Report No. FHWA-SC-09-03

Synthesis of Optimal Usage of Available Aggregates in Highway Construction and Maintenance

FINAL REPORT

Sponsor Agency:
South Carolina Department of Transportation

In Cooperation with:
U.S. Department of Transportation
Federal Highway Administration

Project Investigators:
Bradley J. Putman
Benjamin W. Skidmore
Serji N. Amirkhanian

Department of Civil Engineering
Clemson University
Clemson, SC 29634-0911

November 2009

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-SC-09-03		

4. Title and Subtitle Synthesis of Optimal Usage of Available Aggregates in Highway Construction and Maintenance	5. Report Date November 2009
	6. Performing Organization Code
7. Author(s) B.J. Putman, B.W. Skidmore, and S.N. Amirkhanian	8. Performing Organization Report No.
9. Performing Organization Name and Address Clemson University Department of Civil Engineering 109 Lowry Hall Clemson, SC 29634	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. SPR 674
12. Sponsoring Agency Name and Address South Carolina Department of Transportation Office of Materials and Research 1406 Shop Road Columbia, SC 29201	13. Type of Report and Period Covered Final Report, May 2004 to Nov. 2009
	14. Sponsoring Agency Code

15. Supplementary Notes
Prepared for the SCDOT in cooperation with the Federal Highway Administration

16. Abstract

The optimization of available aggregates for highway construction and maintenance is vital both from an economic and environmental perspective. By not optimizing the aggregate supply, project costs escalate as a simple response to supply and demand. Just as important is the fact that aggregate is a natural resource and a limited one, it is crucial that it is used as efficiently as possible. This study examined specifically the use of aggregates by the South Carolina Department of Transportation, but can easily be adapted to any state. Through DOT surveys and an examination of aggregate gradation specifications, it was determined what specific sieve sizes were significantly different than other states. These specific sizes were then examined to determine if an adjustment of the specifications could better utilize the available aggregates. It was found that times of high construction greatly affect the balance of aggregates, but also that gradation specifications could be adjusted to better use the available aggregate sizes. In South Carolina, hot mix asphalt pavements are the primary causes of over and under-utilization of certain aggregate sizes. The 3/8-inch and 1/2-inch aggregate sizes have been the most over-utilized, and these sizes have a relatively tighter specification than other states. Based on the findings of this study, several recommendations have been made. It is recommended to further research the performance of possibly wider specification bands that will utilize some of the more available aggregates in the state. In addition, it is recommended to investigate the use of the maximum dust to binder ratio as well as the possibility of a base substitution, which could possibly better utilize the graded aggregate base materials such as crusher run. As long as performance and cost can be maintained, these changes could possibly better optimize the usage of the available aggregates in construction and maintenance. Finally, it is recommended that the SCDOT consider methods to forecast future aggregate needs and communicate this with the suppliers, who can then be better prepared to meet the demand.

17. Key Words	18. Distribution Statement
Aggregates, highway construction, highway maintenance	No restrictions.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. Of Pages	22. Price
Unclassified	Unclassified	200	

Form DOT F 1700.7 (8–72) **Reproduction of completed page authorized**

ACKNOWLEDGEMENTS

The authors wish to extend their appreciation to the South Carolina Department of Transportation (SCDOT) and the Federal Highway Administration (FHWA) for sponsoring this research project. The input and guidance of the Steering and Implementation Committee was also greatly appreciated. The information provided by representatives of the state departments of transportation that completed the survey as well as information provided by the Mining Association of South Carolina was instrumental in completing this study.

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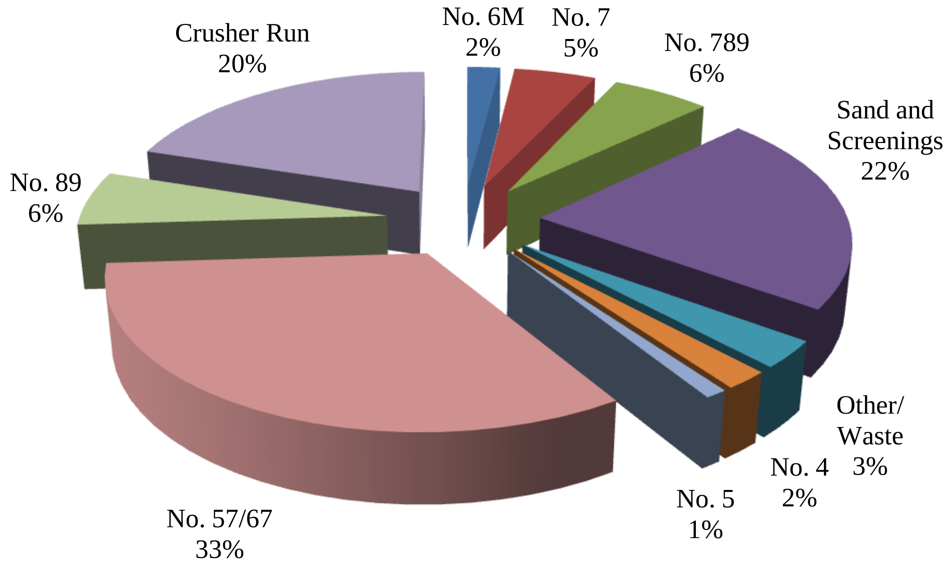
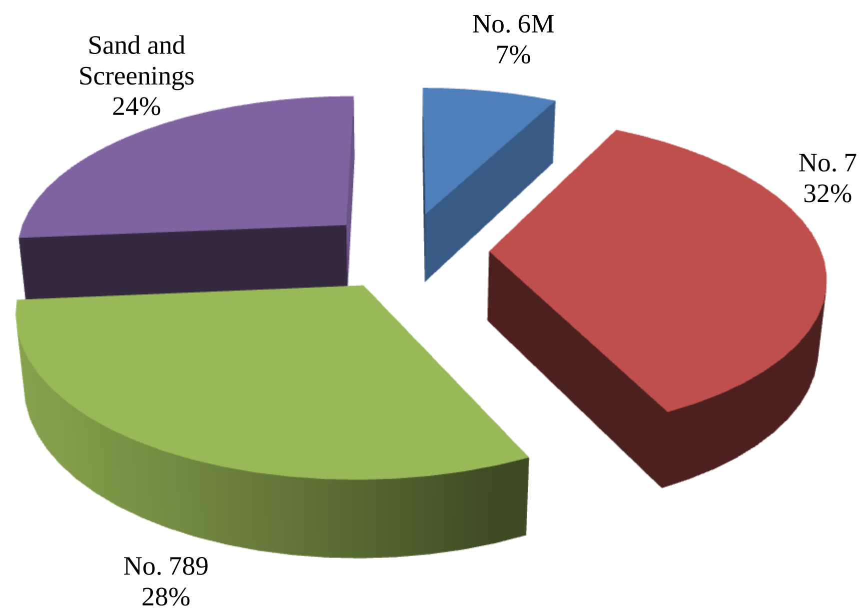
CHAPTER I: INTRODUCTION

Problem Statement

In recent years, the South Carolina Department of Transportation (SCDOT) has experienced a situation in which South Carolina quarries have had an overabundance of certain sized aggregates in supply while having lesser amounts of other, premium-sized aggregates available. This issue arose during the “27 in 7” campaign, in which 27 years of roadway construction was completed in 7 years. Some of these aggregates currently have limited demands in highway construction and maintenance while others have numerous applications in highway construction and are consequently in higher demand. Figure 1.1 illustrates the percentages of aggregate sizes produced as well as the percentages of aggregate sizes used in the old Surface 1-C designation asphalt mix (the primary roadway mix). Clearly, the SCDOT No. 7 and 789 stone were in high demand, but production to meet this demand resulted in excessive amounts of screenings that led to an imbalance in available aggregate supply. In fact, 60% of the mix is composed of two sizes that are only 11% of the production. According to the SCDOT in a 2005 presentation, the state requires approximately 80% of the 1/2-inch material produced. This, in turn leaves producers with excess crusher run and fines. Because many construction and maintenance operations involve the use of aggregates, SCDOT could potentially be paying more for projects than what is possible with a better balance of aggregate production and use. The aim of this research, conducted in partnership with industry, was to investigate possible additional ways the various aggregate sizes being produced could be used in highway projects and where the use of premium-sized aggregates can potentially be reduced (i.e., achieving mass balance) without sacrificing the final product’s performance, quality, cost, or expectations.



(a)



(b)

Figure 1.1: (a) Average Quarry Production Percentages (b) SCDOT Asphalt Mix Percentages for the Former Surface 1-C Designation

Study Objectives

The ultimate goal of this research was to identify possible ways to achieve aggregate mass balance by optimizing existing material specifications and usage to efficiently utilize available aggregate supplies—all without sacrificing the final product's performance, quality, or expectations. The specific tasks of this study were to

- Conduct a literature review of previous research addressing this topic
- Evaluate the aggregate specifications and usage in South Carolina and other states
- Evaluate the potential benefits of using more abundantly available aggregate sizes in lieu of premium-sized aggregates in highway construction and maintenance materials (e.g., concrete, asphalt, soils, base courses, etc.)
- Provide recommendations for implementation and/or additional in-depth research

Background and Significance

Optimization of aggregate material utilization should be a partnership between producers and the customers (e.g., suppliers, contractors, and highway departments). The premise behind this optimization is to achieve a mass balance where all of the aggregate material produced is utilized and there are little to no surplus materials. The impact of this work could potentially reach beyond the state of South Carolina because there has been little attention paid to this subject.

In 2002, the European Commission launched the *European Construction in Service of Society* network (ECOserve Network) with the mission to identify the needs of the European Construction Industry in its endeavor towards sustainability of the industry's products and production processes. The ECOserve Network was composed of four technical clusters focusing on specific aspects of the construction industry (ECOserve 2007). Cluster 3 focused on aggregate production and published a report recommending best available technologies for

- Inventory and planning
- Quarrying and production

- Use of aggregates in construction
- Reclamation of mined-out area

The recommendations (or best available technologies (BATs)) for achieving mass balance in this report are included in the list below and include recommendations for both aggregate producers, material suppliers, and specifying agencies (ECOserve 2006).

- *Provide vital information for planning for the availability of aggregate sources*: Identify potential environmental problems and suggest solutions to solve them—or scientific basis for decision-making. The balance and choice between local quarries providing aggregates within short transport distance and large regional quarries that serve the local area but need more transport should be considered.
- Use of novel *crushing and sorting technology* that minimizes surplus sizes. New and improved technologies are available to crush smaller aggregate sizes into cubical shape without excess fines generating. New dry classifying technologies are also available to make pre-designed grading curves for manufactured sand and fillers.
- It is also essential that production be balanced versus market, to minimize the production of non-marketable sizes.
- Avoid *too strict and narrow requirements* for road materials to promote a broader utilization of sizes and less surplus material.
- Apply the newest standards and obtain *novel application and mixing technology* for crushed and recycled materials in product recipes, including the adaptation of chemical admixtures, depending on (and utilizing properties of) the aggregate type available, and taking the specific end use into consideration.
- Implementation of *new test methods for characterization of physical properties* of both aggregates and concrete (e.g., size, shape, and density of aggregates and various rheological properties of concrete).

In the United States, much of the recent work related to this topic has been focused on optimizing aggregate physical properties to produce the most efficient product (e.g., asphalt mixture, concrete mixture, aggregate base, etc.). For example, research in NCHRP project 4-30A recommended test methods to accurately measure shape, angularity, and texture of aggregates (Masad *et al.* 2007). There were, however, no acceptable limits established for these physical characteristics that should be used in different pavement layers or in different types of asphalt mixture designs. With this type of measurement technology, it may be possible to have adaptable design methods and specifications to accommodate aggregates with a wide range of properties (*Methods to Optimize* 2007). Such adaptable practices could produce more economical finished products and help to achieve aggregate mass balance.

Evaluation of these and other ideas related to highway construction and maintenance is necessary to avoid the potential surplus of certain sized aggregate materials in the future. Additionally, with the implementation of new specifications by SCDOT (e.g., SC-M-714: *Supplemental Technical Specification for Permanent Pipe Culverts*), there may be other areas in which these traditionally underutilized materials may be used.

Benefits

The quarries across the state of South Carolina produce varying quantities of different aggregate sizes to meet many product demands. Identifying areas of highway construction and maintenance that may benefit from the use of alternate aggregate gradations could help reduce the demand for a premium-sized stone if another, more economically available sized stone would suffice with no reduction in the quality of the final product. The optimization may provide SCDOT more options for highway construction and maintenance applications while also serving to help reduce the cost of raw materials used in that work.

Scope of Work

To achieve the objectives of this study, the following tasks were completed:

1. Literature review

   There has been a relatively limited research conducted in the area of optimizing aggregate usage in the United States. The objective of this task was to study what has been done previously with regard to aggregate usage to help generate ideas for the research components to follow.

2. Survey of State DOTs

   Surveys were created to gather information regarding aggregate utilization and balance from state departments of transportation (DOTs).

3. Survey of State DOT Aggregate Gradation Specifications

   A survey of gradation specifications for bases and subbases, asphalt and concrete pavements, asphalt surface treatments, and incidental construction was conducted to compare the specification bands across the country. This information was used specifically to compare the allowable ranges in South Carolina with DOTs across the country.

4. Questionnaire of the South Carolina Aggregate Industry

   A questionnaire was sent to the Mining Association of South Carolina to obtain information and recommendations from the local aggregate industry related to aggregate production and use patterns in highway construction and maintenance operations.

5. Data Compilation and analysis

Organization of Report

This report is comprised of six chapters. The first chapter provides some background information and lists the study objectives and scope of research. Chapter II is the Literature Review in which research regarding aggregate optimization is summarized. Its sections include aggregate resource, reuse, and production optimization. Chapter III is the Research Methodology, which explains the processes taken to acquire the necessary information. It explains the surveys used, as well as the information obtained from individual state departments of transportation specifications books. Chapter IV is the Results and Discussions, which analyzes all of the data received from the surveys and aggregate specification gradation database. It is divided into sections for the department of transportation surveys and the aggregate gradation specifications (divided into application type), as well as a smaller section for other aggregate property comparisons. Chapter V is comprised of examples of potential aggregate utilization scenarios. And the final chapter, Chapter IV is the Conclusions and Recommendations produced from the research.

CHAPTER II: LITERATURE REVIEW

Overview

The concept of aggregate optimization is certainly not new; however, it is a concept that focuses on many different and very separate areas. This review will discuss the research areas that have been covered regarding aggregate optimization. It is important to note that the idea of mass balance or aggregate optimization from a grain size perspective has not been a researched or published focus. It is possible that this problem of specific aggregate size imbalance has come about only recently from large development in a time of very specific design specifications. The primary areas documented include: aggregate optimization as a function of design strength and functionality; availability as a whole from a geological perspective; potential ways to utilize seemingly unwanted or discarded aggregate; and the optimization of aggregate production.

Aggregate Performance Optimization

Many research projects have been conducted attempting to determine the optimum aggregate blend in pavements. Research papers both in concrete and asphalt, relating to aggregate gradation, have been published making claims as to what type of gradation is best. In 2005, Richardson completed research with concrete (Richardson 2005), which indirectly suggested a gradation that may help maintain particle size mass balance. Richardson reported that typical practice has evolved into the use of two distinct aggregate fractions, coarse and fine, which has resulted in a gap-graded aggregate blend for most applications. However, the DOTs in Iowa, Minnesota, Kansas, and Washington and other specifying agencies (ACPA, MCIB, and USAF) have formally adopted a concept of optimization of aggregate gradations that address the concern of gap-graded mixes (Richardson 2005). These optimizations have stemmed from research relating to the strength and functionality of concrete pavements. Richardson suggested that these gradation optimizations can create a more well-graded mix that tends to have fewer problems with pavement edge slump, segregation due to vibration, finishing, raveling at joints, and wear resistance in concrete. However, he also noted that these optimization techniques could also require additional equipment to be purchased, extra handling involved, and extra shipping costs due to the fact that certain natural resources may not be conducive to producing certain aggregate sizes.

At typical concrete batch plants, only one coarse and one fine aggregate source are stocked for the purposes of routine production. This creates gap-graded mixes with associated behavioral problems in strength and functionality, but also creates an imbalance due to a lack of intermediate sizes (Richardson 2005). It has been suggested that there are problems with the current gradation specifications such as ASTM C 33 and with the current way of specifying aggregates (Shilstone and Shilstone, Jr. 1987). Shilstone and Shilstone, Jr. recommended the use of an Individual Percent Retained method, or IPR, to account for the intermediate grain sizes that are seemingly missing in most mixes. Such a gradation method could be beneficial in potentially achieving mass balance between particular aggregates sizes. It was from this gradation method that the concept of the “8-18 band” originated.

The 8-18 band is an attempt to prevent severe gap-grading or excessively coarse or fine gradations as characterized by excessive peaks or valleys in a gradation’s IPR plot. The Minnesota DOT has provided incentives and disincentives relating to meeting the 8-18 band, and the Mid-West Concrete Board has adopted it into its specifications. The general trend seen is that the 8-18 band is gaining widespread use among state DOTs, consulting engineers, contractors, and owners (Richardson 2005). The 8-18 band describes the percent retained desired for each individual size. The hope is that all the intermediate sizes have an individual percent retained between 8 and 18 percent; this results in a “haystack” shaped IPR plot.

The 8-18 band concept is not without opposition. Some aggregate producers believe that many natural aggregates cannot meet the 8-18 specification because the aggregate does not have the fractions available to meet all the intermediate sizes. In other words, some aggregates cannot be efficiently crushed into a well-graded mix with all the intermediate sizes (Richardson 2005). This would ultimately result in additional waste products and, in turn, may result in the need for new equipment or plant modifications, which would of course create higher initial costs. So while the 8-18 band seems to keep a good mass balance between sizes, some of the required sizes may not be available at many quarries.

Research is also being conducted in the area of the use of fines more specifically in concrete pavements. ICAR, the International Center for Aggregate Research at the University of Texas at Austin, as conducted research focused on the use of fines and has many publications pertaining to the optimization of the use of fines in Portland cement concrete. While this research is primarily concerned with hot mix asphalt construction, the thought process of optimizing gradations, such as utilizing fines, an under-utilized aggregate size, is exactly the line of thought that can lead to a more optimized use of the available aggregates.

Aggregate Resource Optimization

Another area of aggregate optimization focuses on managing and protecting aggregate resources as a whole. By protecting and managing the current aggregate sources as well as examining future aggregate sources, the balance of aggregate sizes could be more effectively handled. The United States Geological Survey (USGS) has published numerous reports regarding the importance and need to manage aggregate resources. Natural aggregates are the most valuable non-fuel mineral commodity in the world, and as such, the managing of the aggregates is paramount (Lüttig 1994). The government, industry, and the public must cooperate at the regional and local planning levels for sustainable aggregate extraction to be successful (Langer 2002). The U.S. Environmental Protection Agency (US EPA) defines sustainability as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. While Langer was concerned with the overall availability of aggregate, a similar importance must be placed on the balance of aggregate grain sizes. All uses of aggregates require certain gradations according to given specifications. The loss of certain sizes can be just as detrimental as the loss of a whole aggregate source. As such, it will be imperative for all groups involved; producers, contractors, and governing regional and local planning organizations, to work together in addressing the issue.

In 2004, Horvath stressed the importance of developing a life cycle analysis of construction materials (Horvath 2004). Crushed stone, sand, and gravel use has grown significantly from 33% in 1900 to approximately 70% of all materials used in 1998. The analysis can take into account short and long-term stocks and flows of materials as well as the geographical distribution of the materials used. A method proposed by Graedel and Klee helps estimate the ratio of current consumption rate to a "sustainable rate" **(**Graedel and Klee 2002**)**. For materials used in United States construction, the consumption rate is estimated to be less than the sustainable use rate for now. To continue to track this, the available supply of the resources must be established, resource supplies must be allocated amongst the population, and the sustainable rate determined including reuse and recycling (Horvath 2004). In short, at the rate these materials are being used, the United States will not stay below the sustainable use rate, so measures must be taken to optimize the usage of these construction materials, including aggregates.

In the United Kingdom, the Department of the Environment, Transport, and Regions published a paper in 2000, *Planning for the Supply of Aggregates in England*, which identified nine major issues in protecting and managing aggregate sources: 1) defining the needs of aggregates, 2) assessing the supply of aggregates, 3) estimating the future demand of aggregates, 4) considering imports and exports, 5) considering inter-regional supplies, 6) considering multi-modal transportation of aggregate, 7) assessing and mitigating environmental impacts of aggregate development, 8) identifying preferred areas for aggregate extraction, and 9) planning for future development of aggregate resources (Department of the Environment 2000). Certainly, the need for planning and preparing for future aggregate supplies and sources is of great importance, but in the same way managing the current aggregate supply is vital to protecting the resource. A number of steps described above regarding aggregate supply will also be important in addressing the mass imbalance in aggregate sizes. The current and future needs must be known and the supplies assessed. Communication between inter-regional supplies could be extremely valuable as certain quarries may be lacking or overwhelmed with particular grain sizes. Clearly, there is a need for managing and protecting the supply of these natural resources; however, the way in which different aggregate sizes are used will need to be closely examined as well—whether it can be addressed by altering current specifications or by finding uses for aggregate sizes experiencing a surplus. There is research being completed both in finding alternative aggregate sources through recycled materials and also the use of marginal aggregates (which does not meet certain specifications) in other applications (Department of the Environment 2000).

The Federal Highway Administration (FHWA) has also investigated the importance of planning for the future. In 1974, the FHWA completed a database of highway construction usage factors for aggregates. It was identified that the planning and estimating of future requirements for materials for the industry to be geared to supply such material was an important phase in highway construction. A state-by-state usage factor was developed in hopes to best prepare for the future. These usage factors were intended to aid commercial pit and quarry operations as well as highway contractors, engineers, and economists in planning to meet the needs of the highway construction program (FHWA 1974). While this research was geared towards federal highway projects, the usage factors could be used across road applications. "Highway Construction Usage Factors for Aggregates" was an important step in developing an effective pavement management system, and points to the importance of not only looking to the future, but also optimizing the aggregates that are currently available.

The combination of the depleting natural resources as well as the extreme expense of aggregate transportation has led to the recognition of a GIS, spatially significant, aggregate source management system proposed in Iowa (Harding 2007). Although valuable aggregate sources are viewed by the public as a nuisance and planning generally is focused on agriculture or urban development. By continually developing over usable lands, the supply will continue to deplete resulting in increased construction prices. This GIS system will allow users to visually integrate data on current and historic aggregate sources with other relevant data such as land use, soil, and demographic information, among others (Harding 2007). This will allow the state to better plan for the future and designate key areas as places for future mining to prevent the depletion of aggregate sources.

A 1996 USGS study showed that in the Denver, Colorado area, 80 percent of asphalt debris and 50 percent of concrete debris were reused in some capacity, thereby reducing the need for new material from mining operations. This is a good sign considering fifty percent of the combined estimated sand and gravel and crushed stone used in construction in 2005 was for highways (Sullivan 2006). Although large portions of the available resources are being reused, the high volume of construction requires additional measures to best utilize the available aggregates. In addition to highways, other recyclable processes have been suggested.

Aggregate Reuse Optimization

The Oregon State Department of Forest Engineering suggested that aggregate recycling of decommissioned forest roads could provide a usable aggregate source that is cost-effective to reclaim. Aggregate is used on many low volume forest roads to reduce wheel stresses transferred to the subgrade, reduce erosion, maintenance costs, and driver discomfort. It has been shown that there is a potential for aggregate to be recovered and used elsewhere on the road network, at a reduced cost compared to purchasing aggregate from a quarry (Thompson and Sessions 2008). In addition, the decommissioning of these roads could have environmental benefits as well.

This reclamation process can be aided by the use of geotextiles. The presence of geotextiles can increase the percentage of aggregate recovery, by helping to prevent contamination of the base layer by the subgrade material (Thompson and Sessions 2008). In addition, these geotextiles can help reduce the need for aggregates to stabilize a subgrade or base in effect increasing the available supply at the quarries. Aggregate reclamation and the use of geotextiles could be beneficial in both reducing the need for aggregate and also replenishing the available supply in the market. The reclamation of heavily used aggregate sizes could help balance the grain size availability for various projects. Even the aggregate that fails to meet many pavement specifications can still be useful.

Grau suggests that marginal quality aggregates (aggregates that do not meet existing specifications) can be used in the construction of surface pavement layers of asphalt and Portland cement concrete in secondary roads, parking lots, or storage areas (Grau 1980). The study included the mixing and placing of both zero-slump concrete and asphalt concrete with poorly graded sand, gravelly-clayey sand, gravelly sand, poorly graded gravel, crushed limestone, clayey sand, and sand (all of which did not meet specifications for large volume roadways). The mixes were tested under low volume loadings for strength and the surface examined for functionality. The mixes held up under the load, but some suffered from polishing of the surface aggregate resulting in a slick surface, as well as raveling, which was more apparent in wet weather conditions. While marginal aggregates may not be considered useful in large volume pavement applications they can still be effective in parking lots and storage areas. In the same vein, researchers have begun to identify other sources that can be used for aggregate besides reclaimed or marginal aggregate.

Research is currently being conducted concerning pavements composed primarily of RAP (reclaimed asphalt pavement) as well as recycled concrete pavements. If these recycled pavements can be approved and allowed in construction specifications in larger quantities they could help balance the aggregate grain sizes and perhaps more importantly increase the available supply of aggregates. A paper presented at the 2002 Annual Conference of the Transportation Association of Canada identified the need to plan for the future with aggregate demands rising and supply depleting. It was suggested that cold mix recycling of existing pavements and granular base courses, the stabilization of subgrade layers, and the introduction of higher strength and more durable pavements are gaining attention as means to reduce the need for natural aggregates. In Manitoba, there is a scarcity of coarse aggregate, which is used more and more in construction specifications and therefore the Materials & Research Branch (MRB) of the Manitoba

Transportation and Government Service is looking into further planning methods and legislation to better manage their aggregate (Blais *et al.* 2002). While the use of aggregates in other applications or the reclamation or recycling of used aggregates can largely influence aggregate grain size balance, the optimization of the production of aggregate can directly change the supply for particular sizes.

Aggregate Production Optimization

There are a number of numerical models used to optimize aggregate production. One of the methods described by Ou *et al.* (1982) uses mixed integer linear programming (MILP) techniques in aggregate management planning for energy conservation. By optimizing the energy required for production, the process has essentially been optimized for profit. The distribution pattern is based on the quantity and quality of both the supply and demand of aggregate. The method takes into account inventory of aggregate, trip generation, modal split, cost estimates, and the supply and demand of the aggregates. This method was utilized in the Gifford Pinchot National Forest to generate an optimal aggregate allocation pattern based on the least cost as well as the least fuel consumption (Ou *et al.* 1982). Although this particular case study investigated supply and demand of the aggregate as a whole, numerical optimizations could be made regarding the supply and demand of specific aggregate sizes in effect attempting to optimize the mass balance of aggregate sizes. In addition to the overall production process, mathematical models have been established to optimize individual processes within aggregate production.

This optimization is not a new finding. In 1969 McKisson published a paper for the Department of the Interior focusing on aggregates for concrete production. McKisson stated that it is not the amount of material per se, but rather the amount of aggregate, which can be processed to satisfy certain specification limits that are important. Therefore, it is imperative to optimize the amount of aggregate innately present in a deposit, which can theoretically be processed to satisfy the specification limits. Linear programming was used to determine a unique solution for a particular grain size fraction (McKisson 1969). This need to optimize particular aggregate sizes in production has lead to numerical modeling and processing techniques for the crushers and screens used in processing.

Shi, in 1999, developed nonlinear mathematical models for modeling the setting of crushers, setting of screens, and flow rates. An optimum setting for the screens and crushers can be set, producing a linear mathematical model in regards to the production flow rate. From this linear model, the optimum production rate can be determined. A sensitivity analysis must then be completed to see if the screen or crusher settings should be altered to further optimize production (Shi 1999). The systems available and used in various aggregate production plants are very sophisticated and set to optimize production. Unfortunately, this optimum production procedure may not result in the volumes of particular grain sizes needed to create a mass balance of the particular grain sizes.

Conclusion

The need for further planning and optimization in aggregates has been identified, but little has been published regarding correcting the mass imbalance between grain sizes brought about by heavy production. The continual use of similar sizes has left a surplus of certain grain sizes. With the growing needs of aggregates for development and the reducing availability, it is important to begin to manage and plan the aggregates available both as a whole and as individual sizes.

CHAPTER III: RESEARCH METHODOLOGY

The objective of this study was to investigate the imbalance of particular aggregate sizes and recommend ways to reduce this problem in the future. This required a thorough examination of past problems, both in South Carolina and other states, as well as an examination of the current aggregate specifications. The primary means used were surveys and a constructed database of state aggregate specifications.

Survey of State DOTs

The survey was intended for all the state DOTs to obtain a better understanding of the problems, or lack thereof, they had experienced in the past, what caused those problems, and how they were dealt with. The full surveys can be seen in Appendix A. To better understand what was happening in South Carolina, it was helpful to compare the issues from state to state. The surveys were carefully constructed to keep the length short, but to ensure that all of the necessary information could be obtained. They were then sent to the Materials Engineer within each state's DOT. All the responses were then compiled and analyzed. The majority of the questions were objective, which allowed the surveys to be more easily tallied and compared across the country. Graphical figures were then used to present the information received.

Aggregate Gradation Specifications

The second aspect of the research approach was to construct a database containing all of the applicable aggregate gradation specifications for all fifty states. The areas of interest included: bases and subbases, hot mix asphalt surface, intermediate, and base courses, asphalt surface treatments, concrete pavements, and incidental construction (primarily drainage and backfill uses). Each state's specification manual was searched to obtain all of the desired specifications from each subcategory. To more easily compare the specifications, each state had its own column in the database with given information for each application. The gradations were divided into individual sieve sizes and percent passing to isolate specific aggregate sizes.

Each gradation was then compared to that of South Carolina and described as the same, coarser, finer, broader, or narrower. A coarse designation was given for a sieve size if the midpoint of the specification range was greater than 2% lower than the midpoint of the South Carolina specification; finer designation was for sieve sizes with a midpoint of the specification range more than 2% greater than the midpoint of the South Carolina specification; broader was assigned for sieve sizes with a lower percent passing for the lower limit and greater percent passing for the upper limit; and narrower, for sieve sizes with greater percent passing the lower limit and lower percent passing the upper limit as compared to the SCDOT specifications. If a specification included 0 or 100% passing, it was also considered broader or narrower if one of the limits was equal while the other was higher or lower (by more than 2%). With gradations from all fifty states in all the applications of interest categorized, certain sieve sizes of high variability could be identified. While further research would be required to guarantee any new gradation would meet all performance requirements, possible sizes and gradations could then be suggested for further study. After certain applications with high variability were identified, graphical representations of the other states' gradation bands with respect to the current South Carolina gradation bands were presented.

Aggregate Properties Comparison

In addition to the surveys and database, aggregate properties, specifically the LA Abrasion and dust-to-binder specifications across the nation were examined for multiple applications: base, hot mix asphalt surface, intermediate, and base courses, and concrete pavements. By examining the LA Abrasion values, one can determine if there is a correlation between coarser mixes and higher allowable abrasion values because a higher allowable abrasion will likely result in the actual in-place gradation being less coarse than the specification due to aggregate breakdown.

Aggregate Industry Questionnaire

A questionnaire was distributed to the Aggregate Committee of the Mining Association of South Carolina (MASC). The information obtained from the questionnaire was compiled and compared to the responses from the survey of state DOTs. This questionnaire requested the following information from the member aggregate producers:

1. Historical production/sales figures (tons) of different aggregate sizes.
2. Historical figures on aggregate utilization. What was the aggregate used for?
3. During times of imbalance, what aggregate sizes are in high demand and which are in low demand?
4. What markets have the greatest impact on potential aggregate imbalances (e.g., HMA, asphalt surface treatments, concrete, base/subbase, incidentals, etc.)?
5. Typical aggregate breakdown at a quarry. In other words, of a given quantity of rock crushed, what is the breakdown of the different products (e.g., percentage)?
6. Any ideas that the members of the Association have to cope with the issue of aggregate imbalance.
7. Of the aggregate producers that supply for SCDOT, approximately what percentage of aggregate sales is to SCDOT compared to other customers?
8. What effects do the SCDOT aggregate specifications have on production/sales of aggregates in South Carolina?
9. Any other information that you feel is of importance to the study.

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CHAPTER IV: RESULTS AND DISCUSSION

This chapter is organized into two sections: survey results, and the specification database results. The survey consisted of a series of questions for the state departments of transportation to help determine if aggregate mass imbalance is an issue elsewhere and, if so how was it handled, and what types of results were seen from it. The aggregate specification database was then used to compare SCDOT gradation specifications with other DOTs in the nation to determine if the allowable gradation bands in the state could potentially contribute to the development of an aggregate imbalance. The raw data from both the surveys and the aggregate gradation specifications can be found in the Appendices.

Survey Results

Of the 50 states polled, 25 responded to the survey. Of the respondents, only six had experienced an over or under-utilization of particular aggregate sizes (South Carolina, Kansas, Louisiana, New Jersey, New York, and Ohio) (Figure 4.1). Of those six, five had experienced the problem as a recurring issue (Figure 4.2). It is of interest to note that the six states that had experienced aggregate imbalance did not share any geographical classification, as there were states from the Midwest, South, and Northeast. Those six states were then asked to answer additional questions concerning their specific imbalance as can be seen in the full survey results found in Appendix A-2. The period, duration, and effect of high volume construction for all states can be seen graphically (Figures 4.3, through 4.5), as well as descriptions of the issues faced by the states that had seen imbalance in their aggregate supply.

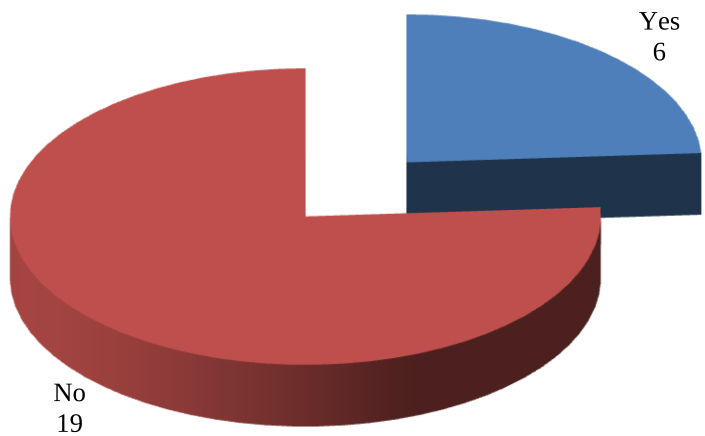


*Figure 4.**1**: States Experiencing Over or Under-utilization of Particular Aggregate Sizes*

While a small fraction of the states had seen an aggregate imbalance, of the states that had experienced it, the majority (five out of six) experienced the imbalance as a recurring problem (Figure 4.2). This further supports the need for review in South Carolina to ensure the imbalance does not become a recurring issue.

The time periods in which an aggregate imbalance existed spanned much of the last two decades in most cases (Figure 4.3). There was a slight increase in the late 1990s and early 2000s, but the number of occurrences was very consistent from 1985 on, varying slightly as development and high volume construction varied with the economic situation.

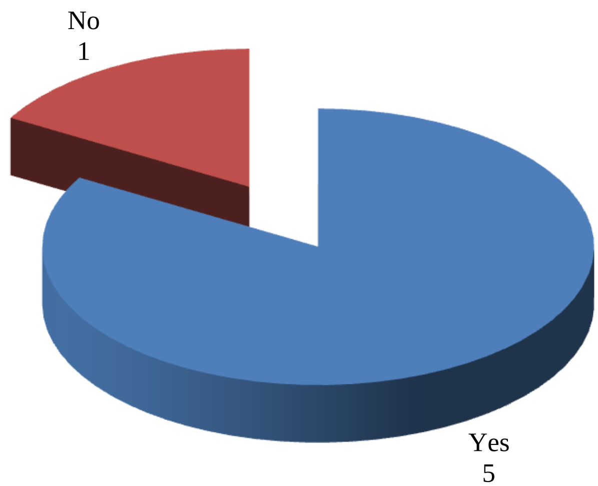


*Figure 4.**2**: States Experiencing a Recurring Aggregate Imbalance*

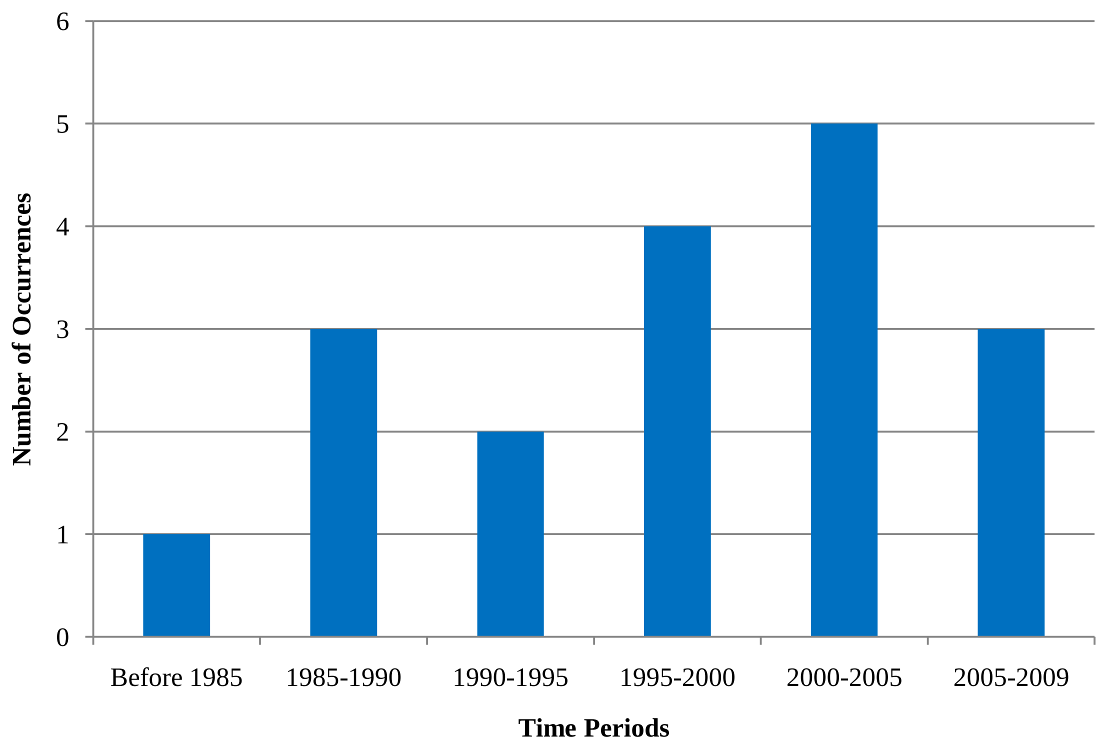


*Figure 4.**3**: Periods of Aggregate Imbalance*

With so few responses, the duration of the imbalance data did not yield any strong relationship; however, it is clear that the durations can greatly vary as supply and implementation of strategies to improve the aggregate balance varies (Figure 4.4). Aggregate imbalance is an issue that can carry on indefinitely, but it is also an issue that can be improved.

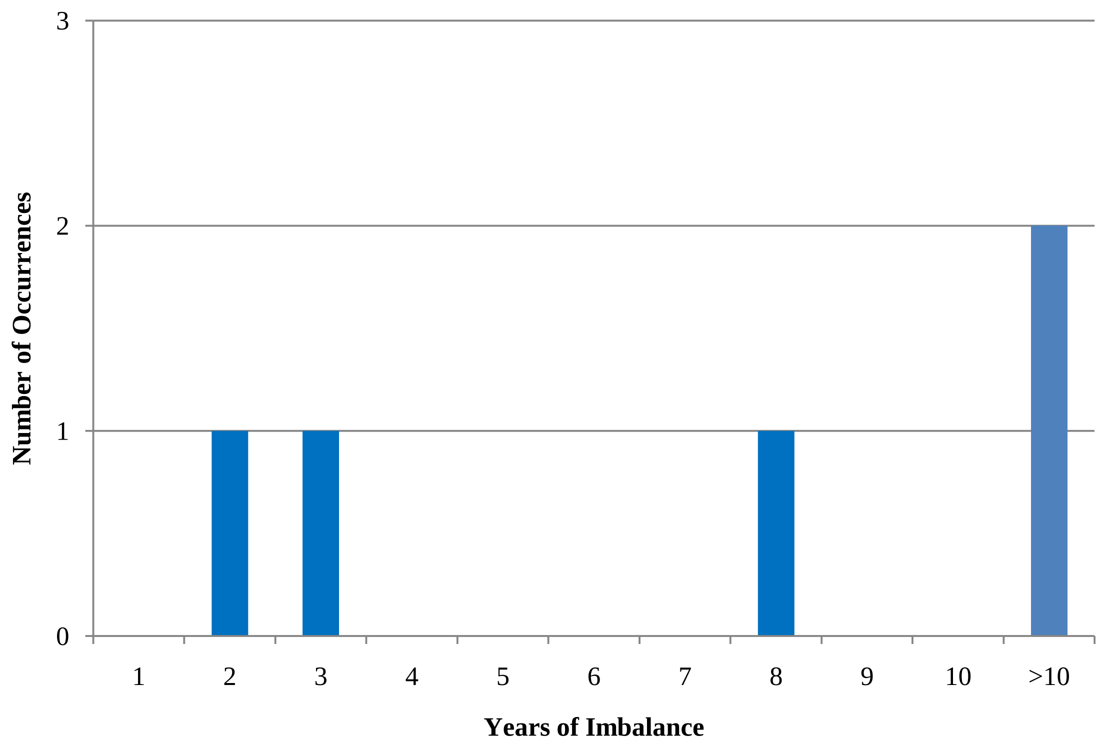


*Figure 4.**4**: Duration of Aggregate Imbalance*

States that had experienced an aggregate imbalance and those that have not were asked to predict or state (if they had experienced) what the effect of high volume construction would be on the aggregate supply. The majority of the states answered no change or effect as one would expect since they have not experienced any imbalances in supply; however, four of the states that have seen an imbalance answered the question, two with a slight imbalance and two with a moderate imbalance (Figure 4.5). In addition, three states predicted that a slight imbalance would result if they were to see a larger volume of construction.

