PART 400

BITUMINOUS PAVEMENTS

SECTION 401

DENSE GRADED HOT MIX ASPHALT (HMA) PAVEMENTS

401.01 DESCRIPTION. This work consists of constructing HMA pavements on prepared foundations in conformity with the dimensions and details indicated on the Plans, and in accordance with these Specifications. These Specifications are applicable to all types of Dense Graded HMA pavements irrespective of aggregate gradation, grade of performance graded asphalt binder (PGAB), or pavement use.

401.02 MATERIALS.

401.02.1 Aggregates. Aggregates shall meet the applicable requirements of **Subsection M.03.02.2** of these Specifications and AASHTO M 323. No more than 10% of the aggregate in the HMA shall be natural sand with the exception of Class 4.75 HMA which shall include no more than 20%.

401.02.2 Performance Graded Asphalt Binder (PGAB). All grades shall conform to AASHTO M 320 and R 29. The PGAB shall meet the requirements of PG 64S-28 with the exception of both Class 19.0 and mixes designated as “Base Course” which shall incorporate PG 64S-22 for mixes with less than 15% RAP. Both Class 19.0 and “Base Course” mixes with 15 to 25 percent RAP shall incorporate PG 58S-28.

Re-refined engine oil bottoms