UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2009
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2009

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SECTION 32 12 18

RESIN MODIFIED PAVEMENT SURFACING MATERIAL
08/08

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NOTE: This guide specification covers the requirements for resin modified pavement surfacing material.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: A representative of the Airfield and Pavements Branch, Geotechnical and Structures Laboratory, U.S. Army Engineer Research and Development Center (CERDC) should be consulted in the planning and designing of an RMP.

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1.1 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 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 320	(2009) Performance-Graded Asphalt Binder

ASTM INTERNATIONAL (ASTM)

ASTM C 127	(2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2007a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 131	(2006)Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150/C 150M	(2009) Standard Specification for Portland Cement
ASTM C 566	(1997; R 2004) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 618	(2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 140/D 140M	(2009) Sampling Bituminous Materials

ASTM D 1461	(1985; R 2006) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 2041	(2003a) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(2005) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 3381	(2009) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 4125	(2005) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D 4791	(2005e1) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 5444	(2008) Mechanical Size Analysis of Extracted Aggregate
ASTM D 6307	(2005) Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D 70	(2009e1) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D 75/D 75M	(2009) Standard Practice for Sampling Aggregates
ASTM D 995	(1995b; R 2002) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete

1.2 SYSTEM DESCRIPTION

1.2.1 Asphalt Mixing Plant

Provide a bituminous asphalt plant with enough capacity to produce the quantities of bituminous mixtures required for the project and conforming to the requirements of ASTM D 995, with the following changes:

a. Testing Facilities. Provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's quality control testing.

b. Storage Bins. Use of storage bins for temporary storage of hot-mix

asphalt will be permitted as follows:

(1) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 1 hour.

(2) Provide hauling equipment, paving machines, rollers, miscellaneous equipment, and tools in sufficient numbers, capacity and in proper working condition to place the asphalt paving mixtures at a rate equal to the plant output.

1.2.2 Asphalt Paver

Provide asphalt pavers which are self-propelled, with a vibrating screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt meeting the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

1.2.3 Receiving hopper

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

1.2.4 Automatic Grade Control

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

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

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

1.2.5 Slurry Grout

The additional requirements for production of slurry grout for the Resin Modified Pavement (RMP) are a concrete batch plant, a ready mix truck, or portable mixer for grout mixing, and small 1.8 metric ton 2 ton (maximum) tandem steel wheeled vibratory roller for compaction of RMP.

1.3 SUBMITTALS

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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. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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.

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.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Open Graded Asphalt Job Mix Formula
Job Mix Formula for Slurry Grout

Materials required to produce the open graded asphalt mixture and slurry grout job-mix-formulas in the quantities indicated below.

Aggregates representing each stockpile to be used in the production of the open-graded asphalt mixture: 45 kg 100 pounds each

Bituminous Material	19 liters 5 gallons
Slurry Grout Sand	23 kg 50 pounds
Fly Ash	23 kg 50 pounds
Cement	23 kg 50 pounds
Cross Polymer Resin	4 liters l gallon

Along with the Contractor's preliminary job mix formulas,

deliver samples, 30 days before starting production, to U.S. Army Engineer Waterways Experiment Station Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi, 39180-6199, ATTN: CEWESERD-GP-Q.

SD-06 Test Reports

Coarse Aggregate[; G][; G, [_____]]
Coarse and Fine Aggregates[; G][; G, [_____]]
Open-Graded Mix Aggregate[; G][; G, [_____]]
Bituminous Material[; G][; G, [_____]], [_____]
Slurry Grout Sand[; G][; G, [_____]]
Filler (Fly Ash)[; G][; G, [_____]]
Job Mix Formula for Slurry Grout[; G][; G, [_____]]
Contractor Quality Control[; G][; G, [_____]]

Aggregate and QC test results. Conduct slurry grout viscosity tests immediately prior to application on the pavement surface and 30 minutes thereafter.

SD-07 Certificates

Cement[; G][; G, [_____]]
Cross Polymer Resin[; G][; G, [_____]]
Curing Compound[; G][; G, [_____]]

Copies of certificates.

1.4 QUALITY ASSURANCE

Provide the Contracting Officer access at all times, to all parts of the bituminous plant, for checking adequacy of any equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

1.4.1 Aggregates

1.4.1.1 Sampling and Testing

Use ASTM D 75/D 75M in sampling coarse and fine aggregates. Points of sampling will be designated by the Contracting Officer. Make all tests necessary to determine compliance with the specified requirements, using a Corps of Engineers certified Commercial Laboratory.

1.4.1.2 Sources

Select sources of aggregates well in advance of the time when the materials are required in the work. Submit samples 30 days before starting production. If a sample of material fails to meet the specified requirements, replace the material represented by the sample, and the cost of testing the replaced sample shall be at the Contractor's expense. Approval of the source of the aggregate does not relieve the Contractor of the responsibility to deliver aggregates that meet the specified requirements.