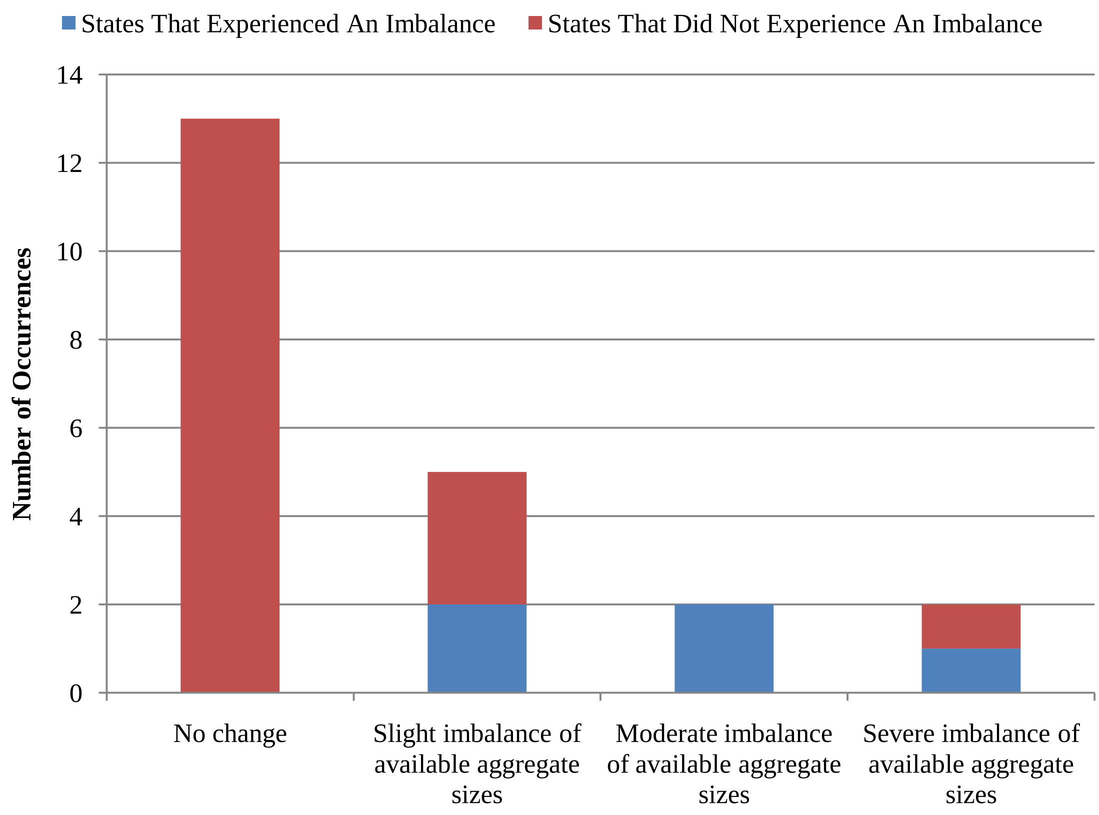


Figure 4.5: Effect of High Construction Volume on Aggregate Supply

Again, all of the states were asked to hypothesize or state (if they had experienced an imbalance) what types of construction would likely contribute to the over or under-utilization of certain aggregate sizes resulting in an aggregate imbalance. Asphalt pavements and surface treatments as well as concrete pavements were the overwhelming favorites (Figure 4.6). In South Carolina, the majority of aggregates are used in asphalt pavements and, therefore, the specifications for all asphalt pavements and surface treatments were analyzed. Base and subbase, as well as drainage, received some responses, but pavements were the majority.

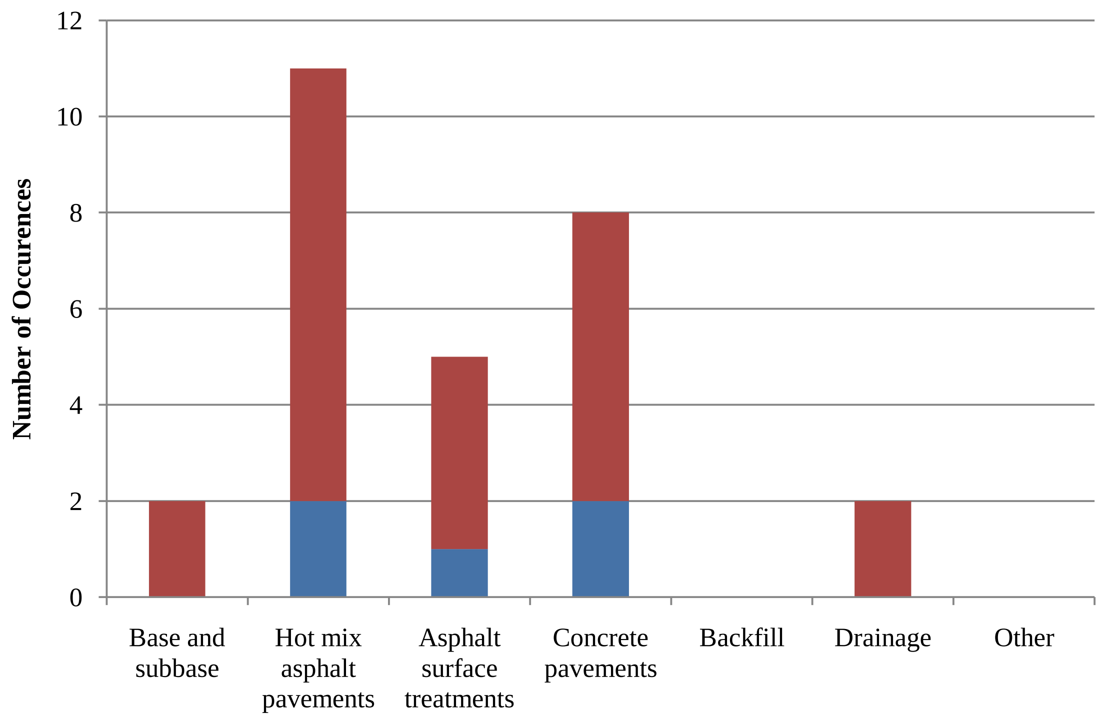


Figure 4.6: Types of Construction Likely to Contribute to Over or Under-utilization of Aggregates

In addition to the objective questions, each state was asked to identify what specific aggregate sizes were or are being over-utilized as well as under-utilized.

- Over-utilized Aggregate Sizes
  - South Carolina: 3/8-inch and 1/2-inch aggregates
  - Kansas: aggregates larger than 3/8-inch sieve
  - Louisiana: aggregates larger than 3/4-inch and between the No. 40 and No. 8 sieves
  - New Jersey: by having to select in production either a No. 57 or 67 stone, one size becomes over-utilized, while the other becomes under-utilized
  - New York: aggregates between 1/8-inch and 1/4-inch sieves
  - Ohio: No. 8 stone due to asphalt usage

- Under-utilized Aggregate Sizes
    - South Carolina: screenings and crusher run aggregates
    - Louisiana: aggregates between the No. 4 and 3/8-inch sieves
    - New Jersey: HMA sand or fines
    - New York: aggregates larger than 1-inch sieve

Just as important as the aggregate sizes are the reasons, or potential contributors to the imbalance. In Kansas's case, the imbalance stemmed from high demand of concrete aggregate. Not all suppliers were focusing on marketing the 3/8-inch material and increased construction produced a higher demand of that particular aggregate size for concrete roadways. Like Kansas, Louisiana also experienced a high demand for concrete aggregate. Due to low availability of local supplies they rely on the importation of crushed stone to meet their needs.

New Jersey was more affected by plant production restrictions. This occurred in the mid 1980s, when there was a need for both No. 57 stone and No. 67 stone; however, they could not be produced at the same time. In addition, concrete sand became a concern with the onset of SUPERPAVE. The issue was resolved through simple communication with the DOTs and the producers, and the market responded by producing more washed stone sands and having more natural sand pits.

In New York, most HMA mix designs use #1A sized aggregate (1/8-inch to 1/4-inch) and rarely use +1-inch sized aggregates in either HMA or PCC mixes. To supply the #1A sized aggregate that meets the demand, larger sized aggregate must be re-crushed, which increases the price. The greatest demand for #1A stone is in the Downstate area, in the vicinity of New York City. In Upstate (the rest of New York), there is significantly less imbalance in the market. NYSDOT made no attempt to deal with this issue because they consider it a market issue that is reflected in bid price.

Ohio is perhaps most similar to South Carolina in situation and saw an aggregate imbalance rise due to the increased volume in asphalt pavement construction. The surveys indicated that there is a number of contributing factors as well as responses, or solutions. The majority of the imbalances were derived from high demand caused by high volume construction in pavements (both in PCC and HMA). It is also clear that there is an inseparable connection with construction, the regulating body, and the suppliers.

South Carolina's primary aggregate use in construction is hot mix asphalt pavements. Specifically, during the "27 in 7" campaign, large amounts of asphalt paving were completed resulting in an aggregate balance. The 3/8-inch and 1/2-inch aggregate sizes became over-utilized, while the fines and screenings were left under-utilized.

Aggregate Gradation Specification Results

The results are subdivided into sections based on application in the following order: Base and Subbase, Hot Mix Asphalt Surface Courses, Hot Mix Asphalt Intermediate Courses, Hot Mix Asphalt Base Courses, Asphalt Surface Treatments, Concrete, and Incidental Construction. However, for comparison the concrete and incidental construction specifications were not shown graphically because South Carolina's primary aggregate use was asphalt related based on their survey response. All specifications can be found in Appendix B. Within each subcategory, the number of differences within the specifications compared to SCDOT were determined and plotted to isolate specific sizes that seemed to be significantly different than the other states. In the database itself, each difference was coded as broader (both upper and lower specification limits outside that of SCDOT by greater than 2%), narrower (both upper and lower specification limits within that of SCDOT by greater than 2%), coarser (midpoint of the specification limits more than 2% less than that of SCDOT), finer (midpoint of the specification limits more than 2% greater than that of SCDOT), or no change. All of these categories were applied with a tolerance of plus or minus two percent. The sum of all these differences was then taken to identify the specific sizes with large differences. Once identified, a pie chart of those sizes was created to show the breakdown of the differences.

Base and Subbase

After comparing all the specifications of other states with South Carolina's Macadam Base Course, three sizes in particular varied from South Carolina's allowable range, the 1.5-inch, No.4, and No. 200 sieves. As Figure 4.7 shows, the variation at the 1.5-inch sieve was most significant, but the No. 4 and No. 200 also showed significant variation. The 1.5-inch sieve specifications across the other states were predominantly finer or narrower than South Carolina. The differences in the No. 4 sieve were mostly finer. The No. 200 sieve was fairly evenly split between coarser, finer, broader, and narrower, however there were more specifications that were narrower.

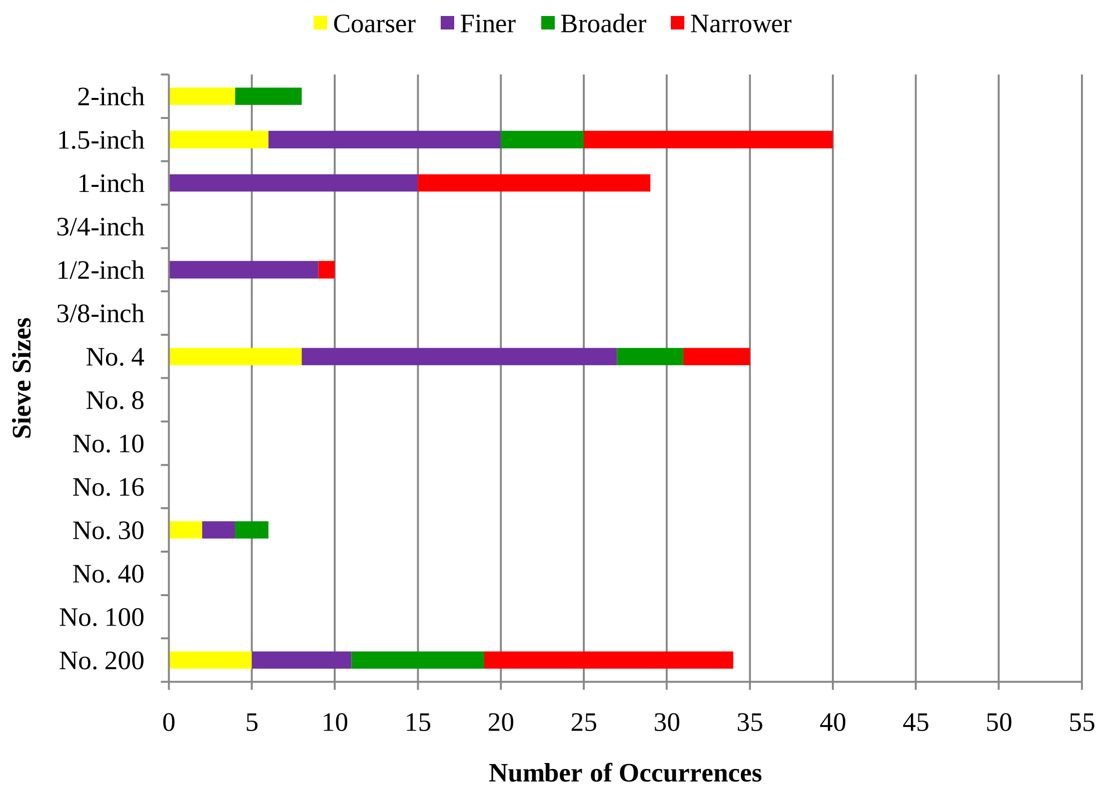
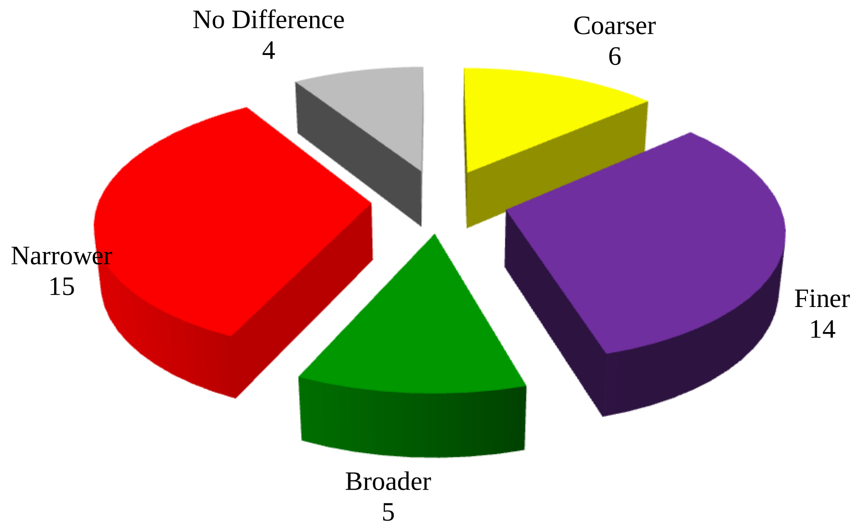


Figure 4.7: Number of Differences in Base and Subbase Gradation by Size

Figure 4.8 summarizes the comparison of the SCDOT specifications for the 1.5-inch sieve. The majority of states had finer specifications (14 states), or more percent passing the 1.5-inch sieve, or simply had a narrower specification (15 states). Only four states had the same specification with a two percent tolerance, 6 states had a coarser specification, and 5 states had a broader specification. The remaining 24 states did not have a requirement for the 1.5-inch sieve.

The gradation differences at the No. 4 sieve had a large percentage of states with a finer specification (19 states) (Figure 4.9). Of the 38 specifications for the No. 4 sieve examined, 8 were found to be coarser (lower percent passing), 4 broader, 4 narrower, and just 6 with no significant difference. Therefore, only 10 out of the 38 specifications were the same or narrower than South Carolina. Only Ohio, New Mexico, Vermont, Maryland, Alaska, and Illinois (states not reduced to one geographical region) had specifications with no difference compared to South Carolina, within a 2% tolerance.

Finally, the gradation breakdown for the No. 200 sieve showed a different picture than the previous two sizes (Figure 4.10). Although there was high variability in the specifications, the majority of the differences at the No. 200 sieve were narrower or the same. Of the 40 specifications for the No. 200 sieve, 15 were narrower ranges and 12 were the same, therefore, 27 of the 40 were the same or even tighter than the South Carolina specifications. Five specifications were coarser, 6 finer, and 8 broader.



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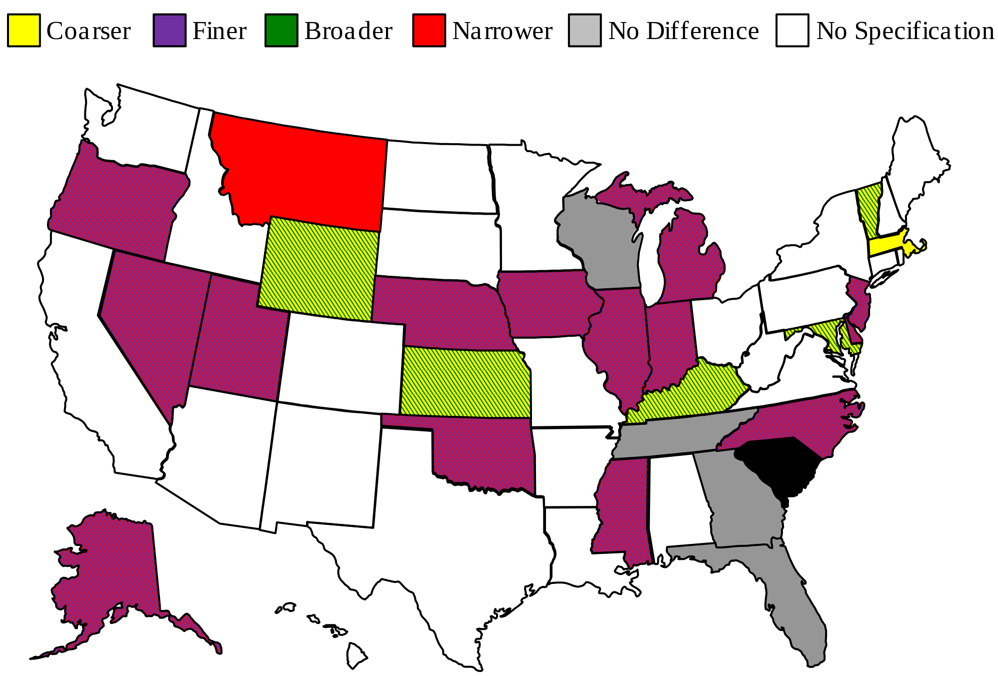
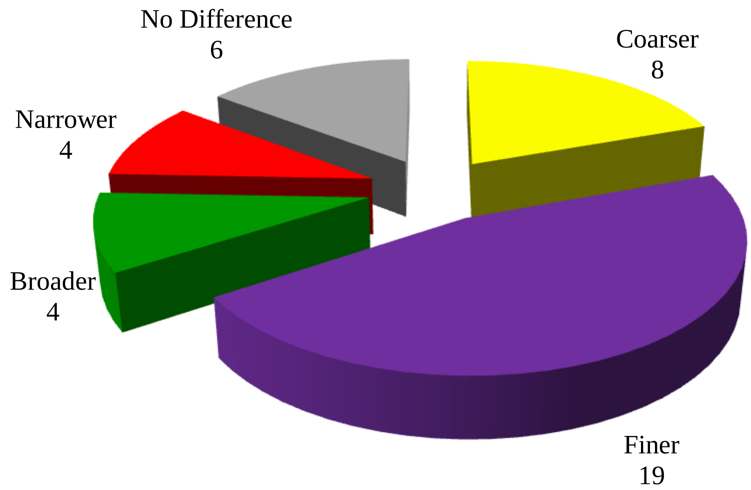


(b)

Figure 4.8: (a) Gradation Breakdown for Base and Subbase at the 1.5-inch Sieve;(b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



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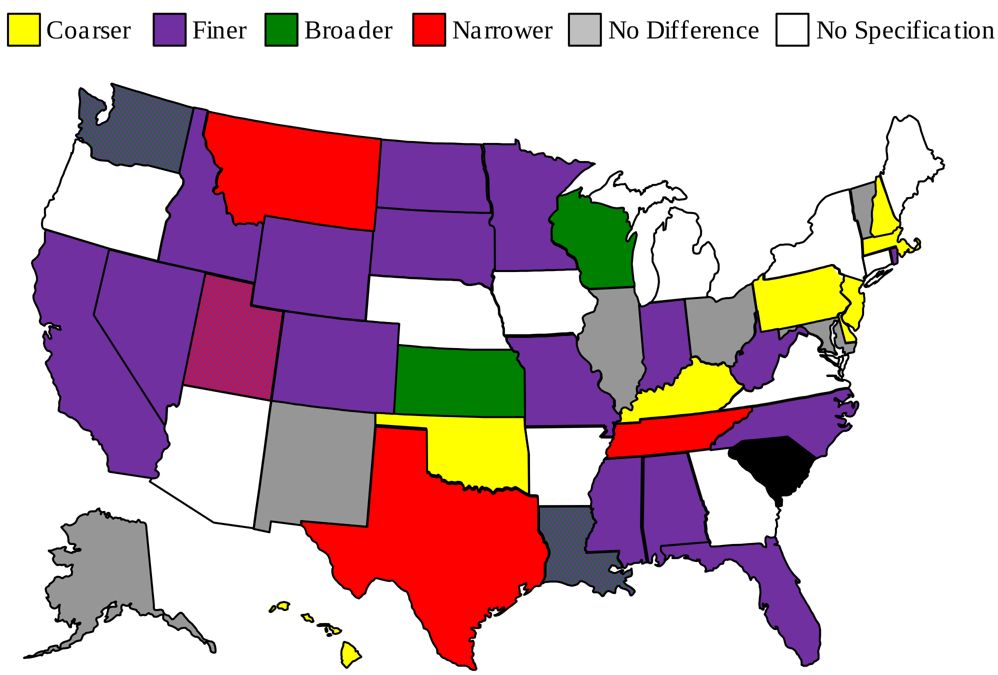

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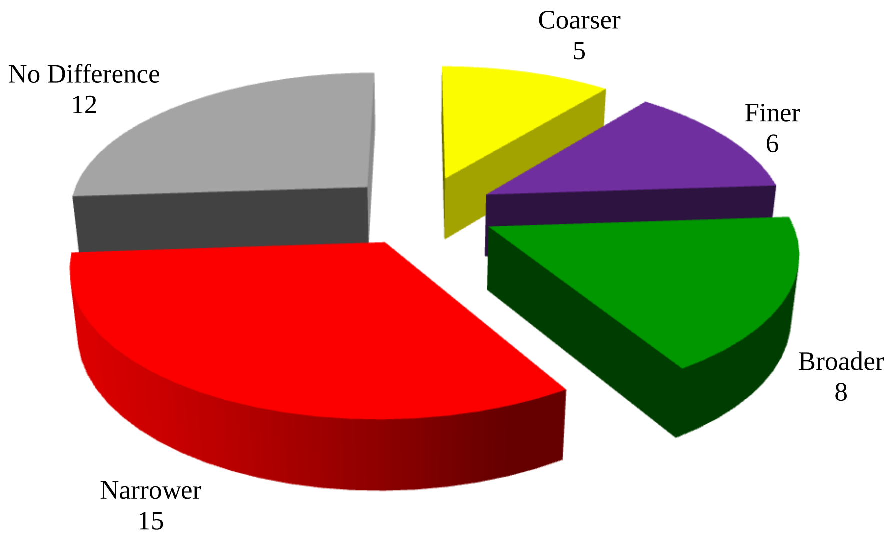
Figure 4.9: (a) Gradation Breakdown for Base and Subbase at the No. 4 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



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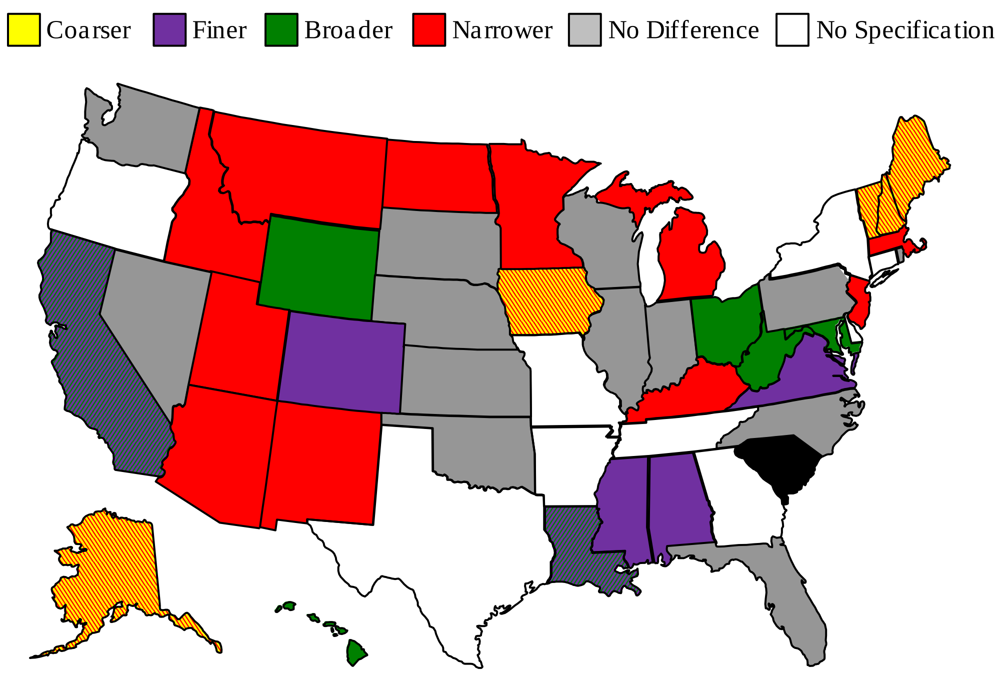


(b)

Figure 4.10: (a) Gradation Breakdown for Base and Subbase at the No. 200 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category

Hot Mix Asphalt Surface Courses

As previously discussed in the survey section of the results, the aggregates used in pavement applications were seen as the major contributor to aggregate imbalance. Because South Carolina uses most of its aggregates in asphalt pavements, the differences in specifications for the asphalt applications were of the utmost importance in identifying potential contributors to the aggregate imbalance and then addressing such issues. The first application analyzed was the Type A and B hot mix asphalt surface course. As can be seen in Figure 4.11, the greatest differences in specifications were seen at the 3/8-inch sieve and the No. 8 sieve, both with more than 37 specifications with varying allowable ranges. The majority of the differences in the 3/8-inch seemed to stem from broader ranges, while most of the differences in the No. 8 sieve came from finer ranges.

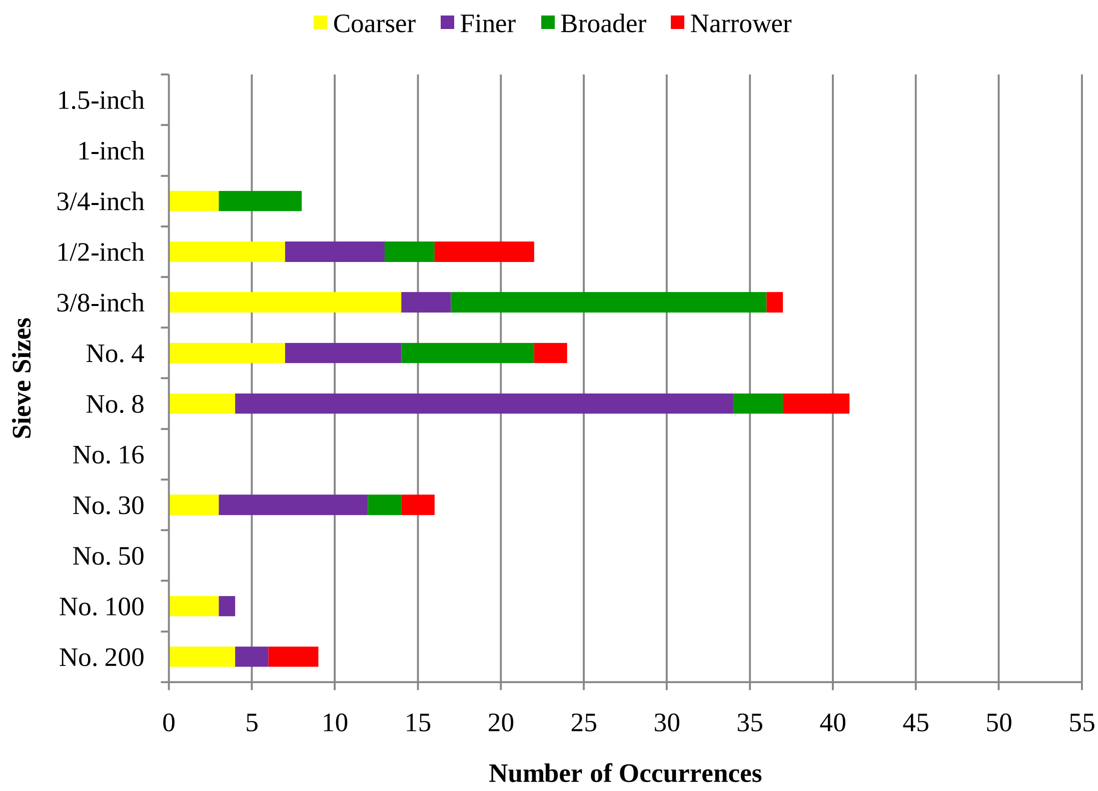
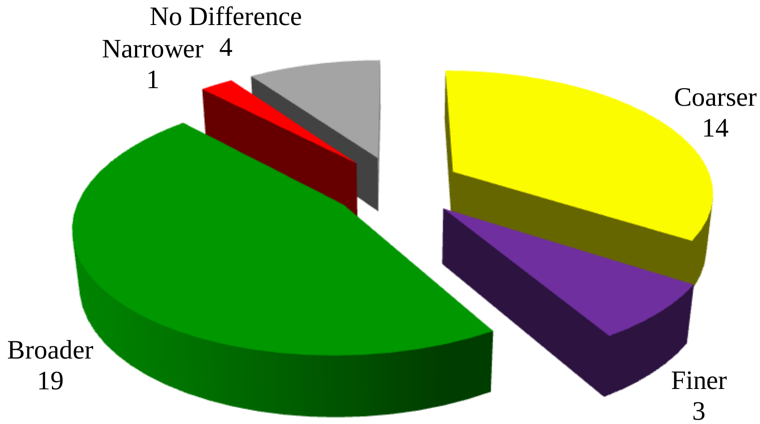


Figure 4.11: Number of Differences in Type A/B Hot Mix Asphalt Surface Course Gradation by Size

A more specific breakdown of the differences in the 3/8-inch sieve shows that of the 38 specifications for the 3/8-inch sieve, 19 are broader than the South Carolina specifications (Figure 4.12), while another 14 are coarser and 3 finer, leaving only 5 of the 38 the same or narrower than South Carolina. In addition, of the four states with the same specification (California, Rhode Island, Hawaii, and Vermont) there is no geographical or regional significance to the acceptable aggregate range.

The breakdown for the No. 8 sieve, as seen in Figure 4.13, shows a slightly different trend, instead of being broader (upper and lower limits of the range outside of South Carolina), the majority of the differences stemmed from finer specifications (ranges with higher percent passing). It is important to recall that finer is defined as having the upper limit being above that of South Carolina and the lower limit equal to or greater than South Carolina. Of the 37 specifications for the No. 8 sieve compared, 30 of them were finer, 4 coarser, and 3 broader, leaving only 4 narrower as there were no states with the same specification range.

The Type C Hot Mix Asphalt surface course specifications had a similar band where the ranges saw significant differences from other states as seen in Figure 4.14. The 3/8-inch, No. 4, and No. 8 sieves all had more than 30 differences in specification range. The 1/2-inch sieve also had a large number of states with a narrower specification, but the real difference was that 31 states had a specification of 100% passing compared to the 97-100% passing for South Carolina. The 3/8-inch specifications tended to be finer and narrower in other states, while the No. 4 and No. 8 specifications tended to be broader and/or coarser. While the type of difference is not necessarily identical to the Type A or B HMA surface course, it is certainly of interest to note that the band of difference is similar and also coincides with stone sizes currently categorized as over-utilized in South Carolina.



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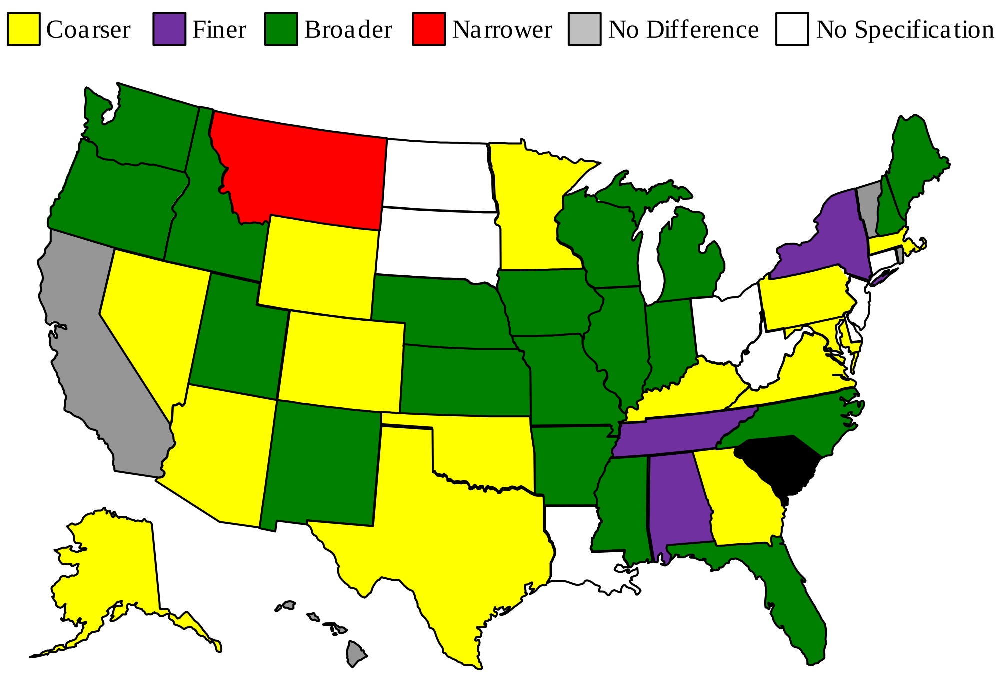
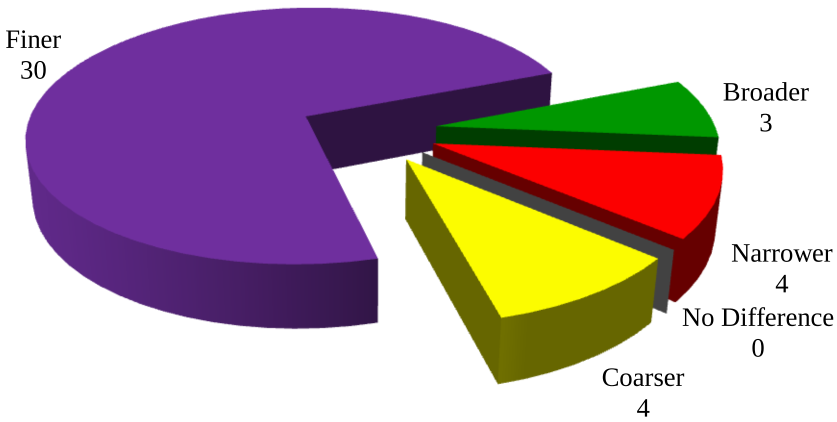


(b)

Figure 4.12: (a) Gradation Breakdown for HMA Surface Course Type A/B at the 3/8-inch Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



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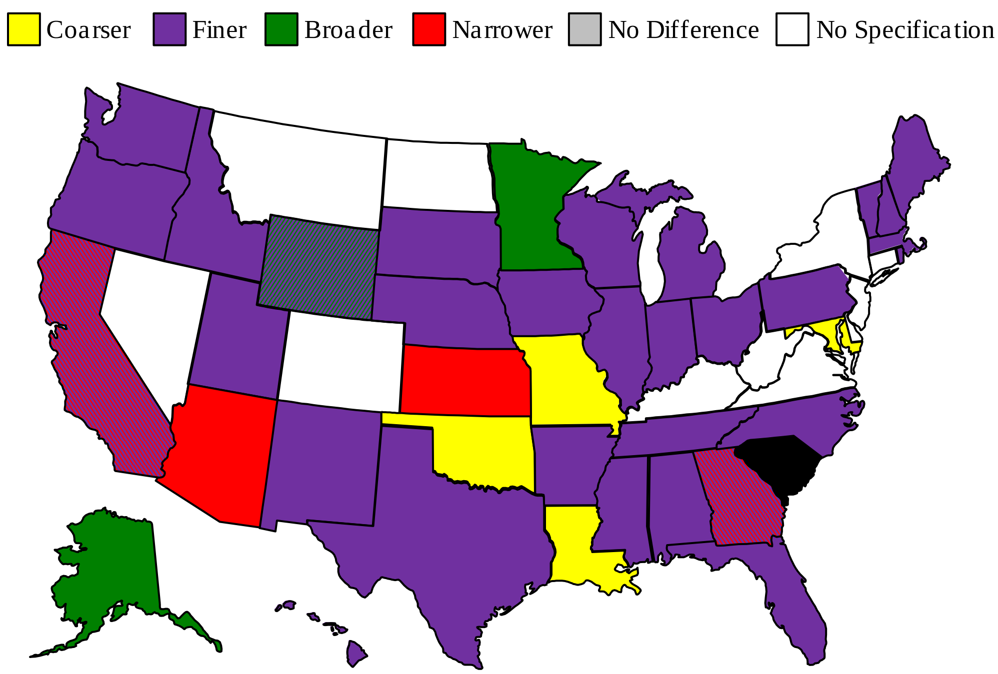


(b)

Figure 4.13: (a) Gradation Breakdown for HMA Surface Course Type A/B at the No. 8 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category

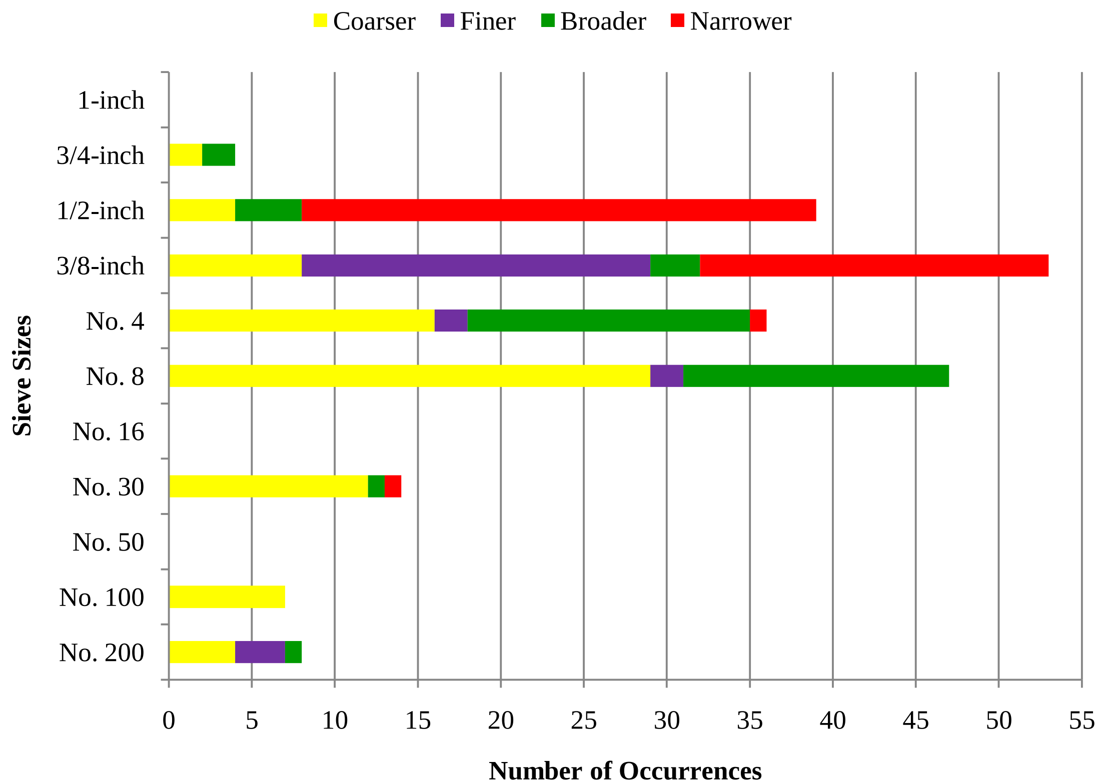
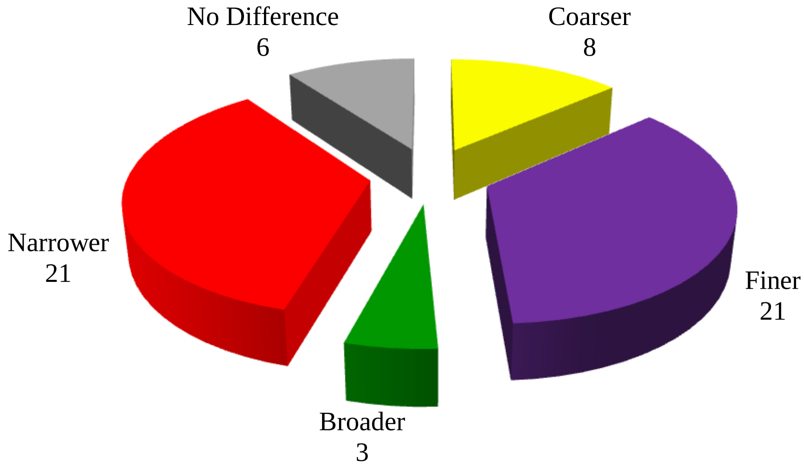


Figure 4.14: Number of Differences in Type C Hot Mix Asphalt Surface Source Gradation by Size

The individual breakdown of the differences at the 3/8-inch sieve confirms that a significant portion of the specifications in other states was finer and narrower than that of South Carolina (Figure 4.15). Of the 36 specifications compared, 21, or more than half, were finer and narrower than South Carolina, 3 were broader, 8 were coarser, and 6 had no significant difference. The six states with no significant difference included Minnesota, Kentucky, Virginia, West Virginia, Delaware, and Nevada, which span regions and geography, suggesting that the differences were not a regional issue.

