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USACE / NAVFAC / AFCEC / NASA **UFGS-32 12 15.16 (February 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 13 17 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2019
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STONE MATRIX ASPHALT (SMA) FOR AIRFIELD PAVING

02/19

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SECTION 32 12 15.16

STONE MATRIX ASPHALT (SMA) FOR AIRFIELD PAVING

02/19

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NOTE: This guide specification covers the requirements for stone matrix asphalt (SMA) for airfield pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present. Do not edit or rewrite the unbracketed text without the express consent of the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement subject matter expert (SME), or the Naval Facilities Engineering Command (NAVFAC).

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: Modifications must be made to this guide specification during conversion to a project specification in accordance with the NOTES which are located throughout the document. These NOTES are instructions to the designer, and will not appear in the project specification.

Specifications developed for Corps of Engineers managed projects must be edited in accordance with

ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

This guide specification only pertains to the stone matrix asphalt aspects of the project and not to any surface preparation requirements dealing with aggregate base courses, milling, or tack or prime coats. Cover surface preparation requirements by either including them in this guide specification or by adding pertinent sections to the project documents.

SMA can be used as a surface course for any airfield pavement. SMA provides increased durability, resistance to rutting, resistance to reflective cracking compared to HMA. Local state highway experiences with SMA should be considered when developing the job specification.

This specification utilizes a Quality Assurance and Quality Control (QA/QC) construction management philosophy. Quality Assurance refers to the actions performed by the Government or designated representative Engineer to assure the final product meets the job requirements. Results of QA testing are the basis for pay. Quality Control refers to the actions of the Contractor to monitor the construction and production processes and to correct these processes when out of control. Results of QC testing are reported daily on the process control charts maintained by the Contractor. Quality Control is covered in paragraph CONTRACTOR QUALITY CONTROL.

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1.1 FULL PAYMENT

1.1.1 Method of Measurement

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NOTE: For unit-price Contracts, include first bracketed statements and delete the second set. For lump sum Contracts, delete the first bracketed statements and include the second set. Lump sum Contracts should not be used when the job exceeds 1000 metric tons tons.

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[The amount paid for will be the number of metric tons tons of SMA used in the accepted work. Weigh the SMA after mixing, and no adjustment will be made for weight of asphalt cement material incorporated herein.] [Measurement of the quantity of SMA, per metric ton ton placed and accepted, will be made for the purposes of assessing the pay factors stipulated below.]

1.1.2 Basis of Payment

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NOTE: For unit-price contracts, include first bracketed statements and delete the second set. For lump sum contracts, delete the first bracketed statements and include the second set. Include prescriptive unit price based on the Government/Engineer estimate for payment adjustment. Lump sum contracts should not be used when the job exceeds 1000 metric tons tons.

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[Quantities of SMA mixture, determined as specified above, will be paid for at respective contract unit prices or at reduced prices adjusted in accordance with paragraphs PERCENT PAYMENT and QUALITY ASSURANCE. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.][The measured quantity of SMA mixture will be paid for and included in the lump sum Contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph QUALITY ASSURANCE, a unit price of [_____] per ton will be used for purposes of calculating the payment reduction.]

1.2 PERCENT PAYMENT

When a lot of material fails to meet the specification requirements for 75 percent pay as outlined in the following paragraphs, remove and replace that lot. The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in place density, grade or smoothness (each discussed below). Pay factors based on different criteria (i.e., laboratory air voids and in place density) of the same lot will not be multiplied together to get a lower lot pay factor. At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by that lot's pay factor. When work on a lot is required to be terminated before all sublots are completed, the results from the completed sublots will be analyzed to determine the percent payment for the lot following the same procedures and requirements for full lots but with fewer test results.

1.2.1 Mat and Joint Densities

The average in place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. The average TMD for each lot will be determined as the average TMD of the four random samples per lot. The average in place mat density and joint density for a lot are determined and compared with Table 1 to calculate a single pay factor per lot based on in place density, as described below. First, a pay factor for both mat density and joint density are determined from Table 1. The area associated with the joint is then determined and will be considered to be 3 meters 10 feet wide times the length of completed longitudinal construction joint in the lot. This area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of SMA mixture, either an adjacent freshly paved lane or one paved at any time previously. The area associated with the joint is expressed as a percentage of the total lot area. A weighted pay factor for the joint is determined based on this percentage (see example below). The pay factor for mat density and the weighted pay factor for joint density is compared and the lowest selected. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density. Remove and replace rejected lots. Remove 100 mm 4 inches into the cold (existing) lane for rejected areas adjacent to longitudinal joints. Complete and report all density results for a lot within 24 hours after the construction of that lot.

Table 1. Pay Factor Based on In-Place Density

Average Mat Density (4 Cores)	Pay Factor, Percent	Average Joint Density (4 Cores)
94.0 or 96.0	100	above 92.5
93.9	100	92.4
93.8 or 96.1	99.9	92.3
93.7	99.8	92.2
93.6 or 96.2	99.6	92.1
93.5	99.4	92.0
93.4 or 96.3	99.1	91.9
93.3	98.7	91.8
93.2 or 96.4	98.3	91.7
93.1	97.8	91.6
93.0 or 96.5	97.3	91.5
92.9	96.3	91.4
92.8 or 96.6	94.1	91.3
92.7	92.2	91.2
92.6 or 96.7	90.3	91.1
92.5	87.9	91.0
92.4 or 96.8	85.7	90.9
92.3	83.3	90.8
92.2 or 96.9	80.6	90.7
92.1	78.0	90.6
92.0 or 97.0	75.0	90.5
below 92.0, above 101.0	0.0 reject	below 90.5

1.2.2 Pay Factor Based on In-Place Density

An example of the computation of a pay factor (in inch-pound units only) based on in place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 93.2 percent (of TMD). (2) Average joint density = 91.5 percent (of TMD). (3)

Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 1:

Mat density of 93.2 percent = 98.3 pay factor
Joint density of 91.5 percent = 97.3 pay factor

b. Step 2: Determine ratio of joint area (length of longitudinal joint x 10 ft) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 10 feet width and divide by the mat area (total paved area in the lot).