1.4.2 Bituminous Materials

Obtain samples of bituminous materials in accordance with ASTM D 140/D 140M.

Sselect sources well in advance of the time materials will be required for the work. In addition to the initial qualification, samples shall be obtained and tested before and during construction when shipments of bituminous materials are received, or when necessary to assure that some condition of handling or storage has not been detrimental to the bituminous material.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Mineral Aggregates

Deliver mineral aggregates to the site of the bituminous mixing plant and stockpile them in such a manner as to preclude segregation or contamination with objectionable material.

1.5.2 Bituminous Materials

Maintain bituminous materials below a temperature of 150 degrees C 300 degrees F during storage without heating by the application of a direct flame to the walls of storage tanks or transfer lines. Thoroughly clean storage tanks, transfer lines and weigh buckets before a different type or grade of bitumen is introduced into the system.

1.5.3 Slurry Grout Sand

Store slurry grout sand at the grout production site to prevent contamination with foreign materials and saturation with rain water. Determine moisture content of this sand just prior to grout production so that corrections to the job mix formula water content can be made to compensate for any moisture in the sand.

1.5.4 Cementitious Materials

The temperature of the cementitious materials, as delivered for storage at the site, shall not exceed 65 degrees C 150 degrees F.

1.5.5 Open Graded Bituminous Mixture

Do not store the open graded bituminous mixture for longer than one hour prior to hauling to the job site.

1.6 ENVIRONMENTAL REQUIREMENTS

The bituminous mixture shall not be placed upon a wet surface, in rain, or when the surface temperature of the underlying course is less than l0 degrees C 50 degrees F. Once the bituminous mixture has been placed, and if rain is imminent, place protective materials consisting of rolled polyethylene sheeting at least 0.l mm 4 mils thick, of sufficient length and width to cover the mixture. If the open graded bituminous mixture becomes saturated, allow the pavement voids to thoroughly dry out prior to applying the slurry grout.

PART 2 PRODUCTS

2.1 AGGREGATE

Provide aggregate consisting of crushed stone, or crushed gravel without sand or other inert finely divided mineral aggregate. The portion of materials retained on the 4.75 mm No. 4 sieve shall be known as coarse

aggregate, the portion passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve as fine aggregate. Conduct sieve analysis of coarse and fine aggregates in accordance with ASTM C 136.

2.1.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating with the bituminous material. The percentage of wear shall not be greater than 40 percent when tested in accordance with ASTM C 131. The magnesium sulfate soundness loss shall not exceed 18 percent, after five cycles, when tested in accordance with ASTM C 88. Provide aggregate containing at least 75 percent by weight of crushed pieces having two or more fractured faces. The area of each fractured face shall be equal to at least 75 percent of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. Obtain fractured faces by artificial crushing.

2.1.2 Crushed Aggregates

Particle shape of crushed aggregates shall be essentially cubical. Quantity of flat (width to thickness ratio greater than 3) and elongated particles (width to length ratio greater than 3) in any sieve size shall not exceed 8 percent by weight, when determined in accordance with ASTM D 4791.

2.1.3 Open-Graded Mix Aggregate

The gradations in Table I represent the limits which shall determine the suitability of open-graded mix aggregate for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table I and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

TABLE I

OPEN-GRADED MIX AGGREGATE

Sieve Size	Percent by Weight Passing
19 mm	100
12.5 mm	54-76
9.5 mm	38-60
4.75 mm	10-20
2.36 mm	8-16
0.60 mm	4-10
0.075 mm	1-3

TABLE I

OPEN GRADED MIX AGGREGATE

Sieve Size	Percent by Weight Passing
3/4 in.	100

TABLE I

OPEN GRADED MIX AGGREGATE

Sieve Size	Percent by Weight Passing
1/2 in.	54-76
3/8 in.	38-60
No. 4	10-20
No. 8	8-16
No. 30	4-10
No. 200	1-3

Table I is based on aggregates of uniform specific gravity; the percent passing various sieves may be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentages passing various sieves may be directed by the Contracting Officer when aggregates vary more than 0.2 in specific gravity.

2.1.4 Slurry Grout Sand

Provide slurry grout sand consisting of clean, sound, durable, particles of processed silica sand that meet the requirements for wear and soundness specified for coarse aggregate. The sand shall contain no clay, silt, or other objectionable matter. The gradations in Table II represent the limits which will determine the suitability of silica sand for use from the sources of supply.

TABLE II

FINE SAND FOR SLURRY GROUT

Sieve Size	Percent by Weight Passing
1.18 mm	100
0.600 mm	95-100
0.075 mm	0-2

TABLE II

FINE SAND FOR SLURRY GROUT

Sieve Size	Percent by Weight Passing
No. 16	100
No. 30	95-100
No. 200	0-2

The sand gradations shown are based on sand of uniform specific gravity, and the percentages passing the various sieves will be subject to appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

2.1.5 Filler (Fly Ash)

Provide fly ash having at least 95 percent by weight of material passing the

0.075 mm No. 200 sieve and conforming to ASTM C 618 Class F requirements.