The differences in the No. 4 sieve were distributed differently, but the overall pattern of South Carolina having generally tighter specifications remained (Figure 4.16). The majority of the differences in specifications were simply broader. Of the 35 specifications at the No. 4 sieve, 17 of them were broader than South Carolina, 16 were coarser, 2 were finer, 2 had no significant difference, and 1 were narrower. The states with no significant difference were Connecticut and South Dakota, again, covering a wide geographical region. The number of specifications that were coarser was somewhat surprising considering the high number of finer specifications in the 3/8-inch sieve, so the overall volume of aggregate in this size band may not be so different. However, with almost half of the specifications being broader, it certainly leaves the opportunity to utilize smaller aggregate sizes.

The No. 8 and No. 4 sieves were almost identical in gradation range differences. Of the 35 specifications for the No. 8 sieve, 16 were broader, 29 coarser, 2 finer, 3 with no significant difference, and none were narrower (Figure 4.17). The states with no significant differences in specification were also identical to the No. 4 sieve with the addition of Massachusetts. Again, the predominant difference was a broader range, but there were a significant number of specifications with a coarser range, or smaller percent passing than South Carolina.



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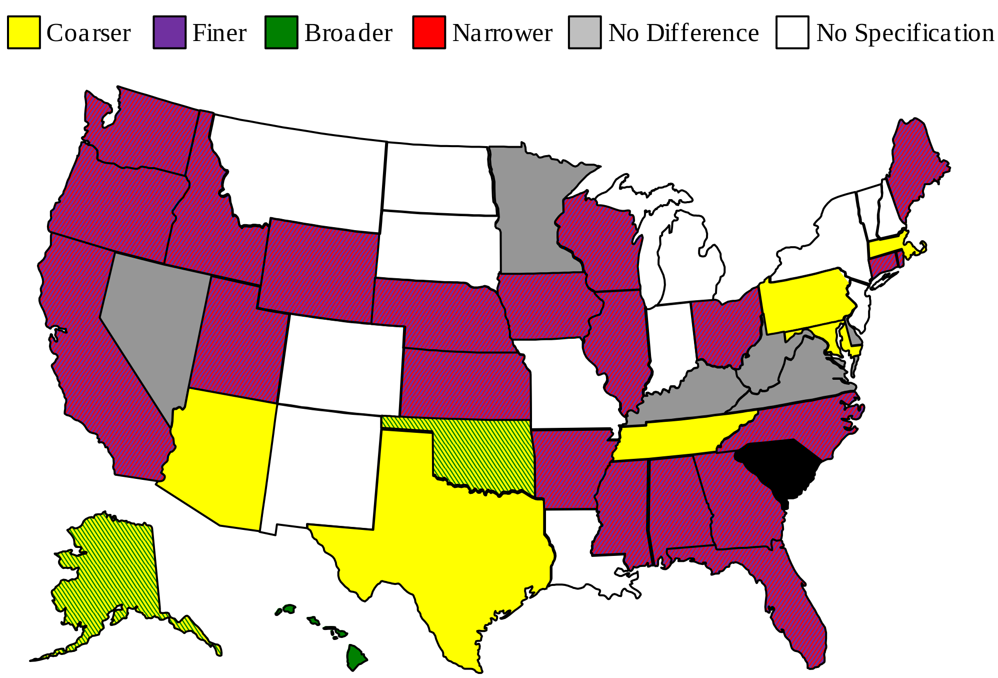
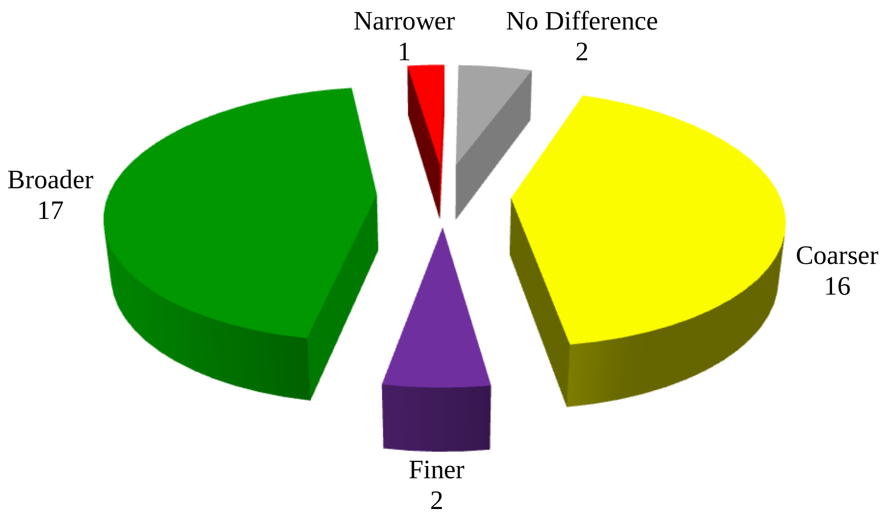


(b)

Figure 4.15: (a) Gradation Breakdown for HMA Surface Course Type C at the 3/8-inch Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



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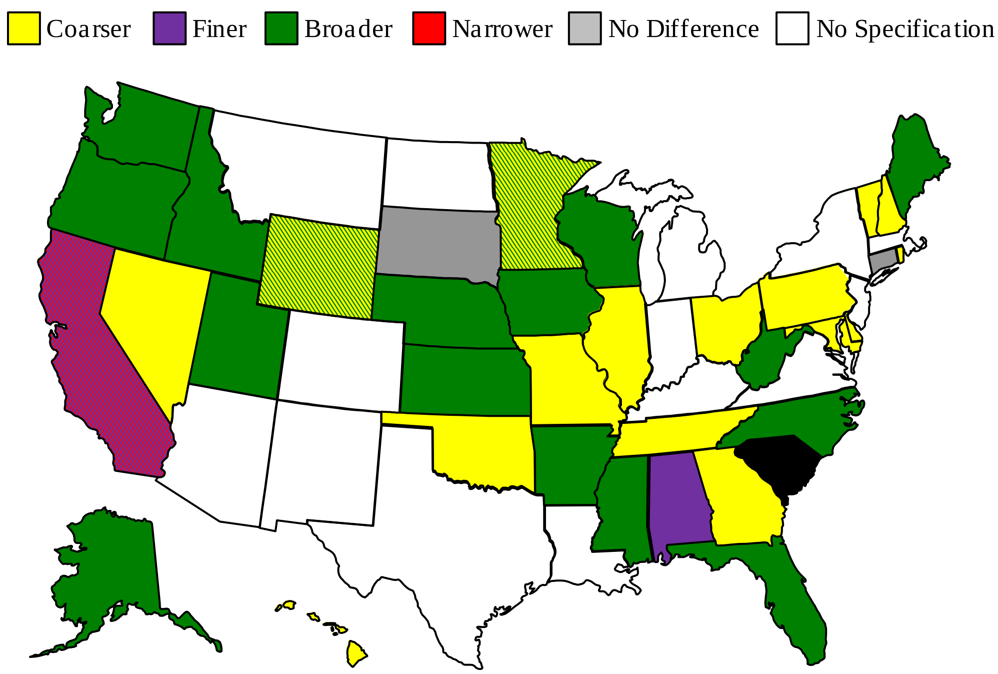

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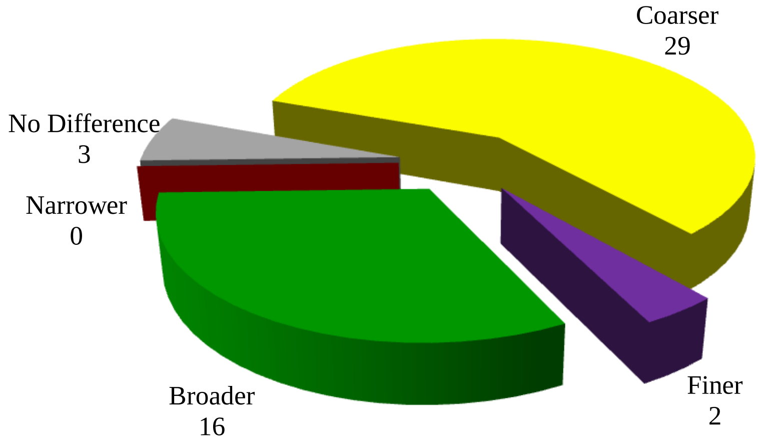
Figure 4.16: (a) Gradation Breakdown for HMA Surface Course Type C at the No. 4 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



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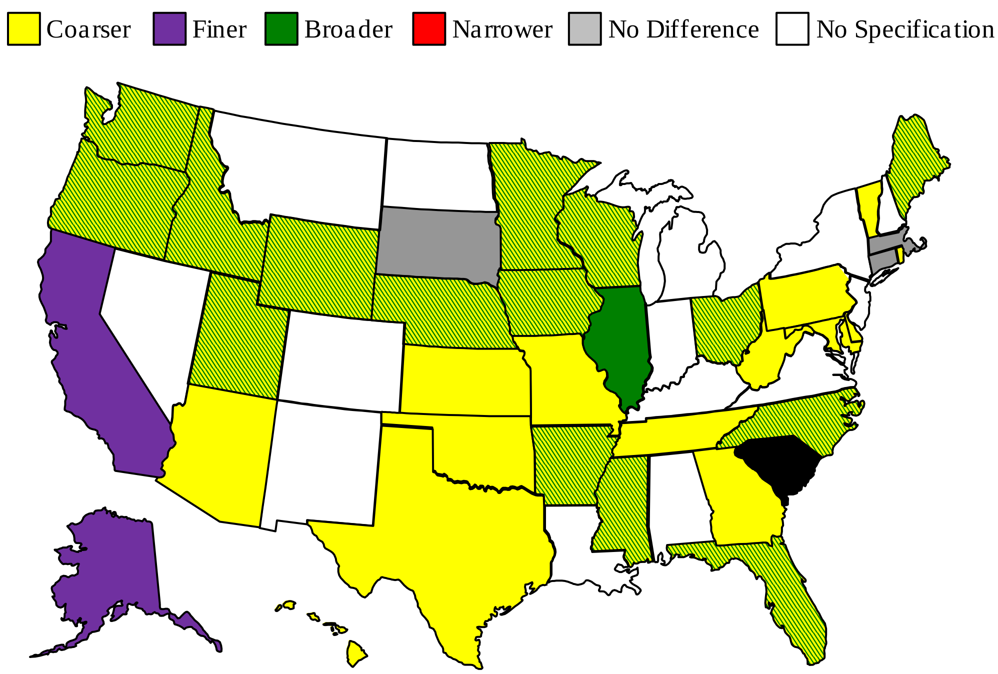

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Figure 4.17: (a) Gradation Breakdown for HMA Surface Type C at the No. 8 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category

The final type in the surface courses was the Type E Seal Course. While the highest differences in the specification ranges were at the No. 4 and No. 8 sieves, there were not enough overall specifications in the comparison to warrant an individual breakdown, or make any general claims. There simply were not enough states with a Seal Course specification. The differences obtained from the available states, however, are still available as can be seen in Figure 4.18.

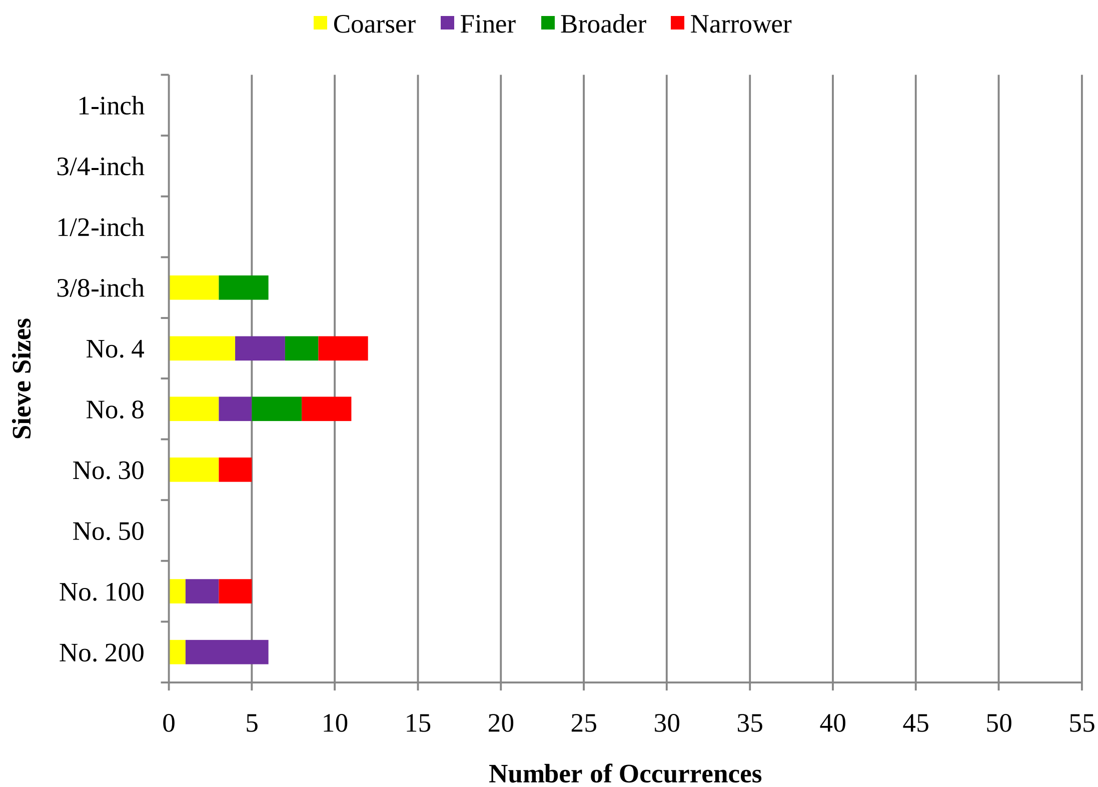


Figure 4.18: Number of Differences in Hot Mix Asphalt Surface Seal Course Gradation by Size

Hot Mix Asphalt Intermediate Course

The HMA Intermediate Course Types A and B had the majority of its differences at the 1/2-inch and No. 8 sieves as can be seen in Figure 4.19. In both cases, the majority of the difference was contributed by specifications with a broader range. Both the 1/2-inch and the No. 8 sieves had more than 35 differences in specification range. In the 3/8-inch and No. 4 sieves, there were not as many differences in the intermediate course as there were in the surface course gradations. Additionally, Figure 4.19 indicates that there are a large number of differences in the 3/4-inch sieve specification. However, there are 23 states that have a specification that is not significantly different than South Carolina.

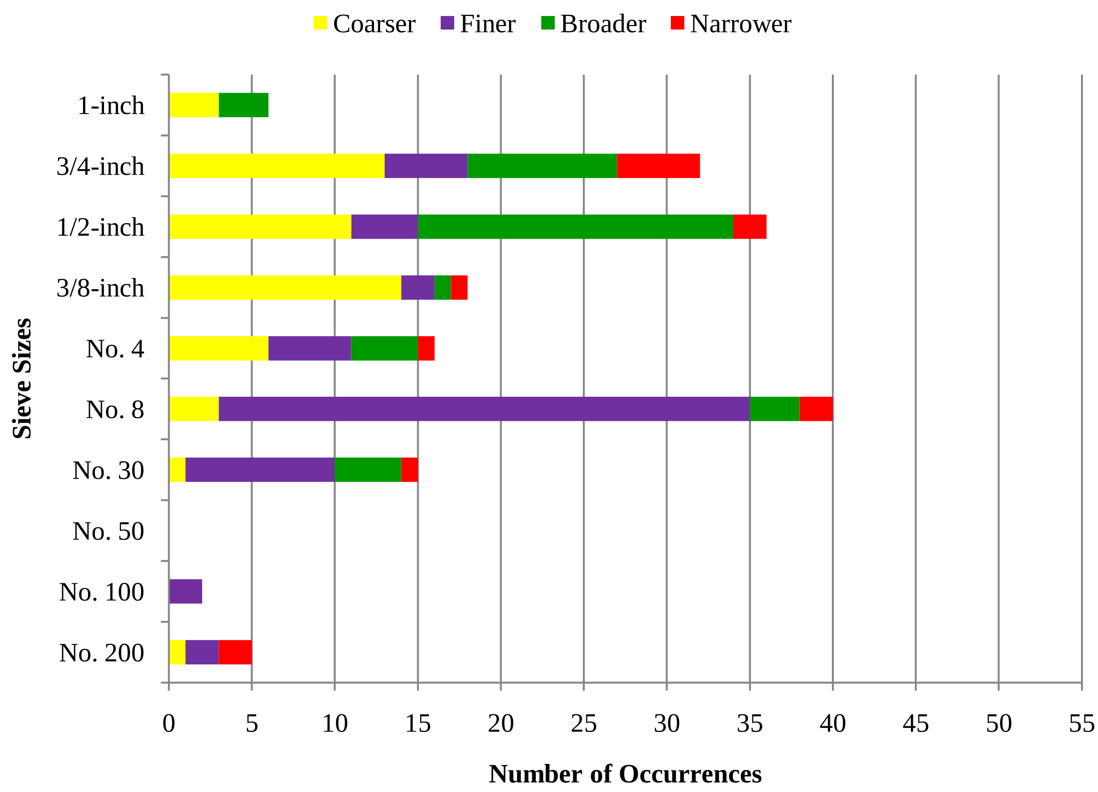
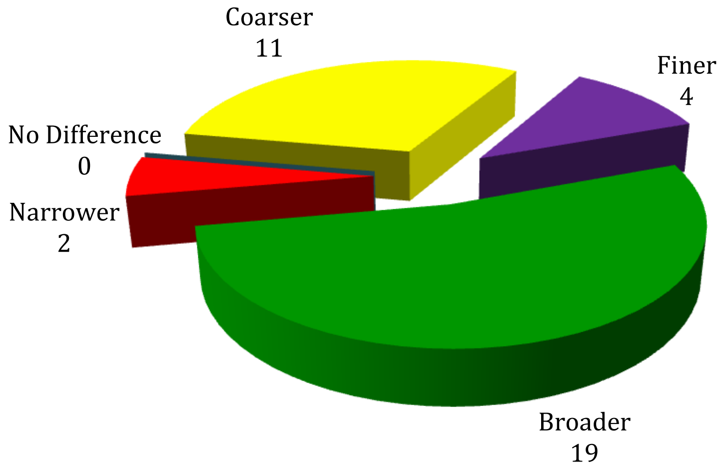


Figure 4.19: Number of Differences in Hot Mix Asphalt Type A/B Intermediate Course Gradation by Size

As seen in the breakdowns in Figures 4.20 and 4.21, the proportions of the types of differences were different in the 1/2-inch sieve and the No. 8 sieve. The majority of the in the 1/2-inch sieve was from specifications with broader ranges with 19 of the 35 specifications compared and 32 of the 41 specifications at the No. 8 sieve were finer than South Carolina. In the 1/2-inch sieve, 11 specifications were coarser while only 4 were finer and 2 were narrower, and none were the same as South Carolina. For the No. 8 sieve, there were 3 that were coarser, 3 that were broader, 2 with no significant difference (Illinois and Delaware), and only 2 that were narrower. While these two sizes are the coarse and fine limits of the critical band seen in the surface course differences (i.e., 3/8-inch and No. 4), it is important to note the heavy lean toward broader or finer specifications in these larger, highly demanded aggregate sizes.



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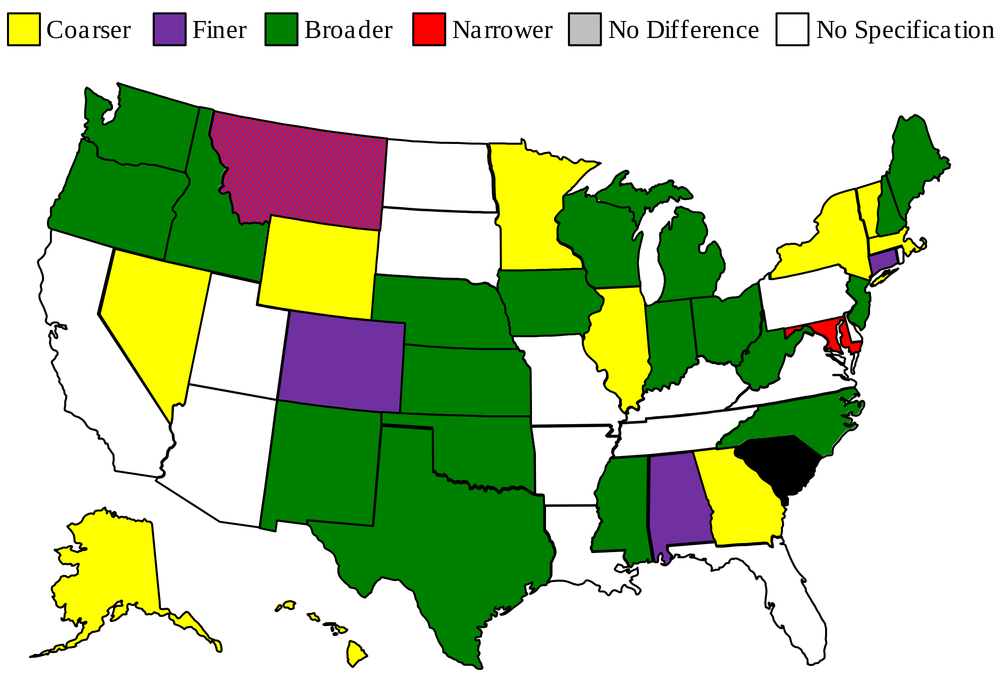
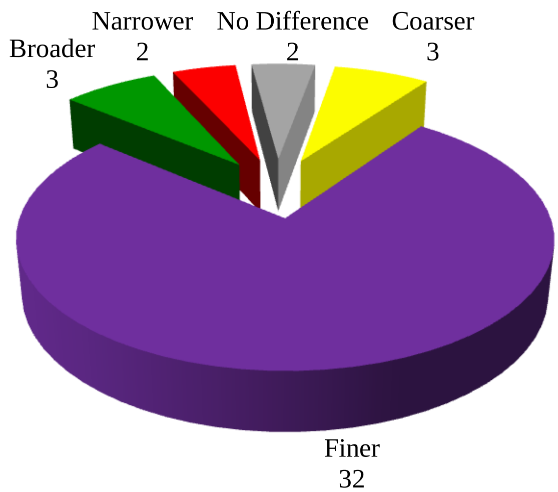


(b)

Figure 4.20: (a) Gradation Breakdown for HMA Type A/B Intermediate Course at 1/2-inch Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



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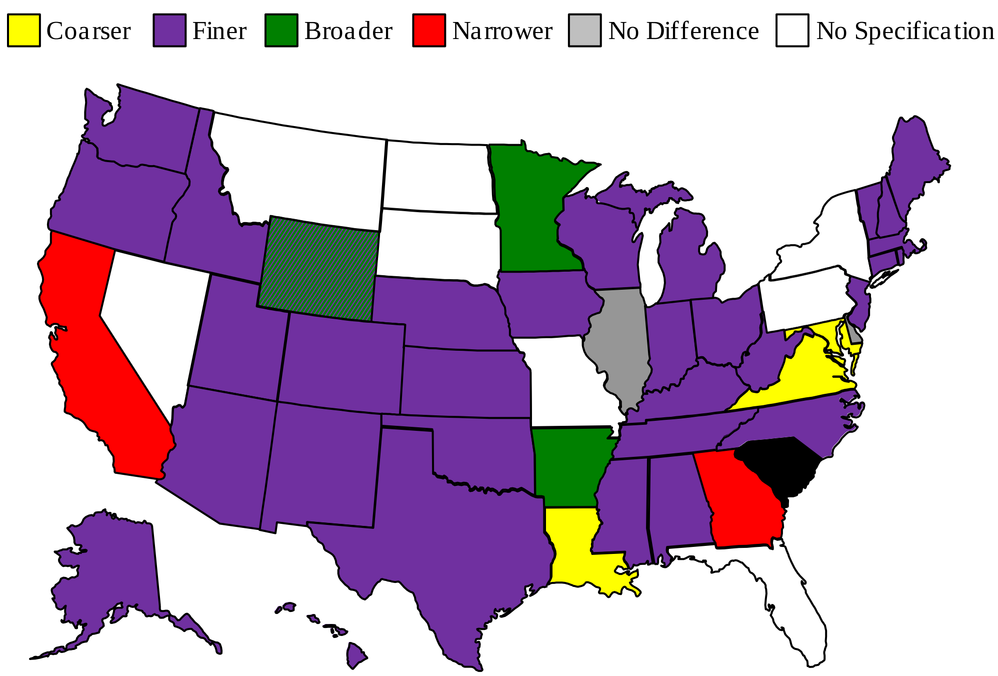


(b)

Figure 4.21: (a) Gradation Breakdown for HMA Type A/B Intermediate Course at No. 8 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category

Hot Mix Asphalt Base Course

The gradation specification differences in the hot mix asphalt base courses showed a significantly different trend than those of the surface and intermediate courses. The differences arose in the large stone sizes, as South Carolina specifications did not include anything above 1.5-inches while many other states did. The differences in the large stone sizes 1.5, 1, and 3/4-inch sieves were all coarser in other states' specifications as seen in Figure 4.22 (a closer look at the 1-inch and 3/4-inch sieves are included in Figures 4.23 and 4.24, respectively). However, the No. 8 sieve, as in the other hot mix asphalt courses, had a large number of differences in the specification ranges.

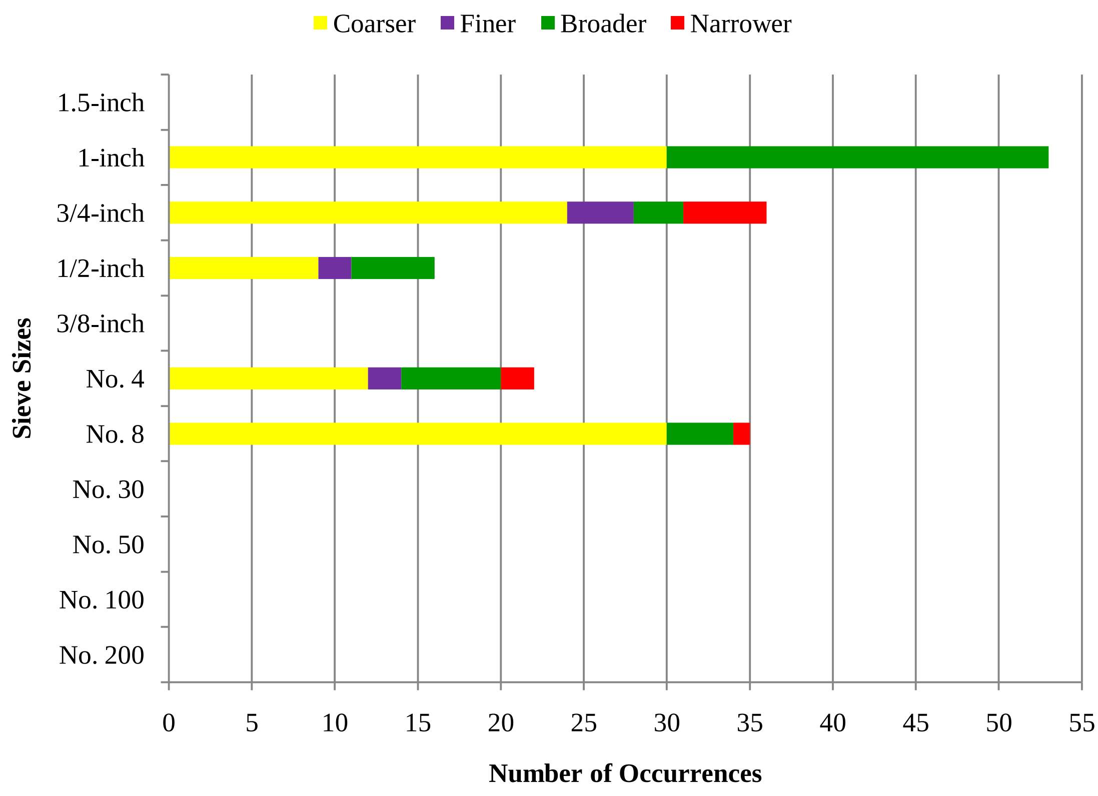
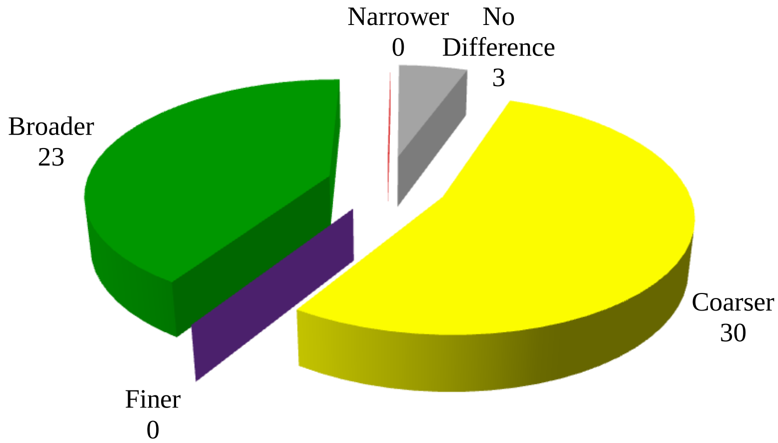
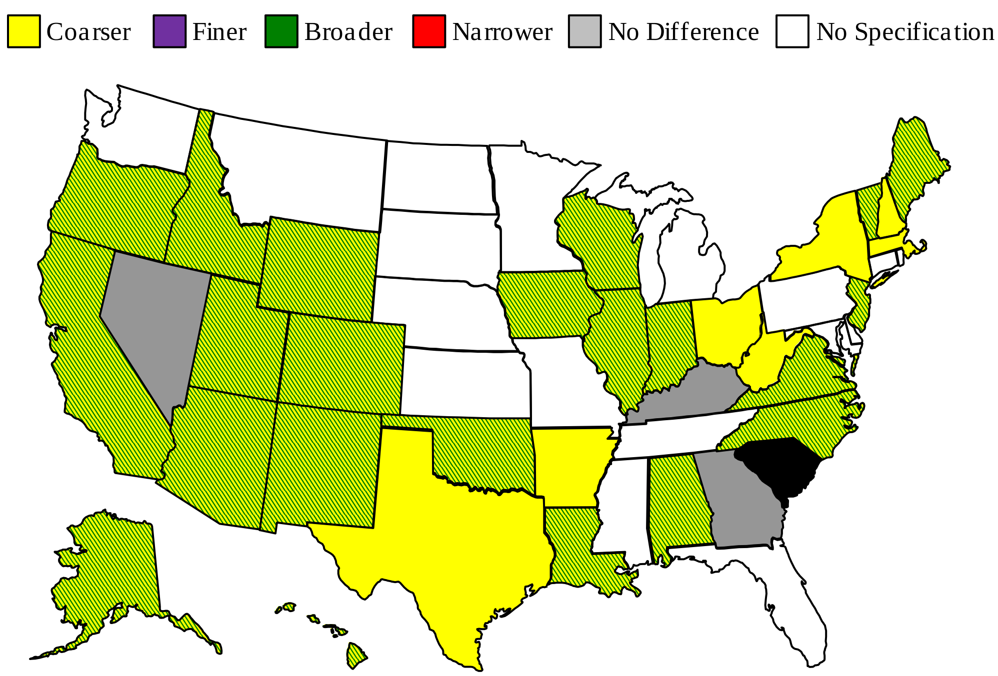


Figure 4.22: Number of Differences in Hot Mix Asphalt Base Course Gradation by Size

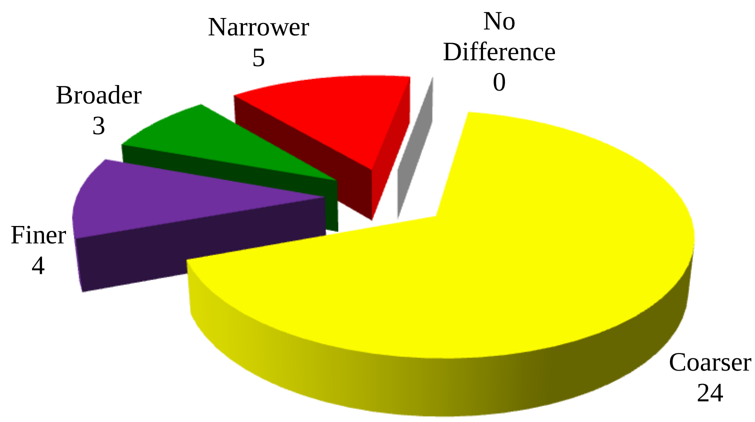


(a)

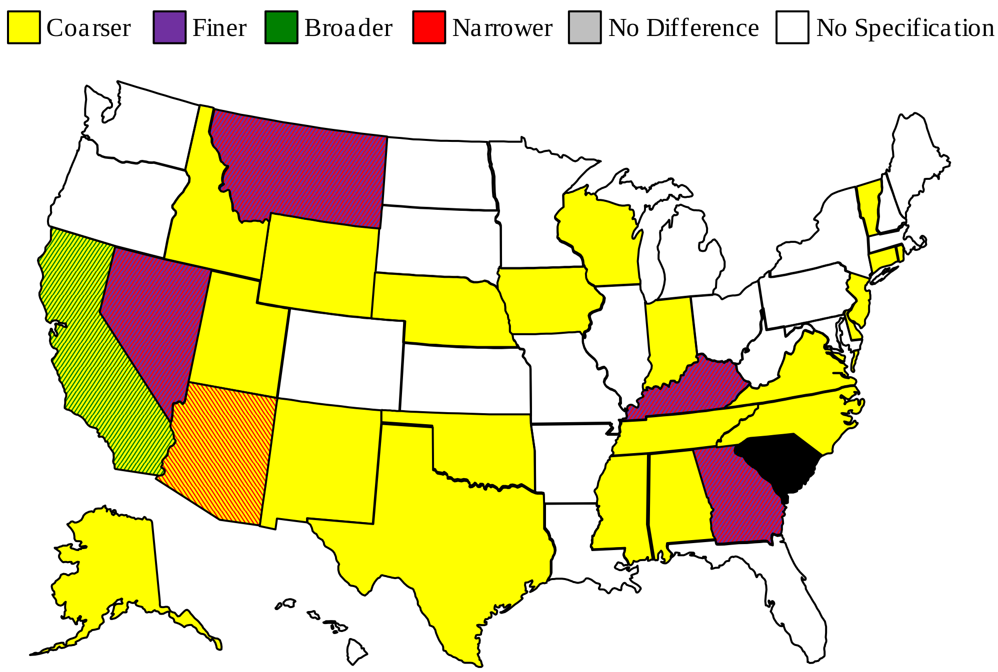


(b)

Figure 4.23: (a) Gradation Breakdown for HMA Base Course at 1-inch Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category



(a)



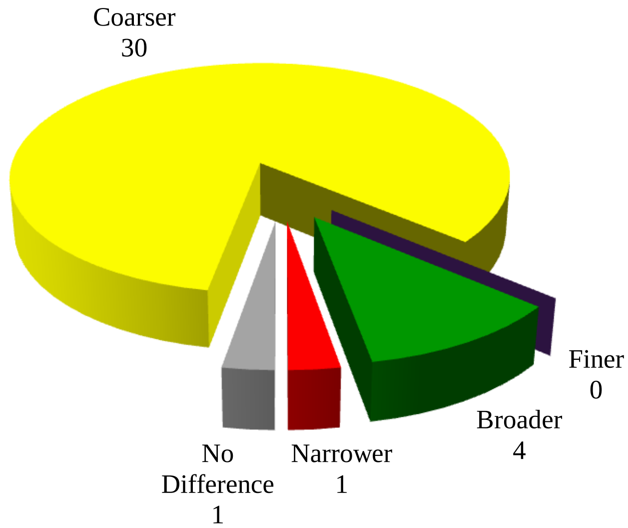
(b)

Figure 4.24: (a) Gradation Breakdown for HMA Base Course at 3/4-inch Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category

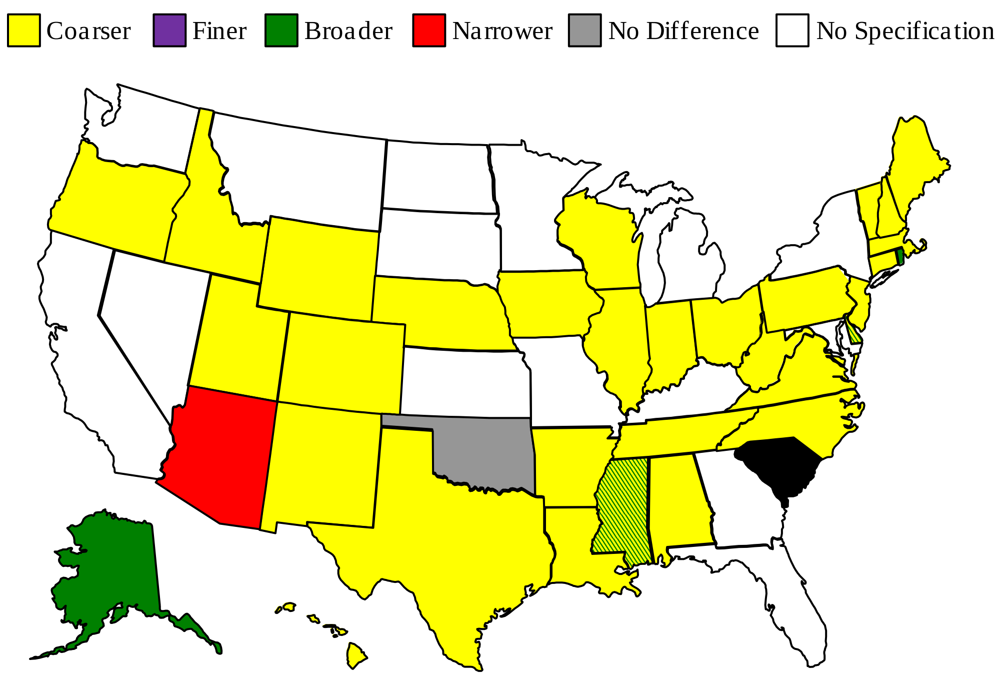
The 1-inch sieve size had an overwhelming amount of differences in the coarser and broader category, as 23 of the 33 specifications were coarser and broader and 7 were just coarser. In addition, 3 of the specifications had no significant difference (Georgia, Kentucky, and Nevada). No specifications were finer or narrower.

The 3/4-inch sieve size also had a large amount of differences in the coarser category, as 24 of the 28 specifications were coarser. In addition, 3 of the specifications were broader, 4 finer, 0 with no significant difference, and 5 narrower.

The No. 8 sieve, with 35 differences, had a somewhat similar distribution as seen in Figure 4.25. A large portion of the differences were coarser (30 of the 35 specifications for the No. 8 sieve), even more than the 1-inch and 3/4-inch sieves. A small number of differences (4) were broader than South Carolina. Only 1 specification was narrower, one that was equal to South Carolina, none were finer.



(a)



(b)

Figure 4.25: (a) Gradation Breakdown for HMA Course at the No. 8 Sieve; (b) Geographical Breakdown of Gradation Differences. Note: Multicolored states have specifications in each color's category

Asphalt Surface Treatments

Asphalt surface treatments were identified as a roadway construction type that could heavily affect the over or under-utilization of particular stone sizes. After analyzing the differences in allowable aggregate gradations for surface treatments, it can be seen in Figure 4.26, that there is a wide range of allowable aggregates used, and South Carolina has an effective coverage of the range. As expected, the majority of aggregates used are the No. 9 stone or finer. South Carolina designates their fine aggregate as FA-13, and while the designation varies across states, the gradation does not vary much. Besides the fine aggregate, there is a good mix of aggregates up to a No. 4 aggregate. South Carolina's use of No. 5, 6, 789, and FA-13 allows for as many options as any other state. However, it should be noted that South Carolina has Special Provisions that require the use of lightweight aggregate for surface treatments, which currently limits the material availability to one supplier.