(2000 ft. x 10 ft)/30000 sq ft = 0.6667 ratio of joint area to mat area (ratio).

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

wpf = joint pay factor + (100 - joint pay factor) (1 - ratio) wpf = 97.3 + (100-97.3) (1-0.6667) = 98.2 percent

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

Pay factor for mat density: 98.3 percent. Weighted pay factor for joint density: 98.2 percent.
Select the smaller of the two values as pay factor based on density: 98.2 percent.

1.2.3 Payment Adjustment for Smoothness (Final Wearing Surface Only)

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NOTE: When Profilograph testing is not required, delete the following paragraph for pay adjustment for smoothness. Profilograph testing is required for runway pavements.
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Profilograph Testing. Record the location and data from all profilograph measurements When the Profile Index of a lot exceeds the tolerance specified in paragraph SMOOTHNESS REQUIREMENTS above by 16 mm per km 1.0 inch per mile, but less than 32 mm per km 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm per km 2.0 inches per mile, but less than 47 mm per km 3.0 inches per mile, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm per km 3.0 inches per mile, but less than 63 mm per km 4.0 inches per mile, the computed pay factor will be 75 percent. Remove and replace the lot when the Profile Index exceeds the tolerance by 63 mm per km 4.0 inches per mile or more at no additional cost to the Government. Regardless of the above, correct any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm per km 5.0 inches per mile or more, by grinding to meet the specification requirements above or remove and replace at no additional cost to the Government.

1.2.4 Laboratory Air Voids and Theoretical Maximum Density

Calculate laboratory air voids in accordance with ASTM D3203/D3203M by determining the density of each lab compacted specimen using the laboratory prepared, thoroughly dry method in ASTM D2726/D2726M and determining the theoretical maximum density (TMD) of four of the sublots using ASTM D2041/D2041M. Laboratory air void calculations for each lot use the average TMD values obtained, for the lot. The mean absolute deviation of the four laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated and a pay factor determined from Table 2. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot. The TMD is also used for computation of compaction, as required in paragraph: MAT AND JOINT DENSITIES above.

1.2.5 Mean Absolute Deviation

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each sublot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

Mean Absolute Deviation = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7-4.0|)/4

= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 2 below that the lot's pay factor based on laboratory air voids is 100 percent.

Table 2. Pay Factor Based on Laboratory Air Voids

Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	0 (reject)

1.2.6 Pay Adjustment Based on Grade

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NOTE: The grade and surface smoothness requirements specified below are for the final wearing surface only. If there is a requirement to test and control the grade and smoothness for the intermediate courses, for example, when the intermediate courses will be exposed to traffic, slight modifications to this specification will be required.

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Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. Construct a final wearing surface of pavement conforming to the elevations and cross sections shown and varying not more than 9 mm 0.03 foot for runways or 15 mm 0.05 foot for taxiways and aprons from the plan grade established and approved at site of work. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements. Deviation from the plan elevation is not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. Determine the grade of the completed pavement surface by running lines of levels at intervals of 7.6 m 25 feet, or less, longitudinally and transversely. Maintain detailed notes of the results of the testing and provide a copy to the Government Engineer immediately after each day's testing. When more than 5 percent of all measurements made within a lot are outside the 9 or 15 mm 0.03 or 0.05 foot tolerance, the pay factor based on grade for that lot will be 95 percent. In areas where the grade exceeds the tolerance by more than 50 percent, remove the surface lift full depth; then replace the lift with SMA mixture to meet specification requirements, at no additional cost to the Government Owner. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas is not permitted.

1.3 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving

Mixtures

AASHTO M 320	(2017) Standard Specification for Performance-Graded Asphalt Binder
AASHTO M 325	(2008) Standard Specification for Stone Matrix Asphalt (SMA)
AASHTO R 46	(2008; R 2017) Standard Practice for Designing Stone Matrix Asphalt (SMA)
AASHTO T 304	(2011; R 2015) Standard Method of Test for Uncompacted Void Content of Fine Aggregate
AASHTO T 329	(2015) Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C612	(2014) Mineral Fiber Block and Board Thermal Insulation
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D140/D140M	(2016) Standard Practice for Sampling

Asphalt Materials

ASTM D1461	(2017) Standard Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D2489/D2489M	(2016) Standard Test Method for Estimating Degree of Particle Coating of Asphalt Mixtures
ASTM D2726/D2726M	(2017) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3203/D3203M	(2017) Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method

ASTM D6373	(2016) Standard Specification for Performance Graded Asphalt Binder
ASTM D6390	(2011; R 2017) Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2016) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM D946/D946M	(2015) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM E1274	(2018) Standard Test Method for Measuring Pavement Roughness Using a Profilograph

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy,

Air Force, and NASA projects.

The "S" classification on an SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.
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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G[, [____]]

SD-02 Shop Drawings

Placement Plan; G[, [_____]]

SD-03 Product Data

Diamond Grinding Plan; G[, [_____]]
Mix Design; G[, [_____]]
Contractor Quality Control; G[, [_____]]

SD-04 Samples

Asphalt Cement Binder
Aggregates

SD-06 Test Reports

Aggregates
QC Monitoring

SD-07 Certificates

Asphalt Cement Binder
Fiber Stabilizer
Testing Laboratory

1.5 QUALITY ASSURANCE[AND QUALITY CONTROL]

****
NOTE: It is highly recommended to keep the Government Engineer's QA testing separate and distinct from the Contractor's QC testing for all

runway, taxiway, and apron projects. However, it is recognized that in house testing capability to provide the QA testing required by this section will not always be available; in this case, it is recommended that an independent material testing company be hired to provide the QA testing for the project. The cost of this testing to assure good long-term performance is very small relative to the overall cost of the construction, and especially compared to the cost of a pavement failure.

QA acceptance testing for projects consisting only of shoulder or overrun areas can be performed by either the Government or Contractor. Although not recommended, this guide specification may be modified to require the Contractor to hire an independent material-testing laboratory to perform the QA testing listed in this section. The results would need to be forwarded daily to the Contracting Officer as the basis for acceptance and pay.

