13 STRUCTURAL FILL. Aggregate containing no muck, frozen material, roots, sod or other deleterious matter and with a plasticity index not greater than 6 as tested by ATM 204 (*Determination of Liquid Limit test*) and ATM 205 (*Determination of Plastic Limit, Plasticity Index*). Meet the following gradation as tested by ATM 304:

TABLE 703-13
REQUIREMENTS FOR GRADING FOR STRUCTURAL FILL MATERIAL

SIEVE	PERCENT PASSING BY WEIGHT
3 in.	100
3/4 in.	75-100
No. 4	25-55
No. 16	10-30
No. 200	0-6

704-2.04 MODULAR CONCRETE BLOCK UNIT. Concrete block units sound and free of cracks or other defects that may interfere with proper placement of units or that may impair their strength or durability..

Dimensional requirements (e.g., thickness, size, dimensional tolerances).

Cement requirements (e.g., Type I, II, or III in accordance with ASTM C 150 or AASHTO equivalent.

Concrete strength requirements (e.g., 28-day compressive strength of at least x,xxx psi in accordance with ASTM C 140 or AASHTO equivalent).

Durability requirements (e.g., freeze-thaw durability of xxx units (ASTM C 1372 or AASHTO equivalent)).

SECTION 630

GEOTEXTILES FOR EMBANKMENT AND ROADWAY SEPARATION, ~~AND~~ STABILIZATION AND REINFORCEMENT

630-1.01 DESCRIPTION. Prepare ground surface~~s~~, and furnish and place geotextiles for ~~embankment~~ separation, ~~and/or~~ stabilization, and/or reinforcement as shown on ~~in~~ the Plans.

630-2.01 MATERIALS. Use materials that conform to the following:

Geotextiles and Sewn Seam Strength ~~Sewing Thread~~ Subsection 729-2.01

Sewing Thread. Use high strength polypropylene, or polyester. Do not use nylon thread. Use thread of contrasting color to that of the geotextile itself.

630-3.01 CONSTRUCTION.

1. Surface Preparation. Prepare ground surface by removing ~~removal of~~ stumps, brush, boulders, and sharp objects. Fill holes and large ruts with material shown on the Plans or as approved by the Engineer.

2. Geotextile Placement. Unroll geotextile directly onto the prepared surface. Stretch geotextile to remove any creases, folds or wrinkles. Do not expose geotextiles to sunlight ~~the elements~~ for longer than 14 ~~5~~ days after removal of protective covering. Do not allow geotextiles to get wet prior to installation ~~when freezing temperatures are anticipated~~.

   a. Separation and Stabilization. Lay geotextile for embankment separation and stabilization parallel to roadway centerline. On horizontal curves, place in segment lengths not exceeding those listed in Table 630-1, with butt ends cut to match and sewn or overlapped. On tangents, straighten the geotextile and sew or overlap butt ends. Shingle overlaps in the same direction as fill placement. Prevent overlapped edges from lifting during construction.

   b. ~~Stabilization~~ Reinforcement. Lay the machine direction of the geotextile for embankment ~~stabilization~~ reinforcement perpendicular to the roadway centerline or as shown on the Plans. Join segments by sewing or an approved bonding or attachment process.

TABLE 630-1
GEOTEXTILE PLACEMENT ON CURVES

Degree of Curve	Maximum Segment Length (ft.)
1	125
2	90
3	75
4	65
5	55
6	50

3. Joining. Join adjacent geotextiles for ~~embankment~~ separation or stabilization by ~~sewing or~~ overlapping or sewing. Join adjacent geotextiles for reinforcement by sewing or as shown on the Plans. ~~Join adjacent geotextiles for stabilization by sewing as required on the Plans.~~ ~~Use o~~Other attachment methods may be used~~,~~ if approved by the Engineer.

a. Sew seams with a Butterfly or J-Seam using . ~~Use~~ a double-thread chain stitch (lock stitch). Bring adjacent sections of geotextile together and fold so that the stitching penetrates four layers of geotextile for the full seam length. Make the stitching line 1-1/4 inches (±1/4 inch) from the folded edge of the seam and at least 1/2 inch from the free edge of the geotextile. Sew seams so that they face upward and ~~are up~~ can be easily inspected by the Engineer. Illustrations showing correct stitch formation and seam configurations are provided in Figure 1-2 (page 1-28) of the FHWA publication, *Geosynthetic Design & Construction Guidelines*, FHWA-NHI-07-092, August 2008.

b. Overlap geotextile sections by a minimum of 3 feet at all longitudinal and transverse joints. Place the beginning of each new roll beneath the previous roll to prevent the advancing fill from lifting the geotextile. Shingle in the direction of construction.

4. Material Placing and Spreading. During placing and spreading of material, maintain a minimum depth of 12 inches of cover material, or a minimum depth equal to the separation distance between multiple layers of geotextile as shown on the Plans when this separation distance is less than 12 inches, at all times between the geotextile ~~fabric~~ and the wheels or tracks of the construction equipment. Limit the size and weight of construction equipment to reduce rutting in the initial lift above the geosynthetic to not greater than 3 inches deep to prevent overstressing the geosynthetic.

Spread the material in the direction of the upper overlapped geotextile ~~fabric overlap~~. Maintain proper overlap and geotextile ~~fabric~~ continuity. If sewn or bonded seams are used, place the cover material and spread in only one direction for the entire length of the geotextile. On weak subgrades limit height of dumped cover material to prevent localized subgrade and/or geotextile failure. ~~spread the cover material simultaneously with dumping to minimize the potential of a localized subgrade failure.~~ Do not drop stones or frozen material larger than 1 foot in diameter directly onto the geotextile from a height of more than 1 foot.

Compact using a smooth drum roller or in a manner approved by the Engineer. Do not allow construction equipment to make sudden stops, starts, or turns on the cover material. Do not allow turning of vehicles on the initial lift of cover material above the geotextile. Fill any ruts over 3 inches deep occurring during construction with additional material shown on the Plans and compact to the specified density.

5. Geotextile Repair. Should the geotextile be torn, punctured, or the overlaps or sewn joints disturbed – as evidenced by visible geotextile damage, subgrade pumping, intrusion, or embankment distortion – remove the backfill around and under (if required by the Engineer) the damaged or displaced area and repair or replace the damaged area at no additional expense to the State. Make repairs to the damaged area with a patch of the same type of geotextile originally placed. Make patches overlap the existing geotextile from the edge of any part of the damaged area by a minimum of 3 feet or sew patches to existing geotextile, as directed by the Engineer.

a. Separation and Stabilization. Overlay torn area with geotextile with a minimum 3 foot overlap around the edges of the torn area or sew and bond according to Subsection 630-3.01.3. Ensure that the patch remains in place when cover material is placed over the affected area.

b. ~~Stabilization~~ Reinforcement. Sew ~~or bond~~ according to Subsection 630-3.01.3.a.

630-4.01 METHOD OF MEASUREMENT. ~~By multiplying plan neat line width by the measured length in final position parallel to installation centerline along the ground surface.~~ Measure geotextile by the square yard of ground surface actually covered. No allowance will be made for overlap, whether at joints or patches.

630-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard. Material used to fill ruts and holes will also be paid for at the unit price for the type of material used.

Payment will be made under:

Pay Item	Pay Unit
630(1) Geotextile, Separation, Class _____	Square Yard
630(2) Geotextile, Stabilization, Class _____	Square Yard
630(3A) Geotextile, Reinforcement – Type 1	Square Yard
630(3B) Geotextile, Reinforcement – Type 2	Square Yard

SECTION 631
GEOTEXTILES FOR SUBSURFACE
DRAINAGE AND EROSION CONTROL

631-1.01 DESCRIPTION. Prepare ground surface, and furnish and place geotextiles for subsurface drainage and erosion control, as shown on ~~in~~ the Plans.

631-2.01 MATERIALS. Use materials that conform to the following for the class specified in the bid schedule:

Geotextiles and Sewn Seam Strength ~~Sewing Thread~~ Subsection 729-2.01

Sewing Thread. Use high strength polypropylene, or polyester. Do not use nylon thread. Use thread of contrasting color to that of the geotextile itself.

631-3.01 CONSTRUCTION.

1. Surface Preparation. Prepare ground surface by removing stumps, brush, boulders, and sharp objects. Fill holes and large ruts with material shown on the Plans or as approved by the Engineer. Construct smooth and stable trench walls.

2. Geotextile Placement. Unroll geotextile directly onto the prepared surface. Stretch geotextile to remove any creases, folds or wrinkles. Place geotextile in a manner which will ensure intimate contact between the trench wall and the geotextile. The geotextile may be held in place with securing pins at 3-foot spacing along all edges (but not closer than 2 inches from the edge) to prevent movement during construction. Do not expose geotextiles to the elements for longer than 14 ~~5~~ days after removal of protective covering. Do not allow geotextile rolls to get wet ~~when freezing temperatures are anticipated~~ prior to installation.

   a. Subsurface Drainage. In trenches, after placing the geotextile and material shown on the Plans ~~drain aggregate~~, fold the geotextile over the top of the material shown on the Plans ~~aggregate~~ to produce a minimum overlap of 12 inches, for trenches greater than 12 inches wide. In trenches less than 12 inches wide, make the overlap equal to the width of the trench. Then cover the geotextile with the subsequent course of material.

   b. Erosion Control. Place and anchor geotextile on the approved surface so it will not be torn or excessively stretched by placement of the overlying materials. Secure the geotextile to the slope but secure it loosely enough so that the geotextile will not tear when riprap or other cover material is placed on the geotextile. The geotextile shall not be keyed at the top of the slope until the riprap or other cover material is in place at the top of the slope. Anchor the terminal ends of the geotextile using key trenches or aprons with a minimum of 24 inches depth into the soil substrate at the crest and toe of slope, or as shown on the Plans. Other temporary or permanent anchoring methods may be used, ~~subject to approval~~ as approved by the Engineer. Place geotextile with the machine direction parallel to the direction of water flow (normally parallel to the slope for erosion control runoff and wave action, and parallel to the stream or channel).

3. Joining. Join geotextile by sewing or overlapping. Joining by bonding or other attachment methods may be used, subject to approval by the Engineer.

   a. Sew seams with a Butterfly or J-Seam using ~~.~~ ~~Use~~ a double thread chain stitch (lock stitch). Bring adjacent sections of geotextile together and fold so that the stitching penetrates four layers of geotextile for the full seam length. Make the stitching line 1-1/4 inches (±1/4 inch) from

the folded edge of the seam and at least 1/2 inch from the free edge of the geotextile. Sew seams so that they can be easily inspected by the Engineer or representative. Illustrations showing correct stitch formation and seam configurations are provided in Figure 1-2 (page 1-28) of the FHWA publication, *Geosynthetic Design & Construction Guidelines*, FHWA-NHI-07-092, August 2008. Conform both factory and field sewn seams to the strength requirements of Table 1 as outlined in the AASHTO M288 for subsurface drainage and erosion control applications.

b. Overlap geotextile sections by a minimum of 3 feet at all longitudinal and transverse joints. Overlap successive geotextile sheets in the direction of flow so that the upstream sheet is placed over the downstream sheet and/or upslope over downslope. In trenches, where overlapped seams are constructed in the longitudinal trench direction, make the overlap equal to the width of the trench.

4. Placement of Cover Material ~~Material Placing and Spreading~~. Following placement of the geotextile on the prepared surface, place cover material of the type shown on the Plans. Place the cover material and armor from the bottom to the top of the slope using ~~Use~~ methods ~~for placing cover material~~ which minimize tearing and/or excessive stretching of the geotextile. In underwater applications, place the geotextile and the required thickness of cover material in the same day. Maintain proper overlap and geotextile continuity. Do not exceed the allowable drop heights for cover material shown in Table 631-1. Do not allow stones with a weight of more than 100 pounds to roll down the slope on the geotextile. Do not grade the slope in a way that will disturb the cover material or armor stone once it has been placed.

TABLE 631-1

INDIVIDUAL STONE Max. Weight (lbs)	**ALLOWABLE DROP HEIGHT (ft)**	
	UNPROTECTED GEOTEXTILE	PROTECTED GEOTEXTILE*
< 5	3	3
5-250	0	3
> 250	0	0**

*Protected geotextile is defined as having a gravelly covering (cushion layer) ~~of 4 inches minimum thickness~~ at least 6 inches thick.

**If stones greater than 250 pounds must be dropped or if a height of drop greater than 3 feet is required, then perform field trials to determine the minimum cushion thickness and/or maximum height of safe drop without damaging the geotextile.

Maintain a minimum depth of 12 inches of cover material between the geotextile and the wheels or tracks of the construction equipment.

5. Geotextile Repair. Should the geotextile be torn, punctured, or the overlaps or sewn joints disturbed – as evidenced by visible geotextile damage – remove the backfill around the damaged area and repair or replace the damaged area at no additional expense to the State. Make repairs to the damaged area with a patch of the same type of geotextile originally placed. Overlay torn area with geotextile with a minimum 3 foot overlap around the edges of the torn area. Ensure that the patch remains in place when material is placed over the affected area.

631-4.01 METHOD OF MEASUREMENT. Measure geotextile by the square yard of ground surface actually covered. No allowance will be made for overlap, whether at joints or patches.

631-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard. Material used to fill ruts and holes will also be paid for at the unit price for the type of material used.

Payment will be made under:

Pay Item	Pay Unit
631(1) Geotextile, Drainage, Class _____	Square Yard
631(2) Geotextile, Erosion Control, Class _____	Square Yard

SECTION 632

PAVING FABRIC

632-1.01 DESCRIPTION. Furnish and install geotextile paving fabric where shown on the Plans.

632-2.01 MATERIALS. Use materials that conform to the following:

Paving Fabric	Subsection 729-2.03
Asphalt Cement	Subsection 702-2.01 (for grade of asphalt used in the overlay)

632-3.01 CONSTRUCTION.

1. Surface Preparation. Prepare the surface on which the fabric is to be placed as follows:

   a. Remove excess asphalt material, loose aggregate, and other foreign materials from the surface.

   b. Fill all potholes and cracks wider than 1/4 inch with an approved asphalt emulsion and sand slurry.

2. Application of Sealant. Apply asphalt sealant by distributor meeting all requirements set forth under Subsection 402-3.02. Apply the asphalt sealant uniformly at 0.20 to 0.30 gallons per square yard and at a minimum temperature of ~~between~~ 295 °F ~~min.~~ and maximum temperature of 320 ~~325~~ °F in the distributor tank, or as directed by the Engineer and/or Paving Fabric manufacturer. Do not apply asphalt material on a wet surface or when the ambient air temperature is below 45 °F or when other conditions would prevent proper application.

3. Fabric Laydown Equipment. Use approved mechanical laydown equipment to place fabric.

4. Fabric Placement. Place fabric directly on top of the asphalt sealant (tack coat) before the sealant has cooled and lost its tackiness. Lay fabric in full rolls without wrinkles and/or folds. Place the fabric per the manufacturer's recommendations. Overlap geotextile joints to ensure full closure of the joint, but do not exceed 6 inches of overlap. Overlap transverse joints in the direction of paving. Apply 0.20 gallons per square yard of additional asphalt sealant beneath all fabric joints. Removal and replacement of damaged geotextiles is the responsibility of the Contractor.

5. Bituminous Surface Course Overlay. Place the bituminous surface course closely following the fabric laydown to avoid exposure of uncovered fabric overnight or to traffic or inclement weather. Do not allow the temperature of the hot-mix asphalt to exceed manufacturer's recommendations. If asphalt sealant bleeds through the fabric before the placement of the overlay, apply sand or bituminous surface course evenly over the affected area to prevent fabric pick-up by construction equipment. Prevent paver or other construction equipment from turning and/or pivoting on the fabric.

632-4.01 METHOD OF MEASUREMENT. Measure paving fabric by the surface area of pavement covered. No allowance will be made for overlap, whether at joints or patches. ~~Overlapping of fabric is subsidiary.~~

632-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard.

Pay Item	Pay Unit
632(1) Paving Fabric	Square Yard

SECTION 633

SILT FENCE

633-1.01 DESCRIPTION. Furnish, install ~~place~~, maintain, and remove temporary silt fence as shown on ~~in~~ the Plans or as directed by the Engineer.

633-2.01 MATERIALS. Use materials that conform to the following:

Geotextile	Subsection 729-2.02 ~~4~~
Posts	Wood, steel, or approved synthetic material. Wood posts shall be 1.5 inches by 1.5 inches and a minimum length of 36 inches.
Prefabricated Silt Fence	May be used if the system meets Section 633 requirements.
Attachment Devices	Staples; wire; self-locking nylon, plastic, or wire ties; or other means to attach fabric to posts.
Support Mesh Between Posts	If required, use any commercially available14-gage welded wire fencing, or metal chain-link fabric, or geosynthetic mesh with equivalent strength. Use maximum mesh spacing of 6 inches. Use height shown on the Plans, or specified in the Bid Schedule.

633-3.01 CONSTRUCTION. Install silt fence according to Plans. Use Trenchless Detail when installing silt fence over permanently frozen ground. Support post holes may need to be predrilled.

~~1. Post Installation. Use posts that can be driven to the depths specified on the Plans and resist the maximum expected hydraulic and sediment material loads without damage. Place posts a maximum of 8 feet apart and drive a minimum of 18 inches into the ground.~~

~~2. Geotextile Placement. Install geotextile on posts in a vertical position and support by a wire or geosynthetic mesh if additional support is shown on the Plans or is deemed necessary by the contractor. Set the geotextile at the height specified in the Contract. Secure the bottom 18 inches of the geotextile on the upslope side of the posts and support system as shown on the Plans. Backfill trench used to secure the bottom with tamped soil. Join adjacent sections of geotextile only at posts with a minimum of 6 inches of overlap and only at posts.~~

633-3.02 MAINTENANCE. Maintain the integrity of the fence to contain sediment in runoff until final stabilization, according to the Plans. ~~as long as it is necessary to contain sediment runoff. Inspect daily and correct any deficiencies immediately. Remove and dispose of fence when adequate vegetative growth ensures no further erosion of the slopes. Cut off the fabric at ground level and remove the wire and posts. When thickness of trapped sediment is in excess of 4 inches above the ground, either remove sediment from the site or spread sediment uphill of the fence and seed all exposed soil immediately, following the requirements of Section 618.~~

633-3.04 REMOVAL. After disturbed area has been accepted as permanently stabilized or when sediment protection is no longer needed, remove according to the Plans.

633-4.01 METHOD OF MEASUREMENT. Measure silt fence the length of fence installed (Section 109). No allowance will be made for overlap, whether at joints or patches.

633-5.01 BASIS OF PAYMENT. The contract price includes installation, maintenance, removal and disposal of the fence.

Payment will be made under:

Pay Item		Pay Unit
633(1)	Silt Fence	Linear Foot
633(2)	Support Mesh Reinforced Silt Fence	Linear Foot

SECTION 634

GEOGRID FOR EMBANKMENT AND ROADWAY STABILIZATION AND REINFORCEMENT

634-1.01 DESCRIPTION. Furnish and install geogrid material as ~~at locations~~ shown on the Plans.

634-2.01 MATERIALS. Use materials that conform to the following:

Geogrid	Subsection 729-2.0~~4~~ ~~5~~

~~CONSTRUCTION REQUIREMENTS~~

~~634-3.01 WEATHER LIMITATIONS. Do not expose geogrid to the elements for longer than 14 days after removal of protective covering.~~

634-3.01 CONSTRUCTION ~~REQUIREMENTS~~

1. ~~634-23.02~~ Surface Preparation.

   a. Soft Ground (CBR ≤3 ~~1-3~~). Prepare surface by removal of stumps, brush, boulders, and sharp objects. Fill holes and large ruts with material shown on the Plans or as approved by the Engineer.

   b. Firm Ground (CBR >3). Compact and finish subgrade or subbase prior to placement of the geogrid.

2. ~~634-3.03~~ Geogrid Placement. Unroll geogrid directly onto the prepared ground surface in the direction of advancing construction, parallel to the centerline of the roadway or according to the Plans. Do not drag the geogrid across the subgrade. Install the geogrid in the longest continuous practical length, free from folds, creases or wrinkles. Hold the geogrid in place with pins, staples, sandbags or piles of granular material. Do not expose geogrids to the elements for longer than 14 days after removal of protective covering.

   a. Soft Ground (CBR ≤3). Overlap geogrid panels ~~at all joints~~ a minimum of 24 inches at all joints with the upper geogrid in the direction that fill will be placed. Tie panels together securely with cable ties or hog rings at 20 foot intervals.

   b. Firm Ground (CBR >3). Overlap geogrid panels a minimum of 12 inches at all joints in the direction that fill will be placed. Tie panels together securely with cable ties or hog rings at 20 foot intervals and hand ~~manufacturer-recommended pins or bars. H and~~-tension geogrid and stake to the ground at the edges, overlaps, and in the center of each roll, at 30 foot intervals or as specified on the Plans**.**

   Place the beginning of each new roll beneath the previous roll to prevent the advancing fill from lifting the geogrid. Stagger end overlaps at least 10 feet from other end overlaps in adjacent rolls.

3. ~~634-3.04~~ Placing and Spreading Cover Material. Do not operate equipment directly on the unprotected geogrid. Spread fill material in the direction of the fabric overlap. Compact using a smooth drum roller. Do not allow construction equipment to make sudden stops, starts, or turns on the cover material.

a. Very Soft Ground (CBR < 1). End-dump material onto previously placed material and spread over the geogrid with a low ground pressure dozer to the depth permitted. Maintain a minimum depth of 12 inches of cover material at all times between the geogrid and the wheels or tracks of the construction equipment unless otherwise shown on the Plans or directed by the Engineer. Do not dump material directly onto the geogrid. To prevent a mud wave, end-dump fill along the edges of the geogrid to form toe berms or access roads that extend one to two panel widths ahead of the remainder of the embankment fill placement. After constructing the two berms, spread fill in the area between the toe berms by placing material parallel to the alignment and symmetrical from the toe berms inward toward the center to maintain a U-shaped leading edge (i.e., concave outward) to contain the mud wave. Limit height of dumped piles above the geogrid to avoid local bearing failure. Traffic on the first lift should be parallel to the embankment alignment. Do not allow construction equipment to turn on the first lift. Compact first lift by tracking in place with dozers or end-loaders. Compact with specified compaction equipment once embankment is at least 2 feet above the geogrid.

b. Soft Ground (1 ≤ CBR ≤ 3). End-dump ~~back-dump~~ material onto previously placed material and ~~the geogrid.~~ spread over the geogrid ~~material ahead~~ with a low ground pressure dozer to the depth permitted. Maintain a minimum depth of 6 inches of cover material at all times between the geogrid and the wheels or tracks of the construction equipment unless otherwise shown on the Plans or directed by the Engineer. Place the end-dumped material along the roadway centerline and spread it outward to the roadway edges to prevent the development of wrinkles or movement of the geogrid during construction. Fill in any ruts that form during construction with material shown on the Plans. Do not cut down the fill adjacent to the ruts.

c. Firm Ground (CBR > 3). Maintain a minimum depth of 6 inches of cover material at all times between the geogrid ~~fabric~~ and the wheels or tracks of the construction equipment.

4. ~~634-3.05~~ Geogrid Repair. Should the geogrid be torn, punctured, or the overlaps disturbed – as evidenced by visible geogrid damage – remove the backfill around the damaged area and repair or replace the damaged area at no additional expense to the State. Make repairs to the damaged area with a patch of the same type of geogrid originally placed. Overlay torn area with geogrid with a minimum 3 foot overlap around the edges of the torn area and secure as recommended by the geogrid manufacturer, unless otherwise directed by the Engineer.

634-4.01 METHOD OF MEASUREMENT. ~~By the square yard, in final position, determined by multiplying plan neat line width by the measured length parallel to installation centerline along the ground surface, for installations acceptably completed.~~ Measure geogrids by the square yard of ground surface actually covered. No allowance will be made for overlap, whether at joints or patches.

634-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard.

Material used to fill ruts and holes will be paid for at the unit price for the type of material used. Payment will be made under:

Pay Item	Pay Unit
634(1) Geogrid, ~~Type ___~~ Stabilization, Class _____	Square Yard
634 (2) Geogrid, Reinforcement, Class _____	Square Yard

SECTION 729

GEOSYNTHETICS

729-2.01 GEOTEXTILE FOR SUBSURFACE DRAINAGE, SEPARATION, STABILIZATION, EROSION CONTROL AND EMBANKMENT REINFORCEMENT.

1. Subsurface Drainage. A non-woven geotextile that meets ~~Meet~~ AASHTO M 288 Class 2 for Subsurface Drainage.
2. Separation. Meet AASHTO M 288 for Separation, except provide a minimum permittivity of 0.05 sec^{-1}.
3. Stabilization. Meet AASHTO M 288 Class 1 for Stabilization, except provide a minimum permittivity of 0.08 sec^{-1}.
4. Erosion Control. Meet AASHTO M 288 Class 1 for Permanent Erosion Control.
5. Reinforcement. Meets the requirements in Table 729-1 for Type 1 or Type 2.

Package, label, handle and store geotextile materials according to ASTM D 4873.

TABLE 729-1
GEOTEXTILE REINFORCEMENT PROPERTIES

Property	Test Method	Units	Requirement[a]	
			Type 1	Type 2
Grab Tensile	ASTM D4632	lb.	200/200	400/400
Grab Elongation	ASTM D4632	% (MD)	10	10
Wide Width Tensile	ASTM D4595	lb/in. (ultimate)	200/200	400/400
Wide Width Tensile	ASTM D4595	lb/in. (@ 5% strain)	100/100	200/200
Seam Breaking Strength	STM D 4632	lb./in.	180	360
Puncture	ASTM D6241	lb.	500	1500
Trapezoidal Tear	ASTM D4533	lb.	100	150
AOS	ASTM D4751	U.S. sieve size	#30[b]	#30[b]
Permittivity	ASTM D4491	sec^{-1}	0.20	0.20
Flow Rate	ASTM D4491	$gal./min./ft^2$	10	10

[a] Minimum Average Roll Values (MARV) in machine direction (MD) / cross-machine direction (XD) unless otherwise specified
[b] Maximum average roll value

~~**729-2.02 GEOTEXTILE SUBSURFACE DRAINAGE AND EROSION CONTROL.**~~

729-2.02 4 SILT FENCE. Meet AASHTO M 288 for Temporary Silt Fence.

729-2.03 PAVING FABRIC. Meet AASHTO M 288 for Paving Fabric.

729-2.04 ~~5~~ GEOGRID FOR EMBANKMENT AND ROADWAY STABILIZATION AND REINFORCEMENT. Provide geogrid consisting of a regular network of connected polymer tensile elements with aperture geometry sufficient to provide significant mechanical interlock with the surrounding material. Provide dimensionally stable geogrid that is able to retain its geometry during construction. Provide geogrid structure that resists ultraviolet degradation and all forms of chemical and biological degradation encountered in the material in which it is buried.

Package, label, handle, and store geogrid material according to ASTM D 4873.