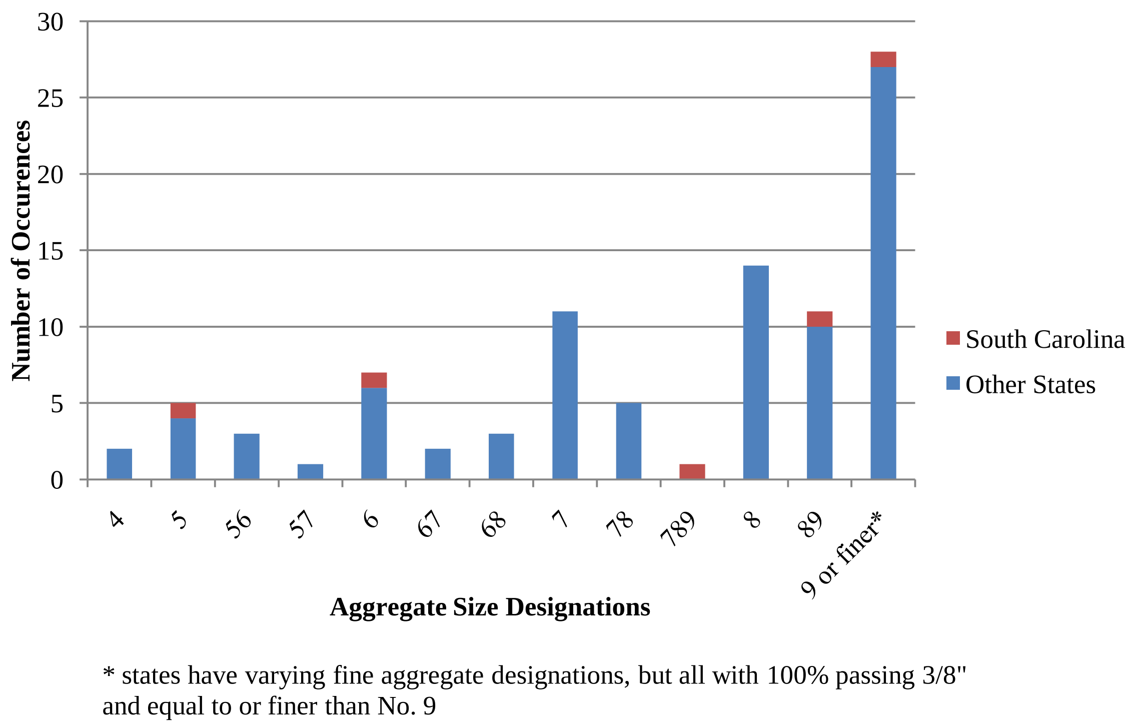


Figure 4.26: Aggregate Sizes Used in Asphalt Surface Treatments

For all of the South Carolina specifications it is important to note that the newer specifications (2007) were used in all comparisons rather than the 2000 specifications which were in use during the “27 in 7” campaign. To insure that none of the specifications moved further from the general trend of other states, the two specification editions were compared. Most of the changes were only 1 to 2 percent adjustments and no changes were made that moved the South Carolina specifications further from the general trend of other states. Of the sizes identified as having large differences in the gradation breakdowns discussed previously, only six had specifications that were changed from the 2000 to 2007 specification book. The No. 4 sieve for base applications saw an increase in range, producing a gradation closer to the other states. The HMA Type A/B surface application had changes at both the 3/8-inch and No. 8 sieves. The 3/8-inch sieve was tightened from 70-92 percent passing to 72-90 percent passing, which created a greater difference from other states, but the No. 8 sieve was simply shifted 1 percent passing higher or coarser, which actually brought the South Carolina specification closer to other states. The HMA Type C surface application was a combination of the old Surface Type 1 and Surface Type 3 specifications. The differences were at the 3/8-inch, No. 4, and No. 8 sieve sizes and all new specifications were more in-line with the other states.

Aggregate Properties Comparison

L.A. Abrasion Specifications

Aggregate gradations are not specifically based on Los Angeles Abrasion values; however, aggregate breakdown could directly affect the final in-place gradation. The L.A. Abrasion specification values were compared across the nation to determine if there was any correlation to South Carolina’s specifications based on aggregate breakdown. Particularly, did South Carolina have a coarser or finer gradation based on whether their L.A. Abrasion value was higher or lower than another state? Different applications have different abrasion specifications, specifically bases, hot mix asphalt courses (surface, intermediate, and base), and Portland cement concrete aggregates were examined (Figure 4.27). In all applications South Carolina had either the highest allowable percent loss value, or equal to the highest. These values are primarily based on the available aggregate, but it does play a factor into the final gradation after the mix has gone through the plant and then is placed and compacted. Because South Carolina had high allowable abrasion values, having coarser gradation specifications would make sense to compensate for the aggregate property. However, as a whole, there was no trend of South Carolina having coarser mixes than states with lower L.A. Abrasion values.

Figures 4.28 through 4.32 are identical graphs, but split into the specific application to be more easily compared. Further research is required to determine the specific effect of the high allowable abrasion values, but higher allowable abrasion could speak to the generally coarser mixes in certain applications. However, the availability of only highly abrasive aggregates is more a regional issue than statewide, so the gradations even across the state could vary due to the breakdown both in the plant and during placement. This makes taking this particular aggregate property into account when setting gradation specifications very difficult. It would essentially require a different set of specifications for each region based on aggregate types available, which would be impractical. In addition, aggregates are not always obtained from the region in which the work is being performed.

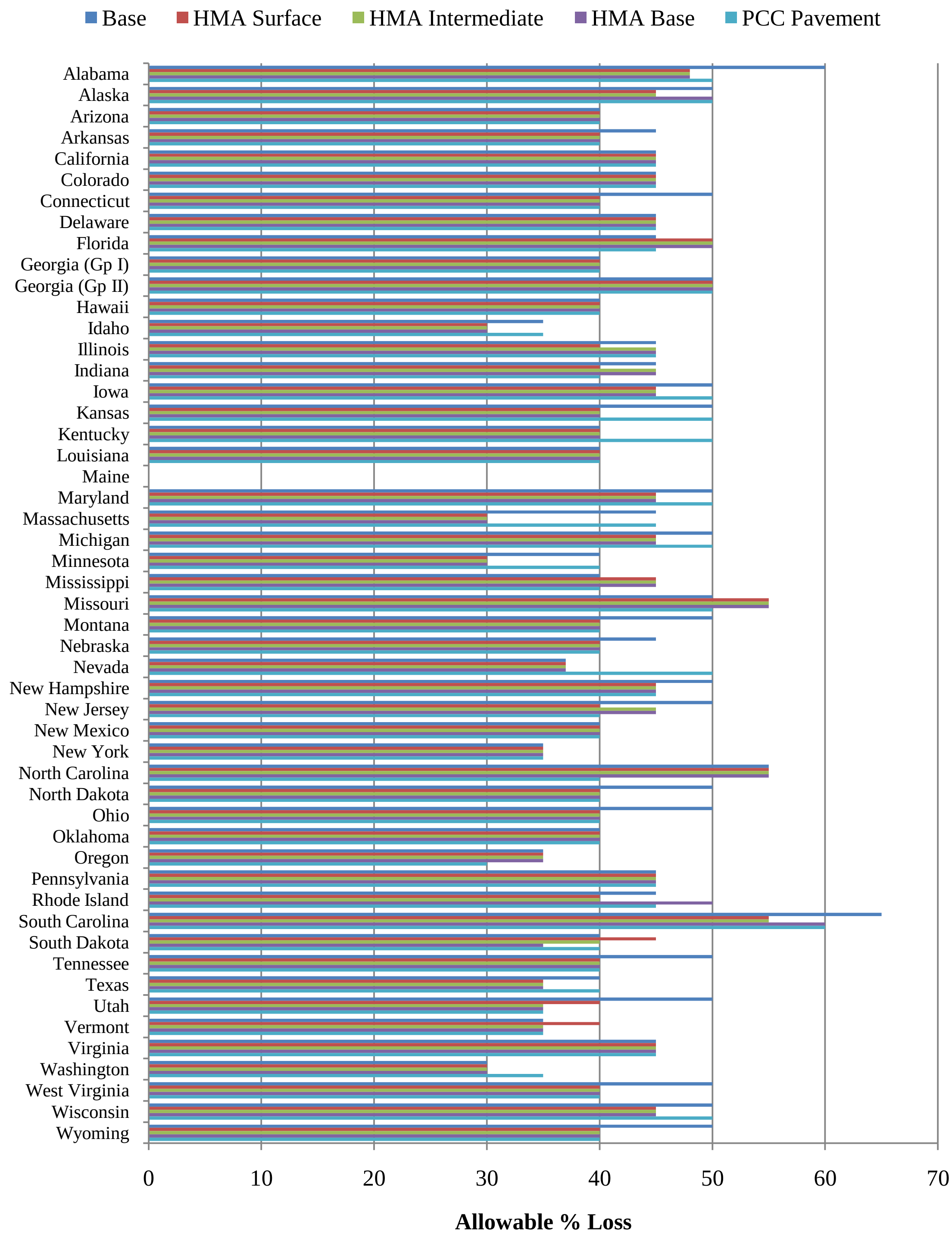


Figure 4.27: Comparison of Los Angeles Abrasion Values across all states and application

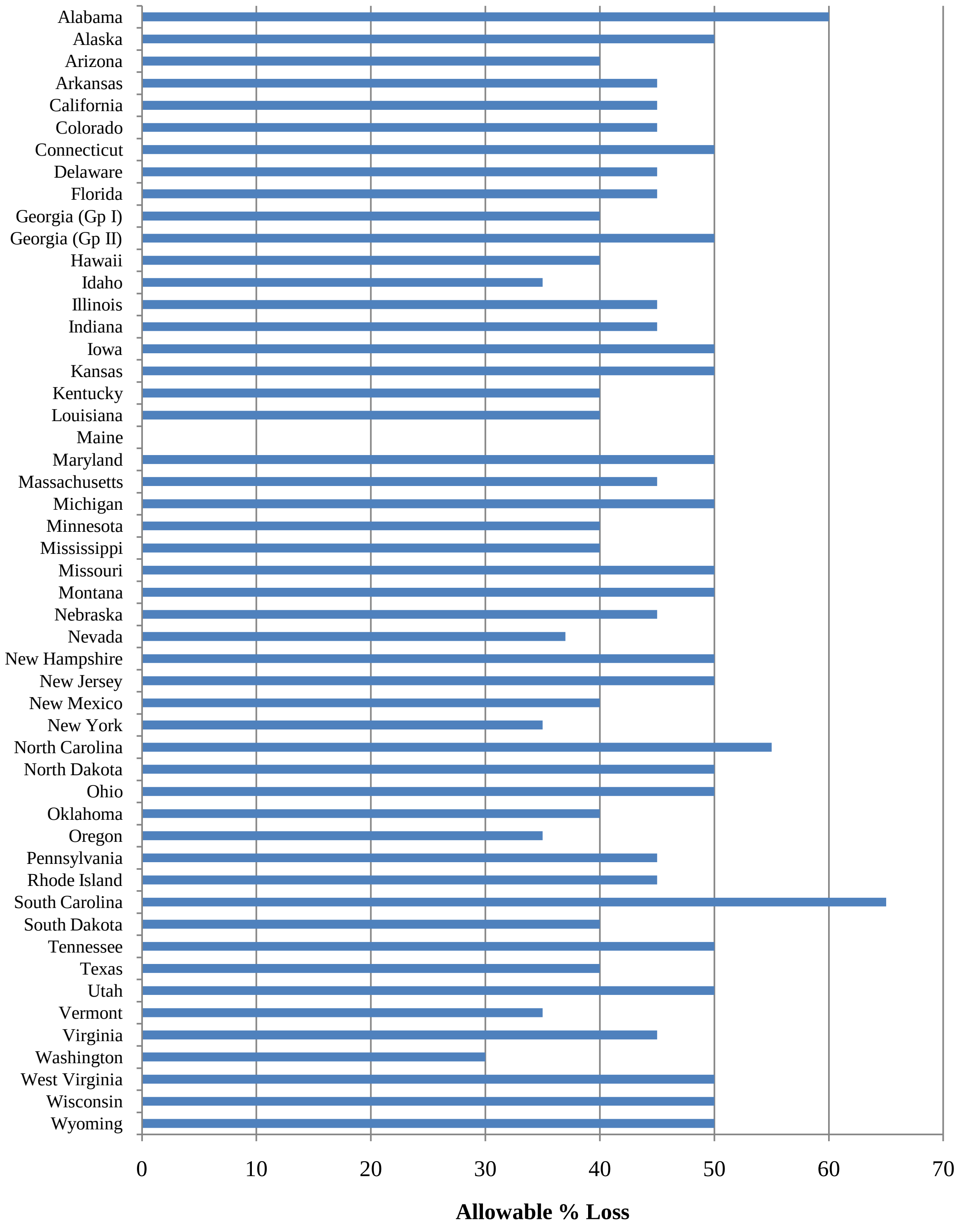


Figure 4.28: Comparison of Los Angeles Abrasion Values for Base Aggregates

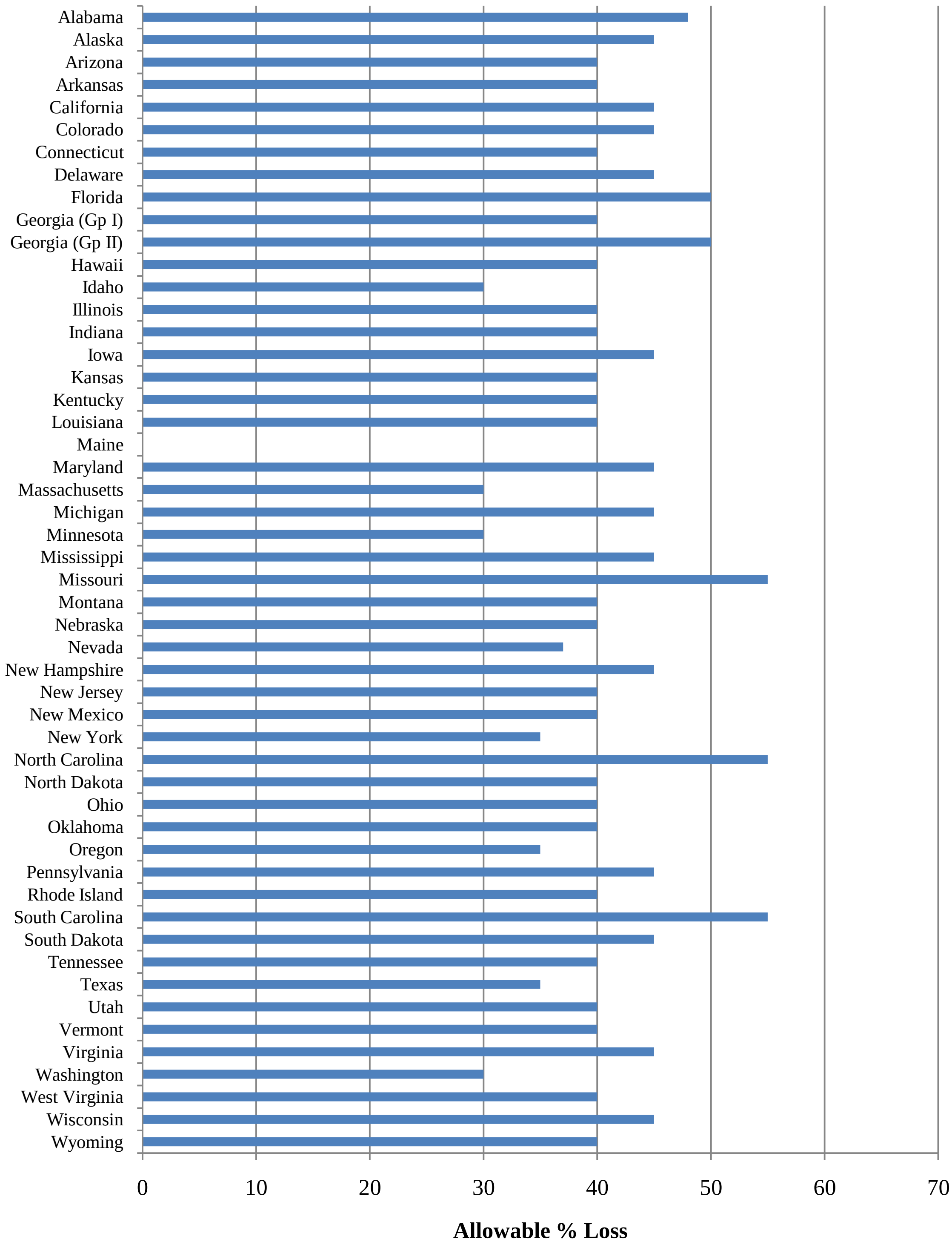


Figure 4.29: Comparison of Los Angeles Abrasion Values for HMA Surface Aggregates

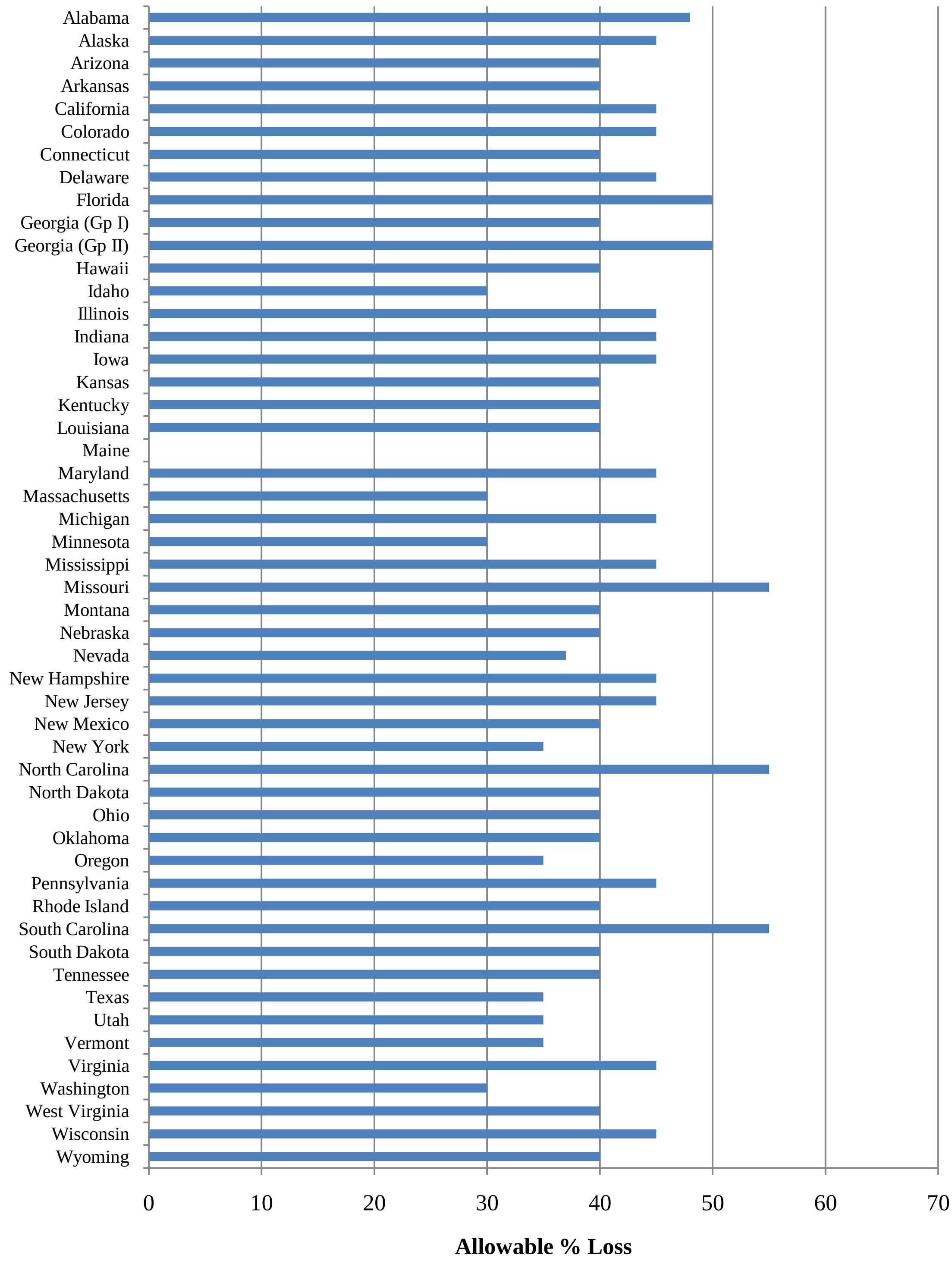


Figure 4.30: Comparison of Los Angeles Abrasion Values for HMA Intermediate Aggregates

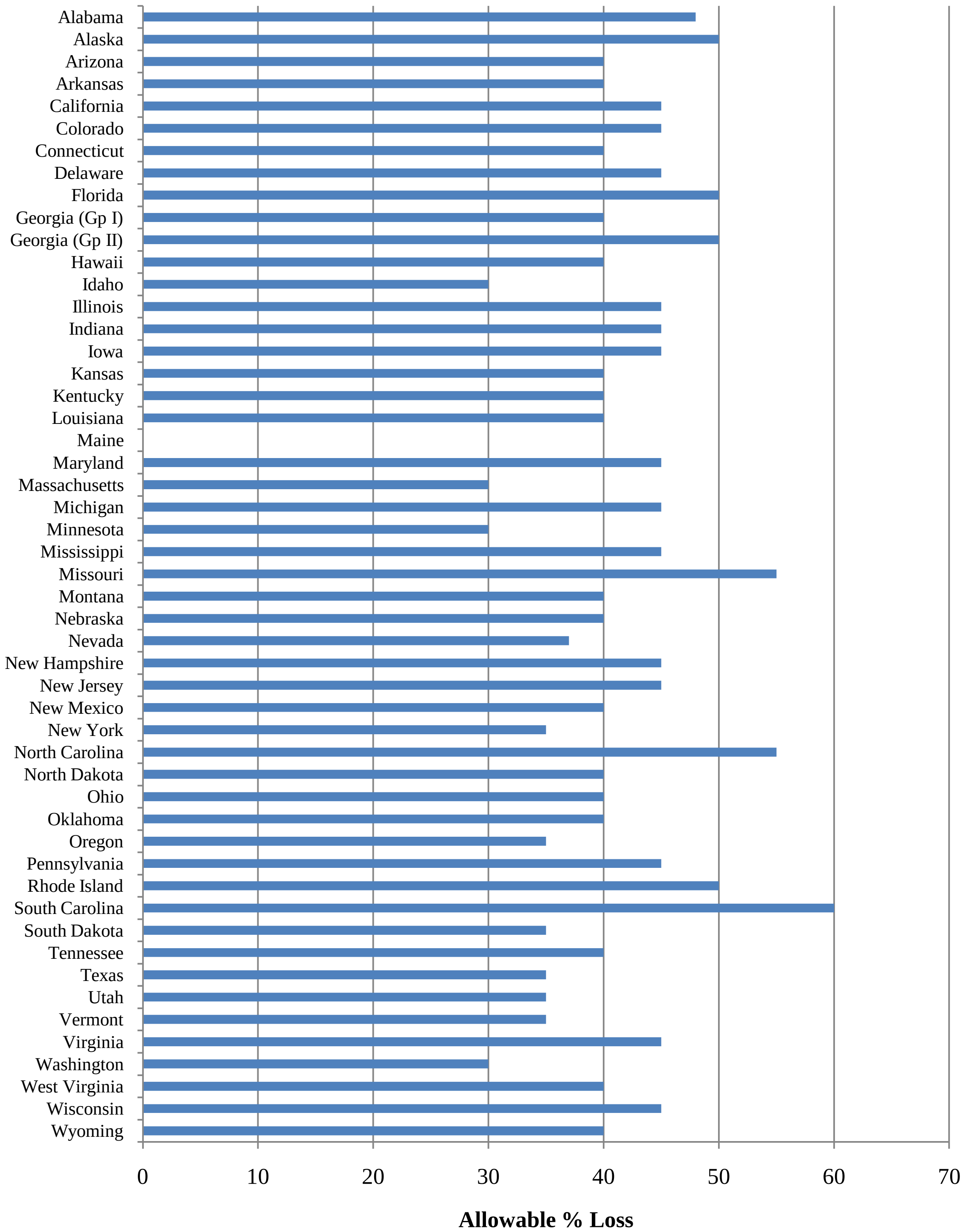


Figure 4.31: Comparison of Los Angeles Abrasion Values for HMA Base Aggregates

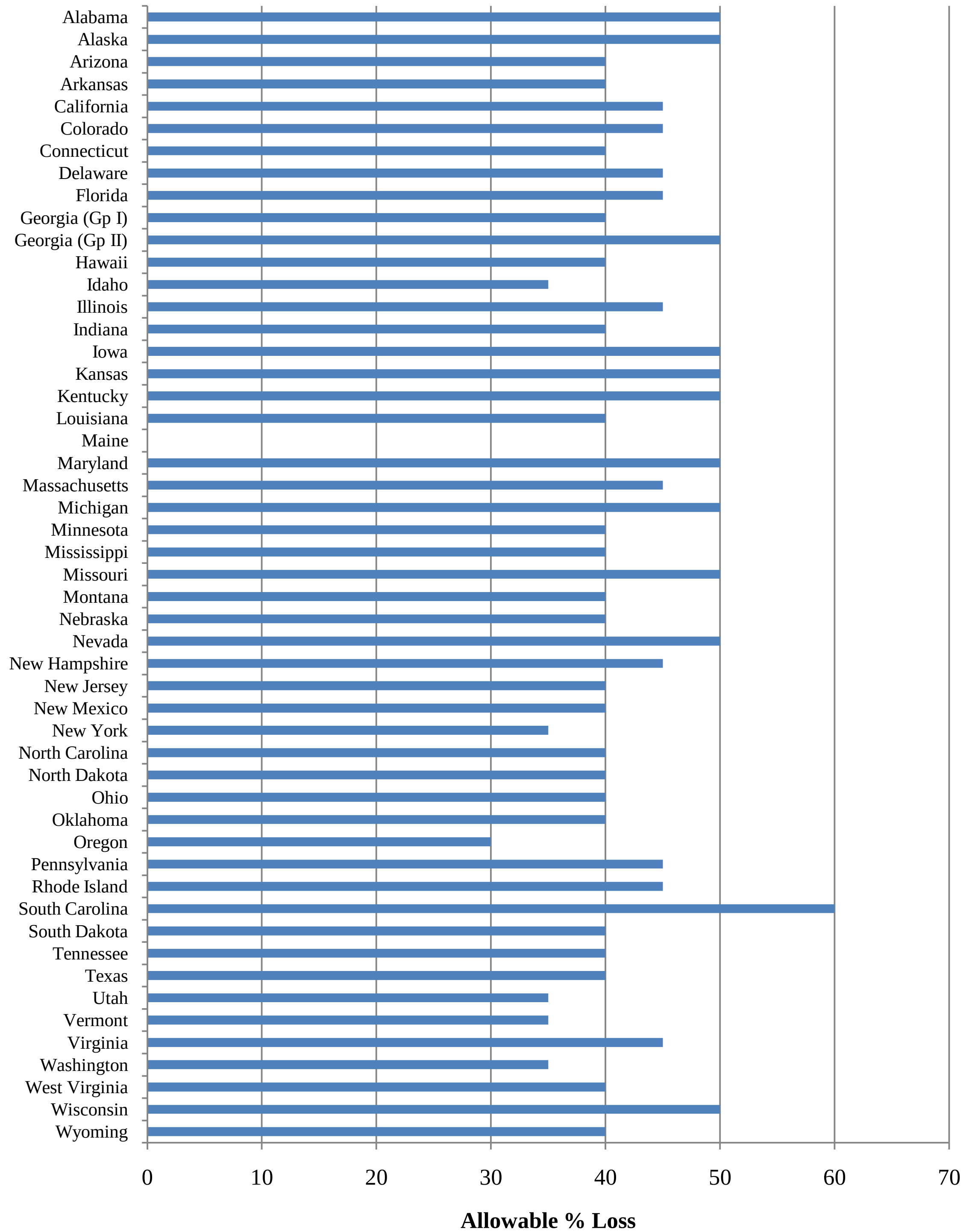


Figure 4.32: Comparison of Los Angeles Abrasion Values for PCC Aggregates

Dust-to-Binder Specifications

The dust to binder ratio specification essentially controls the amount of fines in an asphalt mix, which is of particular interest because fines and screenings are aggregate sizes that are consistently under-utilized in South Carolina. Dust-to-binder ratio (AASHTO uses "silt-clay" rather than "dust," but is the same property) specifications are normally 0.6 - 1.2, but a ratio of up to 1.6 may be used at an agency's discretion. So according to SUPERPAVE the ratio must fall between 0.6 and 1.6 depending on the aggregate gradation (Asphalt Institute, 2001). Based on the state specifications, a range of 0.6 to 1.2 is what the majority of states employed, with the option of having 1.6 for the upper limit for certain gradations. However, in this case it is less what the specification max is, and more of what ratio is actually used. Naturally, when fines are a reality, barriers in specifications are not pushed. It is possible that the utilization of the highest allowable dust to binder ratio set out by SUPERPAVE of 1.6 could potentially increase the utilization of fines and screenings.

Aggregate Industry Questionnaire

The questionnaire submitted to the local aggregate industry via the Mining Association of South Carolina did not receive much response. In fact, only two producers provided any information. This low response rate is likely due to factors such as competition and anti-trust laws. However, based on personal correspondence with producers, the official responses that were received generally reflected the industry as a whole. Figure 4.33 summarizes the total aggregate production numbers of one aggregate producer during the period from 2002 to 2005 (the time period leading up to the peak in aggregate demand in South Carolina) and Figure 4.34 illustrates the percentage of aggregate sales for HMA during the same period for the same producer.

Much of the information obtained from the producers about the aggregate demand matched the information provided by SCDOT in the survey of state DOTs. To summarize, during periods of high aggregate demand, the most utilized aggregate sizes were Nos. 8, 89, and 789 stone. The demand for these particular sizes was primarily due to HMA production. Screenings were in the least demand, but continued to be produced as a product of the crushing operations to produce the heavily demanded stone sizes. In recent years, the production of coarser HMA mixtures that limit fines has affected the aggregate balance. Additionally, the substitution of HMA base for crushed stone base has significantly reduced the demand for crusher run and increased the demand for clean stone. This has also resulted in an increase in the amount of fines stockpiled at aggregate production facilities.

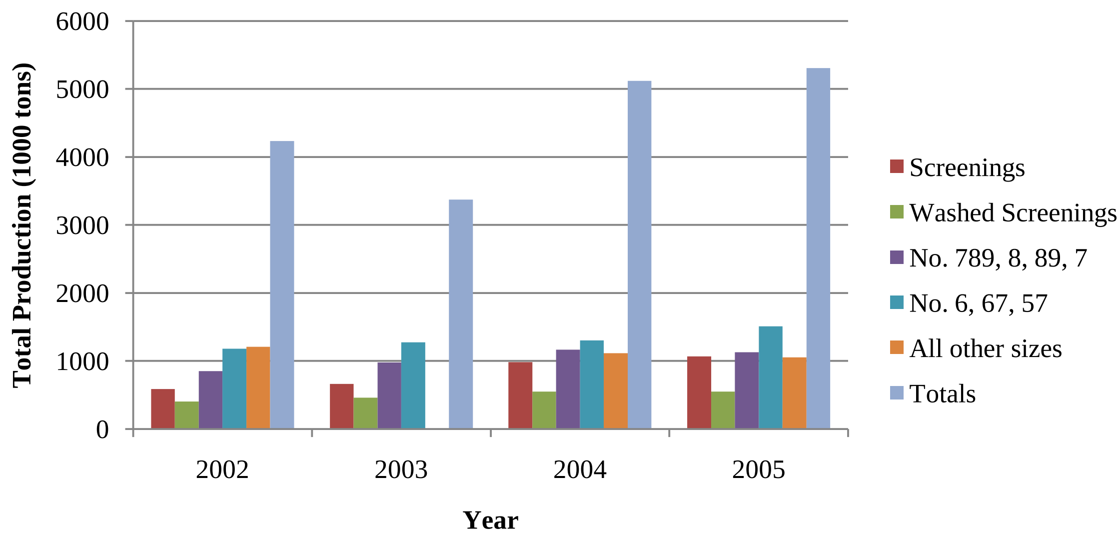


Figure 4.33: Total Aggregate Production Figures From One South Carolina Aggregate Producer (2002-2005)

Because aggregate producers provide a substantial amount of material for SCDOT construction projects, they are required to produce aggregates that meet SCDOT gradation specifications. When asked whether the SCDOT aggregate specifications had any effect on aggregate production and sales, the response indicated that the current gradation parameters were acceptable and had no significant impact on the quarry operations.

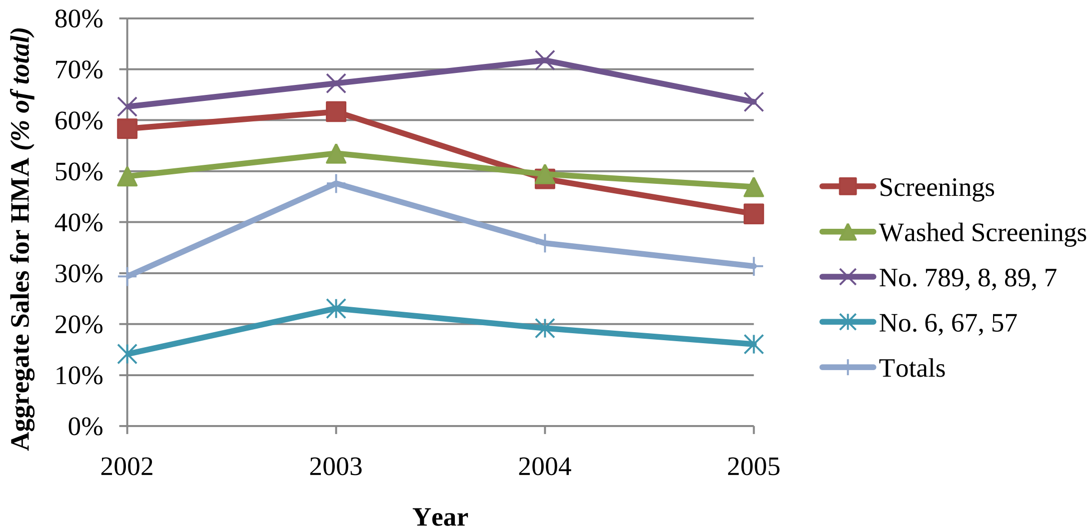


Figure 4.34: Aggregate Sales for HMA as a Percentage of Total Production Figures From One South Carolina Aggregate Producer (2002-2005)

The questionnaire also asked producers to provide recommendations on how to potentially shift to a more balanced utilization of available aggregates and they provided several recommendations for consideration. The first recommendation was to provide a forecast (at least one year in advance) of future aggregate needs for construction and maintenance. This would enable the producers to plan for increased demand of particular materials and allow them to balance the production evenly throughout the entire year instead of crashing the production schedule in the high demand summer months. Another recommendation was to consider increasing the use of aggregate base material in lieu of HMA base in roadway construction. Again, this would increase the demand for crusher run material that contains higher amounts of fine material.

CHAPTER V: AGGREGATE UTILIZATION SCENARIOS

This chapter examines potential scenarios in which the utilization of aggregate could potentially be optimized through adjustments in the gradation specifications, dust-to-binder ratios, or base substitution in hot mix asphalt pavements. The examples in this chapter illustrate how altering the gradation specifications could effectively change the utilization of different aggregate sizes in HMA aggregate blends (i.e., No. 789, No. 67, or screenings). In addition, the dust-to-binder ratio will be examined specifically to see what effects using the maximum allowable ratio of 1.6 (AASHTO) could have on the usage of manufactured sands or screenings. Finally, examples of base substitution, specifically substituting a graded aggregate base for HMA base course, will be examined, understanding that this substitution will have a corresponding depth change. These examples will be used to identify potential methods to better optimize available aggregates by making subtle changes to the existing system. These scenarios are strictly hypothetical examples and not proposed gradation specifications.

Gradation Specification Change

In this exercise, the sieve sizes previously identified as having a large number of differences between South Carolina and other states were changed and the most common specification replaced the SCDOT specification creating a new "trial" specification. These specifications are only for use in the hypothetical examples and have no performance quality associated with them, nor are they the specific gradation this research would propose for SCDOT. Further research must be completed before actual specifications are created. However, the specifications used for these examples can be seen below in Table 5.1.

Table 5.1: SCDOT current and trial specifications for examples

	HMA Surface Type A/B		HMA Surface Type CM/C		HMA Intermediate Type A/B		HMA Base	
Size/Spec.	Current SCDOT	Trial	Current SCDOT	Trial	Current SCDOT	Trial	Current SCDOT	Trial
1-inch	100	100	----	----	100	100	100	90-100
3/4-inch	98-100	98-100	100	100	90-100	80-100	85-100	90 Max
1/2-inch	90-100	90-100	97-100	97-100	75-90	90 Max	60-80	55-85
3/8-inch	72-90	90 Max	83-100	90-100	64-80	55-80	----	----
No. 4	44-62	40-65	58-80	90 Max	38-54	38-60	40-55	35-55
No. 8	23-43	28-58	42-62	32-67	22-36	22-49	30-45	19-45
No. 30	10-25	10-25	20-40	20-40	8-22	8-22	----	----
No. 100	4-12	4-12	8-20	8-20	3-10	3-10	----	----
No. 200	2-8	2-8	3-9	3-9	2-8	2-8	----	----

For the utilization scenarios gradations from two producers were used. The producers will be referred to as “Source 1” and “Source 2” to maintain their anonymity. However, both of these sources are from South Carolina. Their specific gradations for the standard SCDOT aggregate sizes used in the utilization scenarios can be seen in Table 5.2. Note that even within specified SCDOT sizes there is a large difference between the gradations between the two quarries. This fact makes the optimization process quarry dependent as to whether or not an optimization can be made for the given gradations that control the blend.

Table 5.2: Aggregate gradations from producers

Sieve Size	Source 1				Source 2			
	No. 67	No. 789	Regular Screenings	Man. Sand	No. 67	No. 789	Regular Screenings	Man. Sand
1-inch	100	100	100	100	100	100	100	100
3/4-inch	99.2	100.0	100	100	96.1	100	100	100
1/2-inch	79.8	97.8	100	100	55.1	97.4	100	100
3/8-inch	46.4	93.0	100	100	29.4	82.3	100	100
No. 4	4.7	21.4	99.5	99.8	5.2	26.8	99.3	99.5
No. 8	2.6	6.7	86.8	83.9	2.5	7.1	85.4	85.6
No. 30	1.3	3.9	57.6	51.8	1.6	4.5	51.7	47.4
No. 100	0.8	1.6	21.0	9.6	1.0	1.3	21.4	8.7
No. 200	0.59	0.82	10.84	2.37	0.60	0.62	11.33	3.08

With new trial gradation specifications and source gradations, hypothetical blends for hot mix asphalt mixes can be produced. Examples for Surface Type A/B, Type C, and Intermediate Type A/B were completed. No optimizations were able to be made for the Source 1 aggregate because the controlling sieve size for the blend was the No. 30 sieve, which did not have significant difference from other states and was, therefore, left unchanged. However, the Source 2 aggregate saw optimizations with both the Surface Type C and the Intermediate Type A/B courses as it had critical sieves in the range in which the specifications were changed. Tables 5.3 – 5.5 illustrate the percentages for the blend as well as the resulting gradations. The grey cells are the critical sieves, which control the blend, and the red type denotes the changes in specification. If an optimization was able to be made (either a reduction in the No. 789, or an increase in the No. 67 or fines), the cell was highlighted in green. Note that all of these blends were produced to maximize the amount of fines in the mix. One would not design for a limiting specification, but if one were to compare the midpoint values, similar differences would likely be seen. Therefore, by producing blends, which optimize the upper limit (the fines) a reasonable difference can be seen that would also hold true for a comparison of the mid-point values of the specifications. As such, these blends are not suggested for use as they push the upper limit of the gradations, it is only the difference in aggregate percentages that is of interest.

As mentioned previously, the critical sieve for blending in both Surface Type A/B examples was the No. 30 sieve in which no change was made. Neither aggregate source was able to be optimized for this application. Although further research is suggested, this particular application is not the most likely for successful optimization. The attempted blends can be seen on the following page in Table 5.3.

Table 5.3: Aggregate utilization scenario for HMA Surface Course Type A/B

	Source 1				Source 2			
Blends	% of #67 45%	% of #789 12%	% of #67 45%	% of #789 12%	% of #67 20%	% of #789 34%	% of #67 20%	% of #789 34%
	% Dry Sand 22%	% Man. Sand 21%	% Dry Sand 22%	% Man. Sand 21%	% Dry Sand 23%	% Man. Sand 23%	% Dry Sand 23%	% Man. Sand 23%
Sieve Size	Current SCDOT	Value	Trial Gradation	Value	Current SCDOT	Value	Trial Gradation	Value
1-inch	100	100	100	100	100	100	100	100
3/4-inch	98-100	99.7	98-100	99.7	98-100	99.2	98-100	99.2
1/2-inch	90-100	90.7	90-100	90.7	90-100	90.1	90-100	90.1
3/8-inch	72-90	75.1	90 Max	75.1	72-90	79.9	90 Max	79.9
No. 4	44-62	47.6	40-65	47.6	44-62	55.9	40-65	55.9
No. 8	23-43	38.7	28-58	38.7	23-43	42.2	28-58	42.2
No. 30	10-25	24.6	10-25	24.6	10-25	24.6	10-25	24.6
No. 100	4-12	7.2	4-12	7.2	4-12	7.6	4-12	7.6
No. 200	2-8	3.2	2-8	3.2	2-8	3.7	2-8	3.7

For the HMA Surface Type C application, an optimization was able to be made for Source 2, as its critical sieve was the No. 8. This percent passing specification was changed in the trial specification due to a significant number of differences from other states. The amount of No. 789 stone was able to be reduced from 30% to 25% and the amount of Dry Sand (regular screenings) was increased from 70% to 75%, again these blends are strictly hypothetical, but were used to maximize the fines in the mix. The specific blends and changes can be seen in Table 5.4.