2.2 BITUMINOUS MATERIAL

Provide bituminous material conforming to the requirements of [ASTM D 3381 with a viscosity grade [AC-10] [AC-20] [AC-30] [AR-4000] [AR-8000] and an original penetration of 40 to 100.][AASHTO M 320 Performance Grade (PG) [_____]].

2.3 CEMENT

The cement used in the slurry grout shall be portland cement conforming to ASTM C 150/C 150M, Type [I] [II] [III] [V].

2.4 CROSS POLYMER RESIN

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NOTE: The cross polymer resin to be used in the slurry grout, Prosalvia-7, is a proprietary product which has been waived for use throughout the Corps of Engineers and is available from the Alyan Corporation, P.O. Box 788, Vienna, VA 22183, (703) 573-8134.

A complete description of the Marsh flow cone and the grout viscosity test method is found in ETL 1110-1-177 "Use of Resin Modified Pavement (RMP)".

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Utilize a cross polymer resin of styrene and butadiene, Prosalvia L7, as a plasticizing and strength producing agent. After mixing the resin into the slurry grout, the mixture shall have a viscosity which would allow it to flow from a Marsh Cone in accordance with Table III. A Marsh cone has dimensions of 155 mm 6-1/8 inches base inside diameter, tapering 315 mm 12-3/8 inches to a tip inside diameter of 10 mm 3/8 inches. The 10 mm 3/8 inch diameter neck shall have a length of 60 mm 2-3/8 inches.

TABLE III

SLURRY GROUT VISCOSITY

Time Elapsed After Addition of PL7	Marsh Flow Cone Viscosity
0 to 30 minutes	8 to 10 seconds
After 30 minutes	9 to 11 seconds

2.5 CURING COMPOUND

Membrane-forming curing compound shall be white pigmented compounds conforming to COE CRD-C 300.

2.6 JOB MIX FORMULA FOR OPEN-GRADED ASPHALT AND SLURRY GROUT

****

NOTE: It is recommended that the job mix formula for the open graded bituminous mixture and the mixture proportions for the slurry grout be approved

by the appropriate ERDC representative. On a case by case basis, this approval may result from a simple review of the Contractor's mix design test reports, or it may require verification of the mix design by repeating some or all of the required mix design tests. This recommendation is to ensure that proper laboratory procedures are used to determine mix designs for this new paving process.

A complete description of the proper methods used to produce job mix formulas for the open graded bituminous mixture and slurry grout is found in ETL 1110-1-177 "Use of Resin Modified Pavement (RMP)."

****

2.6.1 Open Graded Asphalt Job Mix Formula

Furnish the Job Mix Formula (JMF) for the open graded bituminous mixture for approval by the Government. No payment will be made for mixtures produced prior to the approval of the JMF by the Contracting Officer.

2.6.1.1 Initial Laboratory Procedure

a. Sample aggregates according to ASTM D 75/D 75M and asphalt cement according to ASTM D 140/D 140M. An open-graded asphalt concrete mix design requires a minimum of 45 kg 100lbs of each aggregate stockpile and 15 L 4 gal of asphalt cement.

b. Oven dry aggregate stockpile samples and conduct a sieve analysis (ASTM C 136) on each sample. Determine the combination of aggregate stockpiles that results in a gradation closest to the center of the limiting gradation band. This stockpile combination will become the blending formula for the open-graded asphalt concrete.

c. Measure apparent specific gravity of aggregates (ASTM C 127 and ASTM C 128) from each stockpile used in the final gradation. Calculate apparent specific gravity of combined aggregates using the blending formula percentages. Measure specific gravity of asphalt cement (ASTM D 70).

d. Estimate the optimum asphalt content using the following equation:

$$\text{Optimum asphalt content} = 8.61(0.21G + 5.4S + 7.2s + 135f)^{0.2} \div SG$$

where

SG = apparent specific gravity of the combined aggregates
G = percentage of material retained on the 4.75 mm No. 4 sieve
S = percentage of material passing the 4.75 mm No. 4 and retained on the 0.6 mm No. 30 sieve
s = percentage of material passing the 0.6 mm No. 30.sieve and retained on the 0.075 mm N0. 200 sieve
f = percentage of material passing 0.075 mm No. 200 sieve

e. Round the calculated optimum asphalt content value to the nearest tenth of a percent. Use this asphalt content value along with two asphalt contents above this amount and two asphalt contents below this amount in the production of mix design samples. Use 0.5 percent above and below the optimum and 1.0 percent above and below the optimum as

the four additional asphalt contents. Calculate maximum theoretical specific gravities for each of these five asphalt cement contents using ASTM D 2041.