1. Stabilization. Provide geogrid that meets the survivability requirements in Table 729-2 and meets the physical requirements in Table 729-3.
2. Reinforcement. Provide geogrid that meets the survivability requirements in Table 729-2 and as shown on the Plans.

~~Biaxial polymer grid, specifically fabricated for use as a soil reinforcement, having high tensile strength, modulus, and stiffness in both principal directions. Use a single- layered, integrally formed grid structure. Use either extruded or punched and drawn polypropylene or high density polyethylene. Geogrid must be UV-stabilized, chemically inert, and meets the physical requirements in Table 729-1.~~

TABLE 729-2
GEOGRID SURVIVABILITY REQUIREMENTS

Property	Test Method	Units	Requirement	
			CLASS 1	CLASS 2
Ultimate Multi-Rib Tensile Strength[a]	ASTM D 6637	lb./ft.	1230	820
Junction Strength[a]	ASTM D7737	lb.	25	25
Ultraviolet Stability (Retained Strength)	ASTM D 4355	%	50% after 500 hours of exposure	

[a] Minimum Average Roll Value (MARV) in any rib direction.

TABLE 729-3 ~~TABLE 729-1~~
GEOGRID PHYSICAL REQUIREMENTS

Property	Test Method	Units	Requirement
2% Tensile Strength[a]	ASTM D6637	lb./ft.	≥ 400
5% Tensile Strength[a]	ASTM D6637	lb./ft.	≥ 800
Percent Open Area	COE, CW-02215	%	50 – 80
Aperture Size[b]	Direct measure	in.	0.5 – 3.0

[a] Minimum Average Roll Value (MARV) in machine and cross-machine directions.
[b] measured as the spacing between parallel ribs.

PROPERTY	REQUIREMENT	TEST METHOD
Average Aperture Size, MD[1] XD[2]	 0.8-2.0 in. 0.8-2.0 in.	I.D Calipered Maximum Inside Dimension
Installation Damage Resistance	80%[3]	Sample per D5818 Test per D6637
Rib Thickness, min. (Nominal)	40 mils	Rib Thickness Calipered Minimum
Tensile Strength, min. At 2% Strain At 5% Strain	MD & XD 400 lb/ft 800 lb/ft	ASTM D6637
Junction Strength, min.	90%[4]	GRI GG-GG2
[1] MD: Machine Direction which is along roll length. [2] XD: Cross machine direction which is across roll width. [3] 80% relative to pre-installation Tensile Strength values. Perform Test install using GP or GW Class soil. [4] 90% relative to Ultimate Tensile Strength as determined by ASTM D6637		

Recommendations for Future Work

The revised specifications are much improved from the 2004 version; however, further development may be required to update many of the geosynthetic specifications based on suggestions provided by the GMA. The following bulleted list provides some suggestions for revisions that may be considered by AKDOT in the future.

- Consider the special provisions from the Utah Department of Transportation (see Appendix B) to potentially update the Material and Constructions subsections within Section 511 – MSE Walls to allow for more efficient use of geosynthetics as reinforcement.
- Consider using 30 mil geomembrane below road base in situations where the reinforcing steel may be exposed to deicing or chloride-based chemicals (Section 511).
- Consider adding design requirements that would incorporate current FHWA guidelines, AASHTO LRFD Specifications, and Interim Specifications for Highway Bridges in design of the selected wall systems (Section 511).
- Consider how best to join or bond adjacent geotextiles when used as reinforcement (Section 630-3.01.2.b.)
- Consider revising the wording describing the direction that the geotextile erosion control material is placed with respect to slope and water flow (Section 631-3.01.2.b.)
- Consider adding "Hybrid Paving Mat" to list of potential paving fabrics that can be used in Section 632-2.01.
- Determine whether grab tensile and grab elongation are appropriate material properties for geotextile reinforcement products (refer to Table 729-1). Likewise, determine whether seam breaking strength is an appropriate material property for geotextile reinforcement products (refer to Table 729-1).
- Consider the addition of a table to describe "enhancement" geotextiles in Section 729. Properties that may be included in this table describing Class 1+ geotextiles include wide-width tensile strength, permittivity, apparent opening size, and ultraviolet stability requirements.
- Consider adding Paving Interlayer chart (see Appendix C) into Section 729-2.03.
- Consider separating the requirements for biaxial and multi-axial geogrids used as reinforcement.

References

Cuelho, E. and Perkins, S. (2013) "Review and Update of Geosynthetic Specifications in the State of Alaska," Alaska Department of Transportation and Public Facilities, Report number FHWA-AK-RD-13-08, 43 p.

Holtz, R.D., Christopher, B.R., Berg, R.R. (2008) Geosynthetic Design and Construction Guidelines, FHWA-NHI-07-092, Federal Highway Administration, Washington, D.C., 592 p.

Appendix A – Comments and Suggested Changes from GMA

SECTION 511

MECHANICALLY STABILIZED EARTH (MSE) WALLS

Comment [LP1]: This section is lacking a lot of pertinent details to create a quality MSE specification. More thought should be given to address these items. Utah DOT special provision is a good example of many elements that are missing in this specification

511-1.01 DESCRIPTION. Furnish and install mechanically stabilized earth wall.

511-2.01 MATERIALS. Meet the following:

Class A Concrete	Section 501
Precast and Cast-in-Place Concrete Panels	Section 501
Reinforcing Steel	Section 503
Structural Steel	AASHTO M 270
Modular Concrete Block Unit	Subsection 704-2.04
Pipe and Perforated Pipe	Section 706
Geotextile for Drainage	Subsection 729-2.02
Geogrid	Subsection 729-2.05
Geocomposite Drainage System	As Specified
Porous Backfill Material	Subsection 703-2.10
Structural Fill	Subsection 703-2.13

Comment [LP2]: This section doesn't exist in AKDOT specifications. If this is a new section, GMA should be allowed to review to be sure it complies with current MSE Wall and Slope design guidance.

1. Structure Backfill and Foundation Fill. Meet Subsection 703-2.13, Structural Fill. Use materials with a sodium sulfate soundness loss less than 15% after five cycles as determined by AASHTO T 104 and free of shale or other particles of low durability.

   When using polyester geosynthetic reinforcement, use backfill material with a pH range between 3 and 9 as determined by AASHTO T 289. When using polyolefin geosynthetic reinforcement, use backfill material with a pH of 3 or greater as determined by AASHTO T289. When using steel soil reinforcement, use backfill material meeting the following electrochemical requirements:
   - pH of 5 to 10 (AASHTO T 289)
   - Resistivity not less than 30 ohm-meters (AASHTO T 288)
   - Chlorides not greater than 100 ppm (AASHTO T 291)
   - Sulfates not greater than 200 ppm (AASHTO T 290)
   - Organic content of 1% max (AASHTO 267)

2. Wall Members. Provide facing consisting of precast concrete panels, modular concrete block units, cast-in-place concrete, or welded wire fabric, as specified.

   Manufacture concrete panels with a minimum 28-day concrete compressive strength of 4,000 psi and thickness of 5.5 inch. Finish the exposed face with a smooth finish or as detailed on the Plans. For the face not exposed to view, provide a uniform surface finish free of open pockets of aggregate or surface distortions in excess of 1/4 inch and a minimum concrete cover of 1.5 inch over concrete reinforcing steel. Locate soil reinforcement connection hardware during concrete placement to avoid contact with the panel reinforcing steel. Shop-fabricate welded wire fabric reinforcement from cold-drawn wire meeting AASHTO M 32 and conforming to the specifications for welded wire fabric in accordance with AASHTO M 55. Steel reinforcements supporting roadways exposed to deicing salts, or materials treated with deicing salts, should have a 30 mil geomembrane placed below the road base and tied into the drainage system to mitigate penetration of the deicing salts.

3. Soil Reinforcement.

   Use approved geogrid reinforcement that meets the requirements listed in Subsection 729-2.04 or as specified on the Plans.

   Galvanize all steel soil reinforcement and any steel connection hardware to meet AASHTO M 111. Manufacture steel strip reinforcement by hot rolling to meet ASTM A 572, Grade 450, or approved alternate.

Comment [LP3]: As written, section 729-2.04 is not relevant or adequate for MSE wall and slope applications. Unless updated to accommodate any of the standard design protocols for MSE walls and slopes (e.g. reduction factors for creep, installation damage, etc.), this reference should only include "as specified on plans" or "as designed by supplier". Connection strength should also be addressed given the high seismic zones in parts of Alaska.

4. Working Drawings. Submit all working drawings and design calculations, sealed by licensed Engineer, including:
   a. Earthwork requirements including specifications for material and compaction of backfill.
   b. Details and revisions or additions to drainage systems or other facilities required to accommodate the system.
   c. Existing ground elevations verified by the Contractor for each location involving construction wholly or partially in original ground.
   d. Complete design calculations substantiating that all proposed designs satisfy the design parameters in the Contract documents. List all design parameters, assumptions, and design life in design calculations.
   e. Complete details of all elements required for the proper construction of the system, including complete material specifications.
   f. Complete plan and elevation sheets including dimensions, details and cross-sections necessary to construct the wall.
   g. Details of the facing treatments and connections between facing elements and soil reinforcement.

   Prohibit work on earth retaining systems for which working drawings are required until such drawings have been approved.

5. Design Requirements. Incorporate current FHWA guidelines, AASHTO LRFD Specifications, and Interim Specifications for Highway Bridges in design of the selected wall system in addition to, or as modified by, the following:
   a. For all walls, or sections of walls located within 150 feet of bridge abutments, use a design earthquake peak horizontal ground acceleration coefficient of ____ g, corresponding to a ___ % exceedence in 50 years. For all other walls, or sections of walls more than 150 feet away from bridge abutments, use an acceleration coefficient of ____ g, corresponding to a ____ exceedance in 50 years.
   b. Design retaining wall panel connections in all cases to not fail during the seismic event corresponding to ____ % exceedence in 50 years.
   c. The Contractor-selected wall company is responsible for all stability calculations, except global stability and bearing capacity.
   d. Minimum service life of 75 years.
   e. Provide corrosion protection for metallic reinforcement by one of the following two measures:
      1. Provide sacrificial steel sufficient for a corrosion rate of at least 0.80 mils/year per exposed surface after 16 years of corrosion protection service allowed for the galvanized coating.
      2. Provide a protective geomembrane of at least 30 mils thickness above the final layer of reinforcement and lapped against the top facing element and design the reinforcement to provide sacrificial steel sufficient for a corrosion rate of at least 0.50 mils/year per exposed surface after 16 years of corrosion protection service for the galvanized coating.
   f. Use a vertical spacing of primary reinforcement not exceeding 30 inches for single-stage walls, or 24 inches for two-stage walls to provide a coherent MSE reinforced soil mass. This may require modification of panels.
   g. In accordance with Section 11 of the AASHTO LRFD Bridge Design specifications, provide horizontal benches at least 4 feet in width at the base of walls to be founded on earth slopes. Benches may be eliminated for walls located adjacent to concrete slope-protected slopes.
   9. Use the following soil design properties:

SOIL PROPERTIES	WALL BACKFILL	RETAINED SOIL	FOUNDATION SOIL
Moist Density (pcf)	+ -	130	120
Friction Angle (deg)	+ -	32	30
Cohesion (psf) Factored Bearing	+ -	0	0
Resistance (psf)	N/A +	N/A	7000

511-3.01 CONSTRUCTION.

Comment [LP4]: See Utah DOT special provision for potential improvements

1. Excavation and Backfill. Excavate and backfill earth retaining systems to meet Section 205. Compact the material as specified under Subsection 203-3.04. Do not use studded rollers (i.e., sheepsfoot, padfoot) to compact the backfill material atop soil reinforcement.

2. Drainage. Provide a drainage system at the base of the wall along its back-face with outlet works at sags in the profile and at the low ends of the system.

   a. Weep Holes. Place a minimum of 2 cubic feet of porous backfill material encapsulated with geotextile at each weep hole. Cover joints between retaining wall facing elements, which function as weep holes, with geotextile meeting the requirements in subsection 729-2.01 for Subsurface Drainage and as specified in the Working Drawings. Dry and thoroughly clean the face panels that are to receive the geotextile.

   b. Drainage Blankets. Construct drainage blankets consisting of porous backfill material encapsulated in geotextile, collector pipes, outlet pipes, or cleanout pipes. Construct and compact the subgrade to receive the geotextile so it is free of loose or extraneous material and sharp objects that may damage the geotextile. Stretch, align, and place the fabric in a wrinkle-free manner. Overlap adjacent borders of the fabric from 12 to 18 inches. Repair torn or punctured fabric by covering the damaged area with a piece of fabric large enough to cover the damaged area and meet the overlap requirement.

      Place the porous backfill material in horizontal layers and thoroughly consolidate by the methods specified in Subsection 205-3.03. Prohibit ponding or jetting of porous backfill material or structural material. Maintain a minimum of 6 inches of porous backfill material, backfill select material, or embankment material between the fabric and the equipment during material spreading and compaction.

      Place perforated collector pipe, when required, within the porous backfill material to the flow line elevations shown. Place outlet pipes at sags in the flow line and at the low end of the collector pipe. Construct rock slope protection, when required, at the end of outlet pipes, as shown on the Plans. Place cleanout pipes at the high ends of collector pipes.

c. Geocomposite Drainage Systems. Place and secure the geocomposite drainage material tightly against the excavated face, lagging or back of wall. Protect the drainage material against physical damage and grout leakage when concrete is to be placed against geocomposite drainage material. Use geocomposite material as specified in the Working Drawings.

3. Retaining Wall Construction. Construct mechanically stabilized earth walls consisting of a facing system to which steel or geosynthetic soil reinforcement is connected. Provide facing consisting of precast concrete panels, cast-in-place concrete, modular concrete blocks or welded wire fabric.

Install geosynthetic soil reinforcement in accordance with Section 634.

When constructing cast-in-place concrete facing, embed soil reinforcement which extends beyond the temporary facing into the facing concrete.

Form welded wire facing by bending the horizontal soil reinforcement 90 degrees upward to form the wire face. ~~Connect the vertical portion of the welded fabric forming the face to the next upper level of soil reinforcement.~~ Place a separate backing mat and hardware or geotextile cloth immediately behind the vertical portion of soil reinforcement.

Provide a precast reinforced or cast-in-place concrete leveling pad at each panel foundation level. Place panels or wire fabric and support to achieve the final position.

Place and compact structural fill material at the same time as placement of facing and soil reinforcement, without distortion, damage, or displacement of the facing or soil reinforcement. Use light compaction equipment within 3 feet of the back face of the wall and compact in thinner layers if necessary to achieve specified levels of compaction. Backfill to an elevation approximately 1-1/4 inch above the facing connection level before placing the next level of soil reinforcement. Roughly level the structural fill material before placing the soil reinforcement. Uniformly tension all soil reinforcement to remove any slack in the connection or material prior to placing the next lift of structural fill. At the end of the day, place the final layer of structural fill sloping away from the wall face to provide rain and runoff drainage away from the face of the wall.

Where required, install joint filler, bearing pads, and joint-covering material concurrently with face panel or modular concrete block placement.

Furnish and install instrumentation for monitoring corrosion, where specified.

511-4.01 MEASUREMENT. Measure by the square foot of wall face (Section 109). The vertical height of each section is measured on the outer face from the bottom of the lowermost face element to the top of the wall.

511-5.01 PAYMENT. Payment will be made at the contract unit price per square foot of wall.

Excavation and backfill are paid for under Section 205.

Payment will be made under:

Pay Item	Pay Unit
511(1) Mechanically Stabilized Earth Wall	Square Foot

SECTION 630

GEOTEXTILES FOR EMBANKMENT AND ROADWAY SEPARATION, STABILIZATION AND REINFORCEMENT

630-1.01 DESCRIPTION. Prepare ground surface, and furnish and place geotextiles for separation stabilization and/or reinforcement, as shown on the Plans.

630-2.01 MATERIALS. Use materials that conform to the following:

Geotextiles and Sewn Seam Strength Subsection 729-2.01

Sewing Thread. Use high strength polypropylene, or polyester. Do not use nylon thread. Use thread of contrasting color to that of the geotextile itself.

630-3.01 CONSTRUCTION.

1. Surface Preparation. Prepare ground surface by removing stumps, brush, boulders, and sharp objects. Fill holes and large ruts with material shown on the Plans or as approved by the Engineer.

2. Geotextile Placement. Unroll geotextile directly onto the prepared surface. Stretch geotextile to remove any creases, folds or wrinkles. Do not expose geotextiles to sunlight for longer than 14 days after removal of protective covering. Do not allow geotextile rolls to get wet ~~prior to installation when freezing temperatures are anticipated~~.

   a. Separation and Stabilization. Lay geotextile for embankment separation and stabilization parallel to roadway centerline. On horizontal curves, place in segment lengths not exceeding those listed in Table 630-1, with butt ends cut to match and sewn or overlapped. On tangents, straighten the geotextile and sew or overlap butt ends. Overlaps shall be shingled in the same direction as fill placement to prevent overlapped edges from lifting during construction.

   b. Reinforcement. Lay the primary (principle) strength direction of the geotextile for embankment reinforcement perpendicular to the roadway centerline or as shown on the Plans. ~~Join segments by sewing or an approved bonding or attachment process.~~ No joints, overlaps or seams are permitted in the reinforcement direction of the geotextile.

TABLE 630-1
GEOTEXTILE PLACEMENT ON CURVES

Degree of Curve	Maximum Segment Length (ft.)
1	125
2	90
3	75
4	65
5	55
6	50

3. Joining. Join adjacent geotextiles for separation or stabilization by overlapping or sewing. Join adjacent geotextiles for reinforcement by sewing or as shown on the Plans. Other attachment methods may be used if approved by the Engineer.

a. Sew seams with a Butterfly or J-Seam using a double-thread chain stitch (lock stitch). Bring adjacent sections of geotextile together and fold so that the stitching penetrates four layers of geotextile for the full seam length. Make the stitching line 1-1/4 inches (±1/4 inch) from the folded edge of the seam and at least 1/2 inch from the free edge of the geotextile. Sew seams so that they face upward and ~~are up~~ can be easily inspected by the Engineer. Illustrations showing correct stitch formation and seam configurations are provided in Figure 1-2 (page 1-28) of the FHWA publication, *Geosynthetic Design & Construction Guidelines*, FHWA-NHI-07-092, August 2008.

b. Overlap sections by a minimum of 3 feet at all longitudinal and transverse joints. Place the beginning of each new roll beneath the previous roll to prevent the advancing fill from lifting the geotextile (shingle in the direction of construction).

4. Material Placing and Spreading. During placing and spreading of material, maintain a minimum depth of 12 inches of cover material, or a minimum depth equal to the separation distance between multiple layers of geotextile as shown on the Plans when this separation distance is less than 12 inches, at all times between the geotextile and the wheels or tracks of the construction equipment. Limit size and weight of construction equipment to reduce rutting in the initial lift above the geosynthetic to not greater than 3 inches deep to prevent overstressing the geosynthetic.

Spread the material in the direction of the upper overlapped geotextile. Maintain proper overlap and geotextile continuity. If sewn or bonded seams are used, place the cover material and spread only in one direction for the entire length of the geotextile. On weak subgrades, limit height of dumped cover material to prevent localized subgrade and/or geotextile failure. Do not drop stones or frozen material larger than 1 foot in diameter directly onto the geotextile from a height of more than 1 foot.

Compact using a smooth drum roller or in a manner approved by the Engineer. Do not allow construction equipment to make sudden stops, starts, or turns on the cover material. Do not allow turning of vehicles on the initial lift of cover material above the geotextile. Fill any ruts over 3 inches deep occurring during construction with additional material shown on the Plans and compact to the specified density.

5. Geotextile Repair. Should the geotextile be torn, punctured, or the overlaps or sewn joints disturbed – as evidenced by visible geotextile damage, subgrade pumping, intrusion, or embankment distortion – remove the backfill around and under (if required by the Engineer) the damaged or displaced area and repair or replace the damaged area at no additional expense to the State. Make repairs to the damaged area with a patch of the same type of geotextile originally placed. Make patches overlap the existing geotextile from the edge of any part of the damaged area by a minimum of 3 feet or sew patches to existing geotextile, as directed by the Engineer.

a. Separation and Stabilization. Overlay torn area with geotextile with a minimum 3 foot overlap around the edges of the torn area or sew and bond according to Subsection 630-3.01.3. Ensure that the patch remains in place when fill material is placed over the affected area.

b. Reinforcement. Sew according to Subsection 630-3.01.3.a.

630-4.01 METHOD OF MEASUREMENT. Measure geotextile by the square yard of ground surface actually covered. No allowance will be made for overlap, whether at joints or patches.

630-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard. Material used to fill ruts and holes will also be paid for at the unit price for the type of material used.

Payment will be made under:

Pay Item	Pay Unit
630(1) Geotextile, Separation, Class	Square Yard
630(2) Geotextile, Stabilization, Class ____	Square Yard
630(3A) Geotextile, Reinforcement – Type 1	Square Yard
630(3B) Geotextile, Reinforcement – Type 2	Square Yard

SECTION 631
GEOTEXTILES FOR SUBSURFACE
DRAINAGE AND EROSION CONTROL

631-1.01 DESCRIPTION. Prepare ground surface, and furnish and place geotextiles for subsurface drainage and erosion control, as shown on the Plans.

631-2.01 MATERIALS. Use materials that conform to the following for the class specified in the bid schedule:

Geotextiles and Sewn Seam Strength	Subsection 729-2.01

Sewing Thread. Use high strength polypropylene, or polyester. Do not use nylon thread. Use thread of contrasting color to that of the geotextile itself.

631-3.01 CONSTRUCTION.

1. Surface Preparation. Prepare ground surface by removing stumps, brush, boulders, and sharp objects. Fill holes and large ruts with material shown on the Plans or as approved by the Engineer. Construct smooth and stable trench walls.

2. Geotextile Placement. Unroll geotextile directly onto the prepared surface. Stretch ~~Place~~ geotextile to remove any creases, folds or wrinkles. Place geotextile in a manner which will ensure intimate contact between the trench wall and the geotextile. The geotextile may be held in place with securing pins at 3-foot spacing along all edges (but not closer than 2 inches from the edge) to prevent movement during construction. Do not expose geotextiles to the elements for longer than 14 days after removal of protective covering. Do not allow geotextile rolls to get wet ~~prior to installation when freezing temperatures are anticipated~~.

   a. Subsurface Drainage. In trenches, after placing the geotextile and material shown on the Plans, fold the geotextile over the top of the material shown on the Plans to produce a minimum overlap of 12 inches, for trenches greater than 12 inches wide. In trenches less than 12 inches wide, make the overlap equal to the width of the trench. Then cover the geotextile with the subsequent course of material.

   b. Erosion Control. Place and anchor geotextile on the approved surface so it will not be torn or excessively stretched by placement of the overlying materials. Secure the geotextile to the slope but secure it loosely enough so that the geotextile will not tear when riprap or other cover material is placed on the geotextile. The geotextile shall not be keyed at the top of the slope until the riprap or other cover material is in place to the top of the slope. Anchor the terminal ends of the geotextile using key trenches or aprons with a minimum 24" depth into the soil substrate at the crest and toe of slope, as shown on the Plans. Other temporary or permanent anchoring methods may be used, as approved by the Engineer. Place geotextile with the machine direction parallel to the direction of water flow (normally parallel to the slope elevation change for erosion control runoff and wave action, and parallel to the stream or channel water flow direction).

3. Joining. Join geotextile by sewing or overlapping. Joining by bonding or other attachment methods may be used, subject to approval by the Engineer.

   a. Sew seams with a Butterfly or J-Seam using a double thread chain stitch (lock stitch). Bring adjacent sections of geotextile together and fold so that the stitching penetrates four layers of geotextile for the full seam length. Make the stitching line 1-1/4 inches (±1/4 inch) from the folded edge of the seam and at least 1/2 inch from the free edge of the geotextile. Sew seams so that they can be easily inspected by the Engineer or representative. Illustrations showing correct stitch formation and seam configurations are provided in Figure 1-2 (page 1- 28) of the FHWA publication, Geosynthetic Design & Construction Guidelines, FHWA-NHI-07- 092, August 2008.

Conform both factory and field sewn seams to the strength requirements of Table 1 as outlined in the AASHTO M288 for subsurface drainage and erosion control applications.

b. Overlap sections by a minimum of 3 feet at all longitudinal and transverse joints. Overlap successive geotextile sheets in the direction of flow so that the upstream sheet is placed over the downstream sheet and/or upslope over downslope. In trenches, where overlapped seams are constructed in the longitudinal trench direction, make the overlap equal to the width of the trench.

4. Placement of Cover Material. Following placement of the geotextile on the prepared surface, place cover material of the type shown on the Plans. Place the cover material and armor from the bottom to the top of the slope using methods which minimize tearing and/or excessive stretching of the geotextile. In underwater applications, place the geotextile and the required thickness of cover material in the same day. Maintain proper overlap and geotextile continuity. Do not exceed the allowable drop heights for cover material shown in Table 631-1. Do not allow stones weighing more than 100 pounds to roll down the slope on the geotextile. Do not grade the slope in a way that will disturb the cover material or armor stone once it has been placed.

TABLE 631-1

INDIVIDUAL STONE Max. Weight (lbs)	ALLOWABLE DROP HEIGHT (ft)	
	UNPROTECTED GEOTEXTILE	PROTECTED GEOTEXTILE*
< 5	3	3
5-250	0	3
> 250	0	0**

*Protected geotextile is defined as having a gravelly covering (cushion layer) at least 6 inches thick.

**If stones greater than 250 pounds must be dropped or if a height of drop greater than 3 feet is required, then perform field trials to determine the minimum cushion thickness and/or maximum height of safe drop without damaging the geotextile.

Maintain a minimum depth of 12 inches of cover material between the geotextile and the wheels or tracks of the construction equipment.

5. Geotextile Repair. Should the geotextile be torn, punctured, or the overlaps or sewn joints disturbed – as evidenced by visible geotextile damage – remove the backfill around the damaged area and repair or replace the damaged area at no additional expense to the State. Make repairs to the damaged area with a patch of the same type of geotextile originally placed. Overlay torn area with geotextile with a minimum 3 foot overlap around the edges of the torn area. Ensure that the patch remains in place when material is placed over the affected area.

631-4.01 METHOD OF MEASUREMENT. Measure geotextile by the square yard of ground surface actually covered. No allowance will be made for overlap, whether at joints or patches.

631-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard. Material used to fill ruts and holes will also be paid for at the unit price for the type of material used.

Payment will be made under:

Pay Item	Pay Unit
631(1) Geotextile, Drainage, Class	Square Yard
631(2) Geotextile, Erosion Control, Class	Square Yard

SECTION 632

PAVING FABRIC

Comment [LP5]: Consider revising Section 632 based on provided Paving Interlayer chart

632-1.01 DESCRIPTION. Furnish and install geotextile paving fabric where shown on the Plans.

632-2.01 MATERIALS. Use materials that conform to the following:

Paving Fabric	Subsection 729-2.03
Hybrid Paving Mat	Subsection 729-2.04
Asphalt Cement	Subsection 702-2.01 (for grade of asphalt used in the overlay)

632-3.01 CONSTRUCTION.