Table 5.4: Aggregate utilization scenario for HMA Surface Course Type C

	Source 1				Source 2			
Blends	% of #67 0%	% of #789 33%	% of #67 0%	% of #789 33%	% of #67 0%	% of #789 30%	% of #67 0%	**% of #789 25%**
	% Dry Sand 67%	% Man. Sand 0%	% Dry Sand 67%	% Man. Sand 0%	% Dry Sand 70%	% Man. Sand 0%	**% Dry Sand 75%**	% Man. Sand 0%
Sieve Size	Current SCDOT	Value	Trial Gradation	Value	Current SCDOT	Value	Trial Gradation	Value
3/4-inch	100	100	100	100	100	100	100	100
1/2-inch	97-100	99.3	97-100	99.3	97-100	99.2	97-100	99.4
3/8-inch	83-100	97.7	90-100	97.7	83-100	94.7	90-100	95.6
No. 4	58-80	73.8	90 Max	73.8	58-80	77.6	90 Max	81.2
No. 8	42-62	60.4	32-67	60.4	42-62	61.9	32-67	65.8
No. 30	20-40	39.9	20-40	39.9	20-40	37.5	20-40	39.9
No. 100	8-20	14.6	8-20	14.6	8-20	15.4	8-20	16.4
No. 200	3-9	7.5	3-9	7.5	3-9	8.1	3-9	8.6

The HMA Intermediate Course Type A/B was also able to be optimized, but again only for Source 2. The critical sieve for larger aggregates was the 3/8-inch sieve and the No. 8 for the finer aggregate, both of which were changed in the trial gradation. As a result, the amount of No. 789 was reduced from 16% to 10%, the No. 67 was increased from 45% to 67%, and the Dry Sand was increased from 20% to 22%. The details of the blend and the changes can be seen in Table 5.5.

Table 5.5: Aggregate utilization scenario for HMA Intermediate Course Type A/B

	Source 1				Source 2			
Blends	% of #67 50%	% of #789 12%	% of #67 50%	% of #789 12%	% of #67 45%	% of #789 16%	**% of #67** **49%**	**% of #789** **10%**
	% Dry Sand 20%	% Man. Sand 18%	% Dry Sand 20%	% Man. Sand 18%	% Dry Sand 20%	% Man. Sand 19%	**% Dry Sand** **22%**	% Man. Sand 19%
Sieve Size	Current SCDOT	Value	Trial Gradation	Value	Current SCDOT	Value	Trial Gradation	Value
1-inch	100	100	100	100	100	100	100	100
3/4-inch	90-100	99.6	80-100	99.6	90-100	98.3	80-100	98.1
1/2-inch	75-90	89.7	90 Max	89.7	75-90	79.4	90 Max	77.7
3/8-inch	64-80	72.4	55-80	72.4	64-80	65.4	55-80	63.6
No. 4	38-54	42.8	38-60	42.8	38-54	45.4	38-60	46.0
No. 8	22-36	34.6	22-49	34.6	22-36	35.6	22-49	37.0
No. 30	8-22	22.0	8-22	22.0	8-22	20.8	8-22	21.6
No. 100	3-10	6.5	3-10	6.5	3-10	6.6	3-10	7.0
No. 200	2-8	3.0	2-8	3.0	2-8	3.2	2-8	3.4

Although optimizations were not possible for all scenarios, some applications were able to be optimized with a specification change. Further research is needed to produce proper specifications for performance, but this shows the possibility of an increase in aggregate optimization.

Dust to Binder Ratio

In the previous examples, the dust to binder ratio was not a limiting factor on the mix. Rather, the gradations, particularly at the No. 30 sieve controlled the amount of fines in the mix to where the dust to binder ratio was not able to be maximized. For example, if an asphalt binder content of 5% was assumed, and the dust to binder ratio was taken to be 1.6, then 8% by weight of the mix could be material passing the No. 200 sieve, or roughly 8.42% of the aggregate. However, only the Type C Surface mix had an aggregate blend approaching 8.5% passing the No. 200 sieve, and 5% asphalt content is just an approximation. However, when applicable, utilizing the maximum dust to binder ratio would be beneficial, but only in situations where the fines content was not controlled by the gradation, but rather the dust to binder ratio.

Base Substitution

The concept of the base substitution is to better utilize the crusher run aggregates, which are currently under-utilized. The current HMA Base gradation specifications are relatively narrow compared to other states, and limit the use of crusher-run aggregates, while the graded aggregate base specification allows for the use of crusher-run aggregates. Therefore, the idea is to replace the HMA Base with the graded aggregate base. Naturally, to keep the same structural value there will need to be a thicker layer of graded aggregate base.

To have a comparable substitution, the structural number for the layer must remain the same. The *SCDOT Pavement Design Guidelines* assigns a structural layer coefficient, a_3, of 0.34 for a HMA Base and 0.18 for a graded aggregate base. The structural number is determined by, $SN=D_3*a_3$, the equivalent depth of the graded aggregate base would need to be 1.89 times the depth of the HMA Base design. Clearly, the substitution would need to make financial sense, but it could be an effective way to better utilize crusher run aggregates, which are currently under-utilized and have a high fines content. An example of the required layers can be seen in Figure 5.1.

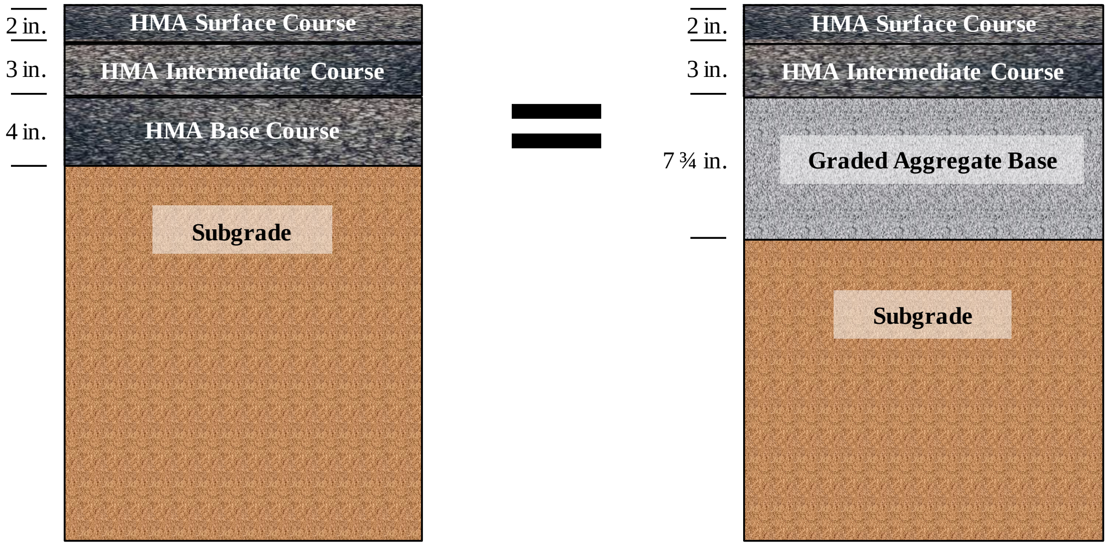


Figure 5.1: Pavement Layer Design Example for Base Substitution

CHAPTER VI: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Survey responses from 25 of the 50 state DOTs were collected and analyzed to better understand the issue of aggregate imbalance across the country. Only six of the respondents had experienced an imbalance, but of those six, five of them experienced it as a recurring problem, which is what makes this research of particular importance and interest. The majority of the effects were seen in pavement construction primarily hot mix asphalt, asphalt surface treatments, and concrete pavements. In addition, a database of specifications was constructed to compare gradations of specific sieve sizes (see Appendix B). From this database, a number of particular sieve sizes in hot mix asphalt gradations were identified as having great variance when South Carolina was compared to other states. It was these sieves that this research suggests should be examined to determine if there is a way to better optimize the available aggregates. The analysis also compared aggregate property specifications across the country. Finally, information about aggregate balance and recommendations for promoting balance was solicited from South Carolina aggregate producers.

This research has resulted in a number of conclusions and recommendations for further research that are presented and organized based on the research method.

Conclusions

The survey results and the aggregate specification database have made it possible to come to a number of conclusions concerning the aggregate mass imbalance, or the over- or under-utilization of particular aggregate sizes.

Survey Conclusions

- 6 of the 25 state DOT respondents had encountered an aggregate imbalance.

- Of the six states that have experienced an imbalance, 5 have experienced a recurring aggregate imbalance.
- The timing and duration of the imbalances varied widely across the responding states.
- High construction volume had slight to severe effects on the aggregate imbalance in all states that responded as having experienced an aggregate imbalance.
- Times of high volume construction are a major factor in aggregate imbalance.
- Roadway construction and maintenance, specifically hot mix asphalt, Portland cement concrete, and asphalt surface treatments was believed to contribute most to the aggregate imbalance.
- Specifically in South Carolina, the 3/8-inch and 1/2-inch aggregates are most over-utilized, while screenings and crusher run aggregates are most under-utilized.

The survey of the Nation's state DOTs supports the thought that times of high volume construction, similar to that experienced in South Carolina during the "27 in 7" campaign certainly contributed to the aggregate imbalance. However, of the states that experienced an aggregate imbalance, the majority experienced it as a recurring problem. So although the "27 in 7" campaign is completed and a similar boom in construction may or may not be occurring again, it is important to take precautions to avoid a recurring aggregate mass imbalance as it ultimately results in further depletion of valuable resources and creates an intensified demand that results in costs much higher than what it would be with a mass balance amongst aggregate sizes. The high volume of construction greatly contributed to the current aggregate imbalance, but although the "27 in 7" campaign is over, the importance and need to maintain aggregate mass balance should continue to be considered.

As hot mix asphalt is the primary aggregate consumer in the state, which was supported by the construction type to have largest effect of aggregate imbalance in the survey, it must be specifically investigated to determine if it can be updated to better obtain aggregate balance. This approach will be further discussed in the aggregate gradation specification section of the conclusions to follow.

Aggregate Gradation Specifications Conclusions

The following is a summary of the comparison of the aggregate gradation specifications of South Carolina to those around the nation.

- For bases, the 1.5-inch, No. 4, and No. 200 sieves produced the most differences.
  - 1.5-inch sieve: The majority of other state specifications were finer or broader. Of 25 specifications, 14 were finer and narrower.
  - No. 4 sieve: The majority of other state specifications varied. Of 38 specifications, 19 were finer, 8 were coarser, and 4 were broader.
  - No. 200 sieve: The majority of other state specifications were similar or tighter. Of 40 specifications, 15 were narrower, and 12 had no difference within tolerance.
- For hot mix asphalt Type A/B surface courses, the 3/8-inch and No. 8 sieves had the most differences.
  - 3/8-inch sieve: The majority of other state specifications were broader or coarser. Of 41 specifications, 19 were broader and 14 were coarser.
  - No. 8 sieve: The majority of other state specifications were finer. Of 38 specifications, 30 were finer.
- For hot mix asphalt Type C surface courses, the 3/8-inch, No. 4, and No. 8 sieves had the most differences.
  - 3/8-inch sieve: The majority of other state specifications were finer and narrower. Of 36 specifications, 21 were finer and narrower, while 8 were coarser.
  - No. 4 sieve: The majority of other state specifications were broader or coarser. Of 35 specifications, 17were broader and 16 were coarser.

  - No. 8 sieve: The majority of other state specifications were broader and/or coarser. Of 35 specifications, 15 were broader and coarser and 14 were coarser.
- For hot mix asphalt Type A/B intermediate courses, the 1/2-inch and No. 8 sieves had the most differences.
  - 1/2-inch sieve: The majority of other state specifications were broader or varied. Of 35 specifications, 19 were broader, 11 were coarser, and 4 finer.
  - No. 8 sieve: The majority of other state specifications were finer. Of 41 specifications, 32 were finer.
- For hot mix asphalt base courses, the 1-inch, 3/4-inch and No. 8 sieves had the most differences.
  - 1-inch sieve: The majority of the other state specifications were coarser and broader. Of 33 specifications, 22 were coarser and broader and 7 were coarser.
  - 3/4-inch sieve: The majority of other state specifications were coarser. Of 28 specifications, 24 were coarser, 5 were narrower, and 4 were broader.
  - No. 8 sieve: The majority of other state specifications were coarser. Of 34 specifications, 30 were coarser.

The fact that South Carolina generally has tighter allowable gradation bands in this aggregate size grouping is not necessarily a bad thing as the tightness of gradation can be directly proportional to pavement function and performance, and it is imperative that if any specifications are to be modified that they maintain the same level of performance. However, from an aggregate mass balance perspective, tight specifications limit the opportunities to utilize aggregate sizes that are typically under-utilized.

- For asphalt surface treatments, South Carolina had allowable aggregates that covered the full range of aggregate sizes used across the nation. However, there is currently a Special Provision requiring the use of lightweight aggregate in asphalt surface treatments.

The surface treatments were identified as a possible contributor to the aggregate mass imbalance, but no clear difference was seen between South Carolina gradations and other states in the allowable aggregates. In fact, South Carolina's range of allowable aggregate gradations was consistent with the range of all states cumulatively and in addition, provided more detail on specific application, which could be beneficial from a performance perspective. The main factor with respect to aggregates for surface treatments is the requirement of lightweight material which limits the availability to one out of state supplier.

As seen with all the varying gradation specifications, a large amount of which are in the range of the most over-utilized aggregate sizes in South Carolina (3/8-inch and 1/2-inch), it would be beneficial to determine if some specifications could be broadened or altered to utilize the available aggregates that are not in high demand while maintaining the performance requirements established by the SCDOT.

Los Angeles Abrasion Value Conclusions

The Los Angeles Abrasion specifications across the country were recorded for various roadway applications and then compared. Maximum percent loss values were found for bases and subbases, hot mix asphalt surface, intermediate, and base courses, and Portland cement concrete, some of the same roadway applications examined in the aggregate gradation sections.

- South Carolina had the highest allowable percent loss value in all applications.

The fact that South Carolina aggregates, particularly in the upstate, could have significantly higher percent loss values than other places around the country likely has a large impact on the specified gradation and the actual gradation due to aggregate breakdown.

Recommendations

The results of this research also suggest the need for further research which will be presented in this recommendation section.

- Test broader or varying HMA gradation ranges in the particular sieve sizes discussed in the conclusions. This research should focus on evaluating new gradations that better utilize aggregate sizes that are currently in lower demand, while meeting South Carolina's performance criteria.

Although South Carolina has differing aggregate gradation specifications, many of which center around over-utilized aggregate sizes, it is paramount to maintain high quality performance. Changes in aggregate gradation would only be viable if similar performance could be achieved. It would not be beneficial to obtain aggregate balance, if the end product performance was reduced. This would create reduced driver rideability, safety, and with additional maintenance could prove to be more economically taxing in the end. However, with further testing, more efficient gradations that better utilize available aggregate sizes could be developed with the same level of performance as the existing roadways.

Another factor to be evaluated in these gradations is the high LA abrasion values, and their effect on the final product.

- Test breakdown of high abrasion loss aggregates both in production and construction.

In addition to examining the effect of broadening some of the aggregate specification bands, it is recommended to further investigate the effect of aggregate breakdown from initial gradation to final gradation (after completion of construction). South Carolina's high allowable LA abrasion limits allow for potentially high variability in designed and actual gradations. This variability could explain the need for some South Carolina specifications to be coarser than other states with lower LA Abrasion limits. In addition, the fact that the high LA abrasion loss aggregate is a regional issue and not state-wide, the change in gradation during plant mixing and compaction could create large variability across the state. Research in this area could help produce more effective design procedures that can better account for aggregate breakdown.

The final recommendations are specific to more effectively utilizing aggregate types that are currently in low demand, specifically crusher run (or a graded aggregate base) and fines, or screenings.

- Determine the effects of using the maximum allowable dust to binder ratio of 1.6

An increase in the designed dust to binder ratio could increase the amount of fines in the mix, utilizing an aggregate size that is currently under-utilized.

- Examine the possibility of base substitution, specifically in HMA pavements replacing the HMA base with a graded aggregate base.

This research would be a combination of resource utilization and economic cost analysis. This substitution would require a considerably deeper layer, as the HMA base would have a much larger structural coefficient than the graded aggregate base. However, it could serve as an effective way to utilize an aggregate type not in high demand, while at the very least avoiding any additional cost to the project, and maintaining the same performance.

- Examine the use of screenings as backfill or soil replacement.

South Carolina has already opened the reinforced concrete pipe backfill specification to utilize these screenings, but the use of screenings could potentially be significantly widened. Other backfill situations, such as road widening, or other construction projects could utilize this under-utilized aggregate size to help balance the aggregate supply. In addition, particularly in South Carolina, there are a number of areas with poor soil, in which structural stability or pumping is a concern. In these areas that soil must be undercut to construct the best performing pavement. Rather than using other high roadbed modulus soils, these under-utilized screenings could be used as a roadbed fill replacement, producing a roadbed with a higher modulus, which could potentially reduce the required design thickness of the pavement. Again, economic analysis would be required for the substitution to be worthwhile. Another factor here is that contractors may not understand that screenings may be used in these types of fill applications.

- More effective planning and communications with producers

More effective forecasting of work would allow quarries to better prepare for upcoming situations and more efficiently optimize the production of aggregates available.

APPENDICES

APPENDIX A: STATE DEPARTMENT OF TRANSPORTATION SURVEY

A-1: State Department of Transportation Survey

A-2: State Department of Transportation Survey Responses

A-1: State Department of Transportation Survey

Has the DOT ever experienced overutilization or underutilization of particular aggregate sizes that has led to an imbalance of aggregate availability?

Yes___ No___

***If you answer "No" to this question, then disregard questions 2 - 9.*

Is aggregate imbalance a recurring problem? Yes___ No___

During what time period(s) did an aggregate imbalance occur *(check all that apply)*?

Before 1985__ 1985-1990__ 1990-1995__
1995-2000__ 2000-2005__ 2005-2009__

How many years did this/these periods of aggregate imbalance last *(check all that apply)*?

1___ 2___ 3___ 4___ 5___ 6___ 7___ 8___ 9___ 10___ > 10___

What aggregate size designations have been over utilized (i.e., in short supply, but high demand)?

What aggregate size designations have been underutilized (i.e., in surplus, with low demand)?

What were the particular causes of this aggregate imbalance?

What measures were taken to resolve or deal with this aggregate imbalance and were these permanent changes?

Since the implementation of these measures, has the aggregate imbalance issue resurfaced?

Yes___ No___

How have times of high construction/maintenance volume affected the supply of aggregate?

___ No change
___ Slight imbalance of available aggregate sizes
___ Moderate imbalance of available aggregate sizes
___ Severe imbalance of available aggregate sizes

What type(s) of construction would likely contribute to an overutilization of a particular aggregate size, thus leading to an imbalance in the aggregate supply *(check all that apply)*?

___ Base and subbase
___ Hot mix asphalt pavements
___ Asphalt surface treatments
___ Concrete pavements
___ Backfill
___ Drainage
___ Other

Thank you for your input. If you have any further comments or information related to this topic that you would like to provide, please include them below.

A-2: State Department of Transportation Survey Responses

	State	Alaska	Arizona	Arkansas	Colorado
1)	Has the DOT ever experienced over-utilization or underutilization of particular aggregate sizes that has led to an imbalance of aggregate availability?	No	No	No	No
2)	Is aggregate imbalance a recurring problem?				
3)	During what time period(s) did an aggregate imbalance occur (check all that apply)?				
4)	How many years did this/these periods of aggregate imbalance last (check all that apply)?				
5)	What aggregate size designations have been over utilized (i.e., in short supply, but high demand)?				
6)	What aggregate size designations have been underutilized (i.e., in surplus, with low demand)?				
7)	What were the particular causes of this aggregate imbalance?				
8)	What measures were taken to resolve or deal with this aggregate imbalance and were these permanent changes?				
9)	Since the implementation of these measures, has the aggregate imbalance issue resurfaced?				
10)	How have times of high construction/maintenance volume affected the supply of aggregate?	No Change	No Change	No Change	
11)	What type(s) of construction would likely contribute to an over-utilization of a particular aggregate size, thus leading to an imbalance in the aggregate supply (check all that apply)?		Concrete pavements	Base and subbase and hot mix asphalt pavements	
12)	Additional Insights				

	Florida	Georgia	Kansas
1)	No	No	Yes
2)			Yes
3)			1995-2005
4)			8
5)			> 3/8"
6)			
7)			High demand for concrete coarse aggregate in the Kansas City immediate area.
8)			A couple of suppliers were not bothering to market the -3/8" material. They were basically only producing to meet the concrete coarse aggregate material. This has caused them to have large piles of -3/8". We have listened to this issue several times over the past 2+ years. I would like to point out that some quarries were able to market their -3/8" material. So I would like to suggest that this is an aggregate producer's management issue.
9)			
10)	No Change	Slight Imbalance	Slight Imbalance
11)		Hot mix asphalt pavements	Concrete pavements
12)		We have experienced minor supply issues with SMA stone in some areas of the State where local quarries are unable to meet SMA specifications (LA Abrasion, Flat and Elongated).	

	Kentucky	Louisiana	Maine	Minnesota
1)	No	Yes	No	No
2)		Yes		
3)		1985-2009		
4)		>10		
5)		PLUS ¾" MATERIAL, ALSO MINUS No. 8 plus No. 40		
6)		Minus 3/8", Plus No. 4		
7)		Nature of deposits, demand for concrete aggregate		
8)		Importation of crushed stone to meet needs. yes, changes were "permanent" as DOT changes go.		
9)		No		
10)		We have had periods that river levels affected shipping, which created some temporary overall aggregate shortages, not any particular size imbalance	Slight Imbalance	No Change
11)	Hot mix asphalt pavements	Concrete pavements	Hot mix asphalt pavements	
12)				

	Missouri	Nevada	New Jersey
1)	No	No	Yes
2)			No
3)			1985-1990 and 1995-2000
4)			3
5)			#57 vs. #67
6)			HMA sand (washed) after the intro. Of Superpave specs.
7)			#57 vs. #67 in the 1985-88 range due to plant production restrictions (you can't make #57 and #67 at the same time and #8's sometimes affected when making #67); concrete sand w/ the onset of superpave, particularly in S. NJ.
8)			Wrote a small in-house memo regarding and the market responded by producing more washed stone sands and more natural sand pits. We have also have Pinelands Land Regs. in NJ that can be restrictive. Natural pits were moved outside this area.
9)			No
10)		No Change	Slight Imbalance
11)		Drainage	Hot mix asphalt pavements
12)			

	New York	North Carolina	Ohio
1)	Yes	No	Yes
2)	Yes		Yes
3)	Before 1985-2009		2000-2009
4)	>10		
5)	Principally NYSDOT #1A crushed stone (1/8"-1/4")		#8 due to asphalt usage
6)	Sizes larger than 1"		Not sure if under utilized but more seeing #57 with less 1/2 inch material. Seeing other sizes with less half inch so that more #8 can be produced.
7)	Most HMA mix designs use #1A sized aggregate and there is almost no use of +1" sized aggregates in either HMA or PCC mixes.		Seems to generally be an issue with #8 because of asphalt usage.
8)	NYSDOT has made no attempt to deal with this because it is a market issue and is reflected in bid price. For the most part, #1A stone can be made available, at a price. True shortages have occurred, but on a very short term basis, and were ultimately addressed by producers.		None
9)	No measures taken		
10)	Moderate Imbalance	Slight Imbalance	Moderate Imbalance
11)	Asphalt surface treatments	Hot mix asphalt pavements and asphalt surface treatments	
12)	In order to supply the #1A sized aggregate that meets the demand, larger sized aggregate must be recrushed, which increases the price. The greatest demand for #1A stone is in the Downstate area, in the vicinity of NYC. Upstate (the rest of New York) there is significantly less imbalance in the market.		

	Rhode Island	South Carolina	Tennessee
1)	No	Yes	No
2)		Yes	
3)		2000-2005	
4)		2	
5)		1/2" and 3/8"	
6)		Screenings and Crusher Run	
7)		The major cause of the imbalance was an accelerated construction program (27 years work in 7 years) combined with large resurfacing programs on high volume routes using asphalt mix designs that placed large demands on critical sieve sizes and low demands on other sizes. Also, the increased use of products like recycled concrete base material has reduced demand for some of the underutilized sizes.	
8)		Some factors that have helped with the imbalance have been increased use of RAP in asphalt mixes, the requirement for the use of lightweight aggregate for surface treatments have helped to reduce the imbalance, but the biggest factors have been a lack of funds for large resurfacing programs, the completion of the accelerated construction program and the slowdown in construction due to the economic downturn. I would say that the first two are permanent as far as our current specifications are concerned although they could change in the future. The slowdown in work should be a temporary condition.	
9)		No. There is currently an underutilization of all sizes.	
10)	No Change	Severe Imbalance	No Change
11)		The biggest contributor to the over-utilization of critical sizes has been hot-mix asphalt. Some of the other uses also contributed, but to a much smaller extent than HMA.	
12)			Fortunately Most of Tennessee has an abundant supply of aggregate sources

	Utah	Virginia	Washington	Wyoming
1)	No	No	No	No
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)	No Change	No Change	No Change	No Change
11)	Concrete pavements		Base and subbase and concrete pavements	Hot mix asphalt pavements and asphalt surface treatments and drainage
12)			We have not had industry problems with sizes of aggregate, but some local sites are poor in larger sized aggregate and rich in sand. That is a competitive issue, but overall the sources have good size distribution (for gravel sites) and our quarries make their own sizes.	Probably about 50% of the aggregate used on DOT projects is produced from sources that are made available by the DOT. Even when the contract specifies a contractor furnished source, the aggregate is most often crushed specifically for that project. For high class roadways we specify 100% crushed aggregate for HMA, which may be from gravel deposits. The contractor often has to do additional crushing to create crushed fines, but it becomes project specific and does not create an overall shortage.

APPENDIX B: AGGREGATE GRADATION SPECIFICATIONS

Section 1: Bases and Subbases

Description	Graded Aggregate Base (Composites)
Code Reference	305.2.5.5
Aggregate Gradation	Macadam Base Course
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
1-inch	70-100
1/2-inch	48-75
No. 4	30-60
No. 16	11-30
No. 200	0-12

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	401.2.2
Aggregate Gradation	Type A and B
Application	Interstate/Intersections
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	98-100
1/2-inch	90-100
3/8-inch	72-90
No. 4	44-62
No. 8	23-43
No. 30	10-25
No. 100	4-12
No. 200	2-8

Aggregate Gradation	Type CM
Application	Low Volume Primary
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	97-100
3/8-inch	83-100
No. 4	58-80
No. 8	42-62
No. 30	20-40
No. 100	8-20
No. 200	3-9

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-402
Aggregate Gradation	Type A and B
Application	Intersections
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	75-90
3/8-inch	64-80
No. 4	38-54
No. 8	22-36
No. 30	8-22
No. 100	3-10
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Courses
Code Reference	401.2 and SC-M-402
Aggregate Gradation	Type A and B
Application	Interstates/Primary
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
1/2-inch	60-80
No. 4	40-55
No. 8	30-45

Section 2e: Asphalt Surface Treatments

Description	Single-1
Code Reference	406.2.2 and 408.2.2
Acceptable Aggregate	6M, 89M, 789
Description	Single-2
Acceptable Aggregate	6M, 89M, 789
Description	Double-1
Acceptable Aggregate	5, 789
Description	Double-2
Acceptable Aggregate	5, 789
Description	Double-3
Acceptable Aggregate	6M, 789
Description	Double-4
Acceptable Aggregate	6M, 89M
Description	Double-5
Acceptable Aggregate	89M, FA-13
Description	Triple-1
Acceptable Aggregate	5, 789, FA-13
Description	Triple-2
Acceptable Aggregate	6M, 89M, FA-13

Section 3: Concrete Pavements

Description	PCC Pavements- Coarse
Code Reference	refer to SC-M-501
Aggregate Gradation	#67 or job mix formula #56 or #57

Description	PCC Pavements- Fine
Code Reference	refer to SC-M-501
Aggregate Gradation	FA-10, FA-10M

Job Mix Formula- use #56 or #57 or have approval from the Structural Materials Engineer

Description	#56
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	40-85
1/2-inch	10-40
3/8-inch	0-15
No. 4	0-5

Description	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Description	#67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Section 4: Incidental Construction

Description	Aggregate Underdrains
Code Reference	801.2.1 (Coarse) 801.2.2 (Fine)
Aggregate Gradation	57, 789, FA-13

Description	Pipe Underdrains
Code Reference	802.2.2
Aggregate Gradation	789

Description	Granular Backfill
Code Reference	713.2.7.2
Aggregate Gradation	% Passing
1"	100 (steel)
3/4"	100 (geosynthetic)
No. 40	0-60
No. 100	0-30
No. 200	0-15

Description	Stone Backfill
Code Reference	713.2.7.3
Aggregate Gradation	67 and 6M (geosynthetic) 5, 57, 67, 6M (steel)

South Carolina Department of Transportation, "SCDOT Standard Specifications for Highway Construction," 2007. <http://www.dot.state.sc.us/doing/const_man.shtml>.

Section 1: Bases and Subbases

Description	Crushed Aggregate Base
Code Reference	824.03
Aggregate Gradation	Type A
Gradation	% Passing
1-inch	100
3/4-inch	86-100
No. 4	26-55
No. 8	15-41
No. 50	3-18
No. 200	5-15

Aggregate Gradation	Type B
Gradation	% Passing
1.5-inch	90-100
1-inch	75-98
1/2-inch	55-80
No. 4	40-70
No. 8	28-54
No. 16	19-42
No. 50	9-32
No. 200	7-18

Section 2a: HMA Surface Courses

Description	HMA
Code Reference	424.02
Aggregate Gradation	1/2 in Max size Mix
Gradation	% Passing (by weight)
1/2"	100
3/8"	90-100
No. 4	<90
No. 8	32-67
No. 200	2-10
No. 200	2-8

Aggregate Gradation	3/8 in Max size Mix
Gradation	% Passing (by weight)
3/8"	100
No. 4	75-100
No. 16	30-60
No. 200	6-12

Section 2b: HMA Intermediate Courses

Description	HMA
Code Reference	424.02
Aggregate Gradation	3/4 in Max size Mix
Gradation	% Passing (by weight)
3/4"	100
1/2"	90-100
3/8"	<90
No. 8	28-58
No. 200	2-10

Section 2c: HMA Base Courses

Description	HMA
Code Reference	424.02
Aggregate Gradation	1 1/2 in Max Size Mix
Gradation	% Passing (by weight)
1"	90-100
3/4"	<90
No. 8	19-45
No. 200	1-7

Aggregate Gradation	1 in Max Size Mix
Gradation	% Passing (by weight)
3/4"	90- 100
1/2"	<90
No. 8	23-49
No. 200	2-8

Section 2e: Asphalt Surface Treatments

Code Reference	401.01 b
Description	Flush Coat B
Acceptable Aggregate	sand
Description	Flush Coat C
Acceptable Aggregate	9
Description	Liquid Seal D
Acceptable Aggregate	78 or 89
Description	Liquid Seal E
Acceptable Aggregate	78
Description	Liquid Seal F
Acceptable Aggregate	78
Description	Liquid Seal G
Acceptable Aggregate	7 or 78
Description	Liquid Seal H
Acceptable Aggregate	6
Description	Surface Treatment J
Acceptable Aggregate	6
Description	Surface Treatment K
Acceptable Aggregate	5
Description	Surface Treatment L
Acceptable Aggregate	1st application- 4 Dry choke- 78 2nd application- 78

Section 3: Concrete Pavements

Description	Coarse Aggregate
Code Reference	450.2
Aggregate Gradation	#357, #467, #57

Description	Fine Aggregate
Code Reference	450.02
Aggregate Gradation	Natural sand

Description	#357
Gradation	% Passing (by weight)
2.5-inch	100
2-inch	95-100
1-inch	35-70
1/2-inch	10-30
No. 4	0-5

Description	#467
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5

Description	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Section 4: Incidental Construction

Description	Aggregate Filler
Code Reference	605.3
Aggregate Gradation	#4, #5, #57

Description	#4
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	20-55
3/4-inch	0-15
3/8-inch	0-5

Description	#5
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	20-55
1/2-inch	0-10
3/8-inch	0-5

Description	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Department of Transportation, "Alabama Department of Transportation Standard Specifications for Highway Construction," ALDOT, 2008. <http://www.state.dot.al.us/>.

Section 1: Bases and Subbases

Description	Base Courses
Code Reference	301-2.01 and 703-2.03
Aggregate Gradation	C-1
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	70-100
3/4-inch	60-90
3/8-inch	45-75
No. 4	30-60
No. 8	22-52
No. 50	8-30
No. 200	0-6

Aggregate Gradation	D-1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	70-100
3/8-inch	50-80
No. 4	35-65
No. 8	20-50
No. 40	8-30
No. 200	0-6

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	703-2
Aggregate Gradation	E-1
Gradation	% Passing (by weight)
1"	100
3/4"	70-100
3/8"	50-85
No. 4	35-65
No. 8	20-50
No. 50	15-30
No. 200	8-15

Aggregate Gradation	F-1
Gradation	% Passing (by weight)
1"	100
3/4"	85-100
3/8"	60-100
No. 4	50-85
No. 8	40-70
No. 50	25-45
No. 200	8-20

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	703-3
Aggregate Gradation	Type 1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-90
1/2-inch	60-84
3/8-inch	48-78
No. 4	28-63
No. 8	14-55
No. 30	6-34
No. 50	5-24
No. 100	4-16
No. 200	3-7

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	703-2
Aggregate Gradation	D-1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	70-100
3/8-inch	50-80
No. 4	35-65
No. 8	20-50
No. 50	8-30
No. 200	0-6

Section 2e: Asphalt Surface Treatments

Description	A
Gradation	% Passing
1.5-inch	100
1-inch	90-100
1/2-inch	0-15
No. 200	0-1

Description	B
Gradation	% Passing
1-inch	100
3/4-inch	90-100
1/2-inch	20-55
3/8-inch	0-15
No. 200	0-1

Description	C
Gradation	% Passing
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-75
No. 4	0-15
No. 8	0-5
No. 200	0-1

Description	D
Gradation	% Passing
1/2-inch	100
3/8-inch	inch
No. 4	0-10
No. 8	0-5
No. 200	0-1

Description	E
Gradation	% Passing
1/2-inch	100
3/8-inch	90-100
No. 4	10-30
No. 8	0-8
No. 200	0-1

Description	F
Gradation	% Passing
3/8-inch	100
No. 4	75-100
No. 8	0-10
No. 200	0-1

Description	G
Gradation	% Passing
3/8-inch	100
No. 4	85-100
No. 8	60-100
No. 200	0-10

Section 3: Concrete Pavements

Description	PCC Pavements - Fine
Code Reference	703-2.01
Aggregate Gradatio	refer to AASHTO M 6: Class A

Description	PCC Pavements - Coarse
Code Reference	703-2.02
Aggregate Gradatio	refer to AASHTO M 80: Class B

Section 4: Incidental Construction

Description	Porous Backfill Material - for Underdrains
Code Reference	703-7

Gradation	% Passing (by weight)
3-inch	100
1-inch	0-10
No. 200	0-5

Alaska Department of Transportation, “Alaska Department of Transportation and Public Facilities Standard Specifications for Highway Construction,” 2004. <http://www.dot.state.ak.us/stwddes/dcsspecs/assets/pdf/hwyspecs/english/2004sshc.pdf>.

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	Table 303-1
Aggregate Gradation	Class 1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
No. 8	35-55
No. 200	0-8

Code Reference	Table 303-1
Aggregate Gradation	Class 2
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
No. 8	35-55
No. 200	0-8

Section 2a: HMA Surface Courses

Description	Asphaltic Concrete Mix Design
Code Reference	416-2 and 417-2
Aggregate Gradation	1/2-inch Mix
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	67-82
No. 8	40-48
No. 40	10-18
No. 200	1.5-4.5

Aggregate Gradation	SHRP Volumetric 1/2" Coarse Mix
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	53-89
No. 8	28-39
No. 40	2-19
No. 200	2-5.5

Designation	SHRP Volumetric 1/2" Fine Mix
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	64-89
No. 8	40-52
No. 40	17-52
No. 200	2-5.2

Section 2b: HMA Intermediate Courses

Description	Asphaltic Concrete Mix Design
Code Reference	416-2 and 417-2
Aggregate Gradation	3/4-inch Mix
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	62-77
No. 8	37-46
No. 40	10-18
No. 200	1.5-4.5

Aggregate Gradation	SHRP Volumetric 3/4" Coarse Mix
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	43-89
No. 8	23-35
No. 40	2-17
No. 200	2-5

Designation	SHRP Volumetric 3/4" Fine Mix
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	60-89
No. 8	36-49
No. 40	15-49
No. 200	2-5

Section 2c: HMA Base Courses

Description	Asphaltic Concrete Mix Design
Code Reference	416-2 and 417-2
Aggregate Gradation	Base Mix
Gradation	% Passing (by weight)
1.25-inch	100
1-inch	90-100
3/4-inch	85-95
3/8-inch	57-72
No. 8	32-42
No. 40	8-16
No. 200	1.5-3.5

Section 2e: Asphalt Surface Treatments

Description	Blotter Material Treatment
Code Reference	402-2.02-B
Gradation	% Passing
3/8-inch	100
No. 4	80-100
No. 16	45-80
No. 200	0-5

Description	Surface Cover Treatment- Class 1
Code Reference	402-2.02-B
Gradation	% Passing
1/2-inch	100
3/8-inch	70-90
1/4-inch	0-10
No. 8	0-5
No. 200	0-1

Description	Surface Cover Treatment- Class 2
Code Reference	402-2.02-B
Gradation	% Passing
3/8-inch	100
1/4-inch	70-90
No. 4	0-10
No. 8	0-5
No. 200	0-1

Section 4: Incidental Construction

Description	Drainage Aggregates
Code Reference	506-2.03
Gradation	% Passing
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5
No. 100	0-2

Description	Structural Backfill
Code Reference	203-5.03-B
Gradation	% Passing
3-inch	3" 100
3/4-inch	3/4" 60-100
No. 8	No. 8 35-80
No. 200	No. 200 0-12

Code Reference	203-5.03-C
Gradation	% Passing
1.5-inch	100
1-inch	90-100
No. 8	35-80
No. 200	0-8

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	1006-2.03-C
Aggregate Gradation	must meet AASHTO M 43

Description	PCC Fine Aggregate
Code Reference	1006-2.03-B
Aggregate Gradation	AASHTO M6 & below gradation

Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	0-30
No. 100	0-10
No. 200	0-4

Arizona Department of Transportation, “Arizona Department of Transportation Standard Specifications for Highway Construction,” AZDOT, 2000. <http://www.state.dot.az.us/>.

Section 1: Bases and Subbases

Description	Aggregate Base Course
Code Reference	Table 303-1
Aggregate Gradation	Class 1 and 2
Gradation	% Passing (by weight)
3-inch	100
2-inch	95-100
3/4-inch	60-100
3/8-inch	40-80
No. 4	30-60
No. 10	20-50
No. 40	10-35
No. 200	3-15

Aggregate Gradation	Class 3
Gradation	% Passing (by weight)
3-inch	100
2-inch	95-100
1.5-inch	85-100
3/4-inch	60-100
3/8-inch	40-80
No. 4	30-60
No. 10	20-45
No. 40	10-35
No. 200	3-12

Aggregate Gradation	Class 4 and 5
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	60-100
3/8-inch	40-80
No. 4	30-60
No. 10	20-45
No. 40	10-35
No. 200	3-12

**Class 6, 7, 8 also available

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	407-1
Aggregate Gradation	1/2 inch [12.5 mm]
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-10

Aggregate Gradation	3/8 inch [9.5 mm]
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Binder Course
Code Reference	406-1
Aggregate Gradation	1" [25 mm]
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-45
No. 200	1-7

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	405-1
Aggregate Gradation	1-1/2" [37.5 mm]
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	90 max
No. 8	15-41
No. 200	0-6

Section 2e: Asphalt Surface Treatments

Description	Tack Coat, Prime Coat, Surface Treatments
Code Reference	403.02
Aggregate Gradation	Class 1
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
No. 4	0-15
No. 10	0-3

Aggregate Gradation	Class 2
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	80-100
No. 10	0-15
No. 16	0-3

Aggregate Gradation	Class 3
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	50-90
No. 10	0-15
No. 16	0-3

Section 3: Concrete Pavements

Description	PCC fine
Code Reference	501.02b
Aggregate Gradation	Fine Aggregate
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	70-95
No. 16	45-85
No. 30	20-65
No. 50	5-30
No. 100	0-5

Description	PCC Coarse
Code Reference	501.02c
Aggregate Gradation	AHTD
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	60-100
3/4-inch	35-75
3/8-inch	10-30
No. 4	0-5

Description	PCC Coarse
Code Reference	501.02c
Aggregate Gradation	AASHTO M43 #57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Section 4: Incidental Construction

Description	Backfill
Code Reference	207.02
Aggregate Gradation	Class 7
1.5-inch	100
1-inch	60-100
3/4-inch	50-90
No. 4	25-55
No. 40	10-30
No. 200	3-10

Arkansas Department of Transportation, “Arkansas Department of Transportation Standard Specifications for Highway Construction,” Arkansas State Highway and Transportation Department, 2003. <http://www.arkansashighways.com/>.