2.6.1.2 Specimen Production

Using the five mix design asphalt contents, produce three 100 mm 4 inch diameter Marshall specimens at each asphalt content. Use approximately 800 grams 1.8 lbs of combined aggregates following the previously determined aggregate blending formula for each specimen. Just before mixing, the temperature of the aggregates should be 145 ± 5°C 290 ± 9°F and the asphalt cement should be 135 ± 5°C 275 ± 9°F. With normal mixing procedures, the temperature of the asphalt mixture during compaction is 120 ± 5°C 250 ± 9°F. Compact the open-graded asphalt concrete specimens with 25 blows from a 4.5 kg 10 lbs Marshall hand hammer on one side of each specimen. Allow the specimens to air cool for a minimum of 4 hours before carefully removing from molds.

2.6.1.3 Measuring voids total mix (VTM)

a. Measure the VTM of each open-graded specimen using the following formula:

VTM = (1 - WTAIR /Volume * 1/SGT) * 100 VTM = [1 - WTAIR /Volume * 1/(SGT * 62.4lbs/CF)] * 100

where

WTAIR = dry weight of specimen in grams lbs
Volume =0.785$(D)^2(H)$
D = diameter in cm feet
H = height in cm feet
SGT = maximum theoretical specific gravity

b. Calculate the average VTM for each of the five asphalt cement contents. Select the optimum asphalt content as that which resulted in a VTM value closest to 30.0 percent. If no VTM averages are in the 30.0 percent range, then make adjustments to the aggregate gradation to achieve the proper void content. Optimum asphalt contents resulting in average VTM values in the 25 to 35 percent range are acceptable, but due to normal production and construction variations, the JMF shall be based on a mix design that provides a 28 to 32 percent VTM value is required. Typical optimum asphalt contents are between 3.5 and 4.5 percent.

2.6.1.4 Job-Mix Formula Submittal

a. The open-graded asphalt concrete job-mix formula will consist of the following information:

(1) Percentage of each aggregate stockpile.
(2) Percentage passing each sieve size for the blended aggregate.
(3) Percentage of bitumen.
(4) Temperature of discharged asphalt mixture.
(5) Voids total mix percentage.

b. The target temperature of the asphalt mixture when it is discharged from the mixing plant should be 125 ± 5°C 257 ± 9°F. Adjust the temperature depending on the ambient temperatures and the haul distance

from the asphalt plant to the job site to meet the lay-down temperature.

2.6.2 Job Mix Formula for Slurry Grout

Furnish the Job-Mix Formula (JMF) for the slurry grout for approval by the Government. Develop the slurry grout job mix formula using the proportions given in Table V.

TABLE V

RESIN MODIFIED CEMENT SLURRY GROUT MIXTURE PROPORTIONS

Material	Percent by Weight
Silica Sand	16-20
Fly Ash	16-20
Water	22-26
Portland Cement	34-40
Cross Polymer Resin	2.5-3.5

Approximately 12 to 15 kg 22 to 28 pounds of mixed slurry grout will fill in one square meter yard (25 mm l inch thickness) of open graded bituminous mixture with 25 to 35 percent voids total mix.

2.6.2.1 Initial Laboratory Procedure

a. Minimum sample size is 23 kg 51 lbs for cement, sand, and fly ash; and is 4 L 1 gal for resin additive.

b. Using the grout material proportions specified in Table V, develop a matrix of initial job-mix formulas for laboratory viscosity testing. The goal of the grout mix design is to produce a material formulation, which results in a field Marsh Flow Cone viscosity of 8.0 to 10.0 seconds. The initial formulations shall ensure that a grout formulation can be produced with a Marsh viscosity no greater than the 10.0 seconds maximum. This is accomplished by testing grout formulations with relatively high w/c ratios and the maximum allowable amount of resin additive.

c. The grout's w/c ratio shall be between 0.65 to 0.75, unless approved by the Contracting Officer. Higher w/c ratios are sometimes necessary to produce grout with Marsh Flow viscosity less than the 10.0-second maximum value. Therefore, the focus of the initial grout viscosity tests is to determine the minimum W/C ratio that will produce a grout viscosity less than or equal to 10.0 seconds. The resin additive serves as a plasticizer which reduces grout viscosity while reducing the amount of water required.

d. The standard laboratory grout batch size should be in the 4 to 5 kg 9 to 11 lbs range. Calculate the material batch weights based on the desired proportions. Multiple grout viscosity tests are facilitated by first blending the dry ingredients (cement, sand, fly ash) for each test sample and then adding the appropriate amount of water and resin additive during the mixing process. These dry ingredient batches should be kept in air-tight containers to prevent loss of material or contamination before mixing. Replicate two samples per blend for grout viscosity testing.