Based on the above, delete the appropriate bracketed statement below.

The QA acceptance testing program includes material tests to determine laboratory air voids and in place density, which are needed to determine percent payment. The project engineer may choose to have additional tests conducted by the QA acceptance test agency to monitor aggregate gradation, asphalt content and volumetric properties. These tests would serve as a check to the Contractor's QC testing.

For projects with less than 2000 total metric tons tons, the entire project can be considered as a single lot. In this case, sublot sampling could occur over several days' production, which could lead to a high sublot variability.

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[The Government Engineer's quality assurance (QA) program for this project is separate and distinct from the Contractor's quality control (QC) program specified in PART 3. Testing for acceptability of work will be performed by the Government Engineer or by an independent laboratory hired by the Contracting Officer Engineer, except for smoothness and grade testing which is performed by the Contractor.][Acquire the services of an independent commercial laboratory to perform acceptance testing.] Acceptance of the plant produced mix and in place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 2000 metric tons tons. Where appropriate, adjustment in payment for individual lots of SMA mixture will be made based on in place density, laboratory air voids, grade and smoothness in accordance with the following paragraphs. Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in place (field) density, each lot will be divided into four equal sublots.

1.5.1 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Government Engineer desires, will be taken from a loaded truck delivering mixture to each sublot, or other appropriate location for each sublot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Determine laboratory air voids from three laboratory compacted specimens of each sublot sample in accordance with ASTM D3203/D3203M. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

1.5.2 Additional Sampling and Testing

The Government Engineer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government Owner. Testing in these areas will be treated as a separate lot. Payment will be made for the quantity of SMA mixture represented by these tests in accordance with the provisions of this specification.

1.5.3 In-Place Density

****

NOTE: Retain the bracketed text when editing for Government Engineer's QA acceptance testing separate and distinct from the Contractor's QA testing as described in the above Designer Note (all runway, taxiway, and apron projects). Delete the bracketed text when specification is edited for Contractor QA testing.

****

For determining in place density, one random core (100 mm or 150 mm in diameter) (4 inches or 6 inches in diameter) at locations [identified by the Government Engineer][identified by random sampling procedures] from the mat (interior of the lane and at least 300 mm 12 inches from longitudinal joint of pavement edge)of each sublot in accordance with ASTM D979/D979M. Each random core will be full thickness of the layer being placed. When the random core is less than 25 mm 1 inch thick, it will not be included in the analysis. In this case, another random core will be taken. After air-drying to meet the requirements for laboratory prepared, thoroughly dry specimens, cores obtained from the mat and from the joints will be used for in place density determination in accordance with ASTM D2726/D2726M.

1.5.4 Surface Smoothness

Use a straightedge and profilograph for measuring smoothness of runway pavements. Use a straightedge for measuring smoothness of all other pavement surfaces. Perform all testing in the presence of the Government Engineer. Maintain detailed notes of the testing results and provide a copy to the Government Engineer immediately after each day's testing. Where drawings show required deviations from a plane surface (for instance crowns, drainage inlets), finish the surface to meet the approval of the Government Engineer.

1.5.4.1 Smoothness Requirements

1.5.4.1.1 Straightedge Testing

Provide finished surfaces of the pavements with no abrupt change of 3 mm 1/8 inch or more, and all pavements within the tolerances specified in Table 3 when checked with an approved 4 m 12-foot straightedge.

Table 3. Straightedge Surface Smoothness-Pavements

Pavement Category	Direction of Testing	Tolerance, mm inch
Runways and taxiways	Longitudinal	31/8
	Transverse	61/4
Shoulders (outside edge stripe)	Longitudinal	61/4
	Transverse	61/4
Calibration hardstands and compass swinging bases	Longitudinal	31/8
	Transverse	31/8
All other airfield and helicopter paved areas	Longitudinal	61/4
	Transverse	61/4

1.5.4.1.2 Profilograph Testing

Provide finished surfaces of runway with a Profile Index not greater than 100 mm per km 7 inches per mile when tested with an approved California-type profilograph.

1.5.4.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in a manner to reveal surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. The maximum area allowed to be corrected by diamond grinding is 10 percent of the total area of the lot. Test the entire area of the pavement with a profilograph. Check a number of random locations along with any observed suspicious locations primarily at transverse and longitudinal joints with the straightedge.

1.5.4.2.1 Straightedge Testing

Hold the straightedge in contact with the pavement surface and measure the maximum distance between the straightedge and the pavement surface. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between these two high points. Use the straightedge to measure abrupt changes in surface grade.

1.5.4.2.2   Profilograph Testing

Perform profilograph testing using an approved California profilograph and procedures described in ASTM E1274. Provide equipment that utilizes electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. Use a "blanking band" that is 5 mm 0.2 inches wide and the "bump template" spanning 25 mm 1 inch with an offset of 10 mm 0.4 inch. Provide profilograph operated by an approved, factory-trained operator on the alignments specified above. Provide a copy of the reduced tapes to the GovernmentEngineer at the end of each day's testing.

1.5.4.2.3   Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding until they do not exceed 7.5 mm 0.3 inch when retested. Taper diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. [At the Contractor's option, pavement areas, including diamond ground areas, may be rechecked with the profilograph in order to record a lower Profile Index.] [Perform additional profilograph testing in all areas corrected by diamond grinding.]

1.6   ENVIRONMENTAL REQUIREMENTS

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NOTE: The temperature requirements are included to avoid problems with the Contractor achieving density because the mix cools too fast. Waivers to these requirements, for isolated incidences during production, are applicable if the density requirements are still met. SMA mixtures are typically placed to provide a compacted thickness of 2 inches.

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Do not place the SMA upon a wet surface or when the surface temperature of the underlying course is less than 7 degrees C 45 degrees F. The temperature requirements may be waived by the Contracting Officer, if requested; however, all other requirements, including compaction, must be met.