Section 1: Bases and Subbases

Description	Class 2 Aggregate Base
Code Reference	26-1.02A
Aggregate Gradation	1.5" Max
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	87-100
3/4-inch	45-90
No. 4	20-50
No. 30	6-29
No. 200	0-12

Description	Class 2 Aggregate Base
Code Reference	26-1.02A
Aggregate Gradation	3/4" Max
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	87-100
No. 4	30-65
No. 16	5-35
No. 100	0-12

Section 2a: HMA Surface Courses

Description	Asphalt Concrete Grading
Code Reference	39-2.02
Aggregate Gradation	varies refer below

Aggregate Gradation	1/2" Max Coarse
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	89-100
3/8-inch	70-95
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	0-10

Aggregate Gradation	1/2" Max Medium
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	89-100
3/8-inch	75-100
No. 4	59-66
No. 8	43-49
No. 30	22-27
No. 200	0-11

Aggregate Gradation	3/8" Max
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	73-77
No. 8	58-63
No. 30	29-34
No. 200	0-14

Section 2b: HMA Intermediate Courses

Description	Asphalt Concrete Grading
Code Reference	39-2.02
Aggregate Gradation	3/4" Max Coarse
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	87-100
3/8-inch	55-80
No. 4	45-50
No. 8	32-36
No. 30	15-18
No. 200	0-10

Aggregate Gradation	3/4" Max Medium
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	60-85
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	0-11

Section 2c: HMA Base Courses

Description	Asphalt Concrete Grading
Code Reference	39-2.02
Aggregate Gradation	Type A and B Base
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	92-100
3/4-inch	77-100
3/8-inch	55-60
No. 4	40-45
No. 30	14-19
No. 200	0-10

Section 4: Incidental Construction

Description	Underdrains
Aggregate Gradation	Class 1-B
2-inch	100
1.5-inch	95-100
3/4-inch	50-100
3/8-inch	15-55
No. 4	0-25
No. 8	0-5
No. 200	0-3

Aggregate Gradation	Class 2
1-inch	100
3/4-inch	90-100
3/8-inch	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

Section 2e: Asphalt Surface Treatments

Description	Seal Coat Fine
Code Reference	37.1-02
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	60-85
No. 8	0-25
No. 16	0-5
No. 30	0-3
No. 200	0-2

Description	Seal Coat Medium Fine
Code Reference	37.1-02
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	30-60
No. 8	0-15
No. 16	0-5
No. 30	0-3
No. 200	0-2

Description	Seal Coat Medium
Code Reference	37.1-02
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	30-May
No. 8	0-10
No. 16	0-5
No. 200	0-2

Description	Seal Coat Coarse
Code Reference	37.1-02
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	50-80
No. 4	0-15
No. 8	0-5
No. 200	0-2

Section 4: Incidental Construction (continued)

Description	Underdrains (continued)
Aggregate Gradation	Class 1-A
Gradation	% Passing (by weight)
3/4-inch	3/4" 100
1/2-inch	1/2" 95-100
3/8-inch	3/8" 70-100
No. 4	No. 4 0-55
No. 8	No. 8 0-10
No. 200	No. 200 0-3

Description	Structural Backfill
Code Reference	19-3.06
Gradation	% Passing (by weight)
3-inch	100
No. 4	35-100
No. 30	20-100

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	90-3.03
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	93-100
No. 8	61-99
No. 16	55-75
No. 30	34-46
No. 50	16-29
No. 100	1-15
No. 200	0-10

Description	PCC Coarse Aggregate
Code Reference	90-3.02
Aggregate Gradation	Coarse 1/2" x No. 4
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	80-100
No. 8	40-78
No. 16	0-18
No. 30	0-7

Aggregate Gradation	1-1/2" x 3/4"
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	85-100
1-inch	19-41
3/4-inch	0-20
3/8-inch	0-9

Aggregate Gradation	1" x No. 4
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	86-100
3/4-inch	52-85
3/8-inch	15-38
No. 4	0-18
No. 8	0-7

Aggregate Gradation	3/8" x No. 4
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	50-85
No. 4	0-28
No. 8	0-7

*California also has further specs for the combining of the FA and CA

State of California Business, Transportation and Housing Agency Department of Transportation, “Standard Specifications,” Caltrans, California Department of Transportation, 2006. <http://www.dot.ca.gov/>.

Colorado

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	Table 703-3
Aggregate Gradation	Class 1
Gradation	% Passing (by weight)
2.5-inch	100
2-inch	95-100
No. 4	30-65
No. 200	2-15

Code Reference	Table 703-3
Aggregate Gradation	Class 4
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	50-90
3/8-inch	30-50
No. 200	3-12

Section 2a: HMA Surface Courses

Description	Cover Coat Aggregate
Code Reference	Table 703-6
Aggregate Gradation	Type IV
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	60-80
No. 200	0-1

Section 2b: HMA Intermediate Courses

Description	HMA Pavement
Code Reference	703-4
Aggregate Gradation	Grading SG
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
No. 8	28-58
No. 200	2-10

Section 2c: HMA Base Courses

Description	HMA Pavement
Code Reference	703-4
Aggregate Gradation	Grading SC
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
No. 8	19-45
No. 200	1-7

Aggregate Gradation	Grading S
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
No. 8	23-49
No. 200	2-8

Section 2e: Asphalt Surface Treatments

Description	Seal Coat
Code Reference	Table 703-6
Aggregate Gradation	Cover Coat Type 1
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	0-15
No. 200	0-1

Aggregate Gradation	Cover Coat Type 2
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	70-100
3/8-inch	0-4
No. 200	0-1

Aggregate Gradation	Cover Coat Type 2
Gradation	% Passing (by weight)
3/4-inch	100
3/8-inch	95-100
1/2-inch	60-80
No. 4	0-1

Section 3: Concrete Pavements

Description	Coarse Aggregate
Code Reference	703.03
Aggregate Gradation	follows AASHTO M 80

Description	
Code Reference	Fine Aggregate
Code Reference	703.01
Aggregate Gradation	follows AASHTO M 6

Section 4: Incidental Construction

Description	Bed Course Material
Code Reference	Table 703-7
Aggregate Gradation	% Passing (by weight)
No. 30	100
No. 50	95-100
No. 200	70-100

Description	Backfill
Code Reference	703.08
Aggregate Gradation	% Passing (by weight)
2-inch	100
No. 4	30-100
No. 50	10-60
No. 200	5-20

**Filter Material gradations available in Table 703-7

Department of Transportation, “CDOT 2005 Standard Specifications for Road and Bridge Construction,” CODOT, 2005. <http://www.state.dot.co.us/>.

Section 1: Bases and Subbases

Description	Processed Aggregate Base
Code Reference	M.05.01
Aggregate Gradation	refer below
Gradation	% Passing (by weight)
2-inch	95-100
3/4-inch	50-75
3/8-inch	25-45
No. 40	5-20
No. 100	2-12

Description	Granular Base
Code Reference	M.02.03
Aggregate Gradation	refer below
Gradation	% Passing (by weight)
3.5-inch	100
1.5-inch	55-100
3/8-inch	25-60
No. 10	15-45
No. 40	5-25
No. 100	0-10
No. 200	0-5

Section 2a: HMA Surface Courses

Description	HMA Marshall Method
Code Reference	M.04.02-1
Aggregate Gradation	Class 2
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	55-80
No. 8	40-64
No. 30	16-36
No. 50	8-26
No. 200	3-8

Aggregate Gradation	Class 3
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	65-87
No. 8	40-70
No. 30	20-40
No. 50	10-30
No. 200	3-8

** Superpave also available with Control Points at Table M-04.02-2

Section 2b: HMA Intermediate Courses

Description	HMA Marshall Method
Code Reference	M.04.02-1
Aggregate Gradation	Class 1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	70-100
3/8-inch	60-82
No. 4	40-65
No. 8	28-50
No. 30	10-32
No. 50	6-26
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Marshall Method
Code Reference	M.04.02-1
Aggregate Gradation	Class 4
Gradation	% Passing (by weight)
2-inch	100
3/4"	60-80
3/8"	42-66
No. 4	30-55
No. 8	20-40
No. 50	5-18
No. 200	0-5

Section 2e: Asphalt Surface Treatments

Description	Surface Treatment
Code Reference	M.05.02
Aggregate Gradation	Sand
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	80-100
No. 50	10-30
No. 100	0-10

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	M.03.01-1
Aggregate Gradation	Class A- Nominal Max No. 4
	Class C, F- Nominal Max No. 6

Description	PCC Fine Aggregate
Code Reference	M.03.01-1
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

Section 4: Incidental Construction

Description	Aggregate Underdrain
Code Reference	M.08.03
Aggregate Gradation	No. 8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Description	Granular Fill
Code Reference	M.02.01
Gradation	% Passing (by weight)
3.5-inch	100
1.5-inch	55-100
1/4-inch	25-60
No. 10	15-45
No. 30	5-25
No. 100	0-10
No. 200	0-5

Connecticut Department of Transportation, “Connecticut DOT Specifications for Roads, Bridges, and Incidental Construction,” Form 815 metric, CTDOT, 2002. <http://www.ct.gov/dot/site/default.asp>.

Section 1: Bases and Subbases

Description	Graded Aggregate Base
Code Reference	821.03
Aggregate Gradation	Type B - Crusher Run
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	50-95
No. 4	20-50
No. 10	15-40
No. 100	2-20

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	823.20
Aggregate Gradation	Job Mix Formula C Dense graded surface course
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	50-75
No. 8	33-59
No. 30	14-32
No. 50	7-26
No. 200	3-10

Section 2b: HMA Intermediate Courses

Description	Dense Graded Binder Course
Code Reference	823.20
Aggregate Gradation	Job Mix Type B
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
3/4-inch	75-95
1/2-inch	50-85
3/8-inch	45-70
No. 4	30-50
No. 8	22-38
No. 30	9-23
No. 50	6-18
No. 200	3-10

Section 2c: HMA Base Courses

Designation	Job Mix Type A
Aggregate Gradation	Open Plant Mix Base Course
Gradation	% Passing (by weight)
3-inch	100
2-inch	90-100
1.5-inch	60-90
1-inch	40-75
1/2-inch	30-65
No. 4	20-45
No. 200	2-10

Section 2e: Asphalt Surface Treatments

Description	Single Treatment
Code Reference	813
Aggregate Gradation	Delaware No. 57 or 67

Description	No. 57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Description	No. 67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Section 3: Concrete Pavements

Description	PCC Pavements - Coarse
Code Reference	804
Aggregate Gradation	follows AASHTO M 80

Description	PCC Pavements - Fine
Code Reference	804
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 50	5-30

Section 4: Incidental Construction

Description	Type B (Special Fill)
Code Reference	209.04
Gradation	% Passing
3-inch	100
No. 200	10 Max

Description	Type C (Backfill)
Code Reference	209.04
Gradation	% Passing
1-inch	85-100
No. 200	25 Max

Delaware Department of Transportation, "Delaware Department of Transportation Specifications for Road and Bridge Construction," DEDOT, 2001. <http://www.deldot.gov/>.

Section 1: Bases and Subbases

Description	Graded Aggregate Base
Code Reference	204
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	65-90
3/8-inch	45-75
No. 4	35-60
No. 10	25-45
No. 50	5-25
No. 200	0-10

Section 2a: HMA Surface Courses
refer below
Section 2b: HMA Intermediate Courses
refer below
Section 2c: HMA Base Courses
refer below
Section 2e: Asphalt Surface Treatments
refer below

Standards for all HMA Superpave mixes adhere to AASHTO M323-04 control points.
In addition aggregates must meet general aggregate requirements.
No state specific gradations set out in Specifications

Code Referernce	334-3.2.2
Aggregate Gradations	SP-9.5, SP-12, SP-19

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	346-2.1
Aggregate Gradation	#57 or #67

Description	#57
Gradation	% Passing (by weight)
1/2-inch	25-60, (1/2")
No. 4	0-10
No. 8	0-5

Description	#67
Gradation	% Passing (by weight)
3/4-inch	90-100
3/8-inch	20-25
No. 4	0-10
No. 8	0-5

Description	PCC Fine Aggregate
Code Reference	346-2.1
Aggregate Gradation	use approved Silica Sand

Section 4: Incidental Construction

Description	Underdrains
Code Reference	404-2 and 902.04
Gradation	% Passing (by weight)
No. 4	95-100
No. 8	85-100
No. 16	65-97
No. 30	25-70
No. 50	5-35
No. 100	0-7
No. 200	<2

Description	Backfill
Code Reference	548-2.6
Gradation	% Passing (by weight)
3.5-inch	100
3/4-inch	70-100
No. 4	30-100
No. 40	15-100
No. 100	5-65
No. 200	0-15

Florida Department of Transportation, "Standard Specifications for Road and Bridge Construction 2007," FLDOT, 2007. <http://www.state.dot.fl.us/>.

Section 1: Bases and Subbases

Description	Graded Aggregate Group I
Code Reference	815.2.1
Aggregate Gradation	refer below
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	97-100
3/4-inch	60-95
No. 10	25-50
No. 60	10-35
No. 200	7-15

Description	Graded Aggregate Group II
Code Reference	
Aggregate Gradation	
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	97-100
3/4-inch	60-90
No. 10	25-45
No. 60	5-30
No. 200	4-11

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	828.2.03

Aggregate Gradation	12.5mm Superpave
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	70-85
No. 8	34-39
No. 200	3.5-7

Aggregate Gradation	9.5mm Superpave (B,C,D)
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	55-75
No. 8	42-47
No. 200	4-7

Aggregate Gradation	Superpave 9.5mm (A)
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	65-85
No. 8	53-58
No. 200	4-7

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	828.2.03
Aggregate Gradation	19mm Superpave
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	60-89
3/8-inch	55-75
No. 8	29-34
No. 200	3.5-6

Section 2c: HMA Base Courses

Description	HMA Base Courses
Code Reference	828.2.03
Aggregate Gradation	varies refer below

Designation	25mm Superpave
Application	
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	55-89
3/8-inch	50-70
No. 30	25-30
No. 200	3-6

Section 2e: Asphalt Surface Treatments

Code Reference	424 Table 2
Description	Single Treatment
Acceptable Aggregate	89, 7, 6
Description	Double Treatment-1
Acceptable Aggregate	7, 6
Description	Double Treatment-2
Acceptable Aggregate	89, 7
Description	Triple Treatment-1
Acceptable Aggregate	6, 5
Description	Triple Treatment-2
Acceptable Aggregate	7
Description	Triple Treatment-3
Acceptable Aggregate	89

**refers to ASTM aggregate sizes

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	439.2 and 801.1
Aggregate Gradation	acceptable Class A and B aggregates

Description	PCC Fine Aggregate
Code Reference	439.2 and 801.2.2
Aggregate Gradation	Size No. 10
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-95
No. 50	8-30
No. 100	1-10
No. 200	0-4

Section 4: Incidental Construction

Description	Crushed Stone Drainage
Code Reference	806.2.02
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
No. 10	10-35
No. 100	0-10

Description	MSE Backfill
Code Reference	812.2.04
Gradation	% Passing (by weight)
4-inch	100
2-inch	80-100
No. 40	20-90
No. 200	0-12

Georgia Department of Transportation, “Specifications: Materials,” GDOT, 2005. <http://www.state.dot.ga.us/>.

Section 1: Bases and Subbases

Description	Aggregate for Subbase
Code Reference	703.17
Aggregate Gradation	Subbase
Gradation	% Passing (by weight)
2.5-inch	100
No. 4	20-60
No. 200	0-15

Description	Untreated Base Grading
Code Reference	703.06-2
Aggregate Gradation	1.5" Nominal Max
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
3/4-inch	50-90
No. 4	25-50
No. 200	3-9

Section 2a: HMA Surface Courses

Description	HMA Grading Requirements
Code Reference	703.09-2
Aggregate Gradation	Mix No. IV
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	72-90
No. 4	48-66
No. 8	32-48
No. 16	21-37
No. 30	15-27
No. 50	9-21
No. 100	6-16
No. 200	4-8

Aggregate Gradation	Mix No. V
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	80-100
No. 4	55-75
No. 8	35-52
No. 16	22-38
No. 30	14-26
No. 50	8-20
No. 100	6-15
No. 200	4-8

Section 2b: HMA Intermediate Courses

Description	HMA Grading Requirements
Code Reference	703.09-2
Aggregate Gradation	Mix No. III
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	70-90
No. 4	40-57
No. 8	30-47
No. 30	16-28
No. 50	10-22
No. 100	8-17
No. 200	4-8

Section 2c: HMA Base Courses

Description	HMA Grading Requirements
Code Reference	703.09-2 and 703.03-1
Aggregate Gradation	Mix No. II
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	85-100
1/2-inch	60-85
No. 4	36-55
No. 8	26-41
No. 30	12-25
No. 50	8-18
No. 100	5-14
No. 200	1-8

Aggregate Gradation	HMA Base Course
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	85-100
3/4-inch	73-92
1/2-inch	60-80
3/8-inch	52-72
No. 4	36-55
No. 8	25-42
No. 30	12-24
No. 50	7-18
No. 100	4-12
No. 200	1-8

Section 2e: Asphalt Surface Treatments

Description	Slurry Seal Type 1
Code Reference	703.11-1
Gradation	% Passing
No. 4	100
No. 8	90-100
No. 16	65-90
No. 30	40-65
No. 50	25-42
No. 100	15-30
No. 200	10-20

Description	Slurry Seal Type 2
Code Reference	703.11-1
Gradation	% Passing
3/8-inch	100
No. 4	90-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-15

Description	Slurry Seal Type 3
Code Reference	703.11-1
Gradation	% Passing
3/8-inch	100
No. 4	70-90
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 50	12-25
No. 100	7-18
No. 200	5-15

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	703.02
Aggregate Gradation	size designation AASHTO M 43

Description	PCC Fine Aggregate
Code Reference	703.01-2
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-12

Section 4: Incidental Construction

Description	Structural Backfill Mat'l A
Code Reference	703.20-1
Gradation	% Passing
3-inch	100
No. 4	20-75
No. 200	0-15

Description	Structural Backfill Mat'l B
Code Reference	703.20-1
Gradation	% Passing
3-inch	100
No. 4	20-100

Hawaii Department of Transportation, “Specifications for Road and Bridge Construction,” HDOT, 2005. <http://hawaii.gov/dot>.

Section 1: Bases and Subbases

Description	Aggregate for Granular Subbase
Code Reference	703.11
Aggregate Gradation	refer below
Gradation	% Passing (by weight)
4-inch	100
3-inch	90-100
No. 4	30-75
No. 200	0-15

Description	Bases
Code Reference	703.03
Aggregate Gradation	2b
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	80-100
No. 4	Oct-40
No. 8	0-4

Aggregate Gradation	3
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	4
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	35-70
No. 4	10-30
No. 8	0-5

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	703.05
Aggregate Gradation	12.5 mm
Gradation	% Passing (by weight)
3/4"	100
1/2"	90-100
3/8"	90 max
No. 8	28-58
No. 200	2-10

Aggregate Gradation	9.5 mm
Gradation	% Passing (by weight)
1/2"	100
3/8"	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	703.05
Aggregate Gradation	19.0 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
3/8-inch	52-80
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	703.05
Aggregate Gradation	25.0 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
3/8-inch	42-70
No. 8	19-45
No. 200	1-7

Section 2e: Asphalt Surface Treatments

Description	Cover Coat Aggregate
Code Reference	703.06
Aggregate Gradation	Class 1
Gradation	% Passing (by weight)
5/8-inch	100
3/8-inch	30-55
No. 4	0-6
No. 8	0-4
No. 200	0-2
Aggregate Gradation	Class 2
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	30-55
No. 4	0-6
No. 8	0-4
No. 200	0-2
Aggregate Gradation	Class 3
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	40-90
No. 4	0-6
No. 8	0-4
No. 200	0-2
Aggregate Gradation	Class 4
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	0-6
No. 8	0-4
No. 200	0-2
Aggregate Gradation	Class 5
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	80-100
No. 8	7-35
No. 200	0-5

Section 4: Incidental Construction

No backfill data provided

Section 3: Concrete Pavements

Description	PCC Pavements - Coarse
Code Reference	703.03
Aggregate Gradation	Coarse - No. 1
Gradation	% Passing (by weight)
3/4"	100
1/2"	90-100
3/8"	40-70
No. 4	0-15
No. 8	0-5
Aggregate Gradation	Coarse - No. 2a
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	95-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5
Aggregate Gradation	Coarse - No. 2b
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
3/8-inch	Oct-40
No. 4	0-4
Aggregate Gradation	Coarse - No. 3
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5
Aggregate Gradation	Coarse - No. 4
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	30-Oct
No. 4	0-5
Aggregate Gradation	Coarse - No. 5
Gradation	% Passing (by weight)
2.5-inch	100
2-inch	95-100
1-inch	35-70
1/2-inch	30-Oct
No. 4	0-5
Description	PCC Pavements - Fine
Code Reference	703.02
Aggregate Gradation	Fine Aggregate
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200	0-4

Idaho Transportation Department, “Standard Specification for Highway Construction – 2004,” ITD, 2004. <http://itd.idaho.gov/>.

Section 1: Bases and Subbases

Description	Base/Subbase
Code Reference	104.04
Aggregate Gradation	CA 6
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	60-90
No. 4	30-56
No. 8	10-40
No. 200	4-12

Aggregate Gradation	CA 10
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	65-95
No. 4	40-60
No. 16	15-45
No. 200	5-13

Section 2a: HMA Surface Courses

Description	HMA Pavement
Code Reference	1030.40
Aggregate Gradation	IL-12.5 mm
Gradation	% Passing (by weight)
3/4-inch	<100
1/2-inch	90-100
3/8-inch	<89
No. 4	28-65
No. 8	28-48
No. 16	10-32
No. 50	4-15
No. 100	3-10
No. 200	4-6

Aggregate Gradation	IL-9.5 mm
Gradation	% Passing (by weight)
3/4-inch	<100
1/2-inch	90-100
No. 4	28-65
No. 8	28-48
No. 16	10-32
No. 50	4-15
No. 100	3-10
No. 200	4-6

Aggregate Gradation	IL-9.5L
Gradation	% Passing (by weight)
1/2-inch	<100
3/8-inch	95-100
No. 4	52-80
No. 8	38-65
No. 30	<50% of percentage passing No. 4
No. 200	4-8

Section 2b: HMA Intermediate Courses

Description	HMA Pavement
Code Reference	1030.04
Aggregate Gradation	IL-19 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	82-100
1/2-inch	50-85
No. 4	24-50
No. 8	20-36
No. 16	10-25
No. 50	4-12
No. 100	3-9
No. 200	3-6

Aggregate Gradation	IL-19.0L
Gradation	% Passing (by weight)
1-inch	<100
3/4-inch	95-100
No. 4	38-65
No. 30	<50% of percentage passing No. 4
No. 200	4-8

Section 2c: HMA Base Courses

Description	HMA Pavement
Code Reference	1030.04
Aggregate Gradation	IL-25.0 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	45-75
No. 4	24-42
No. 8	16-31
No. 16	10-22
No. 50	4-12
No. 100	3-9
No. 200	3-6

Section 2e: Asphalt Surface Treatments

refer to 403.02 list of acceptable classifications to follow

RS-1, RS-2, CRS-1, CRS-2
RC-800, RC-3000, MC-800
MC-3000, SC-3000, PG46-28
PG52-28 HFE-90, HRE-150, HFE-300

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	1003.02
Aggregate Gradation	FA 1
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	97±3
No. 16	65±20
No. 50	16±13
No. 100	5±5

Aggregate Gradation	FA 2
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	97±3
No. 16	65±20
No. 50	20±10
No. 100	5±5

Description	PCC Coarse Aggregate
Code Reference	1020.04
Aggregate Gradation	CA 5
Gradation	% Passing (by weight)
1.5-inch	97±3
1-inch	40±25
1/2-inch	5±5
No. 4	3±3

Aggregate Gradation	CA 7
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95±5
1/2-inch	45±15
No. 4	5±5

Aggregate Gradation	CA 11
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	92±8
1/2-inch	45±15
No. 4	6±6
No. 16	3±3

Aggregate Gradation	CA 14
Gradation	% Passing (by weight)
1/2-inch	90±10
3/8-inch	45±20
No. 4	3±3

Section 4: Incidental Construction

Description	Fine Aggreagte for Underdrains
Code Reference	1003.04
Acceptable Aggregates	FA 1 , FA 2, FA, 20

Description	Coarse Aggreagte for Underdrains
Code Reference	1004.05
Acceptable Aggregates	CA 6, CA 10, CA 18

Description	Fine Aggregate for Backfill
Code Reference	1003.04
Acceptable Aggregates	FA 1, FA 2, FA 6, FA 20

Description	Coarse Aggregate for Backfill
Code Reference	1004.05
Acceptable Aggregates	CA 6, CA 10, CA 17, CA 18

**refer to 1003.01 for fine gradations and 1004.01 for coarse

Illinois Department of Transportation, “Standard Specifications Road and Bridge Construction 2007,” IDOT, 1 Jan. 2007. <http://www.dot.state.il.us/>.

Section 1: Bases and Subbases

Description	Agregate Base/Subbase
Code Reference	301.01
Aggregate Gradation	#53
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	80-100
3/4-inch	70-90
1/2-inch	55-80
No. 4	35-60
No. 8	25-50
No. 30	12-30
No. 200	0-10

Section 2a: HMA Surface Courses

Description	Aggregate Class B
Code Reference	201.05
Aggregate Gradation	HMA Dense Graded 12.5mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	<90
No. 8	28-58
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	Aggregate Class C
Code Reference	201.05
Aggregate Gradation	HMA Dense Graded 19.0mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	<90
No. 8	23-49
No. 200	2-8

Aggregate Gradation	HMA Dense Graded 19.5mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	<90
No. 8	32-67
No. 200	2-10

Section 2c: HMA Base Courses

Description	Aggregate Class D
Code Reference	201.05
Aggregate Gradation	HMA Dense Graded 25.0mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	<90
No. 8	19-45
No. 200	1-7

Section 2e: Asphalt Surface Treatments

Code Reference	404.04
Description	Single Type 1
Acceptable Aggregate	24
Description	Single Type 2
Acceptable Aggregate	12
Description	Single Type 3
Acceptable Aggregate	11
Description	Single Type 4
Acceptable Aggregate	9
Description	Double Type 5
Acceptable Aggregate	Top - 12
	Bottom - 11
Description	
Acceptable Aggregate	Double Type 6
	Top - 11
Description	Bottom - 12
Acceptable Aggregate	
	Double Type 7
Description	Top - 11
Acceptable Aggregate	Bottom - 8

* refer to 904.02 and 904.03 for Indiana aggregate size gradations corresponding to above sizes

Section 3: Concrete Pavements

Description	Portlant Cement Concrete Pavements
Code Reference	501.04
Aggregate Gradation	No 8 Coarse, 23 Fine (904)

Aggregate Gradation	8 (Coarse)
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-10
No. 200	0-3

Aggregate Gradation	23 (Fine)
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	75-95
1/2-inch	40-70
3/8-inch	20-50
No. 4	0-15
No. 8	0-10

Section 4: Incidental Construction

Description	Shoulder Drains
Code Reference	608.02
Aggregate Gradation	8 (Coarse)

Description	Rip Rap
Code Reference	616.02
Aggregate Gradation	23 (Fine)

* refer to gradations provided for Concrete Pavements, the same aggregate sizes are used.

Indiana Department of Transportation, “2008 Standard specifications Book,” INDOT, 2008. <http://www.in.gov/indot/>.

Section 1: Bases and Subbases

Description	Crushed Stone Subbase
Code Reference	4109.02
Gradation	% Passing (by weight)
1.5-inch	100
3/8-inch	40-80
No. 8	5-25
No. 200	0-6

Description	Crushed Gravel Subbase
Code Reference	4109.02
Gradation	% Passing (by weight)
1.5-inch	100
1/2-inch	50-80
No. 8	10-30
No. 60	5-15
No. 200	3-7

Section 2a: HMA Surface Courses

Description	HMA Aggregate Gradations
Code Reference	IM 510-Appendix A
Aggregate Gradation	12.5 mm Mix
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 30	25 max
No. 200	2-10

Aggregate Gradation	9.5 mm Mix
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Aggregate Gradations
Code Reference	IM 510-Appendix A
Aggregate Gradation	19 mm Mix
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 30	24 max
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Aggregate Gradations
Code Reference	IM 510-Appendix A
Aggregate Gradation	25 mm Mix
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-45
No. 200	1-7

Section 2e: Asphalt Surface Treatments

Description	Slurry Mixtures
Code Reference	IM 510-Appendix A

Aggregate Gradation	Coarse Slurry Mix
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	70-90
No. 8	45-70
No. 30	19-34
No. 50	12-25
No. 100	7-18
No. 200	5-15

Aggregate Gradation	Fine Slurry Mix
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	85-100
No. 8	40-95
No. 30	20-60
No. 50	14-35
No. 100	10-25
No. 200	5-25

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	IM 510-Appendix A
Aggregate Gradation	#57 and #67

Description	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Description	#67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Description	PCC Fine Aggregate
Code Reference	IM 510-Appendix A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	70-100
No. 30	10-60
No. 200	0-1.5

Section 4: Incidental Construction

Description	Subdrain Aggregate
Code Reference	2502.02
Aggregate Gradation	No. 29
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	50-100
No. 4	0-50
No. 8	0-8

Description	Backfill Specifications
Code Reference	Table 4109.02
Aggregate Gradation	Crushed Stone
Gradation	% Passing (by weight)
1.5-inch	100
No. 8	10-40
No. 200	0-10

Aggregate Gradation	Gravel
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	75-90
No. 8	30-55
No. 200	3-7

Aggregate Gradation	Granular Backfill
Gradation	% Passing (by weight)
3-inch	100
No. 8	20-100
No. 200	0-10

Iowa Department of Transportation, “Standard Specifications with GS-01016 Revisions,” Iowa DOT, 2009. <http://www.iowadot.gov/>.

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	1104-1
Aggregate Gradation	AB-1
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
3/4-inch	60-95
No. 4	25-65
No. 8	15-46
No. 40	5-22
No. 200	2-10

Aggregate Gradation	AB-2
Gradation	% Passing (by weight)
1-inch	100
3/8-inch	65-99
No. 8	50-75
No. 10	25-40
No. 40	25-40
No. 200	10-18

Aggregate Gradation	AB-3
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	70-95
No. 4	40-65
No. 8	30-55
No. 40	16-40
No. 200	8-20

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	Table 602.01
Aggregate Gradation	SM/SR-12.5A
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	<90
No. 8	39-58
No. 200	2-10

Aggregate Gradation	SM/SR-12.5B
Gradation	% Passing (by weight)
1-inch	----
3/4-inch	100
1/2-inch	90-100
3/8-inch	<90
No. 8	28-39
No. 200	2-8

Section 2a: HMA Surface Courses (continued)

Aggregate Gradation	SM/SR-9.5A
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	<90
No. 8	47-67
No. 200	2-10

Aggregate Gradation	SM/SR-9.5B
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	<90
No. 8	32-47
No. 200	2-10

Aggregate Gradation	SM/SR-9.5T
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	<90
No. 8	32-47
No. 200	2-10

Aggregate Gradation	SM-4.75A
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	<90
No. 16	20-60
No. 200	6-12

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate
Code Reference	Table 602.01
Aggregate Gradation	SM/SR-19A
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	<90
No. 8	35-49
No. 200	2-8

Aggregate Gradation	SM/SR-19A
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	<90
No. 8	23-35
No. 200	2-8

Section 2c: HMA Base Courses

No specification provided

Section 2e: Asphalt Surface Treatments

Description	Cover Material For Seal Coats
Code Reference	Table 1108-1
Acceptable Aggregates	CM-A, CM-B, CM-C, CM-D
	CM-G, CM-H, CM-J, CM-K, CM-L

* refer to Specifications for gradations of above aggregates

Section 3: Concrete Pavements

Description	Coarse Aggregate
Code Reference	Table 1102-3
Acceptable Aggregates	CPA-1, CPA-2, CPA-3
Aggregate Gradation	CPA-1
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	40-100
3/4-inch	65-86
3/8-inch	25-50
No. 8	0-5

Aggregate Gradation	CPA-2
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
No. 4	25-45
No. 8	3-13
No. 30	0-5

Aggregate Gradation	CPA-3
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	65-100
3/8-inch	30-70
No. 4	0-25
No. 8	0-5

Description	Fine Aggregate
Code Reference	Table 1102-5
Acceptable Aggregates	FA-A, FA-B, F-C
Aggregate Gradation	FA-A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	73-100
No. 16	45-85
No. 30	23-60
No. 50	7-30
No. 100	0-10

Aggregate Gradation	FA-B
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	76-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	0-10

Section 3: Concrete Pavements (cont'd)

Aggregate Gradation	FA-C
Gradation	% Passing (by weight)
No. 4	100
No. 8	30-75
No. 16	0-5

Section 4: Incidental Construction

Description	Underdrains and Backfill
Code Reference	Table 1107-1
Aggregate Gradation	SB 1
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
3/4-inch	60-85
3/8-inch	25-50
No. 8	0-5

Aggregate Gradation	SB 2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
3/8-inch	30-60
No. 4	0-25
No. 8	0-5

Aggregate Gradation	SB 3
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	70-95
No. 4	40-65
No. 8	30-55
No. 40	16-40
No. 200	8-20

Kansas Department of Transportation, “Standard Specifications for State Road and Bridge Construction,” KDOT, 2007. <http://www.ksdot.org/>.

Section 1: Bases and Subbases

Description	Crushed Stone
Code Reference	805
Aggregate Gradation	2 in
Gradation	% Passing (by weight)
2.5-inch	100
1.5-inch	90-100
3/4-inch	60-95
3/8-inch	30-70
No. 4	15-55
No. 30	5-20
No. 200	0-8

Description	Densely Graded
Code Reference	805
Aggregate Gradation	3/4 in
1-inch	% Passing (by weight)
3/4-inch	100
3/8-inch	70-100
No. 4	50-80
No. 30	30-65
No. 200	10-40
	4-13

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	802
Aggregate Gradation	1/2 inch
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	45-70
No. 30	5-25
No. 100	0-10
No. 200	0-5

Aggregate Gradation	3/8 inch
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 30	10-30
No. 100	0-10
No. 200	0-5

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	802
Aggregate Gradation	Type 67 3/4 inch
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
No. 8	20-55
No. 100	0-10
No. 200	0-5

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	802
Aggregate Gradation	1 inch
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	20-55
3/8-inch	0-10
No. 4	0-5

Section 2e: Asphalt Surface Treatments

Description	Seal Coats
Code Reference	804.06
Gradation	% Passing (by weight)
No. 16	100
No. 50	10-40
No. 100	0-10

Description	Sand Slurry
Code Reference	804.07
Gradation	% Passing (by weight)
No. 8	100
No. 50	0-40
No. 100	0-5

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	804.03
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 16	45-85
No. 50	5-25
No. 100	0-8

Description	PCC Coarse Aggregates
Acceptable Aggregates	#57 and alternate #57
Aggregate Gradation	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	alternate #57
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	85-100
1/2-inch	35-65
No. 4	0-20
No. 8	0-10
No. 200	0-4

Section 4: Incidental Construction

Description	Backfill
Code Reference	805.07
Gradation	% Passing (by weight)
1.5-inch	100
No. 4	0-30

Description	Underdrains
Code Reference	805.08
Gradation	% Passing (by weight)
1.5-inch	100
No. 4	0-30
No. 100	0-5

Description	Structural Granular Backfill
Code Reference	805.08
Gradation	% Passing (by weight)
4-inch	100
No. 4	0-10
No. 100	0-5

Kentucky Transportation Cabinet, “Standard Specifications for Road and Bridge Construction,” KYTC, 2008. <http://transportation.ky.gov/>.

Section 1: Bases and Subbases

Description	Crushed Stone Class 7
Code Reference	308.03
Aggregate Gradation	Class 7
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	60-100
3/4-inch	50-90
No. 4	25-55
No. 40	10-30
No. 200	3-10

Description	Graded Aggregate Base (Fine)
Code Reference	305.2.25
Aggregate Gradation	Passing No.24
Gradation	% Passing (by weight)
1.5-inch	95-100
No. 4	40-65
No. 40	20-50
No. 200	10-25

Description	Graded Aggregate Base (Composites)
Code Reference	305.2.5.25
Aggregate Gradation	Stone
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	70-100
No. 8	35-65
No. 40	12-32
No. 200	5-12

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	1003.04
Aggregate Gradation	1/2 inch
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
No. 4	15-60
No. 8	0-15
No. 16	0-5
No. 100	0-1

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-423
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5
No. 200	0-1

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	1003.03
Aggregate Gradation	24 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-1

Section 2e: Asphalt Surface Treatments

Description	Aggregate for Surface Treatment
Code Reference	1003.05
Aggregate Gradation	Slag or Stone (No. 5)
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	20-55
1/2-inch	0-10
3/8-inch	0-5
No. 200	0-1

Aggregate Gradation	Crushed Gravel or Lightweight
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
3/4-inch	60-90
3/8-inch	0-15
No. 4	0-5
No. 200	0-1

Aggregate Gradation	Size No. 7
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-80
No. 4	0-15
No. 8	0-5
No. 200	0-1

Aggregate Gradation	Size No. 8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-40
No. 8	0-10
No. 16	0-5
No. 200	0-1

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	1003.02
Aggregate Gradation	Approved natural sand
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-90
No. 50	7-30
No. 100	0-7
No. 200	0-3

Description	PCC Coarse Aggregate
Code Reference	1003.02
Acceptable Aggregates	Grades A, B, D, P
Aggregate Gradation	Grade A (#57)
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	Grade B (#467)
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	85-100
3/4-inch	30-85
No. 4	0-6
No. 200	0-1

Aggregate Gradation	Grade D (#357)
Gradation	% Passing (by weight)
2.5-inch	100
2-inch	90-100
1-inch	35-80
No. 4	0-6
No. 200	0-1

Aggregate Gradation	Grade P (#67)
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Louisiana DOT, “2006 Standard Specifications for Roads & Bridges Manual,” 2006.
<http://www.dotd.louisiana.gov/highways/project_devel/contractspecs/>.