2.6.2.2 Mixing

a. The equipment needed to effectively mix the resin grout includes a laboratory mixer equipped with a wire whip mixing attachment and approximately 10 L 2.5 gal capacity mixing bowl, a calibrated set of weight scales, and various small containers to weigh and transfer mix water and resin additive.

b. Place dry ingredients into mixing bowl and adjust the bowl height so that the wire whip is just off of or touching the bottom and the sides of the bowl. Begin mixing the dry ingredients at a slow speed and immediately add the appropriate amount of water. Once all of the water is added, speed up the mixer to a point where the grout is being thrown onto the sides of the mixing bowl. Mix the grout at this high speed for 5 minutes, then add the appropriate amount of resin additive. Mix the grout again at a high mixing speed for an additional 3 minutes before testing for Marsh Flow viscosity.

2.6.2.3 Viscosity Testing

a. The equipment needed to measure grout viscosity includes a Marsh Flow Cone, a 1,000 mL 0.25 gal glass or clear plastic graduated cylinder beaker, a 1,500 mL 0.38 gal (approximately) empty beaker or bucket, and a stopwatch.

b. Immediately after mixing the grout, transfer the grout from the mixing bowl to the empty beaker or bucket. Take note of any lumps of material or excess sand in the bottom of the mixing bowl. Excess lumps indicate inadequate mixing and render the grout useless for viscosity testing. Immediately fill the Marsh Flow Cone with about 1,100 mL 0.28 gal of grout. A consistent head of grout in the flow cone is achieved for all viscosity tests by marking an 1,100 mL 0.28 gal fill line inside the flow cone. The flow cone outlet is plugged by simply placing one's finger over the outlet opening. Immediately after the flow cone is filled to the 1,100 mL 0.28 gal fill line, position the cone over the 1,000 mL 0.25 gal graduated beaker. Release the grout opening and start the stopwatch timer simultaneously. Measure the time of flow for 1 L 0.25 gal of grout from the flow cone to the nearest tenth of a second.

c. Record each test sample's viscosity, averaging the two replicates for each blend. Adjust the grout mix proportions as needed with the following considerations:

(1) Any grout viscosity between 8.0 and 10.0 seconds is acceptable. It should be noted; however, that when field construction temperatures are expected to be comparatively high (greater than 32°C 90°F) and/or the open-graded asphalt concrete voids are expected to be considerably low (less than 30 percent), then lower viscosity grouts will help to ensure easy grout application and full grout penetration. In most cases, these variables are unknown; therefore, it is prudent to select the grout formulation which has the lowest viscosity.

(2) Select a grout job-mix formula with water and resin additive contents below the maximum allowable limits to allow the Contracting Officer Representative to approve small additions of these ingredients in the field if necessary to meet viscosity requirements.

(3) Low w/c ratios shall be selected, within the viscosity criteria, to produce grout with higher strengths; reduce the chances for drying shrinkage cracking; and produce grout which is more consistent and better able to keep the sand in suspension during mixing and placement.

(4) When the sand is noted to settle out of solution during or immediately after mixing, the JMF shall be adjusted by reducing the amount of sand and increasing the amount of fly ash (both within the specified tolerances).

(5) If the viscosity requirements cannot be met, change the source of materials. Typical problems to investigate include the following: grout sand which is too coarse, portland cement which is highly reactive during the early stages of the hydration process, fly ash with excess cementitious nature.

2.6.2.4 Job-Mix Formula Submittal

The grout job-mix formula will consist of the following information:

(1) Percentage (by weight) of each mixture ingredient rounded to the nearest tenth of a percent.

(2) Type and source of portland cement.

(3) Source of fly ash, silica sand, and resin additive.

(4) Marsh Flow Cone viscosity of job-mix-formula grout.

PART 3 EXECUTION

3.1 PREPARATION OF OPEN GRADED MIXTURES

Regulate rates of feed of aggregates so that moisture content and temperature of aggregates will be within tolerances specified. Convey aggregates and bitumen into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 135 degrees C 275 degrees F. Temperature of aggregate in the mixer shall not exceed 150 degrees C 300 degrees F when bitumen is added. Reject overheated and carbonized mixtures or mixtures that foam.

3.2 WATER CONTENT OF AGGREGATES

Reduce the water content of mixture to less than 0.75 percent by drying operations. Determine water content in accordance with ASTM D 2216; weight of sample shall be at least 500 grams. Report the water content as a percentage of the total mixture.

3.3 TRANSPORTATION OF MIXTURE

Accomplish transportation from the mixing plant to the job site by trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of mixture to truck bodies. Diesel fuel shall not be used as a releasing agent. Drain excessive release agent prior to loading. Cover each load with canvas or other approved material of ample

size to protect mixture from the weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or have become wet will be rejected. Hauling over freshly placed material will not be permitted.