PART 2   PRODUCTS

2.1   SYSTEM EQUIPMENT

Perform the work consisting of pavement courses composed of mineral aggregate, polymer-modified asphalt binder, and a stabilizer, heated and mixed in a central mixing plant and placed on a prepared course. Provide SMA mixture designed and constructed in accordance with this specification conforming to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course. Submit proposed Placement Plan, indicating lane widths, longitudinal joints, and transverse joints for each course or lift.

2.1.1 Asphalt Mixing Plant

Provide plants used for the preparation of SMA mixture conforming to the requirements of AASHTO M 156 with the following changes:

2.1.1.1 Truck Scales

Weigh the SMA mixture on approved scales, or on certified public scales at no additional expense to the Government. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Inspection of Plant

Provide access to the Government Engineer at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance, as requested, for the Government Engineer to procure any desired samples.

2.1.1.3 Storage Silos

The SMA mixture may be stored in non-insulated storage silos for a period of time not to exceed 2 hours. The SMA mixture may be stored in insulated storage silos for a period of time not exceeding 4 hours. Ensure that draindown of the asphalt binder in the SMA mixture is not a problem when stored in the storage silo and when hauling to the job site. Provide draindown less than 0.3 percent when measured in accordance with ASTM D6390. Provide the mix drawn from silos that meet the same requirements as mix loaded directly into trucks.

2.1.2 Hauling Equipment

Provide trucks used for hauling SMA mixture that have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other approved material. Do not use petroleum based products as a release agent. Provide each truck with a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture is delivered to the site at the specified temperature, provide insulated or heated truck beds with covers (tarps) that are securely fastened.

2.1.3 Material Transfer Vehicle (MTV)

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NOTE: A Material Transfer Vehicle is required for runway, taxiway, and apron construction. The use of an MTV is optional for shoulder construction.

****

Provide Material Transfer Vehicles for placement of the SMA mixture. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that is capable of delivering material to the paver from outside the paving lane and without making contact with the paver. Provide MTV capable to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. Provide MTV with remixing and storage capability to prevent physical and thermal segregation.

2.1.4   Asphalt Pavers

Provide mechanical spreading and finishing equipment consisting of a self-powered paver, capable of spreading and finishing the SMA mixture to the specified line, grade, and cross section. Provide paver having screed capable of laying a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed. Provide paver with vibrating screed equipped with a compaction device to be used during all placement.

2.1.4.1   Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and a distribution system to place the mixture uniformly in front of the screed without segregation. Provide paver with vibrating screed that effectively produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

2.1.4.2   Automatic Grade Controls

****

NOTE: Delete information on automatic grade control if not needed. Automatic grade control is needed when the design requires elevations for the SMA pavement surface. Many maintenance and rehabilitation projects require an overlay thickness and do not specify actual grades.

****

If an automatic grade control device is used provide a paver equipped with a control system capable of automatically maintaining the specified screed elevation that is automatically actuated from either a reference line or through a system of mechanical sensors or sensor-directed mechanisms or devices which maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. Provide transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. Do not use the transverse slope controller to control grade. Provide controls capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 9.14 meters 30 feet in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

2.1.5   Rollers

Provide rollers in good condition and operated at slow speeds to avoid displacement of the SMA mixture. Provide sufficient number, type, and weight of rollers to compact the mixture to the required density while it is still in a workable condition. Do not use equipment that causes excessive crushing of the aggregate.

2.1.6 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade. Reduce high areas by diamond grinding the SMA pavement with approved equipment after the SMA pavement is at a minimum age of 14 days. Perform diamond grinding by sawing with saw blades impregnated with an industrial diamond abrasive. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the SMA mixture or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 feet wide. Diamond grinding equipment that causes raveling, fracturing or aggregate, or disturbance to the underlying material is not allowed. The maximum area corrected by diamond grinding the surface of the SMA mixture is 10 percent of the total area of any sublot. The maximum depth of diamond grinding is 12 mm 1/2 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government Owners property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified.

Prior to production diamond grinding operations, perform a test section at the approved location, consisting of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish and transition between adjacent passes. Production diamond grinding operations cannot be performed prior to approval.

2.2 AGGREGATES

Sample aggregates in the presence of a Government Owner Representative. Obtain samples in accordance with ASTM D75/D75M and be representative of the materials to be used for the project. Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, and mineral filler, as required. The portion of material retained on the 4.75 mm No. 4 sieve is coarse aggregate. The portion of material passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve is fine aggregate. The portion passing the 0.075 mm No. 200 sieve is defined as mineral filler. Submit sufficient materials to produce 90 kg 200pounds of blended mixture for mix design verification. Submit all aggregates test results and samples to the Government Engineer at least 14 days prior to start of construction. Perform job aggregate testing no earlier than 6 months before Contract award.

2.2.1 Coarse Aggregate

****

NOTE: The requirement for sulfate soundness (requirement b., below) may be deleted in climates where freeze-thaw does not occur. However, in these areas where freeze-thaw does not occur, requirement b., should remain if experience has shown that this test separates good performing aggregates from bad

performing aggregates. Retain this requirement for all Navy projects.

Percentage of Wear (ASTM C131/C131M) must generally not exceed 30. Aggregates with a higher percentage of wear may be specified, provided a satisfactory record under similar conditions of service and exposure has been demonstrated.
****

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt binder and free from organic matter and other deleterious substances. Provide coarse aggregate particles meeting the following requirements:

a. Loss no greater than 30 percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

b. Sodium sulfate soundness loss not exceeding 12 percent, or the magnesium sulfate soundness loss not exceeding 18 percent after five cycles when tested in accordance with ASTM C88.

c. At least 95 percent by weight of coarse aggregate contain at least two or more fractured faces when tested in accordance with ASTM D5821 with fractured faces produced by crushing.

d. Provide aggregate with essentially cubical particles and containing no more than 20 percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.

e. Provide aggregates with absorption not greater than 2 percent when tested in accordance with ASTM C127.

f. Provide aggregate with clay lumps and friable particles not exceeding 0.3 percent, by weight, when testing in accordance with ASTM C142/C142M.