Section 4: Incidental Construction

No gradations specified for aggregate underdrains or backfill
Only aggregate properties provided in Section 1000

Section 1: Bases and Subbases

Description	Graded Aggregate Base (Composites)
Code Reference	305.2.5.26
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
1/2-inch	45-70
3/8-inch	(1/4 inch) 30-55
No. 40	0-20
No. 200	0-5

Aggregate Gradation	Type B
Gradation	% Passing (by weight)
1/2-inch	(1/2 inch) 35-75
1/4-inch	(1/4 inch) 25-60
No. 40	(No. 40) 0-25
No. 200	(No. 200) 0-5

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	703.09
Aggregate Gradation	12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	<90
No. 8	32-67
No. 200	2-8

Aggregate Gradation	Type B
Application	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	<90
No. 4	32-67
No. 100	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-424
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	<90
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	703.06
Aggregate Gradation	25 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Section 2e: Asphalt Surface Treatments

Description	Surface Treatment
Code Reference	411.02
Gradation	% Passing (by weight)
1-inch	95-100
3/4-inch	90-100
No. 4	40-65
No. 10	10-45
No. 200	0-7

Section 3: Concrete Pavements

Description	PCC fine
Code Reference	703.01
Gradation	% Passing (by weight)
1-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-5

Description	PCC-Coarse
Code Reference	703.02
Aggregate Gradation	Class A
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-1.5

Aggregate Gradation	Class AA
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5
No. 200	0-1.5

Section 3: Concrete Pavements (continued)

Description	PCC-Coarse
Code Reference	703.02
Aggregate Gradation	Class S
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5
No. 200	0-1.5

Section 4: Incidental Construction

Description	Backfill
Code Reference	703.22
Gradation	% Passing (by weight)
1-inch	95-100
1/2-inch	75-100
No. 4	50-100
No. 200	15-80
No. 50	0-15
No. 200	0-5

Description	Underdrains
Code Reference	703.23
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	0-75
No. 4	0-25
No. 10	0-5

Maine DOT, "Standard Specifications," Revision of December 2002, MDOT, 2002. <http://www.state.me.us/mdot/contractor-consultant-information/ss_standard_specification_2002.php.>

Section 1: Bases and Subbases

Description	Crusher Run Aggregate CR-6
Code Reference	901
Aggregate Gradation	D 2940
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
3/4-inch	60-90
No. 4	30-60
No. 200	0-15

Description	Bank Run Gravel - Subbase
Code Reference	901
Aggregate Gradation	D 2940
Gradation	% Passing (by weight)
2-inch	100
1-inch	90-100
1/2-inch	60-100
No. 10	35-90
No. 40	20-55
No. 200	5-25

Description	Graded Aggregate - Base Design Range
Code Reference	901
Aggregate Gradation	D 2940
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	70-92
3/8-inch	50-70
No. 4	35-55
No. 30	12-25
No. 200	0-8

Section 2a: HMA Surface Courses

Designation	Gap Graded HMA -12.5 mm
Code Reference	901
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-99
3/8-inch	70-85
No. 4	28-40
No. 8	18-30
No. 200	8-11

Designation	Gap Graded HMA - 9.5 mm
Code Reference	901
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	100
3/8-inch	75-90
No. 4	30-50
No. 8	20-30
No. 200	8-13

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	901
Aggregate Gradation	Gap Graded HMA - 19.0 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	82-88
3/8-inch	60 max
No. 4	22-30
No. 8	14-20
No. 200	9-11

Section 2c: HMA Base Courses

No specific specifications provided for HMA bases

Section 2e: Asphalt Surface Treatments

Description	Slurry Seal
Code Reference	901
Aggregate Gradation	Mix II
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-15

Aggregate Gradation	Mix III
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	70-95
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 50	12-25
No. 100	7-18
No. 200	5-15

Description	Chip Seal
Code Reference	901
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-70
No. 4	0-15
No. 8	0-5

Description	Chip Seal Alternate
Gradation	% Passing (by weight)
1/2"	100
3/8"	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Section 3: Concrete Pavements

Description	PCC Coarse Aggregates
Code Reference	901
Acceptable Aggregates	#57 and #67
Aggregate Gradation	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	#67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Description	PCC Fine Aggregate
Code Reference	901
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-85
No. 50	5-30
No. 100	0-10

Section 4: Incidental Construction

No specification provided for backfill or underdrain gradations

Maryland DOT, “Book of Standards - for Highway & Incidental Structures,” 2001.
<http://www.sha.state.md.us/businesswithsha/bizStdsSpecs.asp?id=B157+B159.>

Section 1: Bases and Subbases

Description	Dense Graded Aggregate
Code Reference	2.01.07
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	70-100
3/4-inch	50-85
No. 4	30-55
No. 50	8-24
No. 200	3-10

Description	Processed Gravel Subbase
Code Reference	M.1.03.1
Gradation	% Passing (by weight)
3-inch	100
1.5-inch	70-100
1/4-inch	50-85
No. 4	30-60
No. 200	0-10

Section 2a: HMA Surface Courses

Description	HMA Surface Type B
Code Reference	401.2 and SC-M-428
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	95-100
1/2-inch	75-90
3/8-inch	60-75
No. 4	40-60
No. 8	32-44
No. 16	24-34
No. 30	16-26
No. 50	8-18
No. 100	4-13
No. 200	2-7

Designation	Dense Mix
Code Reference	401.2 and SC-M-428
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	80-100
3/8-inch	55-80
No. 8	43-63
No. 16	36-47
No. 30	24-38
No. 50	12-27
No. 100	6-18
No. 200	4-8

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-428
Aggregate Gradation	Dense Binder Course
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
1/2-inch	65-80
No. 4	48-65
No. 8	37-51
No. 30	17-30
No. 50	10-22
No. 200	0-6

Aggregate Gradation	Binder Course
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
1/2-inch	55-75
No. 4	20-45
No. 8	15-33
No. 30	8-17
No. 50	4-12
No. 200	0-4

Section 2c: HMA Base Courses

Description	Base Course
Code Reference	M3.11.03
Gradation	% Passing (by weight)
2-inch	100
1-inch	55-80
1/2-inch	40-65
No. 4	20-45
No. 8	15-33
No. 30	8-17
No. 50	4-12
No. 200	0-4

Section 2e: Asphalt Surface Treatments

Description	Surface Treatment
Code Reference	M3.11.03
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	80-100
No. 8	64-85
No. 16	46-68
No. 30	26-50
No. 50	13-31
No. 100	7-17
No. 200	3-8

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	M4.02.02
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200	0-3

Description	Coarse Aggregate
Code Reference	M4.02.02
Aggregate Gradation	1.5"
Gradation	% Passing (by weight)
1.5-inch	90-100
3/4-inch	35-60
3/8-inch	10-25
No. 4	0-5

Aggregate Gradation	3/4"
Gradation	% Passing (by weight)
3/4-inch	90-100
3/8-inch	20-50
No. 4	0-10
No. 8	0-5

Aggregate Gradation	3/8"
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Section 4: Incidental Construction

Description	Special Burrow
Codfe Reference	M1.02
6-inch	100
2-inch	90-100
No. 4	20-65
No. 200	0-12

Description	Gravel Burrow
Code Reference	M1.03
1/2-inch	50-85
No. 4	40-75
No. 50	8-28
No. 200	0-10

Massachusetts DOT, “Supplemental Specifications to the 1995 Standard Specifications for Highways and Bridges,” 2006. <http://www.mhd.state.ma.us/default.asp?pgid=content/publicationmanuals&sid=about.>

Section 1: Bases and Subbases

Description	Aggregate Base Dense Graded 21AA
Code Reference	302.02, Table 902-1
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	85-100
1/2-inch	50-75
No. 8	20-45
No. 200	4-8

Description	Aggregate Base Dense Graded 21A
Code Reference	302.02, Table 902-1
Aggregate Gradation	% Passing (by weight)
1.5-inch	100
1-inch	85-100
1/2-inch	50-75
No. 8	20-45
No. 200	4-8

Description	Aggregate Base Dense Graded 22A
Code Reference	302.02, Table 902-1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	65-85
No. 8	30-50
No. 200	4-8

Section 2a: HMA Surface Courses

Description	HMA Aggregate Gradations
Code Reference	03SP501
Aggregate Gradation	Mix #3
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	23-49
No. 200	2-8

Aggregate Gradation	Mix # 4
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Aggregate Gradations
Code Reference	03SP501
Aggregate Gradation	Mix #2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	19-45
No. 200	1-7

Aggregate Gradation	Mix #3
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2b: HMA Intermediate Courses

Description	HMA Aggregate Gradations
Code Reference	03SP501
Aggregate Gradation	Mix #2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	19-45
No. 200	1-7

Designation	Mix #3
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

No specification provided for HMA base gradations
Refer to Base and Subbase Section gradations

Section 2e: Asphalt Surface Treatments

Description	Slurry Seal
Acceptable Aggregates	2FA, 3FA, 25A, 29A
Code Reference	506 and 507
Aggregate Gradation	2FA
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21

Aggregate Gradation	3FA
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	70-90
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 50	12-25
No. 100	7-18

Description	Chip Seal
Acceptable Aggregates	25A, 29A
Code Reference	508
Aggregate Gradation	25A
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	60-90
No. 4	5-30
No. 8	0-12

Aggregate Gradation	29A
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	10-30
No. 8	0-10

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	902.03
Acceptable Aggregates	4AA, 6AAA, 6AA, 6A, 17A, 26A

* refer to tables in Section 902 for coarse aggregate gradations

Description	PCC Fine Aggregate
Code Reference	902.03
Acceptable Aggregates	2 NS
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	65-95
No. 16	35-75
No. 30	20-55
No. 50	10-30
No. 100	0-10

Section 4: Incidental Construction

Description	Aggregate Underdrain
Code Reference	404.02
Aggregate Gradation	34 R
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 8	0-5

Description	Backfill
Code Reference	206.02
Acceptable Aggregates	4AA, 6AAA, 6AA 17A, 25A, 26A, 29A 2G, 3G, 4G, 34R, 34G

* refer to tables in Section 902 for specific gradations

Michigan DOT, "Standard Specifications for Construction," 2003. <http://mdotwas1.mdot.state.mi.us/public/specbook/.>

Section 1: Bases and Subbases

Description	Aggregate Bedding
Code Reference	3149.2-G
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	50-90
No. 4	35-80
No. 10	20-65
No. 30	10-35
No. 200	3-10

Description	Stabilizing Aggregate
Code Reference	3149.2-C
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	50-95
No. 4	35-85
No. 10	20-70
No. 40	10-45
No. 200	7-15

Section 2a: HMA Surface Courses

Description	Bituminous Concrete Aggregate Gradations
Code Reference	Table 2360.2-E
Aggregate Gradation	Type B- Superpave 12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	85-100
3/8-inch	35-90
No. 4	20-80
No. 8	15-65
No. 200	2-7

Aggregate Gradation	Type A- Superpave 9.5 mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	25-90
No. 8	20-70
No. 200	2-7

Section 2b: HMA Intermediate Courses

Description	Bituminous Concrete Aggregate Gradations
Code Reference	Table 2360.2-E
Aggregate Gradation	Type C- Superpave 19 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
1/2-inch	45-90
No. 4	20-75
No. 8	15-60
No. 200	2-7

Section 2c: HMA Base Courses

No specific aggregate specifications provided.
Refer to base and subbase section.

Section 2e: Asphalt Surface Treatments

Description	Asphalt Seal Coat
Code Reference	3127
	FA-1, FA-2 (#9), FA-3 (#8)
	FA-4 (#7), FA-5 (#6)

*all acceptable fine aggregates except FA-1 are according to AASHTO M43 aggregate sizes

Aggregate Gradation	FA-1 (sand)
Code Reference	Table 3127-1
Gradation	% Passing (by weight)
1/4-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200	0-1

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	2301.2
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-7

Description	PCC Fine Aggregate
Code Reference	3126
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	55-85
No. 30	30-60
No. 50	5-30
No. 100	0-10
No. 200	0-2.5

Section 4: Incidental Construction

Description	Coarse Filter Aggregate
Code Reference	3149.2-H
Gradation	% Passing
1-inch	100
3/4-inch	85-100
3/8-inch	30-60
No. 4	0-10

Description	Fine Filter Aggregate
Code Reference	3149.2-J
Gradation	% Passing
3/8-inch	100
No. 4	90-100
No. 10	45-90
No. 40	5-35
No. 200	0-3

Description	Aggregate Backfill
Code Reference	3149.2-E
Aggregate Gradatior	% Passing
2-inch	100
No. 4	35-100
No. 10	20-70
No. 40	10-35
No. 200	3-10

Description	Granular Backfill
Code Reference	3149.2-D
Aggregate Gradatior	Passing 3-inch sieve

Minnesota DOT, "Mn/DOT Standard Specifications for Construction," 2005. <http://www.dot.state.mn.us/tecsup/spec/index.html.>

Section 1: Bases and Subbases

Description	Base Aggregates
Code Reference	703.04
Aggregate Gradation	Size No.610
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	70-100
1/2-inch	62-90
3/8-inch	50-80
No. 4	40-65
No. 30	12-26
No. 200	5-12

Aggregate Gradation	Size No. 825 B
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	75-98
1/2-inch	60-85
No. 4	40-70
No. 8	28-54
No. 50	9-32
No. 200	4-18

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	401.02.1.2.3
Aggregate Gradation	12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	89 max
No. 8	20-60
No. 200	4.0-9.0

Aggregate Gradation	9.5 mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	89 max
No. 8	22-70
No. 200	4.0-9.0

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.02.1.2.3
Aggregate Gradation	19 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	89 max
No. 8	18-55
No. 200	4.0-9.0

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	401.02.1.2.3
Aggregate Gradation	25 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	89 max
No. 8	16-50
No. 200	4.0-9.0

Section 2e: Asphalt Surface Treatments

Description	Bituminous Surface Treatments
Aggregate Gradation	Coarse
Acceptable Aggregates	#5, #56, #6

Description	Seal Aggregate
Aggregate Gradation	#7, #8, #89

*All aggregates according to AASHTO M43 sizes

Description	#5
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	20-55
1/2-inch	0-10
3/8-inch	0-5

Description	#56
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	40-85
1/2-inch	10-40
3/8-inch	0-15
No. 4	0-5

Description	#6
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	20-55
3/8-inch	0-15
No. 4	0-5

Description	#7
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-70
No. 4	0-15

Section 2e: Asphalt Surface Treatments (continued)

Description	#8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Description	#89
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 50	0-5

Section 3: Concrete Pavements

Description	PCC Pavements-Coarse Aggregate
Code Reference	MS 703.03.2.4
Acceptable Aggregates	#467, #57, #67, #7

Description	PCC Pavements-Fine Aggregate
Code Reference	MS 703.02.2.2
Gradation	% Passing (by weight)
3/8-inch	97-100
No. 4	92-100
No. 8	75-100
No. 16	45-90
No. 30	25-70
No. 50	3-35
No. 100	0-10

Description	#467
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5

Description	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Description	#67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Section 4: Incidental Construction

Description	Top Dressing/Screening
Code Reference	703.13.3
Gradation	% Passing
3/8-inch	100
No. 4	95-100
No. 50	0-30
No. 100	0-5

Mississippi DOT, “MDOT Standard Specifications for Road and Bridge Construction,” 2004. <http://www.mdot.state.ms.us/Divisions/Highways/Resources.aspx?Div=Construction.>

Section 1: Bases and Subbases

Description	Acceptable Base Aggregates
Code Reference	1007.2 and 1007.3
Aggregate Gradation	Type 1 Aggregate
Gradation	% Passing (by weight)
1-inch	100
1/2-inch	60-90
No. 4	35-60
No. 10	10-35

Aggregate Gradation	Type 5 Aggregate
Gradation	% Passing (by weight)
1-inch	100
1/2-inch	60-90
No. 4	35-60
No. 30	10-35
No. 200	0-15

Section 2a: HMA Surface Courses

Description	Aggregate for Bituminous Surfaces
Code Reference	1004.3
Aggregate Gradation	Grade 1
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	65-95
No. 4	20-55
No. 8	2-20
No. 200	0-5

Aggregate Gradation	Grade 2
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
No. 4	40-80
No. 8	15-50
No. 30	0-30
No. 200	0-5

Aggregate Gradation	Grade 3
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
No. 4	40-80
No. 8	15-50
No. 30	0-30
No. 200	0-5

Section 2b: HMA Intermediate Courses

No specific gradation provided refer to Section 1002

Section 2c: HMA Base Courses

No specific gradation provided refer to Section 1002

Section 2e: Asphalt Surface Treatments

Description	Fine Aggregates
Code Reference	413 and 1002
Acceptable Aggregates	Passing the 3/8" sieve natural or manufactured

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	1005.2.4
Aggregate Gradation	Gradation D
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
3/8-inch	15-55
No. 4	0-10

Aggregate Gradation	Gradation E
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	70-100
3/8-inch	40-70
No. 4	0-10
No. 8	0-6

Description	PCC Fine Aggregate
Code Reference	1005.3.5
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	70-100
No. 16	45-90
No. 30	15-65
No. 50	5-30
No. 100	0-10

Section 4: Incidental Construction

Description	Aggregates for Drainage
Code Reference	1009.3.1 thru 1009.3.5
Aggregate Gradation	Grade 1
Acceptable Aggregate	Basic sand according to 1005.3

Aggregate Gradation	Grade 2
Gradation	% Passing (by weight)
1-inch	100
1/2-inch	55-90
No. 10	25-50
No. 40	10-30
No. 50	0-10
No. 200	0-3

Aggregate Gradation	Grade 3
Aggregate Gradation	Acceptable aggregate according to 1005.2

Aggregate Gradation	Grade 4, gradation A
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	Grade 4, gradation B
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Aggregate Gradation	Grade 5
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	60-80
No. 4	40-55
No. 8	5-25
No. 16	0-8
No. 50	0-5

Description	Structural Backfill
Code Reference	1005.3.5
Gradation	% Passing (by weight)
4-inch	100
No. 40	0-60
No. 200	0-10

Missouri DOT, "Supplemental Specifications to 2004 Missouri Standard Specifications for Highway Construction," Revision 06/01/09. Missouri DOT, 2009. <http://www.modot.mo.gov/business/standards_and_specs/highwayspecs.htm.>

Section 1: Bases and Subbases

Description	Crushed Base Coarse
Code Reference	701.02.4
Aggregate Gradation	Type A - Grade 5A
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	97-100
3/4-inch	78-80
3/8-inch	58-62
No. 4	42-50
No. 40	14-22
No. 200	3-5

Aggregate Gradation	Type A - Grade 6A
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	82-88
3/8-inch	52-64
No. 4	36-48
No. 30	16-24
No. 200	3-5

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	701.03
Aggregate Gradation	Grade A
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	87-93
3/8-inch	77-83
No. 4	52-58
No. 10	36-41
No. 40	19-21
No. 200	6-8

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	701.03
Aggregate Gradation	Grade B
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	86-90
3/8-inch	75-79
No. 4	51-57
No. 200	4.5-6.5

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	701.02
Aggregate Gradation	Grade D
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	79-83
3/8-inch	68-72
No. 4	44-50
No. 200	4.5-6.5

Section 2e: Asphalt Surface Treatments

Description	Crushed Cover Aggregate
Code Reference	701-12
Aggregate Gradation	Grade 1A
Gradation	% Passing (by weight)
5/8-inch	100
3/8-inch	33-55
No. 4	0-15
No. 8	0-5
No. 200	0-2

Aggregate Gradation	Grade 2A
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	40-100
No. 4	0-8
No. 200	0-1

Aggregate Gradation	Grade 3A
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	0-30
No. 8	0-15
No. 200	0-2

Aggregate Gradation	Grade 4A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	0-15
No. 200	0-2

Aggregate Gradation	Grade 5A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	9-50
No. 8	2-20
No. 200	2-5

Section 3: Concrete Pavements

Description	PCC Pavements - Fine
Code Reference	701-2
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-10
No. 200	0-3

Description	PCC Pavements - Coarse
Code Reference	701-4
Acceptable Aggregates	Nos. 1, 2, and 3
Aggregate Gradation	Coarse - No. 1
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5

Aggregate Gradation	Coarse - No. 2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Aggregate Gradation	Coarse - No. 3
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	20-55
3/4-inch	0-15
3/8-inch	0-5

Aggregate Gradation	Coarse - No. 4
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-70
No. 4	0-15
No. 8	0-5

Section 4: Incidental Construction

Description	Drainage Aggregate
Code Reference	701-21
Gradation	% Passing (by weight)
6-inch	100
3/4-inch	0-10
No. 4	0-5

Description	Backfill
Code Reference	701.09
Gradation	% Passing (by weight)
2-inch	95
No. 200	10 Max

Montana DOT, “2006 Standard Specifications,” 2006. <http://www.mdt.mt.gov/business/contracting/standard_specs.shtml.>

Section 1: Bases and Subbases

Description	Crushed Rock Base
Code Reference	Table 1033.09
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	65-95
3/8-inch	36-70
No. 10	10-30
No. 200	0-10

Section 2a: HMA Surface Courses

Description	Superpave AC Gradations
Code Reference	Table 1028.06-09
Aggregate Gradation	12.5 mm Superpave AC
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-10

Designation	9.5 mm Superpave AC
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	Superpave AC Gradations
Code Reference	Table 1028.06-09
Aggregate Gradation	19 mm Superpave AC
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

*No specific HMA Base gradation provided.

Section 2e: Asphalt Surface Treatments

Description	Armor Coat
Code Reference	515.02-2 and Table 1033.06
Gradation	% Passing
3/8-inch	99-100
No. 4	65-85
No. 10	0-15
No. 50	0-10
No. 200	0-3

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	Table 1033.02A
Aggregate Gradation	A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	92-100
No. 10	64-90
No. 30	10-40
No. 200	0-3
Aggregate Gradation	B
1-inch	100
No. 4	77-97
No. 10	50-70
No. 30	16-40
No. 200	0-3
Aggregate Gradation	C
1-inch	100
No. 4	44-88
No. 10	24-50
No. 30	4-20
No. 200	0-3

Description	PCC Coarse Aggregate
Code Reference	Table 1033.03A
Aggregate Gradation	E
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	92-100
3/4-inch	66-90
3/8-inch	15-45
No. 4	0-12
No. 20	0-4
No. 200	0-3
Aggregate Gradation	F
3/4-inch	100
1/2-inch	96-100
3/8-inch	40-90
No. 4	4-30
No. 10	0-8
No. 200	0-3

Section 4: Incidental Construction

Description	Underdrain Backfill
Code Reference	Table 914.02
Gradation	% Passing (by weight)
1-inch	100
1/2-inch	90-98
No. 4	40-90
No. 10	0-40
No. 50	0-10
No. 200	0-6

Description	Granular Backfill
Code Reference	Tables 1033.02A and 1033.06
Acceptable Aggregates	Class A, B, C, D and Armor Coat

Nebraska DOT,“2007 Standard Specifications for Highway Construction,”2007.<http://www.nebraskatransportation.org/ref-man/.>

Section 1: Bases and Subbases

Description	Base Aggregates
Code Reference	704.03.02
Aggregate Gradation	Type 1 and 2, Class A and B
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	80-100
No. 4	30-65
No. 16	15-40
No. 200	2-12

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	705.03
Aggregate Gradation	Type 2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	63-85
No. 4	45-63
No. 10	30-44
No. 40	12-22
No. 200	3-8

Aggregate Gradation	Type 2C
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	88-95
1/2-inch	70-85
3/8-inch	60-78
No. 4	43-60
No. 10	30-44
No. 40	12-22
No. 200	3-8

Aggregate Gradation	Type 3
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	50-75
No. 10	32-52
No. 40	12-26
No. 200	3-8

Aggregate Gradation	9.5 mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	40-65
No. 30	12-22
No. 200	0-5

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	705.03.01
Aggregate Gradation	Type 2C - 19.0 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	88-95
1/2-inch	70-85
3/8-inch	60-78
No. 4	43-60
No. 40	12-22
No. 200	3-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	705.03.01
Aggregate Gradation	Type 2 - 25.0 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	63-85
No. 4	45-63
No. 10	30-44
No. 40	12-22
No. 200	3-8

Section 2e: Asphalt Surface Treatments

Description	Tack Coat
Code Reference	405.02.01
Acceptable Aggregate	conditionally accepted at source

Description	Prime Coat - Sand Blotter Material
Code Reference	705.03.05
Gradation	% Passing (by weight)
1/2-inch	100
No. 4	90-100
No. 16	30-75
No. 200	0-12

Description	Seal Coat - Sand Blotter Material
Code Reference	705.03.05
Gradation	% Passing (by weight)
1/2-inch	100
No. 4	90-100
No. 16	30-75
No. 200	0-12

Section 3: Concrete Pavements

Description	PCC Pavements
Code Reference	706.01
Aggregate Gradation	19 mm Max.
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
3/8-inch	46-70
No. 4	34-50
No. 8	24-42
No. 16	17-34
No. 30	10-25
No. 50	5-15
No. 100	2-7
No. 200	0-3

Aggregate Gradation	25 mm Max.
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	97-100
3/4-inch	70-100
3/8-inch	43-70
No. 4	32-48
No. 8	23-42
No. 16	15-34
No. 30	8-25
No. 50	4-15
No. 100	2-7
No. 200	0-3

Aggregate Gradation	37.5 mm Max.
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	87-100
1-inch	65-90
3/4-inch	48-82
3/8-inch	39-57
No. 4	30-45
No. 8	23-38
No. 16	15-33
No. 30	8-24
No. 50	4-13
No. 100	1-5
No. 200	0-3

Aggregate Gradation	Fine Aggregate
Code Reference	706.03.03
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-35
No. 100	2-12
No. 200	0-5

Section 4: Incidental Construction

Description	Drain Backfill
Code Reference	704.03.01
Aggregate Gradation	Type 1
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
3/4-inch	50-80
No. 4	24-40
No. 16	10-24
No. 100	0-4
No. 200	0-2

Aggregate Gradation	Type 2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 100	0-4
No. 200	0-2

Aggregate Gradation	Type 3
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	60-90
No. 16	26-60
No. 100	0-4
No. 200	0-2

Nevada DOT, "2001 Standard Specifications for Road and Bridge Construction," 2001.
<http://www.nevadadot.com/business/contractor/Standards/.>

Section 1: Bases and Subbases

Description	Graded Aggregate Base (Coarse)
Code Reference	304.4
Aggregate Gradation	% Passing (by weight)
3.5-inch	100
3-inch	85-100
2-inch	60-90
3/4-inch	40-70
No. 4	15-40
No. 200	0-5

Description	Graded Aggregate Base (Fine)
Code Reference	304.5
Aggregate Gradation	% Passing (by weight)
2.5-inch	100
2-inch	85-100
3/4-inch	45-75
No. 4	10-45
No. 100	0-5

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	401.2.4
Aggregate Gradation	12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	42-52
No. 100	2-10

Aggregate Gradation	Type B
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
No. 4	46-56
No. 100	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-426
Aggregate Gradation	19.5 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	32-42
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	401.2.4
Aggregate Gradation	25mm
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	90 max
No. 8	15-41
No. 200	0-6

Section 2e: Asphalt Surface Treatments

Description	Plant Mix Surface Treatments
Code Reference	411.2.1
Aggregate Gradation	Type G (3/8 inch)
Gradation	% Passing (by weight)
No. 4	99-100
No. 8	76-93
No. 16	55-74
No. 30	34-55
No. 50	17-35
No. 100	15-Jun
No. 200	6-Feb

Aggregate Gradation	Type H (3/8 inch)
Gradation	% Passing (by weight)
3/8-inch	95-100
No. 4	70-84
No. 8	54-65
No. 16	35-51
No. 30	20-36
No. 50	10-20
No. 100	5-11
No. 200	2-6

Aggregate Gradation	Blotter Material
Gradation	% Passing (by weight)
No. 4	100
No. 100	70-92
No. 200	0-6

Section 3: Concrete Pavements

Description	PCC Pavement Aggregates
Code Reference	705.02
Aggregate Gradation	#4
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	20-55
3/4-inch	0-15
3/8-inch	0-5

Aggregate Gradation	#357
Gradation	% Passing (by weight)
2-inch	95-100
1-inch	35-70
1/2-inch	10-30
No. 4	0-5

Aggregate Gradation	#467
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5

Aggregate Gradation	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	#67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Aggregate Gradation	#7
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-70
No. 4	0-15
No. 8	0-5

Aggregate Gradation	#89
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 50	0-5

Section 4: Incidental Construction

Description	Structural Backfill
Code Reference	508.2.1.1
Aggregate Gradation	Crushed Gravel
Gradation	% Passing (by weight)
3-inch	100
2-inch	95-100
1-inch	55-85
No. 4	27-52
No. 200	0-12

Aggregate Gradation	Bank-Run
Gradation	% Passing (by weight)
6-inch	100
No. 4	25-70
No. 200	15 Max

Aggregate Gradation	Clean Stone
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5

Description	Underdrain Backfill
Code Reference	605.2.5
Aggregate Gradation	Granular (Sand)
Gradation	% Passing (by weight)
3-inch	100
No. 4	70-100

Aggregate Gradation	Granular (gravel)
Gradation	% Passing (by weight)
3-inch	95-100
No.4	25-70

Aggregate Gradation	#4
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	20-55
3/4-inch	0-15
3/8-inch	0-5

New Hampshire DOT, “NHDOT Standard Specifications,” 2006 Edition, 2006. <http://www.nh.gov/dot/bureaus/highwaydesign/specifications/index.htm.>

Section 1: Bases and Subbases

Description	Aggregate Base Course - Dense
Code Reference	911.10
Aggregate Gradation	varies refer below
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	55-90
No. 4	25-50
No. 50	5-20
No. 200	3-10

Section 2a: HMA Surface Courses

Designation	HMA Surface Course
Application	901.05.02-2
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 200	0-5

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	902.02.03-1
Aggregate Gradation	19.0 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	902.02.03-1
Aggregate Gradation	25.0 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-45
No. 200	1-7

Aggregate Gradation	37.5 mm
Gradation	% Passing (by weight)
1.5-inch	90-100
1-inch	90 max
No. 8	15-41
No. 200	0-6

Section 2e: Asphalt Surface Treatments

No information provided for specific gradations

Section 3: Concrete Pavements

Description	PCC Pavements - Course
Code Reference	901.03.02
Aggregate Gradation	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Aggregate Gradation	#67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Aggregate Gradation	#8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Description	PCC Pavements - Fine
Code Reference	901.06.02
Aggregate Gradation	Fine - Concrete, Mortar, and Grout
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-65
No. 50	10-30
No. 100	1-10
No. 200	0-3.4

Section 4: Incidental Construction

No specific gradations provided for underdrains or backfill

New Jersey DOT, “2007 Standard Specification,” 2007.
<http://www.state.nj.us/transportation/eng/specs/index.shtml#StandardSpecifications.>

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	Table 304.2.1:1
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
No. 4	30-60
No. 10	20-45
No. 200	3-10

Section 2a: HMA Surface Courses

Description	HMA SUPERPAVE
Code Reference	Table 423.2.2.1:1
Aggregate Gradation	SP- IV
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	<90
No. 8	28-58
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA SUPERPAVE
Code Reference	Table 423.2.2.1:1
Aggregate Gradation	SP - III
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	<90
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA SUPERPAVE
Code Reference	Table 423.2.2.1:1
Aggregate Gradation	SP-IV
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	<90
No. 8	19-45
No. 200	1-7

Section 2e: Asphalt Surface Treatments

Description	Prime Coat
Code Reference	Table 408.2.2:1
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	80-100
No. 16	45-80
No. 50	10-30
No. 100	2-10

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	Table 509.2.4.2.3:1
Aggregate Gradation	1.5 inch
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5
No. 200	0-2

Aggregate Gradation	1.0 inch
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-2

Aggregate Gradation	0.75 inch
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5
No. 200	0-2

Aggregate Gradation	0.5 inch
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-70
No. 4	0-15
No. 8	0-5
No. 200	0-2

Description	PCC Fine Aggregate
Code Reference	Table 509.2.4.3.3:1
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	70-95
No. 16	45-80
No. 30	25-60
No. 50	5-30
No. 100	0-8
No. 200	0-3

Section 4: Incidental Construction

Description	Backfill
Code Reference	206.2.1
Aggregate Gradation	AASHTO A-1
Gradation	% Passing (by weight)
No. 10	50 Max
No. 40	30 Max
No. 200	15 Max
Aggregate Gradation	AASHTO A-2-4
Gradation	% Passing (by weight)
No. 200	35 Max
Aggregate Gradation	AASHTO A-3
Gradation	% Passing (by weight)
No. 40	51 Minimum
No. 200	10 Max
Aggregate Gradation	Bedding Sand
Gradation	% Passing (by weight)
3/8-inch	100
No. 40	95-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-10

New Mexico DOT, "2007 Specs for Highway and Bridge Construction," 2007. <http://nmshtd.state.nm.us/main.asp?secid=11183.>

Section 1: Bases and Subbases

Description	Base Course Gradation
Code Reference	304-1
Aggregate Gradation	Type 1
Gradation	% Passing (by weight)
3-inch	100
2-inch	90-100
1/4-inch	30-65
No. 40	5-40
No. 100	0-10

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	403.1
Aggregate Gradation	Type 6,6F2,6F3
Gradation	% Passing (by weight)
3/4-inch	100
3/8-inch	95-100
1/4-inch	65-85
No. 6	36-65
No. 20	15-39
No. 40	8-27
No. 80	4-16
No. 200	2-6

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	403.1
Aggregate Gradation	Binder Type 3
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	70-90
1/4-inch	48-74
No. 6	32-62
No. 20	15-39
No. 40	8-27
No. 80	4-16
No. 200	2-6

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	403.1
Aggregate Gradation	Base Type 1
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	78-95
1/2-inch	57-84
1/4-inch	40-72
No. 6	26-57
No. 20	12-36
No. 40	8-25
No. 80	4-16
No. 200	2-8

Section 2d: Asphalt Surface Treatments

Description	Bituminous Surafce Treatment
Code Reference	410-2.02A
Aggregate Gradation	No. 1ST
Gradation	% Passing (by weight)
1/2-inch	100
1/4-inch	0-15
No. 200	0-1

Description	Aggregate for Slurry
Code Reference	Table 703-5
Aggregate Gradation	2MS
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-20

Aggregate Gradation	3MS
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	70-100
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 50	12-25
No. 100	7-20
No. 200	5-20

Section 3: Concrete Pavements

Description	Coarse Aggregate
Code Reference	704.02
Aggregate Gradation	Type 1B
Gradation	% Passing (by weight)
1/4-inch	100
No. 20	90-100
No. 200	0-1

Description	Coarse Aggregate
Aggregate Gradation	Type 1A
Gradation	% Passing (by weight)
1/2-inch	100
1/4-inch	90-100
No. 20	0-15
No. 200	0-1

Description	Coarse Aggregate
Aggregate Gradation	Type 1ST
Gradation	% Passing (by weight)
1/2-inch	100
1/4-inch	0-15
No. 200	0-1

Section 3: Concrete Pavements (continued)

Description	PCC fine
Code Reference	703.07
Aggregate Gradation	Fine
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	75-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	1-10
No. 200	0-3

Section 4: Incidental Construction

Description	Backfill
Code Reference	700.15
Aggregate Gradation	Type CA 1
Gradation	% Passing (by weight)
1-inch	100
1/2-inch	90-100
1/4-inch	0-15

Description	Backfill
Code Reference	700.15
Aggregate Gradation	Type CA 2
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	93-100
1/2-inch	27-58
1/4-inch	0-8

New York DOT, “2006 Standard Specifications,” 2006. <https://www.nysdot.gov/portal/page/portal/main/business-center/engineering/specifications/2006-standard-specs.>

Section 1: Bases and Subbases

Description	Aggregate Base Course
Code Reference	1008-1
Aggregate Gradation	Base
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	72-100
1/2-inch	51-83
No. 4	35-60
No. 10	20-50
No. 40	10-34
No. 200	3-13

Description	Aggregate Base
Code Reference	1010-1
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	75-97
1/2-inch	55-80
No. 4	35-55
No. 10	25-45
No. 40	14-30
No. 200	4-12

Description	Aggregate Base
Code Reference	1010-1
Aggregate Gradation	Type B
Gradation	% Passing (by weight)
1.5-inch	98-100
1-inch	72-100
1/2-inch	51-83
No. 4	35-60
No. 10	20-50
No. 40	10-34
No. 200	3-11

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	Table 610-1
Aggregate Gradation	12.5mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	4-8

Description	HMA Surface Course
Code Reference	Table 610-1
Aggregate Gradation	9.5mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	32-67
No. 200	4-8

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	Table 610-1
Aggregate Gradation	19mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	3-8

Section 2c: HMA Base Courses

Description	HMA Base Courses
Code Reference	Table 610-1
Aggregate Gradation	25mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-45
No. 200	3-7

Section 2d: Asphalt Surface Treatments

Description	Asphalt Surface Treatment
Code Reference	1012-2
Aggregate Gradation	No. 5, No. 6, No. 78M

Section 3: Concrete Pavements

Description	PCC Coarse
Code Reference	1014-2
Aggregate Gradation	57, 57M, 67, 78M

Description	PCC Fine
Code Reference	1014-1
Aggregate Gradation	No. 2S, No. 2MS

Section 4: Incidental Construction

Description	Aggregate Subdrain
Code Reference	1044-1
Aggregate Gradation	No. 78M

Description	Backfill
Code Reference	453-2
Aggregate Gradation	No. 78M and N. 2S or No. 2MS

North Carolina DOT, “2006 Standard Specifications Book,” 2006. <http://www.ncdot.org/doh/preconstruct/ps/specifications/.>

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	816.03 B
Aggregate Gradation	5
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
No. 4	35-70
No. 30	16-40
No. 200	4-10

Section 2a: HMA Surface Courses

Description	Asphalt Mix Aggregates
Code Reference	816.03 B-II
Aggregate Gradation	Types 27, 29, 31, 33
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	70-100
No. 4	40-70
No. 30	15-35
No. 200	2-7

Section 2b: HMA Intermediate Courses

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type A 19mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
1/2-inch	90 max
No. 8	28-45
No. 200	2-6

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type 2 Intermediate
Gradation	% Passing (by weight)
1-inch	95-100
3/4-inch	85-100
1/2-inch	65-85
No. 4	35-60
No. 8	25-48
No. 30	12-30
No. 50	5-18
No. 100	2-10

Section 2c: HMA Base Courses

No specific gradation provided.
Refer to ase and subbase section.

Section 2d: Asphalt Surface Treatments

Description	Treatment
Code Reference	816.03 B-II
Aggregate Gradation	Chip Seal
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	20-70
No. 8	0-17
No. 200	0-5

Description	Treatment
Code Reference	816.03 B-II
Aggregate Gradation	Sand Seal
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	85-100
No. 16	45-80
No. 50	10-30
No. 200	0-3

Description	Treatment
Code Reference	816.03 B-II
Aggregate Gradation	Blotter Sand
Gradation	% Passing (by weight)
5/8-inch	100
No. 4	90-100
No. 200	0-20

Section 3: Concrete Pavements

Description	PCC Coarse Aggregates
Code Reference	816.02-AI
Aggregate Gradation	PCC Coarse Aggregates
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	40-70
No. 8	0-15
No. 16	0-5
No. 30	0-5
No. 200	1 max
	*plus ASTM 3, 4, 5

Description	PCC Fine Aggregates
Code Reference	816.01-AI
Aggregate Gradation	PCC Fine Aggregates
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	0-10
No. 200	0-3

Section 4: Incidental Construction

Description	Underdrain Aggregate
Code Reference	816.02.A.1
Aggregate Gradation	PCC Coarse Aggregates
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	40-70
No. 8	0-15
No. 16	0-5
No. 30	0-5
No. 200	1 max

Description	Permeable Trench Backfill
Code Reference	816.03 B-I
Aggregate Gradation	PCC Coarse Aggregates
Gradation	% Passing (by weight)
3/4-inch	100
3/8-inch	50-95
No. 10	0-15
No. 30	0-4

North Dakota Department of Transportation, "North Dakota Field Sampling and Testing Manual," Field Sampling and Testing Manual, 2007. <http://www.dot.nd.gov/divisions/materials/testingmanual.htm>.

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	703.17
Aggregate Gradation	Base
Gradation	% Passing (by weight)
2-inch	100
1-inch	70-100
3/4-inch	50-90
No. 4	30-60
No. 40	9-33
No. 200	0-15

Section 2a: HMA Surface Courses

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type 2 Surface
Gradation	% Passing (by weight)
1.5-inchj	100
1-inch	95-100
3/4-inch	85-100
1/2-inch	65-85
No. 4	35-60
No. 8	25-48
No. 30	12-30
No. 50	5-18
No. 100	2-10

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type A 12.5mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
No. 8	32-45
No. 200	2-8

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type A 9.5mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	70 max
No. 8	32-52
No. 200	2-8

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type 1 Surface
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	45-57
No. 8	30-45
No. 30	12-25
No. 100	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type A 19mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
1/2-inch	90 max
No. 8	28-45
No. 200	2-6

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type 2 Intermediate
Gradation	% Passing (by weight)
1-inch	95-100
3/4-inch	85-100
1/2-inch	65-85
No. 4	35-60
No. 8	25-48
No. 30	12-30
No. 50	5-18
No. 100	2-10

Description	HMA Superpave Gradations
Code Reference	442.02 and Table 441.02
Aggregate Gradation	Type 1 Intermediate
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	50-72
No. 8	30-55
No. 30	12-30
No. 50	5-20
No. 100	2-12

Section 2c: HMA Base Courses

Description	Asphalt Concrete Base
Code Reference	301.02 and 302.02
Aggregate Gradation	Type 2
Gradation	% Passing (by weight)
1.5-inch	85-100
1-inch	68-88
3/4-inch	56-80
1/2-inch	44-68
3/8-inch	37-60
No. 4	22-45
No. 8	14-35
No. 30	6-18
No. 50	4-13
No. 200	2-6

Section 2c: HMA Base Courses (continued)

Description	Asphalt Concrete Base
Code Reference	301.02 and 302.02
Aggregate Gradation	Type 1
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	75-100
1/2-inch	50-85
No. 4	25-60
No. 8	15-45
No. 50	3-18
No. 200	1-7

Section 2d: Asphalt Surface Treatments

Description	Prime Coat
Code Reference	408.03
Aggregate Gradation	No. 9 size aggregate

Description	Chip Seal
Code Reference	422.02
Aggregate Gradation	No. 8 size aggregate
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5
No. 200	2 max

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	703.02
Aggregate Gradation	Acceptable AASHTO M 43 Coarse
Gradation	% Passing 200 <3%

Description	PCC Fine Aggregate
Code Reference	703.02
Aggregate Gradation	PCC Fine Aggregate
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	70-100
No. 16	38-80
No. 30	18-60
No. 50	5-30
No. 100	0-10
No. 200	0-5

Section 4: Incidental Construction

Description	Aggregate Underdrain
Code Reference	605.02
Aggregate Gradation	No. 8, 9, or 89

Description	Granular Backfill
Code Reference	703.11
Aggregate Gradation	Item 304
Gradation	% Passing (by weight)
2-inch	100
1-inch	70-100
3/4-inch	50-90
No. 4	30-60
No. 30	9-33
No. 200	0-15

Description	Granular Backfill
Code Reference	703.11
Aggregate Gradation	Item 411
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	75-100
3/4-inch	60-100
3/8-inch	35-75
No. 4	30-60
No. 30	7-30
No. 200	3-15

Description	Granular Backfill
Code Reference	703.11
Aggregate Gradation	Item 617
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	60-100
3/8-inch	35-75
No. 4	30-60
No. 30	9-33
No. 200	0-15

Ohio Department of Transportation, “2008 Construction and Material Specifications,” 2008 Spec Book, 2008.
<http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specifications/2008CMS/2008Specbook.aspx>.

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	703.1
Aggregate Gradation	A
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	40-100
3/8-inch	30-75
No. 4	25-60
No. 10	20-43
No. 40	8-26
No. 200	4-12

Description	Aggregate Base
Code Reference	703.1
Aggregate Gradation	B
Gradation	% Passing (by weight)
3-inch	100
1.5-inch	40-100
3/4"	30-75
3/8"	25-60
No. 4	20-50
No. 10	15-35
No. 40	7-22
No. 200	3-10

Description	Aggregate Base
Code Reference	703:1
Aggregate Gradation	C
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1-inch	80-100
1/2-inch	60-80
No. 4	40-60
No. 40	15-30
No. 200	0-5

Section 2a: HMA Surface Courses

Description	Superpave Gradations
Code Reference	Table 5C from 708-3(c)99
Description	Superpave
Code Reference	
Aggregate Gradation	S4 (12.5mm)
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	34-58
No. 200	2-10

Section 2a: HMA Surface Courses (continued)

Aggregate Gradation	S5 (9.5mm)
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 Max
No. 8	37-67
No. 200	2-10

Aggregate Gradation	S6 (4.75mm)
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	80-100
No. 8	54-90
No. 200	5-15

Section 2b: HMA Intermediate Courses

Description	Superpave Gradations
Code Reference	Table 5C from 708-3(c)99
Aggregate Gradation	S3 (19.0mm)
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	31-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	Superpave Base
Code Reference	Table 5C from 708-3(c)99
Aggregate Gradation	S2 (25.0mm)
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 4	0-40
No. 8	29-45
No. 200	1-7

Section 2d: Asphalt Surface Treatments

Description	Single Coat
Code Reference	403.1
Aggregate Gradation	#2, #3, #3C

Description	Double Coat
Code Reference	403.1
Aggregate Gradation	#1, #2

Section 3: Concrete Pavements

Description	Coarse Aggregate
Code Reference	701.06
Acceptable Aggregates	Class A, Class AP: # 57
	Massive Class A: #57
	Class C: #57, #67, #357
	Thin overlays, etc: #7
	Class AA, Class P: #57, #67
	Class P, if special conditions exist: #7, #8

Description	PCC Concrete
Code Reference	701.11
Aggregate Gradation	Fine Aggregate
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-10
No. 200	0-3

Section 4: Incidental Construction

Description	Underdrain Coarse Cover
Code Reference	703.9
Aggregate Gradation	Coarse
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	20-55
No. 8	0-12
No. 16	0-10
No. 50	0-5

Description	Filter Sand Gradation
Code Reference	703.10
Aggregate Gradation	Sand
Gradation	% Passing (by weight)
3/4-inch	100
No. 4	95-100
No. 16	50-85
No. 50	15-33
No. 100	0-10

Description	Granular Backfill Gradation
Code Reference	703.11
Aggregate Gradation	Backfill
Gradation	% Passing (by weight)
3-inch	100
1-inch	90-100
No. 40	0-45
No. 200	0-10

Oklahoma Department of Transportation, “Standard Specifications for Highway Construction,” Specbook, 1999.
<http://www.okladot.state.ok.us/construction/specbook/specbook-1999.pdf>.