1. Surface Preparation. Prepare the surface on which the fabric is to be placed as follows:
   a. Remove excess asphalt material, loose aggregate, and other foreign materials from the surface.
   b. Fill all potholes and cracks wider than 1/4 inch with an approved asphalt emulsion and sand slurry.
2. Application of Sealant. Apply asphalt sealant by distributor meeting all requirements set forth under Subsection 402-3.02. Apply the asphalt sealant uniformly at 0.20 to 0.30 gallons per square yard and at a minimum temperature of 295 °F and maximum temperature of 320 °F in the distributor tank, or as directed by the Engineer and/or Paving Fabric manufacturer. Do not apply asphalt material on a wet surface or when the ambient air temperature is below 45 °F or when other conditions would prevent proper application.
3. Fabric Laydown Equipment. Use approved mechanical laydown equipment to place fabric.
4. Fabric Placement. Place fabric directly on top of the asphalt sealant (tack coat) before the sealant has cooled and lost its tackiness. Lay fabric in full rolls without wrinkles and/or folds. Place the fabric per the manufacturer's recommendations. Overlap geotextile joints to ensure full closure of the joint, but do not exceed 6 inches of overlap. Overlap transverse joints in the direction of paving. Apply 0.20 gallons per square yard of additional asphalt sealant beneath all fabric joints. Removal and replacement of damaged geotextiles is the responsibility of the Contractor.
5. Bituminous Surface Course Overlay. Place the bituminous surface course closely following the fabric laydown to avoid exposure of uncovered fabric overnight or to traffic or inclement weather. Do not allow the temperature of the hot-mix asphalt to exceed manufacturer's recommendations. If asphalt sealant bleeds through the fabric before the placement of the overlay, apply sand or bituminous surface course evenly over the affected area to prevent fabric pick-up by construction equipment. Prevent paver or other construction equipment from turning and/or pivoting on the fabric.

632-4.01 METHOD OF MEASUREMENT. Measure paving fabric by the surface area of pavement covered. No allowance will be made for overlap, whether at joints or patches.

632-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard.

Pay Item	Pay Unit
632(1) Paving Fabric	Square Yard

SECTION 633

SILT FENCE

633-1.01 DESCRIPTION. Furnish, place, maintain, and remove temporary silt fence as shown on the Plans or as directed by the Engineer.

633-2.01 MATERIALS. Use materials that conform to the following:

Geotextile	Subsection 729-2.04
Posts	Wood, steel, or approved synthetic material.
Prefabricated Silt Fence	May be used if the system meets Section 633 requirements.
Support Mesh Between Posts	If required, 14 gage steel wire with a maximum mesh opening size of 6 inches by 6 inches or prefabricated geosynthetic mesh of equivalent strength.

Comment [LP6]: Pretty sure this is the wrong section. Section 729-2.02?

633-3.01 CONSTRUCTION.

1. Post Installation. Use posts that can be driven to the depths specified on the Plans and resist the maximum expected hydraulic and sediment material loads without damage. Place posts a maximum of 8 feet apart and drive a minimum of 18 inches into the ground.

2. Geotextile Placement. Install geotextile on posts in a vertical position and support by a wire or geosynthetic mesh if additional support is shown on the Plans or is deemed necessary by the contractor. Set the geotextile at the height specified in the Contract. Secure the bottom 18 inches of the geotextile on the upslope side of the posts and support system as shown on the Plans. Backfill trench used to secure the bottom with tamped soil. Join adjacent sections of geotextile with a minimum of 6 inches of overlap and only at posts.

633-3.02 MAINTENANCE. Maintain the integrity of the fence as long as it is necessary to contain sediment runoff. Inspect daily and correct any deficiencies immediately. Remove and dispose of fence when adequate vegetative growth ensures no further erosion of the slopes. Cut off the fabric at ground level and remove the wire and posts. When thickness of trapped sediment is in excess of 4 inches above the ground, either remove sediment from the site or spread sediment uphill of the fence and seed all exposed soil immediately, following the requirements of Section 618.

633-4.01 METHOD OF MEASUREMENT. Measure silt fence the length of fence installed (Section 109). No allowance will be made for overlap, whether at joints or patches.

633-5.01 BASIS OF PAYMENT. The contract price includes maintenance, removal and disposal of the fence, and seeding.

Payment will be made under:

Pay Item	Pay Unit
633(1) Silt Fence	Linear Foot

SECTION 634

GEOGRID FOR EMBANKMENT AND ROADWAY STABILIZATION ~~AND REINFORCEMENT~~

Comment [LP7]: To avoid confusion with true reinforcement applications (e.g. MSE wall/slope), suggest changing title. The term stabilization is appropriate for both soft and firm soils in roadway applications. True reinforcement geogrids for walls, slopes, and embankments over soft soils should be addressed in a standalone section.

634-1.01 DESCRIPTION. Furnish and install geogrid material as shown on the Plans.

634-2.01 MATERIALS. Use materials that conform to the following:

Geogrid	Subsection 729-2.04

634-3.01 CONSTRUCTION

1. Surface Preparation.

   a. Soft Ground (CBR ≤ 3). Prepare surface by removal of stumps, brush, boulders, and sharp objects. Fill holes and large ruts with material shown on the Plans or as approved by the Engineer.

   b. Firm Ground (CBR > 3). Compact and finish subgrade or subbase prior to placement of the geogrid.

2. Geogrid Placement. Unroll geogrid directly onto the prepared ground surface in the direction of advancing construction, parallel to the centerline of the roadway or according to the Plans. Do not drag the geogrid across the subgrade. Install the geogrid in the longest continuous practical length, free from folds, creases or wrinkles. Hold the geogrid in place with pins, staples, sandbags or piles of granular material. Do not expose geogrids to the elements for longer than 14 days after removal of protective covering.

   a. Soft Ground (CBR ≤ 3). Overlap geogrid panels a minimum of 24 inches at all joints with the upper geogrid in the direction that fill will be placed. Tie panels together securely with cable ties or hog rings at 20 foot intervals.

   b. Firm Ground (CBR > 3). Overlap geogrid panels a minimum of 12 inches at all joints in the direction that fill will be placed. If deemed necessary to maintain proper overlap and tensioning, ~~t~~Tie panels together securely with cable ties or hog rings at 20 foot intervals and ~~h~~ ~~manufacturer recommended pins or bars.~~ ~~H~~Hand-tension geogrid and stake to the ground at the edges, overlaps, and in the center of each roll, at 30 foot intervals.

   Place the beginning of each new roll beneath the previous roll to prevent the advancing fill from lifting the geogrid. Stagger end overlaps at least 10 feet from other end overlaps in adjacent rolls.

3. Placing and Spreading Cover Material. Do not operate equipment directly on the unprotected geogrid. Spread fill material in the direction of the fabric overlap. Compact using a smooth drum roller. Do not allow construction equipment to make sudden stops, starts, or turns on the cover material.

   a. Very Soft Ground (CBR < 1). End-dump material onto previously placed material and spread over the geogrid with a low ground pressure dozer to the depth permitted. Maintain a minimum depth of 12 inches of cover material at all times between the geogrid and the wheels or tracks of the construction equipment unless otherwise shown on the Plans or directed by the Engineer. Do not dump material directly onto the geogrid. To prevent a mud wave, end-dump fill along the edges of the geogrid to form toe berms or access roads that extend one to two panel widths ahead of the remainder of the embankment fill placement. After constructing the two berms, spread fill in the area between the toe berms by placing material parallel to the alignment and

symmetrical from the toe berms inward toward the center to maintain a U-shaped leading edge (i.e., concave outward) to contain the mud wave. Limit height of dumped piles above the geogrid to avoid local bearing failure. Traffic on the first lift should be parallel to the embankment alignment. Do not allow construction equipment to turn on the first lift. Compact first lift by tracking in place with dozers or end-loaders. Compact with specified compaction equipment once embankment is at least 2 feet above the geogrid.

b. Soft Ground (1 ≤ CBR ≤ 3). End-dump material onto previously placed material and spread over the geogrid with a low ground pressure dozer to the depth permitted. Maintain a minimum depth of 6 inches of cover material at all times between the geogrid and the wheels or tracks of the construction equipment unless otherwise shown on the Plans or directed by the Engineer. Place the end-dumped material along the roadway centerline and spread it outward to the roadway edges to prevent the development of wrinkles or movement of the geogrid during construction. Fill in any ruts that form during construction with material shown on the Plans. Do not cut down the fill adjacent to the ruts.

c. Firm Ground (CBR ≥ 3). Maintain a minimum depth of 6 inches of cover material at all times between the geogrid and the wheels or tracks of the construction equipment.

4. Geogrid Repair. Should the geogrid be torn, punctured, or the overlaps disturbed – as evidenced by visible geogrid damage – remove the backfill around the damaged area and repair or replace the damaged area at no additional expense to the State. Make repairs to the damaged area with a patch of the same type of geogrid originally placed. Overlay torn area with geogrid with a minimum 3 foot overlap around the edges of the torn area and secure as recommended by the geogrid manufacturer, unless otherwise directed by the Engineer.

634-4.01 METHOD OF MEASUREMENT. Measure geogrids by the square yard of ground surface actually covered. No allowance will be made for overlap, whether at joints or patches.

634-5.01 BASIS OF PAYMENT. Payment will be made at the contract unit price per square yard.

Material used to fill ruts and holes will be paid for at the unit price for the type of material used. Payment will be made under:

Pay Item	Pay Unit
634(1) Geogrid, Stabilization, Class	Square Yard
~~634 (2) Geogrid, Reinforcement, Class~~	~~Square Yard~~

SECTION
729

GEOSYNTHETICS

729-2.01 GEOTEXTILE FOR SUBSURFACE DRAINAGE, SEPARATION, STABILIZATION, EROSION CONTROL AND EMBANKMENT REINFORCEMENT.

1. Subsurface Drainage. Meet AASHTO M 288 Class 2 (default class) for Subsurface Drainage.
2. Separation. Meet AASHTO M 288 for Separation, except provide a minimum permittivity of 0.05 sec^{-1}.
3. Stabilization. Meet AASHTO M 288 for Stabilization, except provide a minimum permittivity of 0.08 sec^{-1}.
4. Erosion Control. Meet AASHTO M 288 Class 1 for Permanent Erosion Control.
5. Reinforcement. Meets the requirements in Table 729-1 for Type 1 or Type 2.
6. Drainage Blankets. Meet AASHTO M288 Class 2 for Subsurface Drainage
7. Geocomposite Drainage Systems

Comment [LP8]: Class 2 & 3 are too light for rip rap placement

Comment [LP9]: Need to develop or reference Geocomposite specification

Package, label, handle, and store geotextile materials according to ASTM D 4873.

TABLE 729-1
GEOTEXTILE REINFORCEMENT PROPERTIES FOR EMBANKMENTS

Property	Test Method	Units	Requirement[a]	
			Type 1	Type 2
Grab Tensile	ASTM D 4632	lb.	200/200	400/400
Grab Elongation	ASTM D 4632	% (MD)	10	10
Wide Width Tensile	ASTM D 4595	lb./in. (ultimate)	200/200	400/400
Wide Width Tensile	ASTM D 4595	lb./in. (@ 5% strain)	100/100	200/200
Seam Breaking Strength	ASTM D 4632	lb./in.	180	360
Puncture	ASTM D 6241	lb.	500	1500
Trapezoidal Tear	ASTM D 4533	lb.	100	150
AOS	ASTM D 4751	U.S. sieve size	#30[b]	#30[b]
Permittivity	ASTM D 4491	sec^{-1}	0.20	0.20
Flow Rate	ASTM D 4491	$gal./min./ft^2$	10	10

[a] Minimum Average Roll Values (MARV) in machine direction (MD) / cross-machine direction (XD) unless otherwise specified

[b] Maximum average roll value

Comment [LP10]: Suggest removing "Grab Tensile Strength" – not a reinforcement property

May want to consider AOS change to 40 US Sieve – in line with AASHTO

Add note requiring Seam Strength certifications only for sewn geotextiles

Comment [LP11]: Consider adding column for 'Type 3' based on the proposed M288 addition of a "Subgrade Enhancement Geotextile" (see inserted chart from proposal to AASHTO SOM TS-4e)

Table 6 – Enhancement Geotextile Property Requirements			
	Test Methods	Units	Requirements
Geotextile Class			Class 1+
Wide Width Tensile	ASTM D 4595	kN/m	70
Permittivity	ASTM D 4491	sec^{-1}	0.2[a]
Apparent Opening Size	ASTM D 4751	mm	0.60 max avg roll value
Ultraviolet Stability (retained strength)	ASTM D 4355	%	70% after 500 h exposure
a. Default value. Permittivity of the geotextile should be greater than that of the soil ($\Psi_g > \Psi_s$). The engineer may also require the permeability of the geotextile to be greater than that of the soil ($k_g > k_s$).			

729-2.02 SILT FENCE. Meet AASHTO M 288 for Temporary Silt Fence.

729-2.03 PAVING FABRIC. Meet AASHTO M 288 Class 1 for Paving Fabric.

729-2.04 GEOGRID FOR EMBANKMENT AND ROADWAY STABILIZATION ~~AND REINFORCEMENT~~. Provide biaxial geogrid consisting of a regular network of connected polymer tensile elements with aperture geometry sufficient to provide significant mechanical interlock with the surrounding material. Provide dimensionally stable geogrid that is able to retain its geometry during construction. Provide geogrid structure that resists ultraviolet degradation and all forms of chemical and biological degradation encountered in the material in which it is buried. Package, label, handle, and store geogrid materials according to ASTM D 4873.

Comment [LP12]: Consider modifying to include new "Interlayer Chart"

Comment [LP13]: Class 2 & 3 may be too light for the Alaska market due to freeze thaw cycles

Comment [LP14]: Section 729-2.04 Geogrid ~~Embankment~~ Stabilization ~~and Reinforcement~~ Recommend changing title to : Geogrid Stabilization (Match pay item in 634-5.01)

Comment [LP15]: The language in the existing AKDOT specification Section 729-2.05 is preferred to this new language. The existing language is non-propriety and is in line with the current standard of practice.

1. Stabilization. Provide geogrid that meets the survivability requirements in Table 729-2 and meets the physical requirements in Table 729-3.

~~TABLE 729-2~~
~~GEOGRID SURVIVABILITY REQUIREMENTS~~

Property	Test Method	Units	Requirement	
			CLASS 1	CLASS 2
Ultimate Multi-Rib Tensile Strength[a]	ASTM D 6637	lb./ft.	1230	820
Junction Strength[a]	ASTM D 7737	lb.	25	25
Ultraviolet Stability (Retained Strength)	ASTM D 4355	%	50% after 500 hours of exposure	

[a] Minimum Average Roll Value (MARV) in machine and cross machinery ~~any rib~~ direction.

TABLE 729-3
BIAXIAL GEOGRID ~~PHYSICAL~~ REQUIREMENTS

Property	Test Method	Units	Requirement
2% Tensile Strength	ASTM D 6637	lb./ft.	≥ 400
5% Tensile Strength	ASTM D 6637	lb./ft.	≥ 800
Percent Open Area	COE, CW-02215	%	50 – 80
Aperture Size[a]	Direct measure	in.	0.5 – 3.0

[a] measured as the spacing between parallel ribs.

Specification Continued: If the geometry of the geogrid ribs or apertures do not allow for testing of the above specification parameters in the machine and cross-machine direction (e.g., no ribs in one or both directions), alternate performance based testing requirements are as follows:

1. Independent full-scale testing is submitted demonstrating less subgrade and/or aggregate rutting relative to another product meeting all specifications shown in Table 729-1 under similar soft soil conditions. This allows acceptance onto the conditionally approved list.
2. After two field trials of stabilizing soft subgrade materials on AKDOT projects, the product is eligible to be added to the Qualified Products List (QPL). The two field trials must successfully stabilize the subgrade according to AKDOT specifications. AKDOT reserves the right to require more field testing if, in AKDOT's opinion, the AKDOT field trials provide questionable assurance of satisfactory performance.

Comment [LP16]: The current existing AKDOT Table 729-1 in Section 729-2.05 "Geogrid" is preferred over the new language and the new tables referenced here. These new tables try to cover too many applications in one table as well as accommodate every geogrid ever manufactured. The result is that the tables are confusing, inadvertently exclude several non-biaxial geogrid products (due to unrealistic tensile property requirements), and introduce AKDOT to a host of biaxial geogrid products that are very unlike their current specification. Is this what AKDOT really wants? This new direction comes with a lot of added risk.

At a practical level, there is no real difference between a Class 1 and Class 2 in these tables - both will result in a Class 1 biaxial geogrid product being delivered to the site. Suggest removing Class 2.

Given how established extruded biaxial geogrid is in Alaska, we recommend sticking with the current Section 729-2.05, with a couple minor tweaks. Remove installation damage and replace it with ultraviolet stability of 70%. Add Ultimate Tensile at 1300 lb/ft and add percent open area of 50-80%. This will result in a completely generic and reasonably effective biaxial geogrid specification that every supplier can meet. To address current and future product innovations that are not biaxial, add performance-based approval language after the table. A qualified product list may be helpful to clarify what products are approved at AKDOT (possible text is included below the tables – borrowed from Oregon DOT).

If AKDOT is set on using the new tables, then we recommend: combining the two tables into one, make it specific to stabilization using biaxial geogrid, remove Class 2, and increase Class 1 ultimate to 1300 lb/ft. Add note below tables to allow alternate products that cannot be measured in the traditional MD and CMD – this allows for fair inclusion of triaxial geogrid and other future products.

Comment [LP17]: Tensile and junction values in both tables should be MARVs

Appendix B – Utah Department of Transportation MSE Walls Special Provisions

September 4, 2014

SPECIAL PROVISION

PROJECT #
PIN #

SECTION 02831S
RETAINING WALL- ALTERNATE SYSTEMS

Add Section 02831:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Select from the following wall systems for retaining walls indicated as Contractor-selected alternative systems. Refer to the project plans for situation and layout drawings.

1. MSE Wall- Reinforced Earth Company Retaining Wall (refer to Section 02833S or 02837S)
2. MSE Wall- SSL MSE *Plus* Retaining Wall (refer to Section 02833S or 02837S)
3. MSE Wall- Tricon Retained Soil Wall (refer to Section 02833S or 02837S)
4. MSE Wall- VISTAWALL Stabilized Earth Wall (refer to Section 02833S or 02837S)
5. MSE Wall- HRW Eureka MSE Wall (refer to Section 02837S)
6. MSE Wall- ARES Geogrid Retaining Wall (refer to Section 02834S or 02838S)
7. MSE Wall- KeySystem I Retaining Wall (refer to Section 02835S)
8. MSE Wall - KeySystem II Retaining Wall (refer to Section 02836S)

9. MSE Wall- Genesis Geogrid Retaining Wall (refer to Section 02836S)

10. MSE Wall – MESA Retaining Wall (refer to Section 02836S)

11. MSE Wall – Versa-Lok/Miragrid Soil Wall (refer to Section 02836S)

12. MSE Wall – Anchor Landmark Reinforced Soil Wall (refer to Section 02836S)

13. MSE Wall – Alan Block AB Three and AB Clasics Segmental Retaining Walls (refer to Section 02836S)

14. MSE Wall- TerraMesh Retaining Wall (refer to Section 02840S)

15. MSE Wall- HRW Welded Wire Wall (refer to Section 02840S)

16. PMGW – Mountain West Precast Redi-Rock Wall (refer to Section 02839S)

17. PMGW – Harper Precast ReCon Wall (refer to Section 02839S)

18. PMGW – Nephi Sandstone Precast Redi-Rock Wall (refer to Section 02839S)

1.2 RELATED SECTIONS

A. Section 02832S: Select Backfill for MSE Walls

B. Section 02833S: MSE Walls Using Concrete Facing Panels and Metal Reinforcing Elements

C. Section 02834S: MSE Walls Using Concrete Facing Panels and Geogrid Reinforcing Elements

D. Section 02835S: MSE Walls Using Modular Block Units and Metal Reinforcing Elements

E. Section 02836S: MSE Walls Using Modular Blocks and Geogrid Reinforcing Elements

F. Section 02837S: Two-Stage MSE Walls Using Concrete Facing Panels and Metal Reinforcing Elements

G. Section 02838S: Two-Stage MSE Walls Using Concrete Facing Panels and Geogrid Reinforcing Elements

H. Section 02839S: Prefabricated Modular Gravity Wall (PMGW) Systems Using Large Modular Block Units

I. Section 02840S: Two-Stage MSE Walls Using Wire Face and Metal Reinforcing Elements

1.3 REFERENCES

A. AASHTO LRFD Bridge Design Specifications

B. AASHTO Interim Specifications for Highway Bridges

C. FHWA Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I, Federal Highway Administration Report No. FHWA-NHI-10-024

1.4 WALL SYSTEM SELECTION

A. Notify the Engineer in writing before the preconstruction conference which option listed in Article 1.1 will be used.

B. Use only one wall system for the Contractor-selected alternative.

C. Do not change the wall type after the preconstruction conference without written approval from the Engineer.

1.5 DESIGN REQUIREMENTS

A. Incorporate current FHWA guidelines, AASHTO LRFD Specifications, and Interim Specifications for Highway Bridges in design of the selected wall system in addition to, or as modified by, the following:

1. For all walls, or sections of walls, located within 50 feet of bridge abutments, use a design earthquake peak horizontal ground acceleration coefficient of 0. g, corresponding to a 3% probability of exceedance in 75 years. For all other walls, or sections of walls more than 50 feet away from bridge abutments, use an acceleration coefficient of 0. g, corresponding to a 7% probability of exceedance in 75 years.
2. Design retaining wall panel/modular block connections in all cases to not fail during the seismic event corresponding to 3% probability of exceedance in 75 years.
3. The Contractor-selected Wall Company is responsible for all stability calculations, except global stability and bearing capacity.
4. Minimum service life of 75 years.
5. The Wall Company is responsible to ensure that drainage features do not negatively impact the wall system, and that the drainage system can function properly through/beneath the wall as the Project Designer intends, without negatively impacting the wall system. This includes checking the drainage system details, and/or developing appropriate MSE reinforcement design details in the vicinity of the drainage features (pipes, catch basins, etc.) within the reinforcement mass, and for the outlet point at the wall face (see article 1.6.A.2).
6. Sections 02832S through 02840S as applicable for the selected wall system.
7. Provide corrosion protection for metallic reinforcement by providing sacrificial steel sufficient for a corrosion rate of at least 0.80 mils per exposed surface per year after 16 years of corrosion protection service allowed for the galvanized coating.
8. Use a vertical spacing of primary reinforcement not exceeding 30 inches for single-stage walls, or 24 inches for two-stage walls to provide a coherent MSE reinforced soil mass. This may require modification of panels.
9. In accordance with Section 11 of the AASHTO LRFD Bridge Design Specifications, provide horizontal benches at least 4 feet in width at the base of walls to be founded on earth slopes.
    a. Benches may be eliminated for walls located adjacent to concrete slope-protected slopes.

10. Use the following soil design properties:

SOIL PROPERTIES	WALL BACKFILL	RETAINED SOIL	FOUNDATION SOIL
Moist Density (pcf)	*		
Friction Angle (deg)	*		
Cohesion (psf)	*		
Factored Bearing Resistance (psf)	N/A	N/A	

*The specific wall backfill characteristics are an integral part of the MSE wall design and shall be determined for the material by the selected Wall Company (with wall backfill meeting the requirements of Section 02832S)

1.6 SUBMITTALS

A. Submit working drawings and design calculations to the Engineer, prepared and signed by a licensed professional engineer, for the wall construction including all plans, profiles, cross sections, quantities, and details that address the following:

1. Cast-in-place concrete coping/cap to the facing panels/blocks to be aesthetically pleasing and to adequately support any fence and/or barrier. Do not use precast coping without prior written approval from the Engineer.

2. Provisions for facilities which penetrate the wall face or soil reinforcing elements (including, but not limited to, drainage catch basins, piping, foundation elements, guard-rail posts, and other buried facilities).

3. MSE wall design accommodates surface and subsurface drainage details.

4. Proposed architectural treatment detail for wall facing elements and proposed color of concrete. Provide architectural treatment for all walls consistent throughout the project and matching all other structural elements incorporated in the project.

5. Design calculations sufficient to determine the walls have been designed in accordance with the required criteria.

B. Allow up to three weeks for the Engineer's review. Within this time, the Engineer will provide either written acceptance of the submittals with any exceptions noted or notification the submittals are insufficient.

1. Upon receiving notification the submittals are insufficient, provide new submittals and allow another two-week period for the Engineer's review.
2. Do not start wall construction until receiving full written acceptance by the Engineer.

1.7 ACCEPTANCE

A. Non-Conformance of Select Backfill for MSE Walls

1. Select Backfill placed and found to be out of conformance with the chemical characteristic requirements of Section 02832S, may be allowed to remain in place at a reduced price in accordance with this paragraph as decided by the Engineer. Refer to Section 02832S for sampling and testing requirements.

2. The Engineer will use the Contractor's bid price and the applicable pay factor in Table 1 to calculate the price adjustment.

3. When deviations exceed those listed for a pay factor of 0.50 in Table 1, have the Wall Company evaluate the backfill to determine whether the wall system meets the required design life.
   a. If the Wall Company determines the wall system meets the required design life, the wall may be accepted with a pay factor less than 0.50 as decided by the Engineer.

B. Non-Conformance for Out-of-Tolerance Wall Facing Elements
1. Provided structural adequacy can be demonstrated, facing elements either placed or that become out-of-tolerance from those specified in the applicable wall system section (02833S through 02840S) before final acceptance may be allowed to remain in place at a reduced price in accordance with this paragraph as decided by the Engineer.
2. The Engineer will use the Contractor's bid price and the applicable pay factor in Table 2 to calculate the price adjustment.
3. The Wall Company and the Engineer will evaluate all wall facing element cases when deviations exceed those listed for a pay factor of 0.50 in Table 2 to determine whether the wall system has sufficient structural integrity and is aesthetically acceptable.
   a. If the Wall Company determines the wall system has sufficient structural integrity, the wall may be accepted at a pay factor less than 0.50 as decided by the Engineer.

C. Price adjustment calculation. The applicable pay factors in Tables 1 and 2 will be applied to the entire wall. However, only the most critical of any one of the backfill criteria or the facing elements tolerances (i.e. the one having the lowest pay factor), will be applied.