2.2.2 Fine Aggregate

****
NOTE: Set the lower limit for uncompacted void content (requirement c., below) at 45 for fine aggregate angularity unless local experiences indicates that a lower value can be used. There are some aggregates which have a good performance record and have an uncompacted void content less than 45. In no case should the limit be set less than 43.
****

Provide fine aggregate consisting of clean, sound, tough, durable particles. Provide aggregate particles free from coatings of clay, silt, or any objectionable material, containing no clay balls and meet the following requirements:

a. Fine aggregate portion of the blended aggregate consisting of 100 percent crushed manufactured fines. No natural sand is allowed.

b. Individual fine aggregate sources with a sand equivalent value greater than 45 when tested in accordance with ASTM D2419.

c. Fine aggregate portion of the blended aggregate with an uncompacted void content greater than 45.0 percent when tested in accordance with AASHTO T 304 Method A.

d. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.3 Mineral Filler

Provide mineral filler consisting of a non-plastic material meeting the requirements of ASTM D242/D242M.

2.2.4 Aggregate Gradation

Provide a combined aggregate gradation that conforms to gradations specified in Table 4, when tested in accordance with ASTM C136/C136M and ASTM C117, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grades uniformly from coarse to fine. Individual aggregate test tolerances can be found in Table 8; however, the JMF must be in compliance with the specification range.

Table 4. Aggregate Gradations

Sieve Size, mm inches	Percent Passing by Mass
25.0 1 inch	---
19.0 3/4 inch	100
12.5 1/2 inch	90-100
9.5 3/8 inch	50-85
4.75 No. 4	20-40
2.36 No. 8	16-28
1.18 No. 16	---
0.60 No. 30	---
0.30 No. 50	---
0.15 No. 100	---
0.075 No. 200	8-11

2.2.5 Fiber Stabilizer

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NOTE: Fibers, either cellulose or mineral, must be used in the SMA mixture.

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Provide a fiber stabilizer to be used in all SMA mixtures. Provide a stabilizer consisting of cellulose or mineral fibers and in amounts sufficient to prevent draindown exceeding 0.3 percent when tested in accordance with ASTM D6390. Submit copies of certified test data. Requirements and test procedures are outlined in Tables 5 and 6.

Table 5. Cellulose Fibers Quality Requirements

Properties	Requirement
Sieve Analysis Method A - Alpine Sieve (1) Analysis	
Fiber length	6 mm 0.25 inch (max)
Passing 0.15 mm No. 100 sieve	70 percent (± 10%)
Sieve Analysis Method B - Mesh Screen (2) Analysis	
Fiber length	6 mm 0.25 inch (max)
Passing 0.850 mm No. 20 sieve	85 percent (± 10%)
Passing 0.425 mm No. 40 sieve	65 percent (± 10%)
Passing 0.106 mm No. 140 sieve	30 percent (± 10%)
Ash Content (3)	18 percent (± 5%) non-volatiles
pH (4)	7.5 (± 1.0)
Oil Absorption (5)	5.0 (± 1.0)(times fiber weight)
Moisture Content (6)	<5 percent (by weight)
(1) This test is performed using an Alpine Air Jet Sieve (Type 200 LS). A representative 5-gram sample of fiber is sieved for 14 minutes at a controlled vacuum of 75 kPa 11 psi. The portion remaining on the screen is weighed.	
(2) This test is performed using standard 850, 425, 250, 180, 150, 106 micron No. 20, 40, 60, 80, 100, 140 sieves, nylon brushes, and a shaker. A representative 10-gram sample of fiber is sieved using a shaker and two nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated. The repeatability of this method is suspect and needs to be verified.	
(3) A representative 2-3 gram sample of fiber is placed in a tared crucible and heated between 595 and 650 degrees C 1100 and 1200 degrees F for not less than 2 hours. The crucible and ash are cooled in a desiccator and reweighed.	
(4) Five grams of fiber is added to 100 mL of distilled water, stirred, and let sit for 30 minutes. The pH is determined with a probe calibrated with pH 7.0 buffer.	
(5) Five grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than 5 minutes to ensure total saturation. It is then placed in a screen mesh strainer (approximately 0.5 square millimeter hole size) and shaken on a wrist-action shaker for 10 minutes (approximately 31.75 mm 1.25 inch motion at 240 shakes/minute). The shaken mass is then transferred without touching, to a tared container and weighed. Results are reported as the amount (number of times its own weight) the fibers are able to absorb.	

Table 5. Cellulose Fibers Quality Requirements	
Properties	Requirement
(6) Ten grams of fiber is weighed and placed in a 121 degree C 250 degrees F forced-air oven for 2 hours. The sample is then reweighed immediately upon removal from the oven.	

Table 6. Mineral Fibers Quality Requirements	
Properties	Requirement
Sieve Analysis	
Fiber length(1)	6 mm 0.25 inch max mean test value
Thickness(2)	0.005 mm 0.0002 inch max mean test value
Shot content(3)	
0.250 mm No. 60 sieve	95 percent passing (min)
0.063 mm No. 230 sieve	65 percent passing (min
(1) The fiber length is determined according to the Baur McNett fractionation.	
(2) The fiber diameter is determined by measuring at least 200 fibers in a phase contrast microscope.	
(3) Shot content is a measure of non-fibrous material. The shot content is determined on vibrating sieves. Two sieves, 0.25 mm No. 60 and 0.063 mm No. 230, are typically utilized; for additional information see ASTM C612.	

2.3 ASPHALT CEMENT BINDER

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NOTE: Specify Performance Graded (PG) asphalt binders wherever available. Use a bumped grade of asphalt binder. In most areas of the US this would be a 76-22 but will vary in colder climates to match the lower PG requirements used by the local DOT.

Retain bracketed verification testing text for runway, taxiway, and apron projects.