Section 1: Bases and Subbases

Description	Graded Aggregate Base (Coarse)
Code Reference	304.4
Aggregate Gradation	Crushed Stone (Coarse)
Gradation	% Passing (by weight)
3.5-inch	100
3-inch	85-100
2-inch	60-90
3/4-inch	40-70
No. 4	15-40
No. 200	0-5

Section 2a: HMA Surface Courses

Description	Dense Graded Mixes
Code Reference	745.12
Aggregate Gradation	Type B
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-10

Description	Dense Graded Mixes
Code Reference	745.12
Aggregate Gradation	3/8" Dense
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-427
Aggregate Gradation	3/4" Dense
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	Dense Graded Mixes
Code Reference	745.12
Aggregate Gradation	1" Dense
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
No. 8	19-45
No. 200	1-7

Section 2d: Asphalt Surface Treatments

Description	Bituminous Surface Treatment
Code Reference	705.10
Aggregate Gradation	Prime Coat
Gradation	% Passing (by weight)
3/8-inch	100
1/4-inch	90-100
No. 8	30-66
No. 30	8-28
No. 100	0-5

Description	Bituminous Surface Treatment
Code Reference	705.10
Aggregate Gradation	Fog Coat
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	55-75
1/4-inch	40-60

Description	Bituminous Surface Treatment
Code Reference	706.12
Aggregate Gradation	Slurry Seal Type I
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	100
No. 8	90-100
No. 16	65-90
No. 30	40-65
No. 50	25-42
No. 100	15-30
No. 200	10-20

Description	Bituminous Surface Treatment
Code Reference	706.12
Aggregate Gradation	Slurry Seal Type II
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-15

Description	Bituminous Surface Treatment
Code Reference	706.12
Aggregate Gradation	Slurry Seal Type III
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	70-100
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 50	12-25
No. 100	7-18
No. 200	5-15

Section 3: Concrete Pavements

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Combined 1 1/2" - #4
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-30
No. 4	0-5

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Separated 1 1/2" to 3/4"
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Separated 3/4" to 1/2"
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
1/2-inch	0-15

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Separated 3/4" - 3/8"
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	20-55
No. 4	0-5

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Separated or Combined 3/4" to #4
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Separated Sizes 1/2" to #4
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
No. 4	0-15
No. 8	0-5

Description	Aggregates for PCC
Code Reference	02690.20(g)
Aggregate Gradation	Separated Sizes 3/8" to #8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Section 4: Incidental Construction

Description	Granular Drain Backfill
Code Reference	430.11
Aggregate Gradation	1.5" to 3/4"
Gradation	% Passing (by weight)
1.5-inch	95-100
3/4-inch	0-15
1/2-inch	0-2

Description	Granular Drain Backfill
Code Reference	430.11
Aggregate Gradation	1.25" to 3/4 in
Gradation	% Passing (by weight)
1.5-inch	100
1.25-inch	90-100
3/4-inch	0-15
1/2-inch	0-2

Description	Granular Drain Backfill
Code Reference	430.11
Aggregate Gradation	3/4" to 1/2"
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	0-15
1/4-inch	0-3

Oregon Department of Transportation, “Oregon Standard Specifications for Construction,” Vol. 1., 2008. <http://www.oregon.gov/ODOT/HWY/SPECS/standard_specifications.shtml#2008_Standard_Specifications>.

Section 1: Bases and Subbases

Description	Subbase
Code Reference	703.2
Aggregate Gradation	No. 2A
Gradation	% Passing (by weight)
2-inch	100
3/4-inch	52-100
3/8-inch	36-70
No. 4	24-50
No. 8	16-38
No. 16	10-30
No. 200	0-10

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	401..2
Aggregate Gradation	ID-3 W.C./H.D. ID-3 W.C.
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	60-80
No. 4	40-65
No. 8	25-50
No. 16	20-40
No. 30	12-28
No. 50	5-25
No. 100	4-14
No. 200	3-6

Section 2b: HMA Intermediate Courses

Description	No information available
Code Reference	refer to Base/Subbase
Aggregate Gradation	

Section 2c: HMA Base Courses

Description	Aggregate-Bituminous Base Course
Code Reference	320.2
Aggregate Gradation	Type A or B
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	52-100
3/8-inch	36-70
No. 8	16-38
No. 30	8-24
No. 50	6-18
No. 100	4-10
No. 200	0-2

Section 2d: Asphalt Surface Treatments

Description	Bituminous Surface Treatment
Code Reference	480.2b
Aggregate Gradation	No. 8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Aggregate Gradation	No. 67
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Section 3: Concrete Pavements

Description	PCC Pavement - Coarse
Code Reference	703.2
Aggregate Gradation	Type A, No. 57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-65
No. 4	0-10
No. 8	0-5

Description	PCC Pavement - Fine
Code Reference	703.1
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	70-100
No. 16	45-85
No. 30	25-65
No. 50	10-30
No. 100	0-10

Section 4: Incidental Construction

Description	Combination Storm Sewer and Underdrain
Code Reference	604.2
Aggregate Gradation	No. 57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-65
No. 4	0-10
No. 8	0-5

Description	Flowable Backfill
Code Reference	220.2
Aggregate Gradation	AASHTO 10

Description	Stone Backfill for Miscellaneous Drainage
Code Reference	613.1
Aggregate Gradation	No. 1
Gradation	% Passing (by weight)
4-inch	100
3.5-inch	90-100
2.5-inch	25-65
1.5-inch	0-15
3/4-inch	0-5

Description	Stone Backfill for Miscellaneous Drainage
Code Reference	613.1
Aggregate Gradation	No. 57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Pennsylvania Department of Transportation, “Specifications,” Construction Specifications, 2 Apr. 2007. <ftp://ftp.dot.state.pa.us/public/bureaus/design/Pub408/Pub%20408%202007%20IE/Pub%20408%20inside%20cover%20IE.pdf>.

Section 1: Bases and Subbases

Description	Base
Code Reference	M.01.09
Aggregate Gradation	Gravel Borrow Base
Gradation	% Passing (by weight)
2-inch	60-100
1/2-inch	50-85
3/8-inch	45-80
No. 4	40-75
No. 40	0-45
No. 200	0-10

Section 2a: HMA Surface Courses

Description	HMA Superpave Gradations
Code Reference	Table M-14
Aggregate Gradation	Surface Class I-1
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	80-95
3/8-inch	70-90
No. 4	50-70
No. 8	35-50
No. 30	18-29
No. 50	13-23
No. 200	3-8

Description	HMA Superpave Gradations
Code Reference	Table M-14
Aggregate Gradation	Surface Class I-2
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	55-75
No. 8	40-55
No. 30	20-30
No. 50	10-20
No. 200	3-8

Section 2b: HMA Intermediate Courses

Description	HMA Binder Course
Code Reference	Table M-14
Aggregate Gradation	Binder Course
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	70-100
3/8-inch	46-74
No. 8	22-52
No. 30	10-34
No. 50	6-26
No. 200	3-8

Section 2c: HMA Base Courses

Description	Bituminous Base Course
Code Reference	Table M-14
Aggregate Gradation	Base Course
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	70-100
3/8-inch	46-74
No. 8	22-52
No. 30	10-34
No. 50	6-26
No. 200	3-8

Section 2d: Asphalt Surface Treatments

Description	Prime Coat
Code Reference	Blotter material
Aggregate Gradation	M.01.08

Description	Seal Coat
Code Reference	Cover Coat
Aggregate Gradation	M.01.08
Note	both use AASHTO M 6

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	M.02.03
Aggregate Gradation	Crushed Quarry Rock or Crushed Gravel
Gradation	(1.5", 1", 3/4", 1/2", 3/8")

Description	PCC Fine Aggregate
Code Reference	M.02.02
Aggregate Gradation	Fine Aggregates (AASHTO M6)

Section 4: Incidental Construction

Description	Underdrains
Code Reference	703.02.3
Aggregate Gradation	Acceptable Filter Stone, Fine Aggregates, and Bedding Stone

Description	Backfill
Code Reference	M.01.09
Aggregate Gradation	Conform to Borrow and Aggregates

Rhode Island Department of Transportation, “Standard Specifications for Road and Bridge Construction,” Publications, 2004. <http://fhwapap04.fhwa.dot.gov/nhswp/reader?agency=Rhode%20Island&fn=Rhode+Island+Std+Specs.pdf&type=standard>.

Section 1: Bases and Subbases

Description	Aggregate Base Course
Code Reference	882.2
Aggregate Gradation	Base Course
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
1/2-inch	68-91
No. 4	46-70
No. 8	34-58
No. 40	13-35
No. 200	3-12

Description	Limestone Ledge Rock Base
Code Reference	882.2
Aggregate Gradation	Base Course
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
1/2-inch	68-90
No. 4	42-70
No. 8	29-53
No. 40	10-28
No. 200	3-12

Section 2a: HMA Surface Courses

Description	Aggregates for Asphalt Concrete
Code Reference	880.2
Aggregate Gradation	Type 1 (Class D, E, G)
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	75-95
No. 4	45-75
No. 8	30-55
No. 30	10-30
No. 200	3-7

Description	Aggregates for Asphalt Concrete
Code Reference	880.2
Aggregate Gradation	Type 2 (Class D, E, G)
Gradation	% Passing (by weight)
1/2-inch	100
No. 4	60-80
No. 8	40-60
No. 50	15-35
No. 200	4-8

Section 2b: HMA Intermediate Courses

Description	**No info available**
Code Reference	refer to Base/Subbase Section
3/8-inch	100
No. 4	0-70
No. 8	0-28
No. 40	0-4
No. 200	0-3

Description	Surface Treatment
Code Reference	881.2
Aggregate Gradation	Type 2B
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	30-90
No. 4	0-50
No. 8	0-20
No. 40	0-5
No. 200	0-3

Description	Surface Treatment
Code Reference	881.2
Aggregate Gradation	Type 2B
Gradation	% Passing (by weight)
5/8-inch	100
No. 4	Oct-75
No. 8	0-62
No. 40	0-35

Section 2c: HMA Base Courses

Description	N/A
Code Reference	no specific info
Aggregate Gradation	refer to base/subbase specs

Section 2d: Asphalt Surface Treatments

Description	Surface Treatment
Code Reference	881.2
Aggregate Gradation	Type 1A
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
1/4-inch	0-70
No. 4	0-15
No. 8	0-5
No. 200	0-1

Description	Surface Treatment
Code Reference	881.2
Aggregate Gradation	Type 1B
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	10-90
No. 8	0-30
No. 40	0-4
No. 200	0-3

Description	Surface Treatment
Code Reference	881.2
Aggregate Gradation	Type 2A
Gradation	% Passing (by weight)
Description	Backfill
Code Reference	850.1
Aggregate Gradation	Granular Backfill
Gradation	% Passing (by weight)
2-inch	100
1-inch	95-100
1/2-inch	25-80
No. 4	0-20
No. 10	0-5
No. 200	0-18

Section 3: Concrete Pavements

Description	PCC Coarse Aggregates
Code Reference	820-D
Aggregate Gradation	PCC Coarse Aggregates
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 8	40-70
No. 16	0-15
No. 30	0-5
No. 50	0-5
No. 200	0-1

Description	PCC Fine Aggregates
Code Reference	800-E
Aggregate Gradation	PCC Fine Aggregates
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-85
No. 50	10-30
No. 100	2-10

Section 4: Incidental Construction

Description	Underdrains
Code Reference	680.2.A
Aggregate Gradation	Porous Backfill
Gradation	Natural Sand conforming to general aggregate specifications in Section 800 and must have a percent passing the No. 200 sieve less than 2%

South Dakota Department of Transportation, “2004 Standard Specifications for Roads & Bridges,” Operations Support Office of South Dakota Department of Transportation, 2004. <http://www.sddot.com/operations/specifications/index2004.htm>.

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	903.05
Aggregate Gradation	Grading B
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	65-95
No. 4	35-55
No. 16	15-45
No. 100	4-15

Description	Aggregate Base
Code Reference	903.05
Aggregate Gradation	Grading C
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/8-inch	45-74
No. 4	30-55
No. 100	4-15

Description	Aggregate Base
Code Reference	903.05
Aggregate Gradation	Grading D
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	85-100
3/4-inch	60-95
3/8-inch	50-80
No. 4	40-65
No. 16	20-40
No. 100	9-18

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	903.11
Aggregate Gradation	C
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/8-inch	45-74
No. 4	30-55
No. 100	4-15

Section 2a: HMA Surface Courses (continued)

Description	HMA Surface Course
Code Reference	903.11
Aggregate Gradation	D
Gradation	% Passing (by weight)
3/4"	100
1/2"	95-100
3/8"	80-93
No. 4	54-76
No. 8	35-57
No. 30	17-29
No. 50	10-18
No. 100	3-10
No. 200	0-6.5

Description	HMA Surface Course
Code Reference	903.11
Aggregate Gradation	E
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	80-93
No. 4	54-76
No. 8	35-57
No. 30	17-29
No. 50	10-18
No. 100	3-11
No. 200	0-8

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	903.05
Aggregate Gradation	BM
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	85-100
3/8-inch	59-79
No. 4	42-61
No. 8	29-47
No. 30	13-27
No. 50	7-20
No. 100	4-10
No. 200	0-6.5

Description	HMA Intermediate Course
Code Reference	903.05
Aggregate Gradation	BM2
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	81-93
3/8-inch	57-73
No. 4	40-56
No. 8	28-43
No. 30	13-25
No. 50	9-19
No. 100	6-10
No. 200	2.5-6.5

Section 2c: HMA Base Courses

Description	HMA Base Courses
Code Reference	903.05
Aggregate Gradation	A
Gradation	% Passing (by weight)
1.5-inch	81-100
3/4-inch	50-71
3/8-inch	35-50
No. 4	24-36
No. 8	13-27
No. 30	7-17
No. 100	0-10
No. 200	0-4.5

Description	HMA Base Courses
Code Reference	903.05
Aggregate Gradation	AS
Gradation	% Passing (by weight)
1.5-inch	75-100
3/4-inch	55-80
No. 4	7-11
No. 100	0-6
No. 200	0-4.5

Description	HMA Base Courses
Code Reference	903.05
Aggregate Gradation	ACRL
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	80-93
3/4-inch	60-75
No. 4	12-16
No. 100	0-4
No. 200	0-3.5

Section 2d: Asphalt Surface Treatments

Description	Double Bituminous Surface Treatment
Code Reference	404.02
Aggregate Gradation	No. 7, 8, 4

Section 3: Concrete Pavements

Description	PCC Coarse Aggregate
Code Reference	903.03
Aggregate Gradation	No. 4, No. 67

Description	PCC Fine Aggregate
Code Reference	903.01
Aggregate Gradation	Fine
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	50-90
No. 50	5-30
No. 100	0-10
No. 200	0-3

Section 4: Incidental Construction

Description	Aggregate Underdrain
Code Reference	903.17
Aggregate Gradation	6, 7, 8, 57, 78

Description	Granular Backfill
Code Reference	903.05
Aggregate Gradation	Type A Grade D
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	85-100
3/4-inch	60-95
3/8-inch	50-80
No. 4	40-65
No. 16	20-40
No. 100	9-18

Tennessee Department of Transportation, “Standard Specifications for Road and Bridge Construction,” Tennessee Department of Transportation - Construction Division, 2006. <http://www.tdot.state.tn.us/construction/specs.htm>.

Section 1: Bases and Subbases

Description	Base
Code Reference	747.2
Aggregate Gradation	Grade 1
Gradation	% Passing (by weight)
7/8-inch	65-90
3/8-inch	50-70
No. 4	35-55
No. 40	17-30

Description	Base
Code Reference	747.2
Aggregate Gradation	Grade 2
Gradation	% Passing (by weight)
1.75-inch	90-100
No. 4	25-55
No. 10	15-30
No. 40	15-40

Description	Base
Code Reference	747.2
Aggregate Gradation	Grade 3
Gradation	% Passing (by weight)
1.75-inch	90-100
No. 4	25-55
No. 40	15-50

Section 2a: HMA Surface Courses

Description	Dense Graded HMA
Code Reference	430.4
Aggregate Gradation	Coarse Surface
Gradation	% Passing (by weight)
3/4-inch	95-100
3/8-inch	70-85
No. 4	43-63
No. 8	32-44
No. 30	14-28
No. 50	7-20
No. 200	2-7

Description	Dense Graded HMA
Code Reference	430.4
Aggregate Gradation	Fine Surface
Gradation	% Passing (by weight)
1/2-inch	98-100
3/8-inch	85-100
No. 4	50-70
No. 8	35-46
No. 30	15-29
No. 50	7-20
No. 200	2-7

Section 2a: HMA Surface Courses (continued)

Description	Perfomance Design Mix
Code Reference	430.4
Aggregate Gradation	SP- C Surface
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	98-100
1/2-inch	90-100
3/8-inch	retain >10% cumulative
No. 8	28-58
No. 16	2-58
No. 30	2-58
No. 100	2-10

Description	Performance Design Mix
Code Reference	430.4
Aggregate Gradation	SP-D Fine Mixture
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	98-100
3/8-inch	90-100
No. 4	retain >10% cumulative
No. 8	32-67
No. 16	2-67
No. 200	2-10

Description	Perfomance Designed Mix
Code Reference	430.4
Aggregate Gradation	CMHB-C Course Surface Mix
Gradation	% Passing (by weight)
1"	100
3/4"	98-100
1/2"	72-85
3/8"	50-70
No. 4	30-45
No. 8	17-27
No. 16	5-27
No. 30	5-27
No. 200	5-9

Section 2b: HMA Intermediate Courses

Description	Performance Designed Mixes
Code Reference	344.2
Aggregate Gradation	SP- B Intermediate
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	98-100
3/4-inch	90-100
1/2-inch	retain >10% cumulative
No. 8	23-49
No. 16	2-49
No. 50	2-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	Dense Graded HMA
Code Reference	430.4
Aggregate Gradation	Coarse Base
Gradation	% Passing (by weight)
1.5-inch	98-100
1-inch	78-94
3/4-inch	64-85
1/2-inch	50-70
No. 4	30-50
No. 8	22-36
No. 30	8-23
No. 50	3-19
No. 200	2-7

Description	Dense Graded HMA
Code Reference	430.4
Aggregate Gradation	Fine Base
Gradation	% Passing (by weight)
1-inch	98-100
3/4-inch	84-98
3/8-inch	60-80
No. 4	40-60
No. 8	39-43
No. 30	13-28
No. 50	6-20
No. 200	2-7

Section 2d: Asphalt Surface Treatments

Description	Aggregate Requirements
Code Reference	302.2
Aggregate Gradation	Types: 1,2,3S, 4S, 4, 5S, 5

Section 3: Concrete Pavements

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 1
Gradation	% Passing (by weight)
2.5-inch	100
2-inch	80-100
1.5-inch	50-85
3/4-inch	20-40
No. 4	0-5

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 2 (467)
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	35-70
3/8-inch	10-20
No. 4	0-5

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 3
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	95-100
3/4-inch	60-90
1/2-inch	25-60
No. 4	0-5

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 4
Gradation	% Passing (by weight)
1.5-inch	100
3/4-inch	60-90
1/2-inch	25-60
3/8-inch	0-5

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 5
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	20-55
3/8-inch	0-10
No. 4	0-5

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 6
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-70
No. 4	0-15
No. 16	0-5

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 7
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	70-95
No. 4	0-25

Description	Coarse Aggregate
Code Reference	360, 421
Aggregate Gradation	Aggregate Grade 8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	95-100
No. 4	20-65
No. 8	0-10

Section 4: Incidental Construction

Description	Underdrains
Code Reference	556.2
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
No. 4	0-10
No. 8	15-35
No. 30	35-65
No. 50	75-100

Description	Underdrains
Code Reference	556.2
Aggregate Gradation	Type B
Gradation	% Passing (by weight)
3/4-inch	0-10
3/8-inch	15-35
No. 4	35-55
No. 20	35-65
No. 50	75-100

Description	Underdrains
Code Reference	556.2
Aggregate Gradation	Type C
Gradation	% Passing (by weight)
1.5-inch	0-10
3/4-inch	20-40
No. 4	40-60
No. 20	35-65
No. 50	75-100

Description	Underdrains
Code Reference	556.2
Aggregate Gradation	Type D
Gradation	% Passing (by weight)
No. 4	0-5
No. 8	0-20
No. 16	15-50
No. 30	40-75
No. 50	70-90
No. 100	90-100

Description	Backfill Gradations
Code Reference	556.2
Aggregate Gradation	Type A
Gradation	% Passing (by weight)
3-inch	0
1/2-inch	50-100
No. 4	See 423.C
No. 40	85-100

Description	Backfill Gradations
Code Reference	556.2
Aggregate Gradation	Type B
Gradation	% Passing (by weight)
3-inch	0
1/2-inch	See 423.C
No. 4	40-100
No. 40	85-100

Description	Backfill Gradations
Code Reference	556.2
Aggregate Gradation	Type C
Gradation	% Passing (by weight)
3-inch	0
1/2-inch	See 423.C
No. 4	----
No. 40	70-100

Description	Backfill Gradations
Code Reference	556.2
Aggregate Gradation	Type D
Gradation	% Passing (by weight)
3-inch	0
3/8-inch	85-100

Texas Department of Transportation, “2004 English Specifications Book,” 2004. <http://www.dot.state.tx.us/business/specifications.htm>.

Section 1: Bases and Subbases

Description	Aggregate for Subbase
Code Reference	703.11
Aggregate Gradation	Granular
Gradation	% Passing (by weight)
4-inch	100
3-inch	90-100
No. 4	30-75
No. 200	0-15

Description	Coarse Aggregate
Code Reference	703.03
Aggregate Gradation	2b
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	80-100
No. 4	10-40
No. 8	0-4

Description	Coarse Aggregate
Code Reference	703.03
Aggregate Gradation	3
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	25-60
No. 4	0-10
No. 8	0-5

Description	Coarse Aggregate
Code Reference	703.03
Aggregate Gradation	4
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
1/2-inch	35-70
No. 4	10-30
No. 8	0-5

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	02741
Aggregate Gradation	SHRP 12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-10

Section 2a: HMA Surface Courses (continued)

Description	HMA Surface Course
Code Reference	02741
Aggregate Gradation	SHRP 9.5 mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-10

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	02741
Aggregate Gradation	SHRP 19 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	02741
Aggregate Gradation	SHRP 25 mm
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-45
No. 200	1-7

Section 2d: Asphalt Surface Treatments

Description	Treatments
Code Reference	02748
Aggregate Gradation	Prime Coat
Gradation	% Passing (by weight)
No. 4	90-100
No. 10	25-80
No. 200	0-15

Description	Treatments
Code Reference	02785
Aggregate Gradation	No. 9 Chip Seal Coat
Gradation	AASHTO T 27 and T 11

Section 3: Concrete Pavements

Description	PCC Pavements
Code Reference	refer to AASHTO M 80
Aggregate Gradation	Coarse

Description	PCC Pavements
Code Reference	refer to AASHTO M 6
Aggregate Gradation	Fine
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10

Section 4: Incidental Construction

Description	Granular Backfill Borrow
Code Reference	02056
Aggregate Gradation	Classification A-1-a , AASHTO 145

Description	Common Fill
Code Reference	02056
Aggregate Gradation	Sand
Gradation	% Passing (by weight)
3/8-inch	100
No. 100	0-10

Utah Department of Transportation, “Standard Specifications for Road and Bridge Construction,” 2008.
<http://www.udot.utah.gov/main/uconowner.gf?n=535070920228586915>.

Section 1: Bases and Subbases

Description	Graded Aggregate Base
Code Reference	704.05
Aggregate Gradation	Fine
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
No. 4	30-60
No. 100	0-12
No. 200	0-6

Description	Graded Aggregate Base (Fine)
Code Reference	305.2.27
Aggregate Gradation	Passing No.26
Gradation	% Passing (by weight)
3.5-inch	100
1.5-inch	90-100
2-inch	75-100
1-inch	50-80
1/2-inch	30-60
No. 4	15-40
No. 200	0-6

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	406.03
Aggregate Gradation	12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
3/8-inch	70-90
No. 4	42-75
No. 8	28-56
No. 16	14-41
No. 30	7-31
No. 50	3-22
No. 200	2-6

Description	HMA Surface Course
Code Reference	406.03
Aggregate Gradation	Type B
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	95-100
No. 4	48-78
No. 8	28-56
No. 16	14-41
No. 30	7-31
No. 50	3-22
No. 200	2-6

Description	HMA Surface Course
Code Reference	406.03
Aggregate Gradation	4.76
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	66-88
No. 16	45-67
No. 30	27-53
No. 50	13-40
No. 100	2-7

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.2 and SC-M-425
Aggregate Gradation	Type II
Gradation	% Passing (by weight)
1"	100
3/4"	95-100
1/2"	64-88
3/8"	50-82
No. 4	32-62
No. 8	22-45
No. 16	13-35
No. 30	8-27
No. 50	3-20
No. 200	2-6

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	406.03
Aggregate Gradation	25 mm
Gradation	% Passing (by weight)
1.25-inch	100
1-inch	95-100
3/4-inch	74-86
1/2-inch	60-80
No. 4	35-60
No. 8	25-45
No. 30	10-25
No. 200	2-6

Section 2d: Asphalt Surface Treatments

Description	Bituminous Surface Treatment
Code Reference	704.11A
Aggregate Gradation	Peastone No. 7
Gradation	% Passing (by weight)
3/4-inch	100
5/8-inch	90-100
No. 4	0-5

Section 2d: Asphalt Surface Treatments (continued)

Aggregate Gradation	No. 89 Stone Grits
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 8	0-10
No. 200	0-3

Aggregate Gradation	No. 9 Sand
Gradation	% Passing (by weight)
5/8-inch	100
No. 4	90-100
No. 100	0-8

Section 3: Concrete Pavements

Description	PCC fine
Code Reference	703.03
Aggregate Gradation	Fine
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	50-80
No. 30	25-60
No. 50	10-30
No. 100	2-10

Description	PCC coarse
Code Reference	703.02
Aggregate Gradation	3/8 inch
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

Description	PCC coarse
Code Reference	703.02
Aggregate Gradation	3/4 inch
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
3/8-inch	20-55
No. 4	0-10
No. 8	0-5

Section 3: Concrete Pavements (continued)

Description	PCC coarse
Code Reference	703.02
Aggregate Gradation	1 1/2 inch
Gradation	% Passing (by weight)
1.75-inch	100
1.5-inch	90-100
1-inch	20-55
3/4 inch	0-15
3/8-inch	0-5

Section 4: Incidental Construction

Description	Backfill
Code Reference	703.03
Aggregate Gradation	Sand Burrow
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
1/2-inch	70-100
No. 4	60-100
No. 100	0-20
No. 200	0-8

Description	Backfill
Code Reference	703.04
Aggregate Gradation	Gravel
Gradation	% Passing (by weight)
No. 4	20-100
No. 200	0-12

Description	Structural Granular Backfill
Code Reference	704.08
Gradation	% Passing (by weight)
3-inch	100
No. 4	45-75
No. 100	0-12
No. 200	0-6

Vermont Department of Transportation, “2001 Standard Specifications for Construction,” 2001. <http://www.aot.state.vt.us/conadmin/2001StandardSpecs.htm>.

Section 1: Bases and Subbases

Description	Base
Code Reference	208.02
Aggregate Gradation	21A
Gradation	% Passing (by weight)
2-inch	100
1-inch	94-100
3/8-inch	63-72
No. 10	32-41
No. 40	14-24
No. 200	6-12

Description	Base
Code Reference	208.02
Aggregate Gradation	21B
Gradation	% Passing (by weight)
2-inch	100
1-inch	85-95
3/8-inch	50-69
No. 10	20-36
No. 40	9-19
No. 200	4-7

Description	Base
Code Reference	208.02
Aggregate Gradation	21C
Gradation	%Passing (by weight)
1-inch	100
3/8-inch	62-78
No. 10	39-56
No. 40	23-32
No. 200	8-12

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	802
Aggregate Gradation	1/2 inch
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-80
No. 30	0-20
No. 100	0-8
No. 200	0-5

Description	HMA Surface Course
Code Reference	802
Aggregate Gradation	3/8 inch
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	84-100
No. 30	10-40
No. 100	0-8
No. 200	0-5

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	802
Aggregate Gradation	Type 68 3/4 inch
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	84-100
3/8-inch	31-65
No. 4	0-20
No. 8	0-8
No. 16	0-5

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	802
Aggregate Gradation	BM
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-38
No. 200	1-7

Section 2d: Asphalt Surface Treatments

Description	Asphalt Penetration Surface
Code Reference	314.05
Aggregate Gradation	Light courses
Acceptable Aggregate	No. 56
Aggregate Gradation	Choke
Acceptable Aggregate	No. 68, No. 78, No. 8
Aggregate Gradation	Seal
Acceptable Aggregate	No. 78, No. 8
Aggregate Gradation	Heavy Courses
Acceptable Aggregate	No. 56
Aggregate Gradation	Choke
Acceptable Aggregate	No. 56, No. 68
Aggregate Gradation	Seal
Acceptable Aggregate	No. 78, No. 8

Section 3: Concrete Pavements

Description	Fine Aggregate
Code Reference	217.02A
Aggregate Gradation	Fine A
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	94-100
No. 8	80-100
No. 16	49-85
No. 30	25-59
No. 50	8-26
No. 100	0-10

Description	Coarse Aggregate
Code Reference	217.02D
Aggregate Gradation	#57
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	26-60
No. 4	0-7
No. 8	0-3

Section 4: Incidental Construction

Description	Backfill
Code Reference	204.02
Aggregate Gradation	No. 78
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	40-80
No. 4	0-20
No. 8	0-8
No. 16	0-5

Description	Backfill
Code Reference	204.02
Aggregate Gradation	No. 8
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	84-100
No. 4	10-40
No. 8	0-8
No. 16	0-5

Description	Backfill
Code Reference	204.02
Aggregate Gradation	General Fill
Gradation	% Passing (by weight)
3-inch	100
2-inch	95-100
No. 10	25-55
No. 40	16-30
No. 200	4-14

Virginia Department of Transportation, “2007 Road and Bridge Specifications,” 2007. Road and Bridge Specifications and Revisions, 22 Apr. 2009. <http://www.virginiadot.org/business/const/spec-default.asp>.

Section 1: Bases and Subbases

Description	Aggregate for Base
Code Reference	9-03.10
Aggregate Gradation	Gravel
Gradation	% Passing (by weight)
2-inch	75-100
No. 4	22-100
No. 200	0-10

Section 2a: HMA Surface Courses

Description	HMA Pavement Control Points
Code Reference	9-03.8(6) H
Aggregate Gradation	1/2" Mix
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-7

Description	HMA Pavement Control Points
Code Reference	9-03.8(6) H
Aggregate Gradation	3/8" Mix
Gradation	% Passing (by weight)
1/2"	100
3/8"	90-100
No. 4	90 max
No. 8	32-67
No. 200	2-7

Section 2b: HMA Intermediate Courses

Description	HMA Pavement Control Points
Code Reference	9-03.8(6) H
Aggregate Gradation	3/4" Mix
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-7

Description	HMA Pavement Control Points
Code Reference	9-03.8(6) H
Aggregate Gradation	3/4" Mix
Gradation	
1.5-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	19-45
No. 200	1-7

Section 2c: HMA Base Courses

Description	Asphalt Treated Base
Code Reference	Table 9-03.6(2)
Aggregate Gradation	Grading
Gradation	% Passing (by weight)
2-inch	100
1/2-inch	56-100
No. 4	32-72
No. 10	22-57
No. 40	8-32
No. 200	2-9

Section 2d: Asphalt Surface Treatments

Description	"Crushed Screeing"
Code Reference	9-03.8(6)
Aggregate Gradation	Crushed Screening
Gradation	% Passing (by weight)

Section 3: Concrete Pavements

Description	Aggregate for Using in PCC
Code Reference	9-03.1(4)C
Aggregate Gradation	Coarse Aggregate

Description	Fine Aggregate
Code Reference	9-03.1(2)B
Aggregate Gradation	Class 1
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 8	68-86
No. 16	47-65
No. 30	27-42
No. 50	9-20
No. 100	0-7
No. 200	0-2.5

Description	Fine Aggregate
Code Reference	9-03.1(2)B
Aggregate Gradation	Class 2
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200	0-2.5

Section 4: Incidental Construction

Description	Underdrains
Code Reference	9-03.12(4)
Aggregate Gradation	% Passing (by weight)
1-inch	100
3/4-inch	80-100
3/8-inch	0-40
No. 4	0-4
No. 200	0-2

Description	Backfill
Code Reference	9-03.12(2)
Aggregate Gradation	% Passing
2-inch	100
1-inch	75-100
1/2-inch	22-66
No. 10	0-5

Washington State Department of Transportation, “Standard Specifications 2008,” State Construction Office, 2008. <http://www.wsdot.wa.gov/biz/construction/MoreBooks.cfm>.

Section 1: Bases and Subbases

Description	Grade 1 Subbase Aggregate
Code Reference	704.6.2A
Aggregate Gradation	Class 5
Gradation	% Passing (by weight)
2-inch	100
No. 4	30-90
No. 200	0-15

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	401.4.2
Aggregate Gradation	Wearing I - 9.5 mm
Gradation	% Passing (by weight)
1/2"	100
3/8"	85-100
No. 4	80 max
No. 8	30-55
No. 200	2-9

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	401.4.2
Aggregate Gradation	Base II, Wearing IV - 19 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	20-50
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	401.4.2
Aggregate Gradation	Base I - 37.5 mm
Gradation	% Passing by weight
1.5-inch	90-100
1-inch	90 max
No. 8	15-36
No. 200	1-6

Section 2d: Asphalt Surface Treatments

Description	Surface Treatment
Code Reference	405.02
Acceptable Aggregates	#56, #6, #7, #78, #8 or #9

Section 3: Concrete Pavements

Description	PCC Pavements - Fine
Code Reference	702.1.6
Aggregate Gradation	refer to AASHTO T 27 and T 11

Description	PCC Pavements
Code Reference	702.1.6
Aggregate Gradation	Mortar Sand
Gradation	% Passing by weight
No. 4	100
No. 8	90-100
No. 100	0-30
No. 200	0-10

Section 4: Incidental Construction

Description	Crushed Stone and Gravel for Underdrains
Code Reference	212
Aggregate Gradation	AASHTO Size # 67, 7 or 78

Description	Crushed Stone Backfill
Code Reference	212.2
Aggregate Gradation	% Passing (by weight)
2"	100
No. 16	0-5

West Virginia Department of Transportation, “Standard Specifications - Roads and Bridges,” Engineering Publications and Manuals, 2000. <http://www.wvdot.com/engineering/TOC_engineering.htm>.

Section 1: Bases and Subbases

Description	Aggregate Base
Code Reference	305.2.2.1
Aggregate Gradation	Dense 1-1/4"
Gradation	% Passing (by weight)
1.5-inch	95-100
3/4-inch	70-93
3/8-inch	42-80
No. 4	25-63
No. 10	16-48
No. 30	8-28
No. 200	2-12

Description	Aggregate Base
Code Reference	305.2.2.1
Aggregate Gradation	Dense 3/4"
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	95-100
3/8-inch	50-90
No. 4	35-70
No. 10	15-55
No. 40	10-35
No. 200	5-15

Description	Aggregate Base
Code Reference	310.2
Aggregate Gradation	Open Graded
Gradation	% Passing (by weight)
1-inch	90-100
3/8-inch	45-65
No. 4	15-45
No. 40	0-10
No. 200	0-5

Section 2a: HMA Surface Courses

Description	HMA Superpave Gradations
Code Reference	Table 460-1
Aggregate Gradation	12.5mm Superpave
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	90 max
No. 8	28-58
No. 200	2-10

Aggregate Gradation	9.5mm Superpave
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	90 max
No. 8	20-65
No. 200	2-10

Wisconsin Department of Transportation, “2009 Standard Specifications,” 2009. <http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm>.

Section 2b: HMA Intermediate Courses

Description	HMA Superpave Gradations
Code Reference	Table 460-1
Aggregate Gradation	19 mm Superpave
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	90 max
No. 8	23-49
No. 200	2-8

Section 2c: HMA Base Courses

Description	HMA Superpave Gradations
Code Reference	Table 460-1
Aggregate Gradation	25 mm Superpave
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
3/4-inch	90 max
No. 8	19-45
No. 200	1-7

Section 2d: Asphalt Surface Treatments

Description	Seal Coat
Code Reference	465.2
Aggregate Gradation	close to 89
Gradation	% Passing
1/2-inch	100
No. 4	0-60
No. 16	0-5

Section 3: Concrete Pavements

Description	PCC Fine Aggregate
Code Reference	501.2.5.3.4
Aggregate Gradation	PCC Fine Aggregate
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	90-100
No. 16	45-85
No. 50	5-30
No. 100	0-10

Description	PCC Coarse Aggregate
Code Reference	501.2.5.4.4
Aggregate Gradation	No. 4, No. 67

Section 4: Incidental Construction

Description	Granular Backfill
Code Reference	209.2.2
Aggregate Gradation	% Passing (by weight)
No. 4	100
No. 10	75
No. 100	15
No. 200	8

Section 1: Bases and Subbases

Description	Subbase and Base
Code Reference	803.4.4-1
Aggregate Gradation	Grading J
Gradation	% Passing (by weight)
2-inch	100
1.5-inch	90-100
No. 4	35-75
No. 200	0-15

Aggregate Gradation	Grading L
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	60-85
No. 4	35-55
No. 8	25-50
No. 30	10-30
No. 200	3-15

Aggregate Gradation	Grading W
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	90-100
1/2-inch	60-85
No. 4	45-65
No. 8	33-53
No. 30	10-30
No. 200	3-12

Section 2a: HMA Surface Courses

Description	HMA Surface Course
Code Reference	803.5.5-1
Aggregate Gradation	Marshall and Superpave Mixes 12.5 mm
Gradation	% Passing (by weight)
3/4-inch	100
1/2-inch	90-100
3/8-inch	55-90
No. 4	35-70
No. 8	20-55
No. 30	5-35
No. 200	2-7

Aggregate Gradation	9.5 mm
Gradation	% Passing (by weight)
1/2-inch	100
3/8-inch	90-100
No. 4	45-85
No. 8	30-65
No. 30	10-40
No. 200	2-7

Section 2b: HMA Intermediate Courses

Description	HMA Intermediate Course
Code Reference	803.5.5-1
Aggregate Gradation	Marshall and Superpave Mixes 19 mm
Gradation	% Passing (by weight)
1-inch	100
3/4-inch	90-100
1/2-inch	55-90
3/8-inch	45-85
No. 4	30-65
No. 8	20-50
No. 30	5-30
No. 200	2-7

Section 2c: HMA Base Courses

Description	HMA Base Course
Code Reference	803.5.5-1
Aggregate Gradation	Marshall and Superpave Mixes 25 mm
Gradation	% Passing (by weight)
1-inch	90-100
3/4-inch	65-90
1/2-inch	50-85
3/8-inch	40-75
No. 4	30-60
No. 8	20-45
No. 30	5-25
No. 200	2-7

Section 2d: Asphalt Surface Treatments

Description	Prime Coat
Code Reference	803.9
Aggregate Gradation	No. 9 or finer
Gradation	% Passing (by weight)
3/8-inch	100
No. 40	85-100
No. 200	0-20

Section 3: Concrete Pavements

Description	PC Concrete Pavements
Code Reference	803.2
Aggregate Gradation	Fine Aggregate
Gradation	% Passing (by weight)
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200	0-4

Description	PC Concrete Pavements
Code Reference	803.2
Aggregate Gradation	Coarse Aggregate
Gradation	% Passing (by weight)
1.5-inch	100
1-inch	95-100
No. 4	0-10
No. 8	0-5
No. 200	0-2

Section 4: Incidental Construction

Description	Flowable Backfill Aggregate
Code Reference	803.16-1
Aggregate Gradation	% Passing (by weight)
3/4-inch	100
No. 200	2-10

Description	Pervious Backfill Material
Code Reference	803.14-1
Aggregate Gradation	% Passing (by weight)
2-inch	100
No. 4	0-50
No. 40	0-35
No. 100	0-10
No. 200	0-4

Wyoming Department of Transportation, “Standard Specifications for Road and Bridge Construction,” Cheyenne: Wyoming Department of Transportation Supplemental Specifications, 2003. <http://www.dot.state.wy.us/wydot/engineering_technical_programs/manuals_publications/standard_specifications/supplemental_specifications>.

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