PART 2 PRODUCTS

2.1 MATERIALS

A. As specified in Sections 02832S through 02836S for the selected wall system.

PART 3 EXECUTION

3.1 INSTALLATION

A. As specified in Sections 02832S through 02836S for the selected wall system.

3.2 PRICE REDUCTION FOR NON-COMFORMING WORK

TABLE 1

PAY FACTORS FOR NON-CONFORMING MSE WALL SELECT BACKFILL						
Deviations of Backfill Chemical Test Results from the Limits Specified in Section 02832S*						
	Pay Factor	1 Test	Avg. of 2 Tests	Avg. of 3 Tests	Avg. of 4 Tests	Avg. of 5 or More Tests
Resistivity (ohm-cm) AASHTO T 288	1.00	0 to 200	0 to 190	0 to 180	0 to 170	0 to 150
	0.95	201 to 400	191 to 380	181 to 360	171 to 340	151 to 300
	0.90	401 to 600	381 to 570	361 to 540	341 to 510	301 to 450
	0.80	601 to 800	571 to 760	541 to 720	511 to 680	451 to 600
	0.70	801 to 1000	761 to 950	721 to 900	681 to 850	601 to 750
	0.60	1001 to 1200	951 to 1140	901 to 1080	851 to 1020	751 to 900
	0.50a	over 1200	over 1140	over 1080	over 1020	over 900
a - But no one test below 1600 ohm-cm will be accepted.						
pH AASHTO T 289	1.00	0 to 0.20	0 to 0.18	0 to 0.16	0 to 0.14	0 to 0.12
	0.90	0.21 to 0.40	0.19 to 0.36	0.17 to 0.32	0.15 to 0.28	0.13 to 0.24
	0.80	0.41 to 0.60	0.37 to 0.54	0.33 to 0.48	0.29 to 0.42	0.25 to 0.36
	0.70	0.61 to 0.80	0.55 to 0.72	0.49 to 0.64	0.43 to 0.56	0.37 to 0.48
	0.60	0.81 to 1.00	0.73 to 0.90	0.65 to 0.80	0.57 to 0.70	0.49 to 0.60
	0.50b	---	over 0.90	over 0.80	over 0.70	over 0.60
b - But no one test below 5.0 or above 10.0 will be accepted						
Chlorides (ppm) AASHTO T 291	1.00	0 to 14	0 to 12	0 to 10	0 to 8	0 to 6
	0.95	15 to 28	13 to 24	11 to 20	9 to 16	7 to 12
	0.90	29 to 42	25 to 36	21 to 30	17 to 24	13 to 18
	0.80	43 to 56	37 to 48	31 to 40	25 to 32	19 to 24
	0.70	57 to 70	49 to 60	41 to 50	33 to 40	25 to 30
	0.60	71 to 84	61 to 72	51 to 60	41 to 48	31 to 36
	0.50c	over 84	over 72	over 60	over 48	over 36
c - But no one test above 200 ppm will be accepted.						
Sulfates (ppm) AASHTO T 290	1.00	0 to 50	0 to 45	0 to 40	0 to 35	0 to 30
	0.95	51 to 90	46 to 80	41 to 70	36 to 60	31 to 50
	0.90	91 to 130	81 to 115	71 to 100	61 to 85	51 to 70
	0.80	131 to 170	116 to 150	101 to 130	86 to 110	71 to 90
	0.70	171 to 210	151 to 185	131 to 160	111 to 135	91 to 110
	0.60	211 to 250	186 to 220	161 to 190	136 to 160	111 to 130
	0.50d	over 250	over 220	over 190	over 160	over 130
d - But no one test above 500 ppm will be accepted.						

* Refer to Section 02832S for minimum sampling and testing frequency. The Engineer determines locations and any additional tests required to evaluate the overall backfill mass.

TABLE 2

PAY FACTORS
FOR OUT-OF-TOLERANCE MSE WALL FACING ELEMENTS

Mean of the Deviations of Wall Placement Tolerances from the Limits Specified in Section 02833S to 02840S (based on the percentage of wall face having the maximum out-of-tolerance measurements)

	Pay Factor	1 to 5%	6 to 10%	11 to 20%	21 to 30%	30% or more
Horizontal Alignment (percent) Spec: 0.7%	1.00	0 to 0.40	0 to 0.35	0 to 0.30	0 to 0.25	0 to 0.20
	0.90	0.41 to 0.80	0.36 to 0.70	0.31 to 0.60	0.26 to 0.50	0.21 to 0.40
	0.80	0.81 to 1.20	0.71 to 1.05	0.61 to 0.90	0.51 to 0.75	0.41 to 0.60
	0.70	1.21 to 1.60	1.06 to 1.40	0.91 to 1.20	0.76 to 1.00	0.61 to 0.80
	0.60	1.61 to 2.00	1.41 to 1.75	1.21 to 1.50	1.01 to 1.25	0.81 to 1.00
	0.50	2.01 or more	1.76 or more	1.51 or more	1.26 or more	1.01 or more
Vertical Alignment* (percent) Spec: 0.7%	1.00	0 to 0.40	0 to 0.35	0 to 0.30	0 to 0.25	0 to 0.20
	0.90	0.41 to 0.80	0.36 to 0.70	0.31 to 0.60	0.26 to 0.50	0.21 to 0.40
	0.80	0.81 to 1.20	0.71 to 1.05	0.61 to 0.90	0.51 to 0.75	0.41 to 0.60
	0.70	1.21 to 1.60	1.06 to 1.40	0.91 to 1.20	0.76 to 1.00	0.61 to 0.80
	0.60	1.61 to 2.00	1.41 to 1.75	1.21 to 1.50	1.01 to 1.25	0.81 to 1.00
	0.50	2.01 or more	1.76 or more	1.51 or more	1.26 or more	1.01 or more
Plumbness * (percent) Spec: 0.5%	1.00	0 to 0.50	0 to 0.41	0 to 0.32	0 to 0.23	0 to 0.18
	0.95	0.51 to 0.64	0.42 to 0.54	0.33 to 0.43	0.24 to 0.33	0.19 to 0.26
	0.90	0.65 to 0.78	0.55 to 0.66	0.44 to 0.54	0.34 to 0.43	0.27 to 0.35
	0.85	0.79 to 0.92	0.67 to 0.79	0.55 to 0.66	0.44 to 0.52	0.36 to 0.43
	0.80	0.93 to 1.06	0.80 to 0.91	0.67 to 0.77	0.53 to 0.62	0.44 to 0.52
	0.70	1.07 to 1.20	0.92 to 1.04	0.78 to 0.88	0.63 to 0.72	0.53 to 0.60
	0.60	1.21 to 1.34	1.05 to 1.17	0.89 to 0.99	0.73 to 0.82	0.61 to 0.68
	0.50	1.35 or more	1.18 or more	1.00 or more	0.83 or more	0.69 or more
Levelness (percent) Spec: 0.5%	1.00	0 to 0.30	0 to 0.28	0 to 0.26	0 to 0.24	0 to 0.22
	0.90	0.31 to 0.60	0.29 to 0.56	0.27 to 0.52	0.25 to 0.48	0.23 to 0.44
	0.80	0.61 to 0.90	0.57 to 0.84	0.53 to 0.78	0.49 to 0.72	0.45 to 0.66
	0.70	0.91 to 1.20	0.85 to 1.12	0.79 to 1.04	0.73 to 0.96	0.67 to 0.88
	0.60	1.21 to 1.50	1.13 to 1.40	1.05 to 1.30	0.97 to 1.20	0.89 to 1.10
	0.50	1.51 or more	1.41 or more	1.31 or more	1.21 or more	1.11 or more
Joint Width (inches) Specs: Panel: 0.5 – 1.2 Block: 0.12– 0.5	1.00	0 to 0.10	0 to 0.09	0 to 0.08	0 to 0.07	0 to 0.06
	0.90	0.11 to 0.20	0.10 to 0.18	0.09 to 0.16	0.08 to 0.14	0.07 to 0.12
	0.80	0.21 to 0.30	0.19 to 0.27	0.17 to 0.24	0.15 to 0.21	0.13 to 0.18
	0.70	0.31 to 0.40	0.28 to 0.36	0.25 to 0.32	0.22 to 0.28	0.19 to 0.24
	0.60	0.41 to 0.50	0.37 to 0.45	0.33 to 0.40	0.29 to 0.35	0.25 to 0.30
	0.50	0.51 or more	0.46 or more	0.41 or more	0.36 or more	0.31 or more
Joint Offset (inches) Specs: Panel: 0.4	1.00	0 to 0.20	0 to 0.19	0 to 0.18	0 to 0.17	0 to 0.16
	0.90	0.21 to 0.40	0.20 to 0.38	0.19 to 0.36	0.18 to 0.34	0.17 to 0.32
	0.80	0.41 to 0.60	0.39 to 0.57	0.37 to 0.54	0.35 to 0.51	0.33 to 0.48
	0.70	0.61 to 0.80	0.58 to 0.76	0.55 to 0.72	0.52 to 0.68	0.49 to 0.64
	0.60	0.81 to 1.00	0.77 to 0.95	0.73 to 0.90	0.69 to 0.85	0.65 to 0.80

Block: 0.25	0.50	1.01 or more	0.96 or more	0.91 or more	0.86 or more	0.81 or more

* For modular block walls these tolerances are measured from the specified wall batter as indicated in 02835 S and 02836 S.

END OF SECTION

September 2, 2014

SPECIAL PROVISION

PROJECT #
PIN #

SECTION 02832S

SELECT BACKFILL FOR MSE WALLS

Add Section 02832:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Placement procedures and requirements for backfill used in constructing MSE walls.

1.2 RELATED SECTIONS

A. Section 02056: Embankment, Borrow, and Backfill

B. Section 02831S: Retaining Wall-Alternate Systems

1.3 REFERENCES

A. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates

B. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils

C. AASHTO T 99: Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12 in.) Drop

D. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

E. AASHTO T 236: Direct Shear Test of Soils Under Consolidated Drained Conditions

F. AASHTO T 267: Determination of Organic Content in Soils by Loss on Ignition

G. AASHTO T 288: Determining Minimum Laboratory Soil Resistivity

H. AASHTO T 289: Determining pH of Soil for Use in Corrosion Testing

I. AASHTO T 290: Determining Water-Soluble Sulfate Ion Content in Soil

J. AASHTO T 291: Determining Water-Soluble Chloride Ion Content in Soil

K. AASHTO T 310: In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

L. FHWA Publication No. FHWA-NHI-00-044

1.4 SUBMITTALS

A. Provide the Engineer with a certificate of compliance, from an AASHTO accredited and UDOT qualified testing lab, certifying the material complies with this section.
   1. Provide the Engineer with copies of the results of all tests performed to determine the Select Backfill source meets the requirements of this section.

B. Provide the Engineer with copies of test results from a UDOT qualified lab for the tests described under article 1.5, Acceptance.

1.5 ACCEPTANCE

A. In addition to the initial testing to verify the Select Backfill source meets the requirements of this section, at a minimum, obtain on-site samples during construction and perform testing at the following frequencies.
   1. Gradation: Every 5,000 cubic yards of backfill used
   2. Electrochemical: Every 10,000 cubic yards of backfill used

B. Include all costs for sampling and testing in the bid price for the work.
   1. The Department will make no separate payment for the cost of sampling and testing required in accordance with this section, except as follows:
   2. The Engineer reserves the right to require additional testing, such as when suspecting a change in the Select Backfill.
      a. When additional testing performed at the direction of the Engineer indicates there is no change in the material and the material is in compliance with the requirements of this section, the Department will pay for the cost of additional sampling and testing as extra work.

C. Density

1. The Department will perform at least one in-place moisture/density determination per lift of backfill for each 100 feet of wall length (minimum two tests per lift) in accordance with AASHTO T 310.
   a. Tests will be made at random locations and/or at specific locations determined by the Engineer.
2. Do not proceed with the placement of each layer of soil reinforcement and overlying lift of backfill until the Engineer indicates and records that all backfill placement and density requirements (including in the 3-foot light-compaction zone) have been met.

PART 2 PRODUCTS

2.1 SELECT BACKFILL

A. Use backfill free from frozen, organic, and otherwise deleterious materials. Conform to the following gradation limits as determined by AASHTO T 27:

TABLE 1

Select Backfill Gradation (percent passing)		
Sieve Size	**Metallic Reinforcement**	**Geogrid Reinforcement**
4 inch	100	–
¾ inch	–	100
No. 40	0 – 60	0 – 60
No. 200	0 –15	0 –15

B. Geogrid reinforcement may use the Select Backfill gradation specified in Table 1 for metallic reinforcement only under the following conditions:
   1. Make arrangements with the wall company to perform site and material specific installation damage testing with a representative sample of the proposed backfill.
      a. Perform testing in accordance with the guidelines provided in sections 4.5 and 5.1 of FHWA Publication No. FHWA-NHI-00-044. The installation damage reduction factor shall be as determined in the test, but no less than 1.2.
      b. Assume all costs for performing the tests and certification of the test results by a registered engineer qualified in this subject/field.

c. Assume any additional costs for the purchase of materials and/or construction of the wall based on the installation damage reduction factor obtained from the testing.

2. Provide additional material specific installation damage testing at the direction of the Engineer when a change in the backfill characteristics from the original tested representative sample is suspected.
   a. Assume all costs for performing this additional testing and certification of the test results by a registered engineer.
   b. Assume any additional costs for the purchase of materials and/or construction of the wall based on the installation damage reduction factor obtained from additional testing.

C. Use backfill with a Plasticity Index (PI) of 6 or less, as determined by AASHTO T 90.

D. Use backfill with an internal friction angle of not less than 34 degrees as determined by AASHTO T 236, using a sample of the material compacted to 95 percent of maximum density at optimum moisture content, determined by AASHTO T 99, Method D.
   1. Internal friction angle testing is not required for backfill material that has at least 80 percent of the material retained on the 3/4 inch sieve.

E. Use backfill that:
   1. Is substantially free of shale or other soft particles of poor durability.
   2. Has a sodium sulfate soundness loss of less than 15 percent after 5 cycles, determined in accordance with AASHTO T 104.
   3. Has an organic content less than one-half of one percent as determined by AASHTO T 267 on the portion of the material finer than the No. 10 sieve.

F. Meet electrochemical properties specified in Table 2

2.2 FREE DRAINING GRANULAR BACKFILL

A. Place Free Draining Granular Backfill along the wall face in accordance with this Section. Refer to Section 02056 for Free Draining Granular Backfill gradation requirements.

B. Meet electrochemical properties specified in Table 2.

TABLE 2

Electrochemical Requirements			
Property	**Metallic Reinforcement**	**Geogrid Reinforcement**	**Test Method**
Resistivity	Minimum 3000 ohm-cm, at 100% saturation	N/A	AASHTO T 288
pH	6.0 – 10.0	5.5 – 10.0*	AASHTO T 289
Chlorides	Maximum 100 ppm	N/A	AASHTO T 291
Sulfates	Maximum 200 ppm	N/A	AASHTO T 290

*Maximum value for polyester geogrid is 9.0; and for values between 8.0 and 9.0, or when saturated conditions are anticipated, use an RF_D value of 1.3.

PART 3 EXECUTION

3.1 INSTALLATION

A. Excavation and Foundation Preparation:
   1. Excavate and grade foundation area to the lines and grades shown on the drawings, or as directed by the Engineer.
   2. Make the width of excavation equal to or exceeding the length of soil reinforcing elements.
   3. Compact the foundation using at least three passes of a lightweight, steel, smooth-drum vibratory roller, or as otherwise determined by the Engineer before the wall construction.
   4. Remove unsuitable foundation soils and replace with Select Backfill, or with other suitable material determined by the Engineer, placed and compacted as specified in this article.

B. MSE Wall:

1. Follow erection of each course of panel/modular block with placement of Select Backfill.
   a. Complete backfill at the front of the wall before backfilling more than 4 feet above the bottom of the lowermost facing element.
2. Do not damage or disturb wall materials or misalign facing panels/modular blocks during backfill placement.
3. Remove and replace or correct, as directed by the Engineer, wall materials damaged or disturbed during backfill placement at no cost to the Department.
4. Remove and replace or correct, as directed by the Engineer, Select Backfill not meeting the specified requirements at no cost to the Department.
5. Make the moisture content of the Select Backfill during placement and compaction uniform throughout each layer.
6. Determine the optimum moisture content in accordance with AASHTO T 99, Method D.
7. Place Select Backfill with the moisture not greater than the optimum moisture content, nor less than four percentage points below optimum.
8. Remove any Select Backfill with placement moisture content in excess of the optimum moisture content.
   a. Select Backfill may be reused, provided it is aerated or otherwise reworked until the moisture content is uniform and acceptable throughout the entire lift.
9. Do not exceed 12 inches (loose) in lift thickness.
   a. Decrease the lift thickness as necessary to obtain the specified density.
   b. Place backfill in uniformly thick layers.
10. Compact backfill to at least 95 percent of the maximum density, AASHTO T 99, Method D.
11. When placing backfill over the soil reinforcement, begin placement 3 to 5 feet from the wall face and proceed away from the wall to prevent the reinforcement from bunching towards the wall face.
12. Operate all placement and compaction equipment parallel to the wall face.
13. Place and compact each layer of backfill in a level manner before placing subsequent backfill layers.
14. Rubber-tired equipment may pass over the reinforcement only at slow speeds (less than 5 mph). Avoid sudden braking and sharp turning.
15. Do not use sheeps-foot or other grid-type rollers for compacting backfill within the limits of the soil reinforcement.

16. During the initial stage of wall construction, to avoid pushing the facing elements out of alignment, do not place or compact backfill against the facing elements until the first layer of soil reinforcement has been installed and one lift of Select Backfill has been placed and compacted over the reinforcement layer.
17. For all subsequent layers of backfill, before placement of the reinforcement, place and compact the backfill to an elevation 2 inches above the reinforcement connection from a point approximately 18 inches behind the back face of the wall facings (panels, modular blocks) to the end of the reinforcing, unless otherwise shown on the plans at specific locations.
18. Achieve compaction within 4 to 5 feet of the back face of the wall facing units and within 2 feet of any obstructions ("light equipment zone"), by at least three passes of a suitable lightweight or medium-weight (hand-held or hand-guided) mechanical roller, tamper, or vibratory compactor.
    a. When compacting a thin leveling lift along the reinforcement connections level, use compaction equipment with a static weight of less than 800 pounds within this zone.
    b. Use a maximum lift thickness within this zone as warranted by the type of compaction equipment actually used.
    c. Compact within this lighter equipment zone to within at least 3 inches of the facing elements.
    d. Exercise care in the compaction process to avoid misalignment of the facing elements.
19. Place Free Draining Granular Backfill within a zone behind the wall extending at least 30 inches from the front face of the wall facings (but at least 12 inches in width measured from the bottom of each backfill lift), and at least 24 inches in width behind the first-stage wire/grid facing of 2-stage wall systems and behind the wire/grid facing of internal phased-construction walls.
    a. Place and compact Free Draining Granular Backfill as specified above for the lighter equipment zone.
20. Use backfill placement and compaction methods to assure that no voids are present beneath the soil reinforcement elements before backfilling over the reinforcement.
21. Place soil reinforcing elements normal to face of wall in plan view.
    a. If necessary, skew elements (minimizing skew angle) to avoid obstructions, but no more than 15 degrees unless approved by the wall company.
22. At the end of each day's operation, slope the backfill away from the wall to direct runoff of rainwater away from the wall face.
    a. Do not allow surface runoff from adjacent areas or groundwater to enter the wall construction site, including at the front face of the wall.

23. Place the top level of soil reinforcement parallel to the top of the facing unit a distance below the top of the wall as shown on the plans.
    a. Place the top level of soil reinforcement at least 3 inches below the bottom of the barrier slab lip or the bottom of the concrete gutter behind the coping.
24. Gradually deflect the upper reinforcement elements downward to avoid conflicts with paving and subgrade preparation.
    a. Pay particular attention to special conditions such as where roadway super-elevation is anticipated.
    b. Maximum deflection of the reinforcement elements is 8 inches or as otherwise noted on the plans.
25. Slope the top of the backfill along the wall such that the top reinforcement layer is covered with at least 16 inches of Select Backfill.

END OF SECTION

September 2, 2014

SPECIAL PROVISION

PROJECT #
PIN #

SECTION 02832S

SELECT BACKFILL FOR MSE WALLS

Add Section 02832:

PART 1 GENERAL

1.3 SECTION INCLUDES

B. Placement procedures and requirements for backfill used in constructing MSE walls.

1.4 RELATED SECTIONS

C. Section 02056: Embankment, Borrow, and Backfill

D. Section 02831S: Retaining Wall-Alternate Systems

1.3 REFERENCES

M. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates

N. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils

O. AASHTO T 99: Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12 in.) Drop

P. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

Q. AASHTO T 236: Direct Shear Test of Soils Under Consolidated Drained Conditions

R. AASHTO T 267: Determination of Organic Content in Soils by Loss on Ignition

S. AASHTO T 288: Determining Minimum Laboratory Soil Resistivity

T. AASHTO T 289: Determining pH of Soil for Use in Corrosion Testing

U. AASHTO T 290: Determining Water-Soluble Sulfate Ion Content in Soil

V. AASHTO T 291: Determining Water-Soluble Chloride Ion Content in Soil

W. AASHTO T 310: In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

X. FHWA Publication No. FHWA-NHI-00-044

1.4 SUBMITTALS

B. Provide the Engineer with a certificate of compliance, from an AASHTO accredited and UDOT qualified testing lab, certifying the material complies with this section.
   1. Provide the Engineer with copies of the results of all tests performed to determine the Select Backfill source meets the requirements of this section.

B. Provide the Engineer with copies of test results from a UDOT qualified lab for the tests described under article 1.5, Acceptance.

1.5 ACCEPTANCE

A. In addition to the initial testing to verify the Select Backfill source meets the requirements of this section, at a minimum, obtain on-site samples during construction and perform testing at the following frequencies.
   1. Gradation: Every 5,000 cubic yards of backfill used
   2. Electrochemical: Every 10,000 cubic yards of backfill used

B. Include all costs for sampling and testing in the bid price for the work.
   1. The Department will make no separate payment for the cost of sampling and testing required in accordance with this section, except as follows:
   2. The Engineer reserves the right to require additional testing, such as when suspecting a change in the Select Backfill.
      a. When additional testing performed at the direction of the Engineer indicates there is no change in the material and the material is in compliance with the requirements of this section, the Department will pay for the cost of additional sampling and testing as extra work.

C. Density

26. The Department will perform at least one in-place moisture/density determination per lift of backfill for each 100 feet of wall length (minimum two tests per lift) in accordance with AASHTO T 310.
    a. Tests will be made at random locations and/or at specific locations determined by the Engineer.
2. Do not proceed with the placement of each layer of soil reinforcement and overlying lift of backfill until the Engineer indicates and records that all backfill placement and density requirements (including in the 3-foot light-compaction zone) have been met.

PART 2 PRODUCTS

2.2 SELECT BACKFILL

C. Use backfill free from frozen, organic, and otherwise deleterious materials. Conform to the following gradation limits as determined by AASHTO T 27:

TABLE 1

Select Backfill Gradation (percent passing)		
Sieve Size	**Metallic Reinforcement**	**Geogrid Reinforcement**
4 inch	100	–
¾ inch	–	100
No. 40	0 – 60	0 – 60
No. 200	0 –15	0 –15

B. Geogrid reinforcement may use the Select Backfill gradation specified in Table 1 for metallic reinforcement only under the following conditions:
1. Make arrangements with the wall company to perform site and material specific installation damage testing with a representative sample of the proposed backfill.
    a. Perform testing in accordance with the guidelines provided in sections 4.5 and 5.1 of FHWA Publication No. FHWA-NHI-00-044. The installation damage reduction factor shall be as determined in the test, but no less than 1.2.
    b. Assume all costs for performing the tests and certification of the test results by a registered engineer qualified in this subject/field.

c. Assume any additional costs for the purchase of materials and/or construction of the wall based on the installation damage reduction factor obtained from the testing.

2. Provide additional material specific installation damage testing at the direction of the Engineer when a change in the backfill characteristics from the original tested representative sample is suspected.
   a. Assume all costs for performing this additional testing and certification of the test results by a registered engineer.
   b. Assume any additional costs for the purchase of materials and/or construction of the wall based on the installation damage reduction factor obtained from additional testing.

C. Use backfill with a Plasticity Index (PI) of 6 or less, as determined by AASHTO T 90.

D. Use backfill with an internal friction angle of not less than 34 degrees as determined by AASHTO T 236, using a sample of the material compacted to 95 percent of maximum density at optimum moisture content, determined by AASHTO T 99, Method D.
   1. Internal friction angle testing is not required for backfill material that has at least 80 percent of the material retained on the 3/4 inch sieve.

E. Use backfill that:
   1. Is substantially free of shale or other soft particles of poor durability.
   2. Has a sodium sulfate soundness loss of less than 15 percent after 5 cycles, determined in accordance with AASHTO T 104.
   3. Has an organic content less than one-half of one percent as determined by AASHTO T 267 on the portion of the material finer than the No. 10 sieve.

F. Meet electrochemical properties specified in Table 2

2.2 FREE DRAINING GRANULAR BACKFILL

A. Place Free Draining Granular Backfill along the wall face in accordance with this Section. Refer to Section 02056 for Free Draining Granular Backfill gradation requirements.

D. Meet electrochemical properties specified in Table 2.

TABLE 2

Electrochemical Requirements			
Property	**Metallic Reinforcement**	**Geogrid Reinforcement**	**Test Method**
Resistivity	Minimum 3000 ohm-cm, at 100% saturation	N/A	AASHTO T 288
pH	6.0 – 10.0	5.5 – 10.0*	AASHTO T 289
Chlorides	Maximum 100 ppm	N/A	AASHTO T 291
Sulfates	Maximum 200 ppm	N/A	AASHTO T 290

*Maximum value for polyester geogrid is 9.0; and for values between 8.0 and 9.0, or when saturated conditions are anticipated, use an RF_D value of 1.3.

PART 3 EXECUTION

3.2 INSTALLATION

A. Excavation and Foundation Preparation:

1. Excavate and grade foundation area to the lines and grades shown on the drawings, or as directed by the Engineer.
27. Make the width of excavation equal to or exceeding the length of soil reinforcing elements.
28. Compact the foundation using at least three passes of a lightweight, steel, smooth-drum vibratory roller, or as otherwise determined by the Engineer before the wall construction.
29. Remove unsuitable foundation soils and replace with Select Backfill, or with other suitable material determined by the Engineer, placed and compacted as specified in this article.

B. MSE Wall:

1. Follow erection of each course of panel/modular block with placement of Select Backfill.
   a. Complete backfill at the front of the wall before backfilling more than 4 feet above the bottom of the lowermost facing element.
2. Do not damage or disturb wall materials or misalign facing panels/modular blocks during backfill placement.
3. Remove and replace or correct, as directed by the Engineer, wall materials damaged or disturbed during backfill placement at no cost to the Department.
4. Remove and replace or correct, as directed by the Engineer, Select Backfill not meeting the specified requirements at no cost to the Department.