****

[Provide asphalt binder that conforms to ASTM D6373 or AASHTO M 320, Performance Grade (PG) [_____]].[Provide asphalt binder that conforms to

ASTM D946/D946M Penetration Grade [______]]. Provide test data indicating grade certification by the supplier at the time of delivery of each load to the mix plant. Submit copies of these certifications to the Government Engineer. The supplier is defined as the last source of any modification to the binder. The Government Engineer may sample and test the binder at the mix plant at any time before or during mix production. [Obtain samples for this verification testing in accordance with ASTM D140/D140M and in the presence of the Government Engineer. Provide these samples to the Government Engineer for the verification testing, which will be performed at the Governments Engineers expense. Submit 20 L 5 gallon sample of the asphalt binder specified for mix design verification and approval not less than 14 days before start of the test section.]

2.4 MIX DESIGN

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NOTE: Use 50 blow Marshall hand-held hammer compaction or 50 gyration Superpave gyratory compaction for all SMA mixtures.

****

Develop the mix design. Perform Job Mix Formula (JMF) and aggregates testing no earlier than 6 months before Contract award. Provide SMA mixture composed of crushed aggregate, mineral filler if required, a fiber stabilizer, and asphalt binder. Provide aggregate fractions sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the Table 4. Do not produce SMA mixture for payment until a JMF has been approved. Design the SMA mixture using 50 blows with hand-held hammer procedures contained in AI MS-2 and the criteria shown in Table 7A. Design the SMA mixture using the Superpave gyratory compactor set at 50 gyrations and the criteria shown in Table 7B. Prepare samples at various asphalt contents and compacted in accordance with ASTM D6925, AASHTO M 325 and AASHTO R 46. Use laboratory compaction temperatures for Polymer Modified Asphalts as recommended by the asphalt binder manufacturer. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M, is less than 75 percent, reject the aggregates or treat the SMA mixture with an anti-stripping agent. Add a sufficient amount of anti-stripping agent to produce a TSR of not less than 75 percent. If an anti-strip agent is required, provide it at no additional cost to the Government. Provide sufficient materials to produce 90 kg 200 pounds of blended mixture to the Government Engineer for verification of mix design at least 14 days prior to construction of test section.

2.4.1 JMF Requirements

Submit the job mix formula in writing, for approval, at least 14 days prior to the start of the test section including as a minimum:

a. Percent passing each sieve size

b. Percent of asphalt binder

c. Percent of each aggregate and mineral filler to be used

d. Asphalt penetration grade or Performance Grade (PG)

e. Type and amount of stabilizer

f. Number of blows of hammer per side of molded specimen. Number of Superpave gyratory compactor gyrations

g. Lab mixing temperature

h. Lab compaction temperature

i. Temperature-viscosity relationship of the asphalt binder

j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size

k. Graphical plots and summary tabulation of air voids, voids in mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Include summary tabulation that includes individual specimen data for each specimen tested

l. Specific gravity and absorption of each aggregate

m. Percent particles with two or more fractured faces (in coarse aggregate)

n. Fine aggregate angularity

o. Percent flat or elongated particles (in coarse aggregate)

p. Tensile Strength Ratio and wet/dry specimen test results

q. Antistrip agent (if required)

r. List of all modifiers

s. Percent draindown

Table 7A. Marshall Mix Design Criteria	
Test Property	50 Blow Mix
Air voids, percent	3.5 (1)
Percent Voids in mineral aggregate (minimum)	17.0
TSR, minimum percent	75
Draindown, percent (maximum)	0.3
(1) Select the JMF asphalt content corresponding to an air void content of 3.5 percent. Verify the other properties of Table 7A meet the specification requirements at the asphalt content.	

Table 7B Superpave Gyratory Mix Design Criteria	
Test Property	50 Gyration mix
Air voids, percent (1)	3.5 (1)
Percent Voids in mineral aggregate (minimum)	17.0
TSR, minimum percent	75
Draindown, percent (maximum)	0.3
(1) Select the JMF asphalt content corresponding to an air void content of 3.5 percent. Verify the other properties of Table 7B meet the specification requirements at the asphalt content.	

2.4.2 Adjustments to JMF

The JMF for each mixture must be in effect until a new formula is approved in writing by the Government Engineer. Should a change in sources of any materials be made, submit for approval by the Government Engineer, a new mix design and a new JMF before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No.4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50sieve; and plus or minus 1 percent on the 0.15 mm No. 100 sieve. Adjustments to the JMF are limited to plus or minus 1.0 percent on the 0.075 mm No. 200sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

PART 3   EXECUTION

3.1   CONTRACTOR QUALITY CONTROL

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NOTE: The Contractor may be able to meet the specified quality control requirements with in-house capability or may have to hire a material testing firm to provide the required quality control testing.

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3.1.1   General Requirements

Submit the Quality Control Plan. Do not produce SMA mixture for payment until the quality control plan has been approved. In the quality control plan address all elements which affect the quality of the SMA mixture including, but not limited to:

a.   Mix Design and unique JMF identification code

b.   Aggregate Grading

c.   Quality of Materials

d. Stockpile Management and procedures to prevent contamination

e. Mixture proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction, including SMA-Portland Cement Concrete joints

l. Surface Smoothness

m. Truck bed release agent

3.1.2 Testing Laboratory

Provide a fully equipped asphalt laboratory, located at the plant or job site that is equipped with heating and air conditioning units to maintain a temperature of 24 plus or minus 2.3 degrees C 75 plus or minus 5 degrees F. Provide laboratory facilities that are kept clean and all equipment maintained in proper working condition. Provide the Government Engineer unrestricted access to inspect the laboratory facility, to witness quality control activities, and to perform any check testing desired. The Government Engineer will advise in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, immediately suspend the incorporation of the materials into the work. Incorporation of the materials into the work will not be permitted to resume until the deficiencies are corrected.

3.1.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. Required elements of the testing program include, but are not limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the SMA mixture, laboratory air voids, in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.1.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per lot (a lot is defined in paragraph QUALITY ASSURANCE) by one of the following methods: extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with the ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M, provided each method is calibrated for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. Use the last weight of ash value in the calculation of the asphalt content for the mixture.