3.4 TEST SECTION

Prior to full production, and in the presence of the Contracting Officer, prepare and place a quantity of open graded bituminous mixture and slurry grout according to the JMF. The test section shall be a minimum of 30 meters 100 feet long and 6 meters 20 feet wide placed in one section and of the same depth specified for the construction of the course which it represents. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. The test section shall meet the requirements specified in paragraph ACCEPTABILITY OF WORK. If the test section should fail to meet these requirements, make the necessary adjustments to the mix design, plant operation, and/or construction procedures. Construct additional test sections, as required, and evaluate them for conformance to the specifications at the Contractor's expense. A representative for the resin manufacturer shall be on site during the test section construction and during the initial placement.

3.5 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of open graded bituminous mixture, clean the underlying course of all foreign or objectionable matter with power brooms and hand brooms.

3.6 TACK COATING

Immediately before placing open-graded asphalt mix, spray contact surfaces of previously constructed pavement with a coat of bituminous material as specified in Section 32 12 10 BITUMINOUS TACK AND PRIME COATS.

3.7 PLACING OPEN GRADED BITUMINOUS MIXTURE

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NOTE: The amount of rolling required to achieve the required voids total mix criteria is usually 1 to 3 passes of the 1.8 metric ton (2-ton) tandem steel wheel roller in the static mode. The appropriate temperature of the freshly placed bituminous mixture required to prevent undue shoving and cutting from the roller is usually in the 50 to 70 degrees C (120 to 160 degrees F) range. The actual number of required passes and temperature range for rolling should be determined during construction and subsequent evaluation of the test section.

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Place the mix at a temperature of not less than 80 degrees C 175 degrees F. Upon arrival, spread the mixture to the full width (minimum 3 meters 10 feet) by a bituminous paver. Strike off the mix in a uniform layer to a depth that, when the work is completed, will produce the required thickness indicated. Regulate the speed of the paver to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, begin placement of the mixture along the center line of a crowned pavement or along the highest side of a sloped cross-section. Place the mixture in consecutive adjacent strips. On areas where irregularities or unavoidable obstacles

make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools. The longitudinal joint in the RMP shall be offset from the longitudinal joint in the underlying asphalt pavement by at least 300 mm 1 foot.

3.7.1 Rollers

Use small (1.8 metric ton 2-ton maximum) tandem steel wheel vibratory rollers to smooth over the surface of freshly placed open graded bituminous mixture. Turn off the vibratory unit during smoothing of the bituminous mixture. Keep rollers in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to roll the mixture to the voids total mix requirement of 25 to 35 percent while it is still in a workable condition. The use of equipment which causes excessive crushing of the aggregate will not be permitted.

3.7.2 Smoothing of Open Graded Bituminous Mixture

The open graded bituminous mixture shall be smoothed with one to three passes of the prescribed roller without vibration. The temperature of the freshly placed open graded bituminous mixture shall be low enough to prevent excessive shoving or cutting of the mat under the roller.

3.7.3 Protection of Ungrouted Pavement

Protect the ungrouted pavement and its appurtenances from traffic and against contamination from mud, dirt, wind blown debris, waterborne material, or any other contamination which could enter the void spaces of the open graded bituminous mixture before grout application. Accomplish protection against contamination by keeping the construction site clean and free of such contaminants and by covering the ungrouted pavement with protective materials when directed by the Contracting Officer. Such protective materials shall consist of rolled polyethylene sheeting as described in paragraph WEATHER LIMITATIONS. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the pavement surface.

3.8 PREPARATION OF SLURRY GROUT

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NOTE: Generally, the cross polymer resin should be added to the grout mixture at the batch plant if the haul distance is less than 20 minutes. If the haul distance is greater than 20 minutes, the cross polymer resin should be added to the grout mixture at the job site.

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Mix the slurry grout using a batch plant, portable mixer and/or ready-mix truck according to mix proportions stated in the approved JMF. Add the cross polymer resin to the mixture after all other ingredients have been thoroughly mixed. When using ready-mix trucks for transporting slurry grout, the grout mixture shall be thoroughly mixed at the job site immediately before application for a minimum of 10 minutes. Thorough mixing shall be accomplished by rotating the mixing drum at the maximum allowable revolutions per minute.

3.9 PLACING SLURRY GROUT

Temperature of the bituminous mixture shall be less than 38 degrees C 100 degrees F before applying grout. Test each batch of slurry grout at the job site immediately before placement and used in the finished product only if it meets the requirements specified in paragraph ACCEPTABILITY OF WORK. Spread the slurry grout over the bituminous mixture using a spreader or squeegees. The application of the slurry grout shall be sufficient to fill the internal voids of the open graded bituminous mixture. Begin the grouting operation at the lowest side of the sloped cross-section and proceed from the low side to the high side. The practical limit for the surface slope of an RMP section is 2 percent. Pavement slopes up to 5 percent can be constructed, but excess hand work and grout overruns are to be expected at slopes greater than 2 percent. Place the slurry grout in successive paving lanes with a maximum width of 6 meters 20 feet. The use of strips of wood lumber or foamed rubber to separate each of the grouting lanes and the RMP from adjacent pavements is optional. The direction of the grouting operation shall be the same as used to pave the open graded bituminous mixture. Use the small (1.8 metric ton 2 ton maximum) tandem steel wheel roller (vibratory mode) passing over the grout covered bituminous mixture to promote full penetration of the slurry grout into the void spaces.