30. Make the moisture content of the Select Backfill during placement and compaction uniform throughout each layer.
31. Determine the optimum moisture content in accordance with AASHTO T 99, Method D.
32. Place Select Backfill with the moisture not greater than the optimum moisture content, nor less than four percentage points below optimum.
33. Remove any Select Backfill with placement moisture content in excess of the optimum moisture content.
    a. Select Backfill may be reused, provided it is aerated or otherwise reworked until the moisture content is uniform and acceptable throughout the entire lift.
34. Do not exceed 12 inches (loose) in lift thickness.
    a. Decrease the lift thickness as necessary to obtain the specified density.
    b. Place backfill in uniformly thick layers.
35. Compact backfill to at least 95 percent of the maximum density, AASHTO T 99, Method D.
36. When placing backfill over the soil reinforcement, begin placement 3 to 5 feet from the wall face and proceed away from the wall to prevent the reinforcement from bunching towards the wall face.
37. Operate all placement and compaction equipment parallel to the wall face.
38. Place and compact each layer of backfill in a level manner before placing subsequent backfill layers.
39. Rubber-tired equipment may pass over the reinforcement only at slow speeds (less than 5 mph). Avoid sudden braking and sharp turning.
40. Do not use sheeps-foot or other grid-type rollers for compacting backfill within the limits of the soil reinforcement.

41. During the initial stage of wall construction, to avoid pushing the facing elements out of alignment, do not place or compact backfill against the facing elements until the first layer of soil reinforcement has been installed and one lift of Select Backfill has been placed and compacted over the reinforcement layer.
42. For all subsequent layers of backfill, before placement of the reinforcement, place and compact the backfill to an elevation 2 inches above the reinforcement connection from a point approximately 18 inches behind the back face of the wall facings (panels, modular blocks) to the end of the reinforcing, unless otherwise shown on the plans at specific locations.
43. Achieve compaction within 4 to 5 feet of the back face of the wall facing units and within 2 feet of any obstructions ("light equipment zone"), by at least three passes of a suitable lightweight or medium-weight (hand-held or hand-guided) mechanical roller, tamper, or vibratory compactor.
    a. When compacting a thin leveling lift along the reinforcement connections level, use compaction equipment with a static weight of less than 800 pounds within this zone.
    b. Use a maximum lift thickness within this zone as warranted by the type of compaction equipment actually used.
    c. Compact within this lighter equipment zone to within at least 3 inches of the facing elements.
    d. Exercise care in the compaction process to avoid misalignment of the facing elements.
44. Place Free Draining Granular Backfill within a zone behind the wall extending at least 30 inches from the front face of the wall facings (but at least 12 inches in width measured from the bottom of each backfill lift), and at least 24 inches in width behind the first-stage wire/grid facing of 2-stage wall systems and behind the wire/grid facing of internal phased-construction walls.
    a. Place and compact Free Draining Granular Backfill as specified above for the lighter equipment zone.
45. Use backfill placement and compaction methods to assure that no voids are present beneath the soil reinforcement elements before backfilling over the reinforcement.
46. Place soil reinforcing elements normal to face of wall in plan view.
    a. If necessary, skew elements (minimizing skew angle) to avoid obstructions, but no more than 15 degrees unless approved by the wall company.
47. At the end of each day's operation, slope the backfill away from the wall to direct runoff of rainwater away from the wall face.
    a. Do not allow surface runoff from adjacent areas or groundwater to enter the wall construction site, including at the front face of the wall.

48. Place the top level of soil reinforcement parallel to the top of the facing unit a distance below the top of the wall as shown on the plans.
    a. Place the top level of soil reinforcement at least 3 inches below the bottom of the barrier slab lip or the bottom of the concrete gutter behind the coping.
49. Gradually deflect the upper reinforcement elements downward to avoid conflicts with paving and subgrade preparation.
    a. Pay particular attention to special conditions such as where roadway super-elevation is anticipated.
    b. Maximum deflection of the reinforcement elements is 8 inches or as otherwise noted on the plans.
50. Slope the top of the backfill along the wall such that the top reinforcement layer is covered with at least 16 inches of Select Backfill.

END OF SECTION

September 10, 2014

SPECIAL PROVISION

PROJECT #
PIN #

SECTION 02834S

MSE WALLS USING CONCRETE FACING PANELS AND GEOGRID REINFORCING ELEMENTS

Add Section 02834:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and construction requirements for mechanically stabilized earth (MSE) walls using a wall system (see Section 02831S) approved by the Engineer using concrete facing panels and geogrid reinforcing elements.

B. Provide and install face panels, reinforcing steel, geogrid, fasteners, joint filler, select backfill, and all necessary attachments from the selected Wall Company.

1.2 RELATED SECTIONS

A. Section 02831S: Retaining Wall -Alternate Systems

B. Section 02832S: Select Backfill for MSE Walls

C. Section 03055: Portland Cement Concrete

D. Section 03211: Reinforcing Steel and Welded Wire

E. Section 03310: Structural Concrete

F. Section 03390: Concrete Curing

G. Section 03924: Structural Concrete Repair and Sealing

1.3 REFERENCES

A. AASHTO M 32: Steel Wire, Plain, for Concrete Reinforcement
B. AASHTO M 55: Steel Welded Wire Reinforcement, Plain, for Concrete

C. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

D. AASHTO M 232: Zinc Coating (Hot-Dip) on Iron and Steel Hardware

E. ASTM D 5262: Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

F. ASTM D 6637: Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

G. UDOT Quality Management Plans

1.4 SUBMITTALS

A. Submit sample of the texture of the panel face for the Engineer's approval.

B. Provide submittals in accordance Section 02831S and working drawings including all design details.

C. Do not start work on any wall until working drawings have been reviewed and accepted by the Engineer.
   1. Review and acceptance of the drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

D. Certificate of Compliance for incorporated materials along with copies of results of any tests performed.

E. Wall Company's construction manual for the specific wall system.

F. Certification from the Wall Company that the completed wall(s) meet all Department and Wall Company specifications/requirements for the specific wall system.
   1. Where the Department's and the Wall Company's specifications or requirements differ, apply the stricter of the two.

1.5 ACCEPTANCE

A. Panel Acceptance
   1. Meet 28-day minimum compressive strength of 4000 psi.
   2. Do not transport panels to the site before seven days after fabrication and until:

a. A minimum 28-day compressive strength of 4000 psi has been achieved, or
b. A minimum compressive strength of 3000 psi has been achieved at 14 days.

3. All panels must be visually free of defects and will be rejected if they:
   a. Do not meet the above requirements
   b. Contain defects due to imperfect molding
   c. Have any honeycomb
   d. Have open texture on front face
   e. Have cracks or spalls that exceed the limits specified in article 3.5

PART 2 PRODUCTS

2.1 PRECAST CONCRETE WALL PANELS

A. Obtain approval from the Engineer for the architectural treatment for all MSE panel walls.

B. Concrete. Class AA(AE) per Section 03055 and Section 03310, having a minimum 28-day compressive strength of 4000 psi.

C. Reinforcing steel to have a minimum cover of 2.0 inches.

D. Casting
   1. Use only a UDOT-qualified supplier for precast concrete panel fabrication in accordance with UDOT Precast/Prestressed Concrete Structures Quality Management Plan
      a. Do not cast panels on site.
   2. Cast panels on a flat area or approved architectural treatment, with the front face down.
      a. Set tie strip guides at back face.
   3. Place concrete in each unit without interruption.
      a. Vibrate with approved equipment to prevent stone pockets or cleavage planes.
      b. Use clean, unused form oil.

E. Reinforcement Connections
   1. Cast at least two soil reinforcement connection levels into all full-size panels.
      a. Where only two connection levels are cast in panels, locate the levels in two different horizontal planes separated by at least one-third the panel height.

F. Curing.
   1. Keep surfaces wet and moist until the curing compound is applied.
   2. Complete all patching or surface finishing before applying compound.
   3. Spray the entire surface of the concrete with a membrane curing compound. Apply the compound at a uniform rate of 1.25 oz/ft^2 of area.
   4. Immediately re-spray any membrane damage which occurs during the curing period.
   5. Leave forms in place until they can be removed without damage to the unit.

G. Concrete Finish
   1. Provide a Class 1 finish for front face of panels.
      a. The thickness of the architectural treatment is in addition to required design thickness.
   2. Provide a uniform surface finish for the back face of panels.
      a. Roughly screen the finish to eliminate open pockets of aggregate and surface distortion in excess of 1/4 inch.

H. Tolerances
   1. All dimensions ± 1/8 inch.
   2. Angular distortion with regard to the height of panel not to exceed 3/16 inch in 5 feet.
   3. Surface defects on form surfaces not more than 1/8 inch in 5 feet.

I. Marking
   1. Mark the date of manufacture and panel type designation on the rear side of each panel so that it is legible during installation.

2.2 REINFORCING STEEL

A. Epoxy coated in accordance with Section 03211.

2.3 LEVELING PAD CONCRETE

A. Use Class A or Class B concrete mixes in accordance with Section 03055.

2.4 GEOGRID

A. Use geogrid consisting of a regular grid network of integrally connected, discontinuous, select high-density polyethylene or polypropylene resin polymer tensile elements.

1. Aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil and/or rock.
2. Structure to be dimensionally stable and be able to retain its geometry under manufacture, transport, and installation.

B. Provide junction strength, minimum GRI-GG2 of 90 percent of ultimate strength.

C. Provide creep rupture test for 75-year design life per ASTM D5262.

D. Provide ultimate strength, minimum per ASTM D6637 and utilize geogrid reinforcement reduction factors as appropriate for the Project.

E. Carefully inspect all soil reinforcement and attachment devices to ensure they are true to size and free from defects.

F. Prevent mud, wet concrete, epoxy, and other contaminants from coming in contact with and affixing to the soil reinforcement and inserts, that would interfere with the geogrid connections.

G. Store soil reinforcement products as recommended by the Wall Company.

2.5 REINFORCED WELDED WIRE MESH AND LOOP INBEDS

A. Meet minimum requirements of Section 03211 with galvanized coating at least 3.4 mils thick.

2.6 PANEL FASTENERS

A. Bolts and nuts to be hexagonal cap screw and galvanize coated, meeting minimum requirements of ASTM A-325 and AASHTO M 232.

2.7 OTHER FASTENERS

A. Fasteners to wingwalls and abutment walls, if required, to be provided by the Wall Company.

2.8 CURING COMPOUND

A. Refer to Section 03390.

2.9 GEOTEXTILE

A. Cover horizontal and vertical joints between panels, when required, by a geotextile of the type and grade recommended by the Wall Company.

2.10 ADHESIVE

A. Per Wall Company's standard.

2.11 LIFTING DEVICES

A. Per Wall Company's standard.

2.12 BEARING PADS

A. Horizontal rubber bearing pads to be of the type and grade recommended and supplied by the Wall Company.

2.13 SELECT BACKFILL

A. Refer to Section 02832S.

2.14 MATERIALS FOR CRACK AND SPALL REPAIR

A. Refer to Section 03924.

PART 3 EXECUTION

3.1 GENERAL

A. Arrange for a qualified representative (minimum five years experience with MSE wall design and construction) from the selected Wall Company to be directly involved and provide technical assistance during all phases of construction of the wall(s).
   1. The Wall Company representative is to be at the project site for at least the first five working days of wall construction and until all aspects of wall construction have been satisfactorily demonstrated to the MSE Wall Company representative and the Engineer. The MSE Wall Company representative is to subsequently visit the site at least once every 10,000 sq. ft. of wall face construction, or as otherwise determined by the Engineer.

2. The Wall Company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
    a. If one or more construction crew members change, the Wall Company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

B. Provide the Wall Company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

C. Provide a final field observations report from the Wall Company that specifically addresses that the completed wall(s) meet all Department and Wall Company specifications/requirements and what deficiencies exist, if any.
1. Where the Department's and the Wall Company's specifications/requirements differ, the stricter of the two shall be applied.

D. Haul, store, and ship wall materials so as to minimize the potential of producing any type of defects.
1. Store panels to avoid damage to connection pieces, such that the tie strips do not bend.

E. Perform excavation and foundation preparation (including removal of unsuitable soils) as specified in Section 02832S.

F. Construct wall system in accordance with the approved plans, specifications, and the Wall Company's recommendations and construction manual.

3.2 LEVELING PAD

A. Prepare the subgrade soils and/or fill so as to cast the leveling pad to the design elevations shown on the drawings and to ensure complete contact of the retaining wall units with the base.

B. Furnish and place concrete in accordance with Section 03055.

C. Place cast-in-place concrete leveling pad upon undisturbed in-situ soils, or upon properly placed and compacted fill as per Section 02832S. If shown on the Wall Company's approved drawings, a maximum 3-inch wide gap

may be left between the end of the leveling pad and the adjacent higher panel where the wall steps up. If such is the case, 1) ensure the entire pad is poured on firm compacted fill or undisturbed subgrade soils, 2) provide that the MSE backfill in the zone behind the gap is fully retained, and 3) the gap is properly backfilled before the remaining backfill in front of the wall face is placed. Place leveling pad to a thickness of at least 6 inches.

D. Allow leveling pad to cure for at least 12 hours before placing concrete panels.

3.3 GEOGRID INSTALLATION

A. Verify the correct orientation (roll direction) of the geogrid.

B. Place geogrid horizontally on the compacted backfill at the proper design.

C. Connect geogrid to the concrete wall units as specified by the Wall Company.

D. Pull the geogrid taut to eliminate loose folds and remove slack in the geogrid at the wall unit connections, pretension the geogrid, and stake or otherwise secure the back edge of the geogrid before and during backfill and compaction.

E. Follow the Wall Company's overlap requirements for uniaxial and biaxial geogrids.

F. Where reinforcement is obstructed by elements such as piles, drilled shafts, guardrail posts, catch basins, drop inlets, culverts, etc. in the wall soil reinforcement zone, modify the reinforcement design using one of the following alternatives:
   1. If the reinforcement is modified, design the surrounding reinforcement layers to carry the additional load.
   2. Place a structural frame around the obstruction which is capable of transferring loads from the reinforcements on one side of the obstruction to reinforcements on the other side of the obstruction.
   3. If the soil reinforcement consists of discrete strips or bar mats rather than continuous sheets, splay the reinforcement around the obstruction.

3.4 WALL CONSTRUCTION

A. Place wall backfill and reinforcement as specified in Section 02832S.

B. Handle panels by means of lifting device set into upper edge or side of the panels and set in position vertically.

C. Place panels on successive horizontal lifts in the sequence shown on the approved plans as backfill placement proceeds.

D. Place panels initially at a slight batter towards the backfill as recommended by the Wall Company to compensate for outward rotation of the panel consequent upon fill placement and compaction.

E. Place bearing pads as required by the Wall Company to prevent concrete-to-concrete contact between panels.

F. Use rubber, wood, or metal shims as necessary to make final adjustments to the wall panel to facilitate lever placement of the panel.
   1. Do not leave wood shims at any location.

G. Wall panel horizontal alignment tolerance is 0.7 percent (for example 2.5 inches in 30 feet). Vertical tolerance is 0.7 percent (for example 0.85 inches in 10 feet). The overall vertical tolerance of the wall (plumbness from top to bottom) not to exceed 0.5 percent (for example 1.2 inches in 20 feet of wall height). Wall panel levelness tolerance not to exceed 0.5 percent (for example 1.2 inches in 20 feet).

H. Install panels so that joints are uniform. The maximum allowable offset in any panel joint is 0.40 inch. Joint width is 1.2 inches maximum and 0.50 inch minimum.

I. Check panel tolerance and reset before placement of the next panel if out of tolerance.

3.5 CRACK AND SPALL REPAIR CRITERIA FOR CONCRETE PANELS

A. A fully penetrating crack is defined as a crack extending through the cross-section of the precast panel from the front face to the back face of the unit.

B. Cracks at Front Face of Panel:
   1. Panels with one or two partially penetrating cracks with widths less than or equal to 12 mils are acceptable.
   2. Reject panels with fully penetrating cracks, or cracks wider than 12 mils.
   3. No more than two cracks per individual panel are allowed without further evaluation.

C. Cracks at Back Face of Panel:
   1. Partially penetrating cracks with widths less than or equal to 12 mils are acceptable.
   2. Partially penetrating cracks with widths between 12 mils and 30 mils are acceptable when repaired with surface sealant according to subparagraph F, Crack Repair Procedures.
   3. Evaluate partially penetrating cracks wider than 30 mils for acceptance with epoxy injection according to subparagraph F, Crack Repair Procedures.
   4. No more than two repairable cracks per individual panel are allowed without further evaluation.

D. Spalls at Front Face of Panel:
   1. Spalls with widths less than 4.0 inches and depths less than 2.0 inches may be repaired with an approved patching material of the same color as panel concrete. Resultant repair to be approved by the Engineer.
   2. Reject panels with spalls wider than 4.0 inches or deeper than 2.0 inches.
   3. Measure spall depth from the structural thickness of the panel excluding architectural surface finish.
   4. Panels with more than two spalls are subject to further evaluation before acceptance.

E. Spalls at Back Face of Panel:
   1. Spalls with widths less than 4.0 inches and depths less than 2.0 inches may be repaired with a patching material acceptable to the Engineer. Resultant repair to be approved by the Engineer.
   2. Reject panels with spalls wider than 4.0 inches or deeper than 2.0 inches.
   3. Panels with more than four spalls are subject to further evaluation before acceptance.

F. Crack Repair Procedures:
   1. Surface Sealing: Prepare surface and apply a sealant acceptable to the Engineer according to Manufacturer's instructions.
   2. Epoxy Injection: Prepare surface and inject cracks in accordance with Section 03924.

G. Spall Repair Procedures:
   1. Prepare surface and apply patching material according to Manufacturer's instructions, and as acceptable to the Engineer.

END OF SECTION

March 13, 2013

SPECIAL PROVISION

PROJECT #
PIN #

SECTION 02835S

MSE WALLS USING MODULAR BLOCK UNITS AND METAL REINFORCING ELEMENTS

Add Section 02835:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and construction requirements for mechanically stabilized earth (MSE) walls using a wall system (see Section 02831S) approved by the Engineer using modular block units for the wall face and metal reinforcing elements.

B. Provide and install modular block wall units, metal reinforcement, joint filler, and all necessary attachments from the selected Wall Company.

1.2 RELATED SECTIONS

A. Section 02831S: Retaining Wall- Alternate Systems

B. Section 02832S: Select Backfill for MSE Walls

C. Section 03055: Portland Cement Concrete

D. Section 03211: Reinforcing Steel and Welded Wire

E. Section 03310: Structural Concrete

1.3 REFERENCES

Y. ASTM C 140: Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

Z. ASTM C 331: Standard Specification for Lightweight Aggregates for Concrete Masonry Units

AA. ASTM C 1262: Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units

BB. ASTM C 1372: Standard Specification for Dry-Cast Segmental Retaining Wall Units

CC. ASTM D 5262: Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

DD. ASTM D 6637: Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-rib Tensile Method

1.1 SUBMITTALS

A. Submit for acceptance at least 10 days before beginning manufacture of the concrete modular block units, a sample of the proposed block texture and at least three color samples of the proposed block units, matched to colors of local features or as otherwise indicated by the Engineer.

B. Provide the Engineer submittals in accordance with Section 02831S and the appropriate working drawings.

C. Do not start work on any wall until all required submittal items have been reviewed and accepted by the Engineer.
   1. Review and acceptance of the drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

D. Provide certificates of compliance from a UDOT-qualified testing lab, certifying that the select backfill, the modular block facing units, and the geogrid complies with this section, and the results of all tests performed for the tests described in this section.

E. Provide the Wall Company's construction manual for the specific wall system.

1.2 ACCEPTANCE

A. Modular Block Units and Cap Blocks: Meet 28-day compressive strength of 4000 psi.
   1. Do not transport block units to the site until:
      a. A minimum 28-day compressive strength of 4000 psi has been achieved.

b. Regardless of strength gain, do not transport block units to the site before seven days after fabrication.

B. All modular block facing units and cap blocks to be visually free of defects and will be rejected for not meeting any of the requirements specified in article 2.1. In addition, any of the following defects will be cause for rejection:
   1. Defects that indicate imperfect molding.
   2. Defects indicating honeycomb or other open-texture concrete .
   3. Cracked or severely chipped block units.
   4. Color variation on exposed face(s) of block unit due to excess form oil or other reasons.

PART 2 PRODUCTS

2.1 CONCRETE MODULAR BLOCK UNITS

A. Meet the following requirements for drycast concrete block units:

   1. Have a minimum 28-day compressive strength of 4,000 psi in accordance with ASTM C 140.
   2. Conform to ASTM C 1372, except as otherwise specified.
   3. Conform to the following freeze-thaw test requirements for the lot of block units produced for use in this project in accordance with ASTM C 1262.
      a. Minimum acceptable performance defined as weight loss at the conclusion of 150 freeze-thaw cycles not exceeding 1 percent of the block unit's initial weight for a minimum of 4 of the 5 block unit specimens tested.
      b. Per Engineer's approval, Project specific freeze-thaw durability tests may be substituted by the tests of units made with the same material, concrete mix design, manufacturing process, and curing method, conducted not more than 12 months prior to delivery. An independent laboratory to provide reports and certifications of the above tests as per ASTM C 1262 and C 1372 as appropriate.
   4. Have a maximum water absorption in accordance with ASTM C 140 no greater than 1 percent above the water absorption content of the lot of block units produced and successfully tested for the freeze-thaw test specified in item 3 above for all concrete block units.
   5. Conform to ASTM C 140 for testing of drycast concrete block units.

B. Concrete block shall be manufactured using a combination of cement, aggregates, admixtures, and other constituents meeting the requirements of Section 03055.
   1. Verify the compatibility of all components and with the environment in which the block will be used, including sulfate soils and/or groundwater.
   2. Lightweight aggregates are subject to the Engineer's approval and must meet the requirements of ASTM C 331.

C. Provide block units with permissible variations of plus 0.12 inch and minus 0.06 inch.

D. Provide block units having angled sides capable of producing concave and convex alignment curves with a minimum radius of 3.3 feet.

E. Provide block units having a polymeric efflorescence control admixture.

F. Finish and Appearance
   1. All units shall be sound and free from cracks or other defects that would interfere with the proper placement of the unit or significantly impair the strength or permanence of the construction.
   2. Minor cracks incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery are not grounds for rejection.
   3. The face or faces of units that are to be exposed shall be free of chips, cracks or other imperfections when viewed from a distance of 33 feet under diffused lighting.
   4. Up to five percent of a shipment may contain slight cracks or small chips not longer than 1 inch.

G. Notify the Engineer in writing at least 72 hours before beginning the casting of concrete modular block units.

H. Sampling
   1. Acceptance of the concrete units with respect to compressive strength will be determined on a lot-by-lot basis.
      a. Randomly sample the lot in accordance with ASTM C 140. Core compressive strength test specimens or conform to the saw-cut coupons provisions of Section 5.2.4 of ASTM C 140. Refer to Table 1 for sampling frequency.

TABLE 1

Lot Size	Samples
0-8,000	3 units

Greater than 8,000	2 additional unit per additional 8000

2. Provide additional samples if required by the Engineer.

I. Acceptance

1. Units will be rejected for not meeting any of the requirements specified above. In addition, any of the following defects will be cause for rejection:
   a. Defects that indicate imperfect molding.
   b. Defects indicating honeycomb or open-texture concrete.
   c. Cracked or severely chipped units.
   d. Color variation on exposed face(s) of unit due to excess form oil or other reasons.

2.2 LEVELING PAD CONCRETE

A. Use Class AA, A or B concrete mixes in accordance with Section 03055.

***2.3** MODULAR BLOCK-UNIT FILL*

A. Use free-draining crushed stone, 3/8 to 3/4-inch within the modular block units requiring fill material.

2.4 REINFORCING STRIPS

A. Hot rolled from steel bars, galvanize coated 3.4 mils thick, meeting minimum requirements of ASTM D1784, Grade 65; AASHTO M-111 and ASTM A-123.

B. All reinforcing strips shall be the specified size (See 02831S, article 1.1E-1) and free from defects.

2.5 REINFORCED WELDED WIRE MESH AND LOOP INBEDS

A. Meet minimum requirements of AASHTO M-32 and AASHTO M-55; and have galvanized coating 3.4 mils thick as per AASHTO M-111 (ASTM A-123).

2.6 FIBERGLASS AND STEEL PINS

A. Provide ½ inch diameter fiberglass connecting pins, where used, having a minimum flexural strength of 128 ksi and short beam shear of 6.5 ksi.

B. Provide steel connecting pins galvanized coated 3.4 mils thick, meeting Wall Company requirements.

2.7 OTHER FASTENERS

A. Fasteners to wingwalls and abutment wall, if required, shall be provided by the selected Wall Company.

2.8 DAMAGED GALVANIZATION

A. Spray with zinc paint, covering the entire area that has been damaged, as an alternative to replacement of any reinforcing steel, reinforcing strips, wire mesh or fasteners that have damaged galvanization.

2.9 GEOTEXTILE

A. Cover horizontal and vertical joints between block units by a geotextile of the type and grade recommended by the Wall Company.

2.10 WALL CAP ADHESIVE

A. Use a medium-viscosity synthetic elastomeric polymer adhesive, such as “Titebond Heavy Duty Construction Adhesive”, or Engineer approved equivalent.

2.11 SELECT BACKFILL

A. Refer to Section 02832S- Select Backfill for MSE Walls.

PART 3 EXECUTION

3.1 GENERAL

A. Arrange for a qualified representative (minimum 5 years experience with MSE wall design and construction) from the selected Wall Company to be directly involved and provide technical assistance during all phases of construction of the wall(s).
   1. The Wall Company representative is to be at the project site for at least the first five working days of wall construction and until all aspects of wall construction have been satisfactorily demonstrated

to the MSE Wall Company representative and the Engineer. The MSE Wall Company representative is to subsequently visit the site at least once every 10,000 sq. ft. of wall face construction, or as otherwise determined by the Engineer.

2. The Wall Company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
    a. If one or more construction crew members change, the Wall Company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

B. Provide the Wall Company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

C. Provide a final field observations report from the Wall Company that specifically addresses that the completed wall(s) meet all Department and Wall Company specifications/requirements and what deficiencies exist, if any.
    1. Where the Department's and the Wall Company's specifications/requirements differ, the stricter of the two shall be applied.

D. Haul, store and ship wall materials so as to minimize the potential of producing any type of defects.

E. Perform excavation and foundation preparation (including removal of unsuitable soils) as described in Section 02832S.

F. Construct the wall system in accordance with the approved plans, this specification, and the Wall Company's recommendations and construction manual.

3.2 LEVELING PAD

A. Prepare the subgrade soils and/or fill so as to cast the leveling pad to the design elevations shown on the drawings to ensure complete contact of the retaining wall units with the base.

B. Place cast-in-place concrete leveling pad upon undisturbed in-situ soils or upon properly placed and compacted fill as per Section 02832S. Place leveling pad to a minimum thickness of 6 inches.

C. Placement requirements shall be per Section 03055

D. Allow leveling pad to cure for at least 12 hours before placing modular block units.

3.3 MODULAR BLOCK UNIT INSTALLATION

A. Place wall backfill as described in Section 02832S.

B. Place the first course of modular block units on the leveling pad. Check the wall units for level and alignment

C. Ensure block units are in full contact with the leveling pad.

D. Install connecting devices in block units as required by the Wall Company.

E. For block units requiring fill material, fill all voids in block units with modular block unit fill. Tamp fill. Ensure each wall course is completely filled, backfilled, and compacted before proceeding to the next wall course.