3.1.3.2 Aggregate Properties

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D5444 or ASTM D6307. For batch plants, test aggregates in accordance with ASTM C136/C136M using actual batch weights to determine the combined aggregate gradation of the mixture. Determine the specific gravity of each aggregate size grouping for each 18,000 metric tons 20,000 tons in accordance with ASTM C127 or ASTM C128. Determine fractured faces for gravel sources for each 18,000 metric tons 20,000 tons in accordance with ASTM D5821. Determine the uncompacted void content of manufactured sand for each 18,000 metric tons 20,000 tons in accordance with AASHTO T 304 Method A.

3.1.3.3 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt binder in the storage tank, the SMA mixture at the plant, and the SMA mixture at the job site.

3.1.3.4 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.1.3.5 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with AASHTO T 329.

3.1.3.6 Laboratory Air Voids and VMA

Obtain mixture samples at least four times per lot and compacted into specimens, using 50 blows per side with the Marshall hand-held hammer as described in ASTM D6926 50 gyrations of the Superpave gyratory compactor as described in ASTM D6925. After compaction, determine the laboratory air voids of each specimen and VMA of each specimen as described in ASTM D6927. Provide mixture with VMA equal to or greater than 17.

3.1.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device may be used to monitor pavement density but only extracted cores are allowed for acceptance.

3.1.3.8 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph QUALITY ASSURANCE.

3.1.3.9 Additional Testing

Perform any additional testing, deemed necessary to control the process.

3.1.3.10 QC Monitoring

Submit all QC test results to the Government Engineer on a daily basis as the tests are performed. The Government Engineer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.1.4 Sampling

When directed by the Government Engineer, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected. Perform all sampling in accordance with standard procedures specified.

3.1.5 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 8, as a minimum. Provide electronic copies or post the control charts as directed by the Government Engineer and maintain current at all times. Identify the following on the control charts, the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 8 applicable to the test parameter being plotted, and the test results. Also show target values (JMF) on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average, the Government Engineer has the option to require removal and replacement of the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. In the Quality Control Plan, indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm No. 4 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	6	8	4	5
0.60 mm No. 30 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	4	6	3	4
0.075 mm No. 200 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	1.4	2.0	1.1	1.5

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts				
	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
Asphalt content, percent deviation from JMF target; plus or minus values	0.4	0.5	0.2	0.3
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment parameter			
In-place Mat Density, percent of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment parameter			
In-place Joint Density, percent of TMD	No specific action and suspension limits set since this is used to determine percent payment parameter			

3.2 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt binder material while avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. Maintain the temperature of unmodified asphalts to no more than 160 degrees C 325 degrees F when added to the aggregates. The temperature of modified asphalts is not to exceed 175 degrees C 350 degrees F.

3.3 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregates for the mixture prior to mixing. No damage to the aggregates due to the maximum temperature and rate of heating used is allowed. Do not exceed a temperature of 175 degrees C 350 degrees F for the aggregates and mineral filler when the asphalt cement is added. Maintain the temperature no lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.4 PREPARATION OF STONE MATRIX ASPHALT MIXTURE

Weigh or meter the aggregates, stabilizer, and the asphalt binder and introduce into the mixer in the amount specified by the JMF. Limit the temperature of the SMA mixture to 175 degrees C 350 degrees F when the asphalt binder is added. Mix the combined materials until the aggregate and stabilizer obtain a thorough and uniform coating of asphalt binder (testing in accordance with ASTM D2489/D2489M may be required by the Government Engineer) and is thoroughly distributed throughout the mixture. The moisture content of all SMA mixture upon discharge from the plant is not to exceed 0.5 percent by total weight of mixture as measured by ASTM D1461 or AASHTO T 329.

3.5 PREPARATION OF THE UNDERLYING SURFACE

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NOTE: A SMA is used as a wearing or surface course overlying a conventional hot-mixed asphalt (HMA). The existing HMA should be cleaned and tack-coated before placing the SMA. Tack coat materials and procedures will need to be addressed in the Contract documents. See Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

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Clean the underlying course of dust and debris immediately before placing the SMA. Apply a tack coat in accordance with the Contract specifications.

3.6 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section of250 tons and two paver passes wide, placed in two lanes, with a longitudinal cold joint. Do not place the second lane of the test section until the temperature of pavement edge is less that 80 degrees C 175 degrees F. Construct the test section of the same depth as the course which it represents. Ensure the underlying grade or pavement structure upon which the test section is to be constructed is the same or very similar to the underlying layer for the project. Use the same equipment in construction of the test section as on the remainder of the course represented by the test section. Construct the test section as part of the project pavement if approved by the Government Engineer.

3.6.1 Sampling and Testing for Test Section

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NOTE: Table 9 applies only to the test section. The limits in Tables 7A, 7B, and 8, apply to a number of tests run from a lot. This is why the limits listed in Table 9 are different from those listed in Tables 7A, 7B, and 8.

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Take one random sample at the plant, triplicate specimens compacted, and tested for density and laboratory air voids. Test a portion of the sample size for TMD, aggregate gradation and asphalt content. Test an additional portion of the sample to determine TSR. Adjust the compacted effort as required to provide TSR specimens with an air void content of 7 plus or minus 1 percent. Obtain four randomly selected cores from the finished pavement mat, and four from the longitudinal joint, and tested for density. Perform random sampling in accordance with procedures contained in ASTM D3665. Construction may continue provided the test results are within the tolerances or exceed the minimum values shown in Table 9. If all test results meet the specified requirements, the test section may remain as part of the project pavement. If test results exceed the tolerances shown, remove and replace the test section and construct another test section at no cost to the Government Owner.