3.10 JOINTS

3.10.1 Joints Between Successive Lanes of RMP

Make joints between successive lanes of RMP ensuring a continuous bond between the paving lanes. All RMP joints shall have the same texture, density, and smoothness as other sections of the course.

3.10.2 Joints Between RMP and Adjacent Pavements

Saw cut the joints between the RMP and any surrounding pavement surfaced with portland cement concrete to the full thickness of the RMP layer and fill them with a joint sealant material approved by the Contracting Officer.

3.11 CURING

Apply the curing compound to the finished pavement surface, by means of a pressurized spraying machine, within 2 hours of the completed slurry grout application. Application of the curing compound shall be made uniformly in one or two coats with a total application rate of not more than 10 square meters/L 400 square feet/gallon.

3.12 PROTECTION OF GROUTED PAVEMENT

Protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents for a period of 21 days. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense. In order to properly protect the pavement against the effects of rain before the pavement is sufficiently hardened have available, at all times, materials for the protection of the edges and surfaces of the unhardened RMP. The protective materials and method of application shall be the same as previously described in paragraph WEATHER LIMITATIONS. When rain appears imminent, all paving operations shall stop, and all available personnel shall begin covering the surface of the hardened RMP with protective covering.

3.13 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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3.13.1 General Quality Control Requirements

Develop an approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the Quality Control Plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l. Surface Smoothness

3.13.2 Quality Control Testing

Perform all quality control tests, applicable to these specifications, as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, slurry grout viscosity, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.13.3 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per days production of open-graded asphalt mix, by one of the following methods: the extraction method in accordance with ASTM D 2172, Method A or B, the ignition method in accordance with the ASTM D 6307, or the nuclear method in accordance with ASTM D 4125, provided the nuclear gauge is calibrated for the specific mix being used. For the extraction method,

determine the weight of ash, as described in ASTM D 2172, 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 obtained in the calculation of the asphalt content for the mixture.

3.13.4 Gradation

Aggregate gradations shall be determined a minimum of twice per day from mechanical analysis of recovered aggregate in accordance with ASTM D 5444. When asphalt content is determined by the nuclear method, determine aggregate gradation from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, test aggregates in accordance with ASTM C 136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.13.5 Temperatures

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

3.13.6 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per day in accordance with ASTM C 566.

3.13.7 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with ASTM D 1461 or an approved alternate procedure.

3.13.8 Air Voids

Determine voids total mix from random core samples taken from in-place open-graded asphalt mixture. Calculate sample voids as outlined in the Job Mix Formula criteria. Voids shall be between 25 and 35 percent. Material not meeting the void criteria shall be removed and replaced at no additional cost to the Government.

3.13.9 Grade and Smoothness

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NOTE: Retain requirements for grade for projects having large paved areas where standing water or ponding of water may occur and projects with plan and profile details. All other projects shall be evaluated for the possibility of standing water before removing the grade requirements.

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Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph ACCEPTABILITY OF WORK.

3.13.9.1 Grade

The final wearing surface of the pavement will be tested for conformance with specified plan grade requirements, before grout is applied. The grade

will be determined by running lines of levels at intervals of 7.6 m 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular area, the Contracting Officer will inform the Contractor in writing, of the results of the grade-conformance tests.

3.13.9.2 Smoothness

Perform all testing in the presence of the Contracting Officer. Detailed notes of the results of the testing shall be kept and a copy furnished to the Government immediately after each day's testing. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), finish the surface to meet the approval of the Contracting Officer. After the the slurry grout has sufficiently cured, but not later than 48 hours after placement, test the surface of the pavement in such a manner as to reveal all surface irregularities exceeding the tolerances specified in table VI. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 8 m 25 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lines less than 6.1 m 20 feet and at the third points for lanes 6.1 m 20 feet or greater. Also test other areas having obvious deviations. Longitudinal testing lines shall be continuous across all joints. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. 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 the straightedge and the pavement surface in the area between these two high points.

3.13.10 Job-Mix-Formula

Routine testing for acceptability of work shall be performed by a Corps of Engineers certified commercial laboratory hired by the Contractor and approved by the Contracting Officer. Additional tests required to determine acceptability of non-conforming material shall be performed by the Contractor at its own expense. Use a Marsh Flow Cone for testing the viscosity of grout.