F. Where connecting pins are used, lay up each course ensuring connecting pins protrude into adjoining courses above at least 1 inch.

G. Pull each block unit forward, away from the embankment, against connecting pins in the previous course and backfill as the course is completed. Repeat procedure to the extent of the wall height.

H. As appropriate where the wall changes elevation, the units can be stepped with grade or turned into the embankment with a convex return end. Provide appropriate buried units on the compacted leveling pad in the area of the convex return end.

I. Horizontal alignment tolerance is 0.7 percent (for example 2.5 inches in 30 feet). Vertical tolerance is 0.7 percent (for example 0.85 inches in 10 feet). The overall vertical tolerance of the wall (plumbness from top to bottom) not to exceed 0.7 percent (for example 1.7 inches in 20 feet of wall height). Levelness tolerance not to exceed 0.5 percent (for example 1.2 inches in 20 feet).

J. Install block units so that joints are uniform. During construction the maximum allowable offset in any block joint is 0.25 inch. Joint width is 0.50 inch maximum and 0.12 inch minimum.

3.4 STEEL SOIL REINFORCEMENT INSTALLATION

A. Lay the steel reinforcement horizontally on the compacted backfill at the proper elevations as designed.

B. Connect steel reinforcement to the block units as required by Wall Company.

C. Pull the reinforcement taut to eliminate any slack; then secure the back edge of the reinforcement before and during backfilling and compaction.

D. Assuming reinforcement is obstructed by elements such as piles, drilled shafts, guardrail posts, catch basins, drop inlets, culverts, etc. in the wall soil reinforcement zone, modify the reinforcement design using one of the following alternatives:
   1. If reinforcement is modified, design the surrounding reinforcement layers to carry the additional load.
   2 Place a structural frame around the obstruction which is capable of transferring loads from the reinforcements on one side of the obstruction to reinforcements on the other side of the obstruction.
   3. If the soil reinforcement consists of discrete strip or bar mats rather than continuous sheets, splay the reinforcements around the obstruction.

E. Place soil reinforcement normal to the face of the wall in plan view.
   1. Where required to splay the reinforcement around obstructions, skew the reinforcement (minimizing the skew angle to no more than 15 degrees). Maintain a set-back for reinforcement of at least 2 inches from piles or other metallic obstructions. Do not exceed horizontal spacing between longitudinal reinforcement of 7 feet.

3.5 WALL CAP INSTALLATION

A. Provide a permanent connection between the wall cap and the top course of the wall units using wall cap adhesive as described in article 2.8. Construct according to the Wall Company drawings and specifications.

3.6 CERTIFICATES OF COMPLIANCE

A. Furnish to the Engineer copies of the certificate of compliance for materials and the results of any tests performed.

3.7 BLOCK UNITS ACCEPTANCE

A. Meet 28-day compressive strength of 4000 psi.
   1. Do not transport block units to the site until:
      a. A minimum 28-day compressive strength of 4000 psi has been achieved, or
      b. A minimum compressive strength of 3000 psi has been achieved at 14 days.
   2. Do not transport block units to the site before seven days after fabrication.

B. Do not allow visible defects in the block units, except as authorized by the Engineer.

END OF SECTION

October 25, 2012

SPECIAL PROVISION

PROJECT #
PIN #

SECTION 02836S

MSE WALLS USING MODULAR BLOCK UNITS AND GEOGRID REINFORCING ELEMENTS

Add Section 02836:

PART 1 GENERAL

1.3 SECTION INCLUDES

A. Materials and construction requirements for mechanically stabilized earth (MSE) walls using a wall system (see Section 02831S) approved by the Engineer using modular block units for the wall face and geogrid reinforcing elements.

B. Provide and install modular block units, geogrid reinforcement, joint filler, and all necessary attachments from the selected Wall Company.

1.4 RELATED SECTIONS

A. Section 02831S: Retaining Wall-Alternate Systems

B. Section 02832S: Select Material for MSE Walls

C. Section 03055: Portland Cement Concrete

D. Section 03211: Reinforcing Steel and Welded Wire

E. Section 03310: Structural Concrete

1.5 REFERENCES

EE. ASTM C 140: Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

FF. ASTM C 331: Standard Specification for Lightweight Aggregates for Concrete Masonry Units

GG. ASTM C 1262: Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units

HH. ASTM C 1372: Standard Specification for Dry-Cast Segmental Retaining Wall Units

II. ASTM D 5262: Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

JJ. ASTM D 6637: Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-rib Tensile Method

1.6 SUBMITTALS

A. Submit for acceptance at least 10 days before beginning manufacture of the concrete modular block units, a sample of the proposed block texture and at least three color samples of the proposed block units, matched to colors of local features or as otherwise indicated by the Engineer.

F. Provide the Engineer submittals in accordance with Section 02831S and the appropriate working drawings.

G. Do not start work on any wall until all required submittal items have been reviewed and accepted by the Engineer.
   1. Review and acceptance of the drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

H. Provide certificates of compliance from a UDOT-qualified testing lab, certifying that the select backfill, the modular block facing units, and the geogrid complies with this section, and the results of all tests performed for the tests described in this section.

I. Provide the Wall Company's construction manual for the specific wall system.

1.7 ACCEPTANCE

B. Modular Block Units and Cap Blocks: Meet 28-day compressive strength of 4000 psi.
   1. Do not transport block units to the site until:
      a. A minimum 28-day compressive strength of 4000 psi has been achieved

b. Regardless of strength gain, do not transport block units to the site before seven days after fabrication.

B. All modular block facing units and cap blocks to be visually free of defects and will be rejected for not meeting any of the requirements specified in article 2.1. In addition, any of the following defects will be cause for rejection:
   1. Defects that indicate imperfect molding.
   2. Defects indicating honeycomb or other open-texture concrete .
   3. Cracked or severely chipped block units.
   4. Color variation on exposed face(s) of block unit due to excess form oil or other reasons.

C. Geogrid: Free of defects and will be rejected if it does not meet the requirements stated in article 2.3.

PART 2 PRODUCTS

2.1 CONCRETE MODULAR BLOCK UNITS

A. Meet the following requirements for drycast concrete modular block units and cap blocks:
   2. Have a minimum 28-day compressive strength of 4,000 psi in accordance with ASTM C 140.
   3. Conform to ASTM C 1372, except as otherwise specified.
   4. Conform to the following freeze-thaw test requirements for the lot of block units produced for use in this project in accordance with ASTM C 1262.
      a. Minimum acceptable performance defined as weight loss at the conclusion of 150 freeze-thaw cycles not exceeding 1 percent of the block unit's initial weight for a minimum of 4 of the 5 block unit specimens tested.
      b. Per Engineer's approval, Project specific freeze-thaw durability tests may be substituted by the tests of units made with the same material, concrete mix design, manufacturing process, and curing method, conducted not more than 12 months prior to delivery. An independent laboratory to provide reports and certifications of the above tests as per ASTM C 1262 and C 1372 as appropriate.
   4. Have a maximum water absorption in accordance with ASTM C 140 no greater than 1 percent above the water absorption content of the lot of block units produced and successfully tested for the freeze-thaw test specified in item 3 above for all concrete block units.

5. Conform to ASTM C 140 for testing of drycast concrete block units.

B. Provide concrete block manufactured using a combination of cement, aggregates, admixtures, and other components meeting the requirements of Section 03055.
   1. Verify the compatibility of all components and the environment in which the block will be used, including sulfate soils and/or groundwater.
   2. Lightweight aggregates are subject to the Engineer's approval and must meet the requirements of ASTM C 331.

C. Provide block units with permissible variations of plus 0.12 inch and minus 0.06 inch.

D. Provide block units having angled sides capable of producing concave and convex alignment curves with a minimum radius of 4 feet.

E. Provide block units having a polymeric efflorescence control admixture.

F. Finish and Appearance
   1. All block units to be sound and free from cracks or other defects that would interfere with the proper placement of the unit or significantly impair the strength or permanence of the construction.
   2. Minor cracks incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery are not grounds for rejection.
   3. The face or faces of units that are to be exposed shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting.
   4. Up to five percent of a shipment may contain slight cracks or small chips not longer than 1 inch.
   5. The faces of the exposed corner facing block units to have the same approved architectural finish as the main face.

G. Notify the Engineer in writing at least 72 hours before beginning the casting of concrete modular block units.

H. Sampling
   1. Acceptance of the block units with respect to compressive strength will be determined on a lot-by-lot basis.
      a. Randomly sample the lot in accordance with ASTM C 140. Core compressive strength test specimens or conform to the saw-cut coupons provisions of Section 5.2.4 of ASTM C 140. Refer to Table 1 for sampling frequency.

TABLE 1

Lot Size	Samples
0-8,000	3 units
Greater than 8,000	2 additional units per additional 8000

2. Provide additional samples if required by the Engineer.

2.2 LEVELING PAD CONCRETE

A. Use Class AA, A ,or B concrete mix as per Section 03055.

2.3 GEOGRID

A. Use geogrid consisting of a regular grid network of integrally connected, discontinuous, select high-density polyethylene, polypropylene resin polymer or polyester tensile elements (specified for wall system selected) with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil and/or rock.
   1. Geogrid structure must be dimensionally stable and be able to retain its geometry under manufacture, transport, and installation.

B. Provide minimum junction strength, in accordance with GRI-GG2, of 90 percent of ultimate strength.

C. Provide creep rupture test for 75-year design life per ASTM D5262.

D. Provide ultimate strength, minimum per ASTM D6637 and utilize geogrid reinforcement reduction factors as appropriate for the Project.

E. Inspect all soil reinforcement and attachment devices to ensure they are true to size and free from defects that may impair their strength and durability.

F. Prevent mud, wet concrete, epoxy and similar contaminants from coming in contact with and affixing to the soil reinforcement and inserts, that would interfere with the geogrid connections.

G. Store soil reinforcement products as recommended by the Wall Company.

2.4 FIBERGLASS PINS

A. If required, provide ½-inch diameter fiberglass connecting pins having a minimum flexural strength of 128 ksi and short beam shear of 6.5 ksi.

2.5 OTHER FASTENERS

A. If required, provide fasteners to wingwalls and abutment wall from the selected Wall Company.

2.6 SELECT BACKFILL

A. Refer to Section 02832S- Select Backfill for MSE Walls.

2.7 MODULAR BLOCK UNIT FILL

A. Use free-draining crushed stone, predominantly 3/8 to 3/4-inch, with no more than 5 percent passing the No 200 sieve, within the modular block units requiring fill material.

2.8 GEOTEXTILE

A. Cover horizontal and vertical joints between block units by a geotextile of the type and grade as recommended by the Wall Company.

2.9 WALL CAP ADHESIVE

A. Use a medium-viscosity synthetic elastomeric polymer adhesive, such as “Titebond Heavy Duty Construction Adhesive”, or Engineer-approved equivalent.

PART 3 EXECUTION

3.1 GENERAL

G. Arrange for a qualified representative (minimum 5 years experience with MSE wall design and construction) from the selected Wall Company to be

directly involved and provide technical assistance during all phases of construction of the wall(s).

1. The Wall Company representative is to be at the project site for at least the first five working days of wall construction and until all aspects of wall construction have been satisfactorily demonstrated to the MSE Wall Company representative and the Engineer. The MSE Wall Company representative is to subsequently visit the site at least once every 10,000 sq ft of wall face construction, or as otherwise determined by the Engineer.
2. The Wall Company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
    a. If one or more construction crew members change, the Wall Company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

H. Provide the Wall Company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

I. Provide a final field observations report from the Wall Company that specifically addresses that the completed wall(s) meet all Department and Wall Company specifications/requirements and what deficiencies exist, if any.
    1. Where the Department's and the Wall Company's specifications/requirements differ, the stricter of the two shall be applied.

J. Perform excavation and foundation preparation (including removal of unsuitable soils) as described in Section 02832S.

K. Construct the wall system in accordance with the approved plans, this specification, and the Wall Company's recommendations and construction manual.

3.2 LEVELING PAD

A. Prepare the subgrade soils and/or fill so as to cast the leveling pad to the design elevations shown on the drawings, to ensure complete contact of the retaining wall units with the base.

B. Place cast-in-place concrete leveling pad as per Section 03055 upon undisturbed in-situ soils, or upon properly placed and compacted fill as per Section 02832S. Place leveling pad to a minimum thickness of 6 inches.

C. Allow leveling pad to cure for at least 12 hours before placing modular block units.

3.3 MODULAR BLOCK UNIT INSTALLATION

A. Place the first course of modular block units on the leveling pad. Check the wall units for level and alignment. The first course is the most important to ensure accurate and acceptable results.

B. Ensure block units are in full contact with the leveling pad.

C. Install connecting devices in block units if required by the Wall Company.

D. Place wall backfill as described in Section 02832S.

E. For block units requiring fill material, fill all voids in block units with modular block unit fill. Tamp fill. Ensure each wall course is completely filled, backfilled, and compacted before proceeding to the next wall course.

F. Where connecting pins are used, ensure connecting pins protrude into adjoining courses above at least 1 inch.

G. Pull each block unit forward, away from the embankment, against connecting devices in the previous course and backfill as the course is completed. Repeat procedure to the extent of the wall height.

H. As appropriate where the wall changes elevation, the units can be stepped with grade or turned into the embankment with a convex return end. Provide appropriate buried units on the compacted leveling pad in the area of the convex return end.

I. Horizontal alignment tolerance is 0.7 percent (for example 2.5 inches in 30 feet). Vertical tolerance is 0.7 percent (for example 0.85 inches in 10 feet). The overall vertical tolerance of the wall (plumbness from top to bottom) not to exceed 0.5 percent (for example 1.2 inches in 20 feet of wall height). Levelness tolerance not to exceed 0.5 percent (for example 1.2 inches in 20 feet).

J. All joints to be uniform. During construction the maximum allowable offset in any block joint is 0.25 inch. Joint width is 0.50 inch maximum and 0.12 inch minimum.

3.4 GEOGRID INSTALLATION

A. Verify the correct orientation (roll direction) of the geogrid.

B. Lay the geogrid soil reinforcement horizontally on the compacted backfill at the proper elevations as designed.

C. Connect geogrid to the concrete wall units as required by Wall Company.

D. Pull the geogrid taut to eliminate loose folds and removing slack in the geogrid at the wall unit connections, pretension the geogrid, and then stake or otherwise secure the back edge of the geogrid before and during backfill and compaction.

E. Follow the Wall Company's guidelines relative to overlap requirements of uniaxial and biaxial geogrid.
   1. Assuming reinforcement is obstructed by elements such as piles, drilled shafts, guardrail posts, catch basins, drop inlets, culverts, etc. in the wall soil reinforcement zone, modify the reinforcement design using one of the following alternatives:
   2. If reinforcement is modified, design the surrounding reinforcement layers to carry the additional load.
   3. Place a structural frame around the obstruction which is capable of transferring loads from the reinforcements on one side of the obstruction to reinforcements on the other side of the obstruction.

3.5 WALL CAP INSTALLATION

A. Provide a permanent connection between the wall cap and the top course of the block units using wall cap adhesive as described in article 2.9. Construct according to the Wall Company drawings and specifications.

3.5 FINAL CERTIFICATION

A. Furnish certification from the Wall Company that the completed wall(s) meet all Department and Wall Company specifications for the specific wall system. Where the Department’s and the Wall Company’s specifications or requirements differ, apply the stricter of the two.

END OF SECTION

September 30, 2010

SPECIAL PROVISION

PROJECT

SECTION 02837S

TWO-STAGE MSE WALLS USING CONCRETE FACING PANELS AND METAL REINFORCING ELEMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

B. Materials and construction requirements for mechanically stabilized earth (MSE) walls using a wall system (refer to Section 02831S) approved by the Engineer using concrete facing panels and metal reinforcing elements.

C. Provide and install face panels, reinforcing steel, tie strips, fasteners, joint filler, select backfill, and all necessary attachments from the selected Wall Company.

1.2 RELATED SECTIONS

B. Section 02831S: Retaining Wall-Alternate Systems

C. Section 02832S: Select Backfill for MSE Walls

D. Section 03055: Portland Cement Concrete

E. Section 03211: Reinforcing Steel and Welded Wire

F. Section 03310: Structural Concrete

G. Section 03390: Concrete Curing

H. Section 03924: Epoxy Injection and Sealing

1.3 REFERENCES

A. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

B: AASHTO M 232: Zinc Coating (Hot-Dip) on Iron and Steel Hardware

C. ASTM A 325: Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

D. ASTM A 572: High-Strength Low-Alloy Columbium-Vanadium Structural Steel

E. ASTM A 709M: Structural Steel for Bridges

F. ASTM A 1011: Standard Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

G. UDOT Quality Management Plans

1.4 SUBMITTALS

A. Submit sample of the texture of the panel face for the Engineer's approval.

B. Provide submittals in accordance with Section 02831S and working drawings including design details which protect the reinforcement connections from corrosion.

C. Do not start work on any wall until working drawings have been reviewed and accepted by the Engineer.
1. Review and acceptance of the drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

D. Certificate of compliance for incorporated materials along with copies of results of any tests performed.

E. Wall Company's construction manual for the specific wall system.

F. Certification from the Wall Company that the completed wall(s) meet all Department and Wall Company specifications/requirements for the specific wall system.
1. Where the Department's and the Wall Company's specifications or requirements differ, apply the stricter of the two.

1.5 ACCEPTANCE

B. Panel Acceptance
1. Meet 28-day minimum compressive strength of 4000 psi.

2. Do not transport panels to the site before seven days after fabrication and until:
    a. A minimum 28-day compressive strength of 4000 psi has been achieved, or
    b. A minimum compressive strength of 3000 psi has been achieved at 14 days.
3. All panels must be visually free of defects and will be rejected if they:
    a. Do not meet the above requirements.
    b. Contain defects due to imperfect molding.
    c. Have any honeycomb.
    d. Have open texture on front face.
    e. Have cracks or spalls that exceed the limits specified in article 3.4

PART 2 PRODUCTS

2.1 PRECAST CONCRETE WALL PANELS

A. Obtain approval from the Engineer for the architectural treatment for all MSE panel walls.

B. Concrete. Class AA(AE) per Section 03055 and Section 03310, having a minimum 28-day compressive strength of 4000 psi.

C. Reinforcing steel to have a minimum cover of 2.0 inches.

D. Casting
1. Use only a UDOT qualified supplier for precast concrete panel fabrication in accordance with UDOT Precast/Prestressed Concrete Structures Quality Management Plan.
    a. Do not cast panels on site.
2. Cast panels on a flat area or approved architectural treatment, with the front face down.
    a. Set tie strip guides at back face.
3. Place concrete in each unit without interruption.
    a. Vibrate with approved equipment to prevent stone pockets or cleavage planes.
    b. Use clean, unused form oil.

E. Reinforcement Connections
1. Cast at least two soil reinforcement connection levels into all concrete panels.

a. Where only two connection levels are cast in panels, locate the levels in two different horizontal planes separated by at least one-third the panel height.

F. Curing
1. Keep surfaces wet and moist until the curing compound is applied.
2. Complete all patching or surface finishing before applying compound.
3. Spray the entire surface of the concrete with a membrane curing compound. Apply the curing compound at a uniform rate of 1.25 oz/ft^2.
4. Immediately re-spray any membrane damage which occurs during the curing period.
5. Leave forms in place until they can be removed without damage to the unit.

G. Concrete Finish
1. Provide a Class 1 finish for front face of panels.
a. The thickness of the architectural treatment is in addition to the required design thickness.
2. Provide a uniform surface finish for the back face of panels.
a. Roughly screen the finish to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch.

H. Tolerances
1. All dimensions ± 1/8 inch.
2. Angular distortion with regard to the height of panel not to exceed 3/16 inch in 5 feet.
3. Surface defects on form surfaces not more than 1/8 inch in 5 feet.

I. Marking
1. Mark the date of manufacture and panel-type designation on the rear of each panel so that it is legible during installation.

2.2 REINFORCING STEEL

A. Epoxy coated in accordance with Section 03211.

2.3 LEVELING PAD CONCRETE

A. Class A or Class B concrete mixes in accordance with Section 03055.

2.4 REINFORCING ELEMENTS

A. Hot rolled from steel bars, galvanize coated 3.4 mils thick, meeting minimum requirements of ASTM A 572, Grade 65; AASHTO M 111.

B. All reinforcing strips to be the specified size and free from defects.

2.5 REINFORCED WELDED WIRE MESH AND LOOP INBEDS

A. Meet minimum requirements of Section 03211 with galvanized coating at least 3.4 mils thick.

2.6 WIRE FACING UNITS

A. Wire facing units to be shop fabricated of cold-drawn steel wire conforming to the minimum requirements of AASHTO M-32 (ASTM A-182) and welded into the finished configuration in accordance with AASHTO M-55 (ASTM A-185). Galvanizing to conform to the minimum requirements of AASHTO M-111 (ASTM A-123).

2.7 TIE STRIPS

A. Shop fabricated, hot rolled steel conforming to minimum requirements of ASTM A 709M, Grade 345; AASHTO M 111; and ASTM A 1011 Grade 345 or equivalent, galvanize coated at least 3.4 mils thick.

2.8 PANEL FASTENERS

A. Bolts and nuts to be hexagonal cap screw and galvanize coated, meeting minimum requirements of ASTM A 325 and AASHTO M 232.

2.9 OTHER FASTENERS

A. Fasteners to wingwalls and abutment walls, if required, to be provided by the Wall Company.

2.10 CONNECTOR RODS

A. Connector rods to be fabricated from cold-drawn steel wire conforming to the minimum requirements of AASHTO M-32 (ASTM A-82); and be galvanized in accordance with AASHTO M-111 (ASTM A-123).

2.11 HAIRPIN CONNECTORS

A. Hairpin connectors to be shop fabricated of hot-rolled steel conforming to the minimum requirements of ASTM A-572, Grade 345 or equivalent; and be galvanized in accordance with AASHTO M-111 (ASTM A-123).

2.12 DAMAGED GALVANIZATION

A. Spray with zinc paint, covering the entire area that has been damaged, as an alternative to replacement of any reinforcing steel, reinforcing strips, wire mesh or fasteners that have damaged galvanization.

2.13 CURING COMPOUND

A. Refer to Section 03390

2.14 GEOTEXTILE

A. Cover horizontal and vertical joints between panels, when required, by a geotextile of type and grade recommended by the Wall Company.

2.15 ADHESIVE

A. Per Wall Company's standard.

2.16 BEARING PADS

A. Horizontal rubber bearing pads to be of the type and grade recommended and supplied by the Wall Company.

2.17 LIFTING DEVICES

A. Per Wall Company’s standard.

2.18 SELECT BACKFILL

A. Refer to Section 02832S.

2.19 MATERIALS FOR CRACK AND SPALL REPAIR

A. Refer to Section 03924.

PART 3 EXECUTION

3.1 GENERAL

G. Arrange for a qualified representative (minimum five years experience with MSE wall design and construction) from the selected Wall Company to be

directly involved and provide technical assistance during all phases of construction of the wall(s).

1. For both the first and second stage of wall construction, the Wall Company representative is to be at the project site for at least the first five working days of wall construction and until all aspects of wall construction have been satisfactorily demonstrated to the MSE Wall Company representative and the Engineer. The MSE Wall Company representative is to subsequently visit the site at least once every 10,000 sq. ft. of wall face construction, or as otherwise determined by the Engineer.
2. The Wall Company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
    a. If one or more construction crew members change, the Wall Company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

H. Provide the Wall Company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

I. Provide a final field observations report from the Wall Company that specifically addresses that the completed wall(s) meet all Department and Wall Company specifications/requirements and what deficiencies exist, if any.
    1. Where the Department's and the Wall Company's specifications/requirements differ, the stricter of the two shall be applied.

J. Haul, store, and ship wall materials so as to minimize the potential of producing any type of defects.
    1. Store panels to avoid damage to connection pieces such that the tie strips do not bend.

K. Perform excavation and foundation preparation (including removal of unsuitable soils) as specified in Section 02832S.

L. Construct wall system in accordance with the approved plans, specifications, and the Wall Company's recommendations and construction manual.

3.2 LEVELING PAD

A. Prepare the subgrade soils and/or fill so as to cast the leveling pad to the design elevations shown on the drawings and to ensure complete contact of the retaining wall units with the base.

B. Furnish and place concrete in accordance with Section 03055.

C. Place cast-in-place concrete leveling pad upon undisturbed in-situ soils, or upon properly placed and compacted fill as per Section 02832S. Place leveling pad to a thickness of at least 6 inches after the required settlement has been achieved following the first-stage wall construction.

D. Allow leveling pad to cure for at least 12 hours before placing concrete panels.

3.3 WALL CONSTRUCTION

A. Place wall backfill and reinforcement for two-stage MSE walls as specified in Section 02832S, and in the Wall Company's Approved-for-Construction drawings.

B. Backfill the void behind the first-stage facing by placing the backfill in two approximately equal lifts, and compacting with lightweight equipment in accordance with Section 02832S.

C. Placement of Select Material as wall backfill to closely follow the erection of each course of wire facing units.

D. Place backfill in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the wire facing units.

E. Where reinforcement is obstructed by elements such as piles, drilled shafts, guardrail posts, catch basins, drop inlets, culverts, etc. in the wall soil reinforcement zone, modify the reinforcement design using one of the following alternatives:

2. If the reinforcement is modified, design the surrounding reinforcement layers to carry the additional load.
3. Place a structural frame around the obstruction which is capable of transferring loads from the reinforcements on one side of the obstruction to reinforcements on the other side of the obstruction.
4. If the soil reinforcement consists of discrete strips or bar mats rather than continuous sheets, splay the reinforcement around the obstruction.

F. Place soil reinforcement strips normal to the face of the wall in plan view.
   1. Where required to splay the reinforcement around obstructions, skew the reinforcement (minimizing the skew angle to no more than 15 degrees).
      a. Maintain a set-back for reinforcement of at least 2 inches from piles or other metallic obstructions.
      b. Do not exceed horizontal spacing between longitudinal reinforcing of 7 feet.

G. Where reinforcement elements are to be connected using bolts and nuts, use a crescent or socket-head ratchet wrench to securely hand-tighten the nut.
   1. Do not use pneumatic equipment.

H. Construct the first-stage facing within 2 inches of the design vertical and horizontal alignments (excluding bulging).

I. Prevent significant bulging of the first-stage facing between reinforcing layers. Where bulging exceeds 3 inches between reinforcing layers, remove and reconstruct this portion of the wall. Bulging will be measured by a plumb straight-edge, or by using a plumb-bob string held in front of the wall face. The bulge measurement shall be the difference in the horizontal measurement from the straight edge or plumb-bob string to the location of maximum bulge and the reinforcement layer immediately above or below the budge (whichever is greater).

J. Proceed with placement of the second stage wall panels after confirmation is given by the Engineer that the required settlement has been achieved.

K. Handle panels by means of lifting device set into upper edge of the panels and set in position vertically.

L. Place bearing pads as required by the Wall Company to prevent concrete-to-concrete contact between panels.

M. Use rubber, wood, or metal shims as necessary to make final adjustments to the wall panel to facilitate level placement of the panel.
   1. Do not leave wood shims at any location.