Table 9. Test Section Requirements for Material and Mixture Properties	
Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm No. 4 and larger	JMF plus or minus 8.0
2.36, 1.18, 0.60, and 0.30 mm No. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6.0
0.15 and 0.075 mm No. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	17.0 minimum
Tensile Strength Ratio (TSR) (At 7 percent plus or minus 1 percent air void content	75 percent minimum
Mat Density, Percent of Maximum Theoretical Density (Average of 4 Random Cores)	92.0 - 96.0
Joint Density, Percent of TMD (Average of 4 Random Cores)	90.5 minimum

3.6.2 Additional Test Sections

If the initial test section proves to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and rolling procedures before beginning construction of a second test section. Construct and evaluate additional test sections, as required, for conformance to the specifications. Full production paving is not allowed until an acceptable section has been constructed and accepted.

3.7 TESTING LABORATORY

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NOTE: Include bracketed sentence for Corps-managed projects.
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Laboratories used to develop the JMF, perform Contractor Quality Control testing, and Government Engineer quality assurance and acceptance testing are required to meet the requirements of ASTM D3666. Perform all required test methods by an accredited laboratory. [The Government will inspect the laboratory equipment and test procedures prior to the start of SMA mixture operations for conformance with ASTM D3666. Maintain the validation for the duration of the project.] Submit a certification of compliance signed by the manager of the laboratory stating that it meets these requirements to the Government Engineer prior to the start of construction. At a minimum, include the following certifications:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.8 TRANSPORTING AND PLACING

3.8.1 Transporting

Transport SMA mixture from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Do not haul over freshly placed material until the material has been compacted as specified, and allowed to cool to 60 degrees C 140 degrees F.

3.8.2 Placing

Place the SMA mixture in lifts of adequate thickness and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; strike off to provide a uniform layer of such depth that, when the work is completed, the required thickness is obtained and the surface conforms to the grade and contour indicated. Do not broadcast waste mixture onto the mat or recycle into the paver hopper. Collect waste mixture and dispose of off site. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 3 m 10 feet. Offset the longitudinal joint of one course from the longitudinal joint in the course immediately below by at least 300 mm 1 foot; however, locate the joint in the surface course at the centerline of the pavement. Offset transverse joints in one course by at least 3 m 10 feet from transverse joints in the previous course. Offset transverse joints in adjacent lanes a minimum of 3 m 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, spreading and luting with hand tools is permitted.

3.9 COMPACTION OF MIXTURE

3.9.1 General

a. After placing, thoroughly and uniformly compact the SMA mixture by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. Determine the sequence of rolling operations and the type of rollers used, except as specified in paragraph SMA-PORTLAND CEMENT CONCRETE JOINTS and with the exception that application of more than three passes with a vibratory roller in the vibrating mode is prohibited. Maintain the speed of the roller, at all times, sufficiently slow to avoid displacement of the SMA mixture and be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

b. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but excessive water is not permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective. Replace with fresh SMA mixture and immediately compact to conform to the surrounding area. Perform this work at no expense to the Government. Skin patching is not allowed.

3.9.2 Segregation

The Government Engineer can sample and test any material that looks deficient. When the in-place material appears to be segregated, the Government Engineer has the option to sample the material and have it tested and compared to the aggregate gradation, asphalt content, and in-place density requirements in Table 9. If the material fails to meet these specification requirements, remove and replace the extent of the segregated material the full depth of the layer of asphalt mixture at no additional cost to the Government Engineer. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

3.10 JOINTS

Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.10.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, place a bulkhead or taper the course. Utilize a cutting wheel on the transverse joint full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. Cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. In both methods, provide a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.10.2 Longitudinal Joints

Cut back longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C 175 degrees F at the time of placing the adjacent lane), or otherwise defective, a maximum of 75 mm 3 inches from the edge with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. Remove cutback material from the project. Cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. Provide a light tack coat of asphalt material to all contact surfaces prior to placing any fresh mixture against the joint.

3.10.2.1 SMA-Portland Cement Concrete Joints

Joints between SMA and Portland Cement Concrete (PCC) require specific construction procedures for the SMA mixture. The following criteria are applicable to the first 3 m 10 feet or paver width of SMA mixture adjacent to the PCC.

a. Place the SMA mixture side of the joint in a direction parallel to the joint.

b. Place the SMA mixture side sufficiently high so that when fully compacted the SMA mixture is greater than 3 mm 1/8 inch but less than 6 mm 1/4 inch higher than the PCC side of the joint.

c. Compact with steel wheel rollers and at least one rubber tire roller. Compact with a rubber tire roller that weights at least 18 metric tons 20 tons with tires inflated to at least 620 kPa 90 psi. Avoid spalling the PCC during placement and compaction of the SMA mixture. Operate steel wheel rollers in a way that prevents spalling the PCC. Repair any damage to PCC edges or joints as directed by the Government Engineer. If damage to the PCC joint or panel edge exceeds a total of 1 m 3 feet, remove and replace the PCC panel at no additional expense to the Government.

d. After compaction is finished, diamond grind a minimum width of 1 m 3 feet of the SMA mixture so that the SMA mixture side is less than 3 mm 1/8 inch higher than the PCC side. Perform diamond grinding in accordance with subparagraph DIAMOND GRINDING above. The SMA mixture immediately adjacent to the joint is not allowed to be lower than the PCC after the grinding operation. Transition the grinding into the SMA mixture in a way that ensures good smoothness and provides drainage of water. The joint and adjacent materials when completed is required to meet all of the requirements for grade and smoothness. Measure smoothness across the SMA-PCC joint using a 4 m 12 feet straightedge. The acceptable tolerance is 3 mm 1/8 inch.

e. Consider the SMA mixture next to the PCC as a separate lot for evaluation. Lots are based on individual lifts. Do not comingle cores from different lifts for density evaluation purposes. Take four cores for each lot of material placed adjacent to the joint. The size of lot is 3 m 10 feet wide by the length of the joint being paved. Locate the center of each of the four cores 150 mm 6 inches from the edge of the concrete. Take each core at a random location along the length of the joint. The requirements for joint density for this lot, adjacent to the PCC joint, are the same as that for the mat density specified in Table 1. For SMA-PCC joints at taxiways abutting runways, aprons, or other taxiways, take two additional randomly located cores along each taxiway intersection.

f. All procedures, including repair of damaged PCC, are required to be in accordance with the approved Quality Control Plan.

-- End of Section --