3.14 ACCEPTABILITY OF WORK

3.14.1 General

When a section of pavement fails to meet the specification requirements, that section shall be totally removed and replaced at the Contractor's expense. The Contracting Officer reserves the right to sample and test any area which appears to deviate from the specification requirements.

3.14.2 Field Sampling of RMP Materials

3.14.2.1 Open Graded Bituminous Mixture

Take samples of open graded bituminous mixture from loaded trucks for every 1,000 square meters yards of pavement, but not less than two samples for each day of paving for determining asphalt content, aggregate gradation, and laboratory compacted voids total mix. Laboratory specimens of open graded bituminous material shall be compacted in 101.6 mm 4 inch diameter molds to a 50.8 mm 2 inch thickness using 25 blows on one side from a Marshall hand hammer. Compare test results from the sampled open graded

bituminous mixture to the approved job-mix-formula for acceptance by the Contracting Officer . The tolerances given in Table IV for sieve analysis, bitumen content, and temperature shall be applied to quality control test results on the open graded bituminous mixture as discharged from the mixing plant.

TABLE IV

JOB-MIX-FORMULA TOLERANCES

Material	Tolerance, Plus or Minus
Aggregate passing 4.75 mm or larger sieves	4 percent
Aggregate passing 2.36 and 0.60 mm sieves	3 percent
Aggregate passing 0.075 mm sieve	1 percent
Bitumen	0.20 percent
Temperature of discharge mix	10 degrees C
Voids Total Mix	2 percent

TABLE IV

JOB-MIX-FORMULA TOLERANCES

Material	Tolerance, Plus or Minus
Aggregate passing No.4 or larger sieves	4 percent
Aggregate passing Nos. 8 and 30 sieves	3 percent
Aggregate passing No. 200 sieve	1 percent
Bitumen	0.20 percent
Temperature of discharged mix	20 degrees F
Voids Total Mix	2 percent

3.14.2.2 Slurry Grout

Test each batch of slurry grout for viscosity at the jobsite after thorough mixing and before application. Reject any batch of slurry grout failing to meet the specified viscosity and remove it from the jobsite. Slurry grout with visible amounts of sand settling out of suspension during application shall be rejected and removed from the jobsite.

3.14.2.3 Core Samples

Take random core samples from the in-place open graded bituminous mixture before and after application of the slurry grout. Take at least two field core samples before grout application and two after grout application for every 1,000 squaremeters yards of finished RMP. Half of the core samples taken after grout application shall be taken from joints between successive grouting lanes. Field core samples shall be 102 or 152 mm 4 or 6 inch diameter and extend the full depth of the RMP surface layer. The ungrouted core samples shall be tested for thickness. The grouted core samples shall be visually inspected for acceptable grout penetration. Acceptable grout penetration shall be through the full thickness of the RMP layer with a minimum of 90 percent of the visible void spaces filled with slurry grout. After testing, turn over all cores to the Contracting Officer. Core holes in ungrouted RMP shall be filled with hot open graded bituminous material

and leveled to match the surrounding pavement surface. Core holes in grouted RMP shall be filled within 24 hours from the time of coring with RMP material, low-shrinkage portland cement concrete material, or other approved patching material.

3.14.3 Thickness, Grade and Surface-Smoothness Requirements

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NOTE: The surface smoothness requirements specified below should be increased to 9 to 12 mm for tank trails and non-critical pavements.
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Finished surface of RMP, when tested as specified below, shall conform to the thickness and grade specified and to surface smoothness requirements specified in Table VI. In areas where the thickness, grade or smoothness exceeds the tolerance, remove the surface lift to full depth; replace the lift with open graded asphalt to meet specification requirements, at no additional cost to the Government. Diamond grinding may be used, after grout has cured, to remove high spots to meet grade or smoothness requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

TABLE VI

SURFACE-SMOOTHNESS TOLERANCES

Direction of Testing	Resin Modified Pavement Tolerance, mm
Longitudinal	6
Transverse	6

TABLE VI

SURFACE-SNOOTHNESS TOLERANCES

Direction of Testing	Resin Modified Pavement Tolerance, inch
Longitudinal	1/4
Transverse	1/4

3.14.3.1 Thickness

The thickness of the RMP shall meet the requirements shown on the contract drawings. The measured thickness of the RMP shall not exceed the design thickness by more than 13 mm 1/2 inch, or be deficient in thickness by more than 6 mm 1/4 inch.

3.14.3.2 Surface Smoothness

Finished surfaces shall not deviate from testing edge of a 3.7 meter 12 foot straightedge more than the tolerances shown for the respective pavement category in Table VI.

3.14.3.3 Surface Texture

The surface texture shall be uniform and free of excess cement grout. Finished surface shall have all grout removed below the top of the open-graded asphalt concrete.

3.14.3.4 Grade

The finished surface of pavement shall conform to the elevations and the cross sections shown and shall vary not more than 15 mm 0.6 inch from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements.

-- End of Section --