N. Construct to and maintain wall facing tolerances as follows:
   1. Horizontal alignment: 0.7 percent (for example 2.5 inches in 30 feet)
   2. Vertical tolerance: 0.7 percent (for example 0.85 inches in 10 feet)
   3. Overall vertical tolerance (plumbness from top to bottom): 0.7 percent (for example 1.7 inches in 20 feet of wall height)

4. Levelness: 0.5 percent (for example 1.2 inches in 20 feet)

O. Install panels so that joints are uniform. The maximum allowable offset in any panel joint is 0.40 inch. Joint width is 1.2 inches maximum and 0.50 inch minimum.

P. Check panel tolerance and reset before placement of the next panel if out of tolerance.

3.4 CRACK AND SPALL REPAIR CRITERIA FOR CONCRETE PANELS

G. A fully penetrating crack is defined as a crack extending through the cross-section of the precast panel from the front face to the back face of the unit.

H. Cracks at Front Face of Panel:
4. Panels with one or two partially penetrating cracks with widths less than or equal to 12 mils are acceptable.
5. Reject panels with fully penetrating cracks, or cracks wider than 12 mils.
6. No more than two cracks per individual panel are allowed without further evaluation.

I. Cracks at Back Face of Panel:
5. Partially penetrating cracks with widths less than or equal to 12 mils are acceptable.
6. Partially penetrating cracks with widths between 12 mils and 30 mils are acceptable when repaired with surface sealant according to subparagraph F, Crack Repair Procedures.
7. Evaluate partially penetrating cracks wider than 30 mils for acceptance with epoxy injection according to subparagraph F, Crack Repair Procedures.
8. No more than two repairable cracks per individual panel are allowed without further evaluation.

J. Spalls at Front Face of Panel:
5. Spalls with widths less than 4.0 inches and depths less than 2.0 inches may be repaired with a patching material acceptable to the Engineer of the same color as panel concrete. Resultant repair to be approved by the Engineer.
6. Reject panels with spalls wider than 4.0 inches or deeper than 2.0 inches.
7. Measure spall depth from the structural thickness of the panel excluding architectural surface finish.

8. Panels with more than two spalls are subject to further evaluation before acceptance.

K. Spalls at Back Face of Panel:
   4. Spalls with widths less than 4.0 inches and depths less than 2.0 inches may be repaired with a patching material acceptable to the Engineer. Resultant repair to be approved by the Engineer.
   5. Reject panels with spalls wider than 4.0 inches or deeper than 2.0 inches.
   6. Panels with more than four spalls are subject to further evaluation before acceptance.

L. Crack Repair Procedures:
   3. Surface Sealing: Prepare surface and apply a sealant acceptable to the Engineer according to Manufacturer's instructions.
   4. Epoxy Injection: Prepare surface and inject cracks with Department-approved product according to Manufacturer's instructions.

G. Spall Repair Procedures:
   1. Prepare surface and apply patching material according to Manufacturer's instructions, and as acceptable to the Engineer.

END OF SECTION

August 2013

SPECIAL PROVISION

PROJECT

SECTION 02838S

TWO-STAGE MSE WALLS USING CONCRETE FACING PANELS AND GEOGRID REINFORCING ELEMENTS

PART 1 GENERAL

1.3 SECTION INCLUDES

D. Materials and construction requirements for mechanically stabilized earth (MSE) walls using a wall system (refer to Section 02831S) approved by the Engineer using concrete facing panels and geogrid reinforcing elements.

E. Provide and install face panels, reinforcing steel, geogrid, fasteners, joint filler, select backfill, and all necessary attachments from the selected Wall Company.

1.4 RELATED SECTIONS

I. Section 02831S: Retaining Wall-Alternate Systems

J. Section 02832S: Select Backfill for MSE Walls

K. Section 03055: Portland Cement Concrete

L. Section 03211: Reinforcing Steel and Welded Wire

M. Section 03310: Structural Concrete

N. Section 03390: Concrete Curing

O. Section 03924: Epoxy Injection and Sealing

1.3 REFERENCES

A. AASHTO M 32: Steel Wire, Plain, for Concrete Reinforcement

B. AASHTO M 55: Steel Welded Wire Reinforcement, Plain, for Concrete

C. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

D: AASHTO M 232: Zinc Coating (Hot-Dip) on Iron and Steel Hardware

E. ASTM A 325: Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

F. ASTM A 572: High-Strength Low-Alloy Columbium-Vanadium Structural Steel

G. ASTM A 709M: Structural Steel for Bridges

H. ASTM A 1011: Standard Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

I. ASTM D5262: Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

J. ASTM D6637: Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

K. UDOT Quality Management Plans

1.4 SUBMITTALS

D. Submit sample of the texture of the panel face for the Engineer's approval.

E. Provide submittals in accordance with Section 02831S and working drawings including design details.

F. Do not start work on any wall until working drawings have been reviewed and accepted by the Engineer.
1. Review and acceptance of the drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

D. Certificate of compliance for incorporated materials along with copies of results of any tests performed.

E. Wall Company's construction manual for the specific wall system.

F. Certification from the Wall Company that the completed wall(s) meet all Department and Wall Company specifications/requirements for the specific wall system.
    1. Where the Department's and the Wall Company's specifications or requirements differ, apply the stricter of the two.

1.5 ACCEPTANCE

C. Panel Acceptance
    1. Meet 28-day minimum compressive strength of 4000 psi.
    2. Do not transport panels to the site before seven days after fabrication and until:
        a. A minimum 28-day compressive strength of 4000 psi has been achieved, or
        b. A minimum compressive strength of 3000 psi has been achieved at 14 days.
    3. All panels must be visually free of defects and will be rejected if they:
        a. Do not meet the above requirements.
        b. Contain defects due to imperfect molding.
        c. Have any honeycomb.
        d. Have open texture on front face.
        e. Have cracks or spalls that exceed the limits specified in article 3.4

PART 2 PRODUCTS

2.20 PRECAST CONCRETE WALL PANELS

A. Obtain approval from the Engineer for the architectural treatment for all MSE panel walls.

B. Concrete. Class AA(AE) per Section 03055 and Section 03310, having a minimum 28-day compressive strength of 4000 psi.

C. Reinforcing steel to have a minimum cover of 2.0 inches.

D. Casting
    1. Use only a UDOT qualified supplier for precast concrete panel fabrication in accordance with UDOT Precast/Prestressed Concrete Structures Quality Management Plan.
        a. Do not cast panels on site.

2. Cast panels on a flat area or approved architectural treatment, with the front face down.
    a. Set tie strip guides at back face.
3. Place concrete in each unit without interruption.
    a. Vibrate with approved equipment to prevent stone pockets or cleavage planes.
    b. Use clean, unused form oil.

E. Reinforcement Connections
1. Cast at least two soil reinforcement connection levels into all concrete panels.
    a. Where only two connection levels are cast in panels, locate the levels in two different horizontal planes separated by at least one-third the panel height.

F. Curing
1. Keep surfaces wet and moist until the curing compound is applied.
2. Complete all patching or surface finishing before applying compound.
3. Spray the entire surface of the concrete with a membrane curing compound. Apply the curing compound at a uniform rate of 1.25 oz/ft^2.
4. Immediately re-spray any membrane damage which occurs during the curing period.
5. Leave forms in place until they can be removed without damage to the unit.

G. Concrete Finish
1. Provide a Class 1 finish for front face of panels.
    a. The thickness of the architectural treatment is in addition to the required design thickness.
2. Provide a uniform surface finish for the back face of panels.
    a. Roughly screen the finish to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch.

H. Tolerances
4. All dimensions ± 1/8 inch.
5. Angular distortion with regard to the height of panel not to exceed 3/16 inch in 5 feet.
6. Surface defects on form surfaces not more than 1/8 inch in 5 feet.

I. Marking
1. Mark the date of manufacture and panel type designation on the rear of each panel so that it is legible during installation.

2.21 REINFORCING STEEL

B. Epoxy coated in accordance with Section 03211.

2.22 LEVELING PAD CONCRETE

B. Class A or Class B concrete in accordance with Section 03055.

2.23 GEOGRID

C. Use geogrid consisting of a regular grid network of integrally connected, select high-density polyethylene or polypropylene resin polymer tensile elements.
   1. Aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil and/or rock.
   2. Structure to be dimensionally stable and be able to retain its geometry under manufacture, transport, and installation.

D. Provide junction strength, minimum GRI-GG2 of 90 percent of ultimate strength.

E. Provide creep rupture test for 75-year design life per ASTM D5262.

F. Provide ultimate strength, minimum per ASTM D6637 and utilize geogrid reinforcement reduction factors as appropriate for the Project.

G. Carefully inspect all soil reinforcement and attachment devices to ensure they are true to size and free from defects.

H. Prevent mud, wet concrete, epoxy, and other contaminants from coming in contact with and affixing to the soil reinforcement and inserts, that would interfere with the geogrid connections.

I. Store soil reinforcement products as recommended by the wall company.

2.24 REINFORCED WELDED WIRE MESH AND LOOP INBEDS

B. Meet minimum requirements of Section 03211 with galvanized coating at least 3.4 mils thick.

2.25 WIRE FACING UNITS

A. Wire facing units to be shop fabricated of cold-drawn steel wire conforming to the minimum requirements of AASHTO M-32 (ASTM A-182) and welded into the finished configuration in accordance with AASHTO M-

55 (ASTM A-185). Galvanizing to conform to the minimum requirements of AASHTO M-111 (ASTM A-123).

2.26 FASTENERS

B. Fasteners to wingwalls and abutment walls, if required, to be provided by the Wall Company.

2.27 CONNECTOR RODS

A. If steel connector rods are required, fabricate from cold-drawn steel wire conforming to the minimum requirements of AASHTO M-32 (ASTM A-82); and be galvanized in accordance with AASHTO M-111 (ASTM A-123).

2.28 HAIRPIN CONNECTORS

A. If steel hairpin connectors are required, shop fabricate hot-rolled steel conforming to the minimum requirements of ASTM A-572, Grade 345 or equivalent; and be galvanized in accordance with AASHTO M-111 (ASTM A-123).

2.29 DAMAGED GALVANIZATION

B. Spray with zinc paint, covering the entire area that has been damaged, as an alternative to replacement of any reinforcing steel, wire mesh or fasteners that have damaged galvanization.

2.30 CURING COMPOUND

B. Refer to Section 03390

2.31 GEOTEXTILE

B. Cover horizontal and vertical joints between panels, when required, by a geotextile of type and grade recommended by the Wall Company.

2.32 ADHESIVE

B. Per Wall Company's standard.

2.33 BEARING PADS

B. Horizontal rubber bearing pads to be of the type and grade recommended and supplied by the Wall Company.

2.34 LIFTING DEVICES

B. Per Wall Company's standard.

2.35 SELECT BACKFILL

B. Refer to Section 02832S.

2.36 MATERIALS FOR CRACK AND SPALL REPAIR

B. Refer to Section 03924.

PART 3 EXECUTION

3.4 GENERAL

M. Arrange for a qualified representative (minimum five years experience with MSE wall design and construction) from the selected wall company to be directly involved and provide technical assistance during all phases of construction of the wall(s).

1. For both the first and second stage of wall construction, the wall company representative is to be at the project site for at least the first five working days of wall construction and until all aspects of wall construction have been satisfactorily demonstrated to the MSE wall company representative and the Engineer. The MSE wall company representative is to subsequently visit the site at least once every 10,000 sq. ft. of wall face construction, or as otherwise determined by the Engineer.
2. The wall company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
    a. If one or more construction crew members change, the wall company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

N. Provide the wall company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

O. Provide a final field observation report from the wall company that specifically addresses that the completed wall(s) meet all Department and wall company specifications/requirements and what deficiencies exist, if any.
   1. Where the Department's and the wall company's specifications/requirements differ, the stricter of the two shall be applied.

P. Haul, store, and ship wall materials so as to minimize the potential of producing any type of defects.
   1. Store panels to avoid damage to connection pieces, such that the tie strips do not bend.

Q. Perform excavation and foundation preparation (including removal of unsuitable soils) as specified in Section 02832S.

R. Construct wall system in accordance with the approved plans, specifications, and the wall company's recommendations and construction manual.

3.5 LEVELING PAD

C. Prepare the subgrade soils and/or fill so as to cast the leveling pad to the design elevations shown on the drawings and to ensure complete contact of the retaining wall units with the base.

D. Furnish and place concrete in accordance with Section 03055.

C. Place cast-in-place concrete leveling pad upon undisturbed in-situ soils, or upon properly placed and compacted fill as per Section 02832S. Place leveling pad to a thickness of at least 6 inches after the required settlement has been achieved following the first-stage wall construction.

D. Allow leveling pad to cure for at least 12 hours before placing concrete panels.

3.6 GEOGRID INSTALLATION

G. Verify the correct orientation (roll direction) of the geogrid.

H. Place geogrid horizontally on the compacted backfill at the proper design.

I. Connect geogrid to the first-stage facing as specified by the wall company.

J. Pull the geogrid taut to eliminate loose folds and remove slack in the geogrid at the wire facing connections, pretension the geogrid, and stake or otherwise secure the back edge of the geogrid before and during backfill and compaction.

K. Follow the wall company's overlap requirements for uniaxial and biaxial geogrids.

L. Where reinforcement is obstructed by elements such as piles, drilled shafts, guardrail posts, catch basins, drop inlets, culverts, etc. in the wall soil reinforcement zone, modify the reinforcement design using one of the following alternatives:

4. If the reinforcement is modified, design the surrounding reinforcement layers to carry the additional load.
5. Place a structural frame around the obstruction which is capable of transferring loads from the reinforcements on one side of the obstruction to reinforcements on the other side of the obstruction.

3.7 WALL CONSTRUCTION

G. Place wall backfill and reinforcement for two-stage MSE walls as specified in Section 02832S, and in the Wall Company's Approved-for-Construction drawings.

H. Backfill the void behind the first-stage facing by placing the backfill in two approximately equal lifts, and compacting with lightweight equipment in accordance with Section 02832S.

I. Placement of Select Material as wall backfill to closely follow the erection of each course of wire facing units.

J. Place backfill in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the wire facing.

E. Construct the first-stage facing within 2 inches of the design vertical and horizontal alignments (excluding bulging).

F. Prevent significant bulging of the first-stage facing between reinforcing layers. Where bulging exceeds 3 inches between reinforcing layers, remove and reconstruct this portion of the wall. Bulging will be measured by a plumb straight-edge, or by using a plumb-bob string held in front of the wall face. The bulge measurement shall be the difference in the horizontal measurement from the straight edge or plumb-bob string to the

location of maximum bulge and the reinforcement layer immediately above or below the budge (whichever is greater).

G. Proceed with placement of the second stage wall panels after confirmation is given by the Engineer that the required settlement has been achieved.

H. Handle panels by means of lifting device set into upper edge or side of the panels and set in position vertically.

I. Place bearing pads as required by the Wall Company to prevent concrete-to-concrete contact between panels.

J. Use rubber, wood, or metal shims as necessary to make final adjustments to the wall panel to facilitate level placement of the panel.
   1. Do not leave wood shims at any location.

K. Wall panel horizontal alignment tolerance is 0.7 percent (for example 2.5 inches in 30 feet). Vertical tolerance is 0.7 percent (for example 0.85 inches in 10 feet). The overall vertical tolerance of the wall (plumbness from top to bottom) not to exceed 0.7 percent (for example 1.7 inches in 20 feet of wall height). Wall panel levelness tolerance not to exceed 0.5 percent (for example 1.2 inches in 20 feet).

L. Install panels so that joints are uniform. The maximum allowable offset in any panel joint is 0.40 inch. Joint width is 1.0 inch maximum and 0.50 inch minimum.

M. Check panel tolerance and reset before placement of the next panel if out of tolerance.

3.4 CRACK AND SPALL REPAIR CRITERIA FOR CONCRETE PANELS

M. A fully penetrating crack is defined as a crack extending through the cross-section of the precast panel from the front face to the back face of the unit.

N. Cracks at Front Face of Panel:
   7. Panels with one or two partially penetrating cracks with widths less than or equal to 12 mils are acceptable.
   8. Reject panels with fully penetrating cracks, or cracks wider than 12 mils.
   9. No more than two cracks per individual panel are allowed without further evaluation.

O. Cracks at Back Face of Panel:

9. Partially penetrating cracks with widths less than or equal to 12 mils are acceptable.
10. Partially penetrating cracks with widths between 12 mils and 30 mils are acceptable when repaired with surface sealant according to subparagraph F, Crack Repair Procedures.
11. Evaluate partially penetrating cracks wider than 30 mils for acceptance with epoxy injection according to subparagraph F, Crack Repair Procedures.
12. No more than two repairable cracks per individual panel are allowed without further evaluation.

P. Spalls at Front Face of Panel:
9. Spalls with widths less than 4.0 inches and depths less than 2.0 inches may be repaired with a patching material acceptable to the Engineer of the same color as panel concrete. Resultant repair to be approved by the Engineer.
10. Reject panels with spalls wider than 4.0 inches or deeper than 2.0 inches.
11. Measure spall depth from the structural thickness of the panel excluding architectural surface finish.
12. Panels with more than two spalls are subject to further evaluation before acceptance.

Q. Spalls at Back Face of Panel:
7. Spalls with widths less than 4.0 inches and depths less than 2.0 inches may be repaired with a patching material acceptable to the Engineer. Resultant repair to be approved by the Engineer.
8. Reject panels with spalls wider than 4.0 inches or deeper than 2.0 inches.
9. Panels with more than four spalls are subject to further evaluation before acceptance.

R. Crack Repair Procedures:
5. Surface Sealing: Prepare surface and apply a sealant acceptable to the Engineer according to Manufacturer's instructions.
6. Epoxy Injection: Prepare surface and inject cracks with Department-approved product according to Manufacturer's instructions.

G. Spall Repair Procedures:
1. Prepare surface and apply patching material according to Manufacturer's instructions, and as acceptable to the Engineer.

END OF SECTION

November 30, 2010

SPECIAL PROVISION

PROJECT

SECTION 02839S

PREFABRICATED MODULAR GRAVITY WALL (PMGW) SYSTEMS USING LARGE MODULAR BLOCK UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and construction requirements for PMGW walls using option K or L as specified in Section 02831S.

B. Provide and install the modular block wall units and all necessary appurtenances from the selected Wall Company.

1.2 RELATED SECTIONS

A. Section 02056: Embankment, Borrow, and Backfill

B. Section 02317: Structural Excavation

C. Section 03055: Portland Cement Concrete

D. Section 03310: Structural Concrete

E. Section 02831S: Retaining Wall - Alternate Systems

1.3 REFERENCES

A. ASTM C140: Sampling and Testing Concrete Masonry Units and Related Units

B. ASTM C331: Lightweight Aggregates for Concrete Masonry Units

C. ASTM D412: Vulcanized Rubber and Thermoplastic Elastomers-Tension

D. ASTM D1248: Polyethylene Plastics Extrusion Materials For Wire and

Cable

E. ASTM D3034: Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

F. American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications

G. National Concrete Masonry Association (NCMA):
1. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
2. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW

1.4 SUBMITTALS

A. Submit sample of the texture for the Engineer's approval.

B. Submit for approval at least 3 color samples of proposed segmental concrete unit colors (if integral color is required), matched to colors of local features or as otherwise indicated, at least four weeks before beginning manufacture of the block units.

C. Provide working drawings and other applicable submittals in accordance with Section 02831S.

D. Do not start work on any wall until working drawings have been reviewed and accepted by the Engineer.
1. Review and acceptance of the drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

E. Certificate of compliance for incorporated materials along with copies of results of any tests performed.

F. Certification from the Wall Company that the completed wall(s) meet all Department and Wall Company specifications.
1. Where the Department's and the Wall Company's specifications differ, the stricter of the two apply.

1.5 ACCEPTANCE

A. Block Units:
1. Compressive Strength: Minimum 28-day of 4000 psi. Block units which meet 75 percent of 28-day strength within 7 days

are acceptable for placement in the wall.

a. Acceptance is determined on a lot basis.

b. The lot will be randomly sampled in accordance with ASTM Specification C140.

c. Test specimens will be cored or conform to the saw-cut coupons provisions of ASTM Specification C140, Section 6.2.4.

d. Block sampling frequency:

TABLE 1

Lot Size	**Samples**
0-2,000	4 units
Greater than 2,000	1 unit per 1,000

e. Provide additional samples if requested by the Engineer.

2. Dimension Tolerances:
   a. Height: +/- 3/16”
   b. Width: +/- 1/2” unless field cut for fitting purposes.
   c. Depth: No less than the unit design depth of the blocks.

3. Finish and Appearance:

a. Block units must be sound, free from visual defects, and free from cracks or other defects that interfere with the proper placement of the unit or impair the strength or durability of the construction.

b. Assure exposed face or faces of units are free of chips, cracks, or other imperfections when viewed from a distance of 30 feet.

c. Acceptance will be at the Engineer’s discretion.

d. Up to five percent of a shipment may contain slight cracks or small chips not longer than 1 inch.

4. Block units will be rejected for failure to meet any of the above specified requirements. In addition, units will be rejected for any of the following defects:
   a. Defects that indicate imperfect molding
   b. Defects indicating honeycomb or open-texture concrete
   c. Cracked or severely chipped units
   d. Color variation on exposed face(s) of unit

B. Completed Wall Construction Tolerances:

1. Horizontal alignment (including curves and corners) is 0.7 percent (for example 2.5 inches in 30 feet).
2. Adjacent block tolerance is 1 percent (for example 0.4 inches in 3 feet).
3. The overall vertical tolerance of the wall (plumbness from top to bottom) not to exceed 1 percent (for example 0.8 inches in 6 feet of wall height).
4. Level tolerance not to exceed 0.5 percent (for example 1.2 inches in 20 feet).
5. All joints must be uniform. Maximum allowable offset in any block joint is 0.5 inch. Maximum joint width is 0.25 inch.

PART 2 PRODUCTS

2.1 CONCRETE MODULAR BLOCK UNITS

A. Concrete. Class AA(AE) per Section 03055 and Section 03310, having a minimum 28-day compressive strength of at least 4000 psi.

B. Manufacture concrete block using a combination of cement, aggregates, admixtures, and other components meeting the requirements of Section 03055.

1. Verify the compatibility of all components and the environment in which the block will be used, including sulfate soils and/or groundwater.
2. Lightweight aggregates are subject to the Engineer's approval and must meet the requirements of ASTM C331.

C. Provide block units having angled sides capable of producing concave and convex alignment curves with a minimum radius as specified in the Wall Company's layout drawings.

D. Notify the Engineer in writing at least 72 hours before beginning the casting of concrete modular block units.

2.2 ADHESIVE

A. Use a urethane or polyurethane adhesive which is specifically described as forming a bond with concrete and masonry materials. Minimum tensile stress of 225 psi and minimum elongation of 600% (ASTM D412).

1. Product examples meeting these criteria are Sikabond Construction Adhesive and Geocel 3500.

2.3 DRAINAGE PIPE

A. If required in Construction Drawings, use perforated or slotted PVC drainage pipe manufactured in accordance with ASTM D3034 or corrugated HDPE pipe manufactured in accordance with ASTM D1248.

2.4 SELECT MATERIAL FOR PMGW

A. Use Select Material for PMGW which is free from frozen, organic and otherwise deleterious materials. Conform to the following gradation limits as determined by AASHTO T-27 / ASTM D422:

TABLE 2

Gradation for Select Material for PMGW Walls	
Sieve Size	Percent passing
2 inch	100
¾ inch	75-100
No. 4	0-60
No. 40	0-30
No. 200	0-5

1. Use Select Material for PMGW that:
   a. Is substantially free of shale or other soft, poor durability particles.
   b. Has an organic content less than 1 percent as determined by AASHTO T-267 on the portion of the material finer than the No. 10 sieve.
2. Furnish the Engineer with a copy of all test results performed to meet the requirements of this section of the specification.

PART 3 EXECUTION

3.1 GENERAL

A. Arrange for a qualified representative (minimum five years experience with MSE wall design and construction) from the selected Wall Company to be directly involved and provide technical assistance during all phases of construction of the wall(s).

1. The Wall Company representative is to be at the project site for at least the first five working days of wall construction and until all aspects of wall construction have been satisfactorily demonstrated to the MSE Wall Company representative and the Engineer. The MSE Wall Company representative is to subsequently visit the site at least once every 10,000 sq. ft. of wall face construction, or as otherwise determined by the Engineer.
2. The Wall Company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
    a. If one or more construction crew members change, the Wall Company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

B. Provide the Wall Company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

C. Provide a final field observations report from the Wall Company that specifically addresses that the completed wall(s) meet all Department and Wall Company specifications/requirements and what deficiencies exist, if any.
    1. Where the Department's and the Wall Company's specifications/ requirements differ, the stricter of the two shall be applied.

D. Haul, store, and ship wall materials to minimize the potential of producing any type of defects.

E. Perform excavation and foundation preparation (including removal of unsuitable soils) as specified in Section 02317.

F. Construct the wall system in accordance with the approved plans, specifications, and the Wall Company's recommendations and construction manual.

G. Do not place any block until it has been cured for at least 7 days and meets all acceptance criteria.

3.2 LEVELING PAD INSTALLATION

A. Prepare the subgrade soils and/or fill to install the leveling pad to the design elevations shown on the drawings, to ensure complete contact

of the retaining wall units with the base so that there are no voids beneath or between units.

1. Remove all foundation soils found to be unsuitable and replace with Select Material for PMGW placed and compacted as described in this Section.

B. Place Select Material for PMGW leveling pad to a thickness of at least 6 inches on undisturbed in-situ soils or on properly placed and compacted fill as per this Section. Provide a level surface on which to place the first course of block units.

D. Width of the leveling pad must extend at least 6 inches in front and 6 inches in back of the base unit footprint.

E. Compact leveling pad material in accordance with Section 02056 so as to provide a smooth, hard surface on which to place the first course of units.

3.3 PMGW BLOCK UNIT INSTALLATION

A. Make the width of excavation equal to or exceeding the required backfill. Refer to the approved plans for backfill dimensions from the back face of the wall.

B. Place the first course of modular block units on the leveling pad. Verify that the wall units are level and properly aligned.

C. Ensure block units are in full contact with the leveling pad.

D. Place unit faces in contact end to end. Do not allow any gaps one-half inch or greater.

E. Follow erection of each course of wall blocks with placement of Select Material for PMGW. Complete backfill at the front of the wall prior to backfilling more than 4 feet above the bottom of the lowermost facing block.

1. Minimum bury depth of the bottom block is 1.0 ft.
2. Do not damage, disturb or misalign block units during backfill placement.
3. Do not exceed individual block height (loose) in lift thickness. Decrease the lift thickness as necessary to obtain the specified density. Place backfill in uniformly thick layers.

F. Ensure each wall course is completely filled, backfilled, and compacted before proceeding to the next wall course.

1. Compact backfill to at least 95 percent of the maximum density, AASHTO T-99, Method C or D (with oversized

correction, outlined in Note 7 of T-99).

2. Place and compact each layer of backfill in a level manner before placing subsequent backfill layers.

G. Lay each successive course making sure that the bottom recess is in full contact with the unit locators of the course below. Pull unit forward as far as possible.

H. Check and maintain level and wall batter. Do not use shims.

I. Clean the top of each course before setting additional courses.

J. At the end of each day's operation, slope the backfill away from the wall to direct runoff of rainwater away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

3.4 WALL CAP INSTALLATION

A. Provide a permanent connection between the wall cap and the top course of the wall units. Construct according to the Wall Company's drawings and specifications.

1. Use a urethane or polyurethane adhesive which is specifically described as forming an excellent bond with concrete and masonry materials.
   a. Minimum tensile stress of 225 psi (ASTM D412).
   b. Minimum elongation of 600% (ASTM D412).

B. Clean and apply exterior concrete cap adhesive to top course of wall units before placement of cap unit.

C. Trim sides of interior cap units to insure proper fit of wall cap. Do not leave cut surfaces exposed to view in the finished wall.

D. Fill and compact soil to finished grade.

END OF SECTION

December 8, 2011

SPECIAL PROVISION

PROJECT

SECTION 02840 S

MSE WALLS USING WIRE FACE AND METAL REINFORCING ELEMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

C. Furnish material and construct mechanically stabilized earth (MSE) walls using an approved wall system employing welded wire for the wall face, and metal reinforcing elements.

D. Make arrangements to purchase welded wire facing, metal reinforcement, and all necessary attachments from the selected Wall Company.

1.2 RELATED SECTIONS

A. Section 02056: Embankment, Borrow and Backfill

B. Section 02372: Wire Enclosed Riprap

C. Section 02831 S: Retaining Wall- Alternate Systems

D. Section 02832 S: Select Material for MSE Walls

E. Section 03055: Portland Cement Concrete

F. Section 03211: Reinforcing Steel and Welded Wire

1.3 SUBMITTALS

A. Submit sample of the texture for approval by the Department.

B. Provide design details which protect the reinforcement connections from corrosion due to salt spray and runoff.

C. Provide all other submittals required in Section 02831 S.

D. Do not start work on any wall until working drawings have been reviewed by the Engineer. The Engineer's review of the Contractor's drawings does not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

PART 2 PRODUCTS

2.1 WELDED WIRE FACING

I. Wire mesh shall be manufactured in strict conformance with the provisions of ASTM A976-97. Specifically the facing shall be manufactured using the dimensions and other requirements of Table 1 of ASTM A975-97 (2000).

J. Each facing lift height shall be limited to no greater that 30 inches.

K. The wire face and components shall be supplied by the Wall Company including a finer liner wire mesh to be placed inside the structural wire facing sufficient to contain the specified wall backfill material.

L. Ring fasteners for facing materials shall be of stainless steel, 0.12 inches in diameter manufactured in accordance to ASTM A313-98, Type 302, Class I. The tensile strength shall be in the range of 222 to 253 ksi as measured in accordance with ASTM A313-98.

M. If the facing units are gabions, all components shall be mechanically connected at the production facility. The external face, reinforcing panel, and lid shall be woven into a single unit. The ends, back and diaphragm shall be secured in position to the base so that no additional lacing is necessary at the job site.

2.2 LEVELING PAD

A. Use Free Draining Granular Backfill or Granular Backfill Borrow per Section 02056.

B. Alternatively, use Class A or B concrete mixes per Section 03055.

2.3 REINFORCED WELDED WIRE MESH

B. Meeting minimum requirements of AASHTO M-32 and AASHTO M-55; and be galvanize coated 3.4 mils thick as per AASHTO M-111 (ASTM A-123).

C. For the TerraMesh system, the mesh shall be manufactured in strict conformance with the provisions of ASTM A976-97. Specifically the mesh shall be manufactured using the dimensions and other requirements of Table 1 of ASTM A975-97 (2000). Wire thickness and corrosion protection meeting the minimum AASHTO design requirement criteria outlining in Special Provision Section 02831 S.

2.4 OTHER FASTENERS

B. Fasteners to wingwalls and abutment wall, if required, shall be provided by the selected Wall Company.

2.5 DAMAGED GALVANIZATION

B. As an alternative to replacement, any reinforcing steel, reinforcing strips, wire mesh or fasteners, that has damaged galvanization, spray with zinc paint covering the entire area that has been damaged.

2.6 GEOTEXTILE

B. The backs and tops of all gabion wall facing units shall be covered by a geotextile of the type and grade as recommended by the Wall Company.

C. As required by Wall Company on no gabion wire facing MSE walls.

2.7 GABION FACING INFILL ROCK

A. See Section 02372 - WIRE ENCLOSED RIPRAP, paragraph 2.1A

2.8 SELECT MATERIAL FOR REINFORCED EARTH BACKFILL

B. See Special Provision Section 02832 S- Select Material for MSE Walls.

PART 3 EXECUTION

3.1 GENERAL

L. Arrange for a qualified representative (minimum 5 years experience with MSE wall design and construction) from the selected Wall Company to be directly involved and provide technical assistance during all phases of construction of the wall(s).

1. The Wall Company representative is to be at the project site for at least the first five working days of wall construction and until all

aspects of wall construction have been satisfactorily demonstrated to the MSE Wall Company representative and the Engineer. The MSE Wall Company representative is to subsequently visit the site at least once every 10,000 sq. ft. of wall face construction, or as otherwise determined by the Engineer.

2. The Wall Company representative is responsible for training the Contractor's wall construction crew(s) and Department inspectors in proper quality control for construction of the walls.
   a. If one or more construction crew members change, the Wall Company representative is responsible to train the new crew member(s).
3. During each site visit, the representative is to meet with the Engineer near the conclusion of the visit to report on the observed wall construction procedures, including providing a copy of the field report.

M. Provide the Wall Company's construction manual to the Engineer, and assure that the wall system-specific requirements in the manual are integrated into the wall construction.

N. Provide a final field observations report from the Wall Company that specifically addresses that the completed wall(s) meet all Department and Wall Company specifications/requirements and what deficiencies exist, if any.
   1. Where the Department's and the Wall Company's specifications/requirements differ, the stricter of the two shall be applied.

O. Haul, store and ship wall materials so as to minimize the potential of producing any type of defects.

P. Perform excavation and foundation preparation (including removal of unsuitable soils) as described in Section 02832S.

Q. Construct the wall system in accordance with the approved plans, this specification, and the Wall Company's recommendations and construction manual.

3.2 LEVELING PAD

E. Prepare the subgrade soils and/or fill so as to cast the leveling pad to the design elevations shown on the drawings, to ensure complete contact of the retaining wall units with the leveling pad.

F. Place free draining granular backfill borrow for leveling pad upon

undisturbed in-situ soils, or upon properly placed and compacted fill as per Section 02832 S. Compact by passing a vibratory roller over the surface of the leveling pad three times. Place leveling pad to a minimum compacted thickness of 6 inches.

G. Alternatively, place cast-in-place concrete leveling pad upon undisturbed in-situ soils, or upon properly placed and compacted fill as per Section 02832 S. Place leveling pad to a minimum thickness of 6 inches.
   a. Placement requirements shall be as per Section 03055, except that placement time limits will be increased by 20 minutes from those presented in Section 03055, Article 3.7-A
   b. Allow leveling pad to cure for at least 12 hours prior to placing first lift of wall facing units.

3.3 WALL FACE INSTALLATION

K. Place wall backfill as described in Section 02832 S.

L. Place the first course facing units on the leveling pad according to Wall Company's specifications. Check the facing units for level and alignment. The first course is the most important to ensure accurate and acceptable results.

M. Install connecting devices as required by the Wall Company.

D. For gabion units requiring fill material, fill all voids in gabion units with specified fill. Tamp fill. Ensure each wall course is completely filled, backfilled, and compacted prior to proceeding to the next wall course. During the filling operation manual placement is required to minimize voids. The cells shall be filled in stages 9 to 12 inches in height to a depth not exceeding 1 foot higher that the adjoining cell.

E. Gabion units shall be slightly over filled to allow settlement of the rock infill and the lid pulled tight until the lid meets the perimeter edge of the basket.

F. As appropriate where the wall changes elevation, the units can be stepped with grade or turned into the embankment with a convex return end. Provide appropriate buried units on the compacted leveling pad in the area of the convex return end.

G. Wall facing horizontal alignment tolerance shall be 0.7 percent (for example 2.5 inches in 30 feet). Vertical tolerance shall be 0.7 percent (for example 0.85 inches in 10 feet). The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 0.5 percent (for example

1.2 inches in 20 feet of wall height). Wall panel levelness tolerance shall not exceed 0.5 percent (for example 1.2 inches in 20 feet).

3.4 STEEL SOIL REINFORCEMENT INSTALLATION

F. Lay the steel reinforcement horizontally on the compacted backfill at the proper elevations as designed.

G. Connect steel reinforcement to the wire face as required by Wall Company.

H. Pull the reinforcement taut to eliminate any slack; then secure the back edge of the reinforcement before and during backfilling and compaction.

I. Assuming reinforcement layers must be partially or fully served in the location of an obstruction (such as a caisson foundation, guardrail post, catch basin, drop inlet, or culvert), in the wall soil reinforcement zone, reinforcement design shall be modified using one of the following three alternatives:
   1. Design the surrounding reinforcement layers to carry the additional load which would have been carried by the severed reinforcement.
   2. Place a structural frame around the obstruction which is capable of transferring loads from the reinforcements on one side of the obstruction to reinforcements on the other side of the obstruction.
   3. If the soil reinforcement consists of discrete strip or bar mats rather than continuous sheets, splay the reinforcements around the obstruction.

E. Soil reinforcement strips shall generally be placed normal to the face of the wall in plan view. However, where required to splay the strips around obstructions, the strips shall be skewed (minimizing the skew angle), but no more than 15 degrees unless approved by the Wall Company. However, in no case shall the maximum horizontal spacing between longitudinal reinforcing straps be greater than 7 feet.

3.5 SAMPLING AND TESTING

B. Certificates of Compliance. Furnish to the Engineer copies of the certificate of compliance for materials and the results of any tests performed by the Wall Company on the materials.

C. Select Material Density Testing. The Engineer will make at least one density determination per lift for each 100 feet of retaining wall. The tests will be made at random locations.

D. Wire face and soil reinforcement testing- provide certifications according to the Wall Company's requirements.

END OF SECTION

Appendix C – Suggested Paving Fabric Interlayer Chart

Classification Property		Class I						Class II			Class III		Class IV
Interlayer Type		Grid or Composite Grid						Paving Mat			Paving Fabric		Composite Membranes
Test Description and Method		Detail or Full Width Crack Control						Moisture Barrier and Crack Control	Moisture Barrier and Crack Control	Moisture Barrier and Crack Control	Moisture Barrier and Crack Control	Moisture Barrier and Crack Control	Moisture Barrier and Crack Control
Description	Test Method	Fiberglass Self Adhesive or Fabric	Fiberglass Self Adhesive or Fabric	Fiberglass Fabric	Fiberglass Self Adhesive or Fabric	Polyester Self Adhesive or Fabric	Polyvinylalcohol Fabric	FG and PET	FG and PET	FG and PET	PP	PP	Nonwoven Self Adhesive
Tensile strength, lb (min)	ASTM D 6637, Method A , modified	560 x 1,120	560 x 560	450x450x450x450	280x280	285x285	285x285	--	--	--	--	--	-
Tensile strength, lb (min)	ASTM D 5035	--	--		--	-		280 x 280	140 x 140	70 x 70 x 70 x 70	--	--	-
Grab tensile strength, lb/in (min)	ASTM D4632	--	--		--	-		--	--	--	120	100	160
Grab tensile Elongation % (min)											50	50	60
Aperture size[e], inch (min)	Calipered	≥ 0.25" x 0.25"	> 0.25" x 0.25"	--	> 0.25" x 0.25"	≥1.25"	>1.25"	--	--	--	--	--	--
Elongation, percent (% max)	ASTM D 6637	5	5	3	5	12	6	5	5	5			
Mass per area, oz/sq yd (min)	ASTM D 5261	16	10	18	10	8	13	7	4	3.7	4.5	4	
Melting point, °F (min)	ASTM D 276	325	325	752 (glass filaments)	325	374	445	>450	>450	>450	300	300	
Permeance	ASTM E 96 Methid B (perms)												0.05
Pliability	ASTM D146 1/4" mandrel @-25 F												No Crack in mastic
Asphalt Retention, minimum, gal/yd2	Per Manufacturers Test Data												

Appendix D – Silt Fence Technical Drawing Sheets and Associated Comments

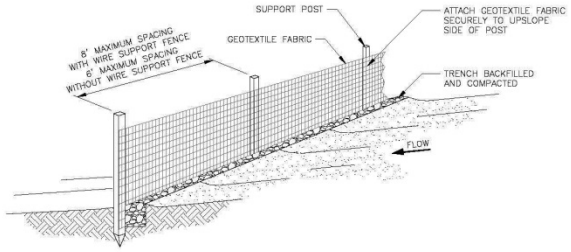
Sheet 1 of 2:

- Materials section – replace 6XX with 633.
- Installation section
    - Note 3: Rewrite this note to be in active voice (i.e., get rid of or replace the word "shall"). I tried this, but was concerned that I might change the meaning of the note.
        - Possible approach, "Do not exceed 100 feet for each segment of silt fence nor exceed 500 feet of total length for each ¼-acre of drainage".
        - Alternate approach, "Do not exceed 100 feet for each ¼-acre of drainage area and do not exceed 500 feet regardless of drainage area."
    - Note 5: in the parentheses should read, "(rather than installing one long, contour-crossing fence that directs drainage to accumulate in low spots)."
    - Note 9: Add the sentence, "Do not excavate trenches in permafrost."
    - Note 13: Replace "wire reinforcement" with "support mesh"
- Machine Slice Installation section
    - Add the parenthetical statement "(Not in permafrost)" after the title of this subsection
- Winter Installation section
    - Add the parenthetical statement "(Not in permafrost)" after the title of this subsection
    - Note 1: Add the sentence "Do not excavate trenches in permafrost."
- Removal section
    - Note 2: Rewrite to read: "Cut fabric at ground level and remove supports.
- Standing Water Notes: Installation section
    - Note 2: Remove the word "wire" from "wire support mesh"
    - Remove arrow pointing from "Support Posts" label that is pointing to the horizontal support member
    - Add separate arrow pointing to Horizontal Support Member
- General Installation drawing
    - Replace "…wire support fence" with "…support mesh"
- Section drawing
    - Remove the word "wire" from "wire support mesh"
- Profile drawing
    - Remove the word "wire" from "wire support mesh"

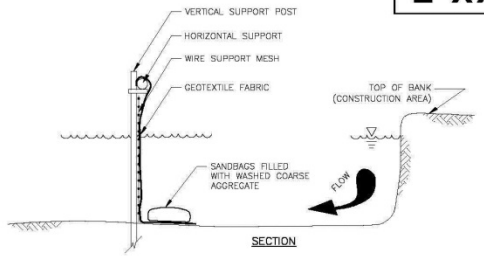
Sheet 2 of 2

- Wire Reinforced Fabric Detail drawing
    - Replace title of this drawing with "Support Mesh Reinforced Fabric Detail"
    - Replace title to notes with "Support Mesh Reinforced Fabric Notes:"
    - Add sentence to Note 2: "Do not excavate trenches in permafrost."
    - Note 3: replace the word "wire" with "support mesh"
    - Replace callout in drawing "wire reinforcement" with "support mesh"

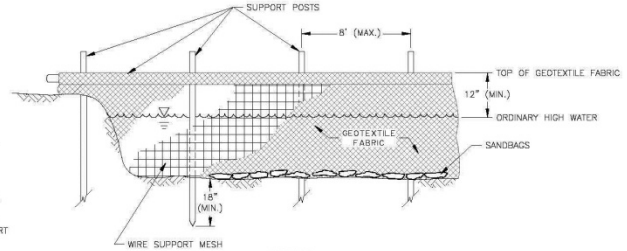
E-XX.XX SHEET 1 of 2



GENERAL INSTALLATION
NOT TO SCALE



SECTION



PROFILE

STANDING WATER INSTALLATION
NOT TO SCALE

SILT FENCE GENERAL NOTES:

MATERIALS

SILT FENCE: SEE SPECIFICATION SECTION 6XX, SILT FENCE.

INSTALLATION

1. INSTALL FENCELINE ALONG A LEVEL CONTOUR AND PERPENDICULAR TO ANTICIPATED SHEET FLOW DRAINAGE PATH(S).
2. ORIENT END SECTIONS UPHILL SLIGHTLY IN A J-HOOK TO PREVENT WATER FROM GOING AROUND THE SILT FENCE.
3. EACH SEGMENT OF SILT FENCE SHOULD BE A MAXIMUM OF 100 FEET FOR EACH 1/4-ACRE OF DRAINAGE AND NOT EXCEED 500 FEET TOTAL LENGTH TO KEEP DRAINAGE FROM SPILLING AROUND BARRIER ENDS.
4. THE DIFFERENCE IN ELEVATION BETWEEN THE HIGHEST AND LOWEST POINT ALONG THE TOP OF THE SEDIMENT FENCE SHALL NOT EXCEED ONE-THIRD THE FENCE HEIGHT.
5. WHERE GROUND SURFACES ARE UNEVEN, INSTALL SHORTER FENCES FOLLOWING CONTOURS (RATHER THAN INSTALL ONE LONG, CONTOUR-CROSSING FENCE THAT DIRECTS DRAINAGE TO ACCUMULATE IN LOW SPOTS).
6. LOCATE FENCE 3 TO 10 FEET BEYOND TOE OF FILL TO LEAVE ROOM FOR A BROAD, SHALLOW SEDIMENTATION POOL AND FOR EQUIPMENT ACCESS DURING FENCE MAINTENANCE AND REMOVAL.
7. IF FEASIBLE, LEAVE A MINIMUM OF 3.5-FOOT BUFFER BETWEEN FENCING AND SENSITIVE RECEIVING AREAS.
8. PLACE GEOTEXTILE ON THE UPSLOPE SIDE OF POSTS OR, WHEN USING SILT FENCE WITH SEWN-IN POCKETS, PLACE POCKETS ON THE UPSLOPE SIDE OF THE FENCE.
9. TRENCHES SHALL NOT BE EXCAVATED WIDER AND DEEPER THAN NECESSARY FOR PROPER INSTALLATION OF THE SILT FENCE.
10. OVERLAP FABRIC AT JOINTS A MINIMUM OF 6 INCHES AT SUPPORT POSTS, BUT DO NOT PLACE OVERLAPPED JOINTS ACROSS POOLED DRAINAGE AREAS.
11. IF USING THE FRONT WHEEL OF A TRACTOR OR ROLLER, COMPACT THE UPSTREAM SIDE FIRST, THEN EACH SIDE TWICE (A TOTAL OF FOUR TRIPS).
12. KEEP FENCE FABRIC TAUT.
13. WHEN USING WIRE REINFORCEMENT, ATTACH GEOTEXTILE TO THE WIRE FENCE WITH FASTENERS SPACED EVERY 24 INCHES AT THE TOP AND MIDSECTION.

MACHINE SLICE INSTALLATION

1. USE A SILT FENCE INSTALLATION MACHINE OR ATTACHMENT TO PLOW OR SLICE THE FABRIC DIRECTLY INTO THE SOIL.
2. BACKFILL SOIL LOOSENED BY THE BLADE INTO THE SLICE AND USE THE TRACTOR TO MECHANICALLY COMPACT THE SOIL.
3. TUCK FABRIC DEEPER INTO THE GROUND WHERE NECESSARY.
4. INSTALL SUPPORT POSTS ALONG THE LENGTH OF THE FENCE FOLLOWING SIMILAR PROCEDURES FOR THE TRENCH METHOD.

WINTER INSTALLATION

1. DIG A TRENCH.
2. BACKFILL TRENCH WITH THE LOOSENED SOIL AND COMPACT SOIL PRIOR TO POST INSTALLATION.
3. MOISTEN THE BACKFILLED SOIL SO IT WILL FREEZE UP AND GRIP THE SILT FENCE FABRIC IN PLACE.
4. DO NOT LEAVE LARGE FROST CHUNKS AS THE BACKFILL.

INSPECTION

1. INSPECT FENCELINE FOR CONTINUITY, COLLAPSE, UNDERMINED AREAS, AND DAMAGE.
2. INSPECT FABRIC FOR TEARS, PUNCTURES, FRAYING, WEATHERING, AND COMPROMISED INTEGRITY.
3. CONFIRM THAT THE FENCE POSTS ARE SECURE.
4. ENSURE THE FENCE IS KEYED IN AND THAT THERE IS NO UNDERCUTTING.
5. LOOK FOR EVIDENCE OF SEDIMENT OR EROSION FLOW LEADING OFF THE DOWNHILL EDGE OF THE FENCE. (THIS MAY BE AN INDICATOR OF DRAINAGE BYPASS OR FENCE UNDERMINE.)
6. NOTE DEPTH OF SEDIMENT BUILD UP AT THE FENCE.
7. LOOK FOR SIGNS OF INADEQUATE PROTECTION OF OFF-SITE SENSITIVE AREAS.
8. CHECK FOR SEDIMENT FLOWING THROUGH THE FENCE.
9. CHECK FOR HOLES IN FENCE WHERE WIRE TIES ARE USED TO SECURE GEOTEXTILE FABRIC TO THE SUPPORT POST.

MAINTENANCE

1. INSTALL ALTERNATE OR ADDITIONAL BMPS AS NEEDED TO PREVENT UNDESIRABLE SEDIMENTATION OF SENSITIVE AREAS.
2. REPLACE DAMAGED FABRIC.
3. REMEDY FENCE SAGS AS NEEDED.
4. REMOVE ACCUMULATED SEDIMENT BEFORE IT ACCUMULATES TO ONE-HALF THE CAPACITY, OR ONE-THIRD OF THE AVAILABLE STORAGE IF PROTECTING A WATER BODY OR STORM DRAIN INLET.
5. DISPOSE OF SILT WASTE IN APPROVED MANNER/LOCATION (TYPICALLY IN A NON-EROSION AREA).
6. IF THERE IS EVIDENCE OF EXCESSIVE SEDIMENTATION AGAINST THE SILT FENCE, PROVIDE INCREASED EROSION CONTROL UPSLOPE.

REMOVAL

1. AFTER DISTURBED AREA HAS BEEN PERMANENTLY STABILIZED OR SEDIMENT PROTECTION IS NO LONGER NEEDED, COLLECT AND PROPERLY DISPOSE OF ACCUMULATED SEDIMENT OR SEED IN PLACE.
2. UNLESS DIRECTED OTHERWISE CUT FABRIC AT GROUND LEVEL, REMOVE SUPPORTS.
3. DISCARD FILTER FENCE AS APPROVED. AVOID DAMAGE TO SENSITIVE AREAS (E.G. WETLAND OR SURFACE WATER).

STANDING WATER NOTES:

INSTALLATION

1. DRIVE SUPPORT POSTS INTO THE GROUND AND ATTACH A HORIZONTAL SUPPORT MEMBER.
2. ATTACH WIRE SUPPORT MESH AND GEOTEXTILE ON THE UPSLOPE SIDE OF THE STAKES, EXTEND GEOTEXTILE ON THE GROUND UPSLOPE OF THE FENCE, AND ANCHOR THE GEOTEXTILE WITH SANDBAGS OR EQUIVALENT TO PREVENT GAPS.
3. SPACE SUPPORT POSTS A MAXIMUM OF 8 FEET APART.
4. KEEP FENCE FABRIC TAUT.

REVISIONS		
Date	Description	By

State of Alaska DOT&PF

SILT FENCE
(NOTES, GENERAL INSTALLATION, & STANDING WATER INSTALLATION)

APPROVED

Date XX/XX/XX

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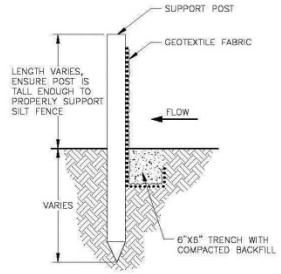
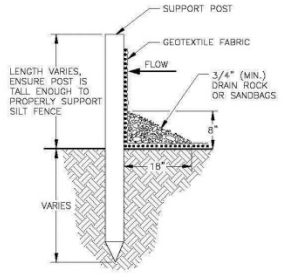
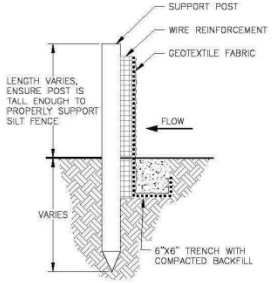
E-XX.XX | SHEET 2 of 2



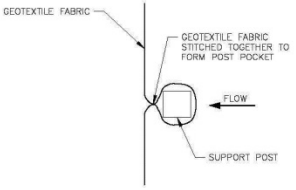
TRENCH DETAIL
NOT TO SCALE



TRENCHLESS DETAIL
NOT TO SCALE



WIRE REINFORCED FABRIC DETAIL
NOT TO SCALE



SEWN–IN POCKET DETAIL
NOT TO SCALE

TRENCH NOTES:
INSTALLATION
1. DRIVE SUPPORT POSTS INTO THE GROUND.
2. FOLLOW MANUFACTURER'S SPECIFICATIONS FOR POST BURIAL DEPTH.
3. EXCAVATE A TRENCH ON THE UPHILL SIDE ALONG THE LINE OF THE STAKES.
4. ATTACH GEOTEXTILE TO STAKES AND BURY GEOTEXTILE BOTTOM.
5. BACKFILL TRENCH AND COMPACT TO SECURE FENCE BOTTOM.

TRENCHLESS NOTES:
MATERIALS
CLEAN ROCK OR SANDBAGS.

INSTALLATION
1. DRIVE SUPPORT POSTS INTO THE GROUND.
2. ATTACH GEOTEXTILE ON THE UPHILL SIDE ALONG THE LINE OF THE STAKES.
3. EXTEND GEOTEXTILE ON THE GROUND UPHILL OF THE FENCE.
4. PLACE DRAIN ROCK ON GEOTEXTILE.

REMOVAL
1. WHEN SILT FENCE IS LOCATED IN WETLANDS OR SENSITIVE AREAS, REMOVE CLEAN ROCK OR SANDBAGS WHEN THE SILT FENCE IS REMOVED.

WIRE REINFORCED FABRIC NOTES:
INSTALLATION
1. DRIVE SUPPORT POSTS INTO THE GROUND.
2. EXCAVATE A TRENCH ON THE UPHILL SIDE ALONG THE LINE OF THE STAKES.
3. EXTEND WIRE A MINIMUM OF 3 INCHES INTO THE TRENCH.
4. ATTACH GEOTEXTILE TO STAKES AND BURY GEOTEXTILE BOTTOM.
5. BACKFILL TRENCH AND COMPACT TO SECURE FENCE BOTTOM.

REVISIONS		
Date	Description	By

State of Alaska DOT&PF

SILT FENCE
(DETAILS)

APPROVED

Date XX/XX/XX

E–XX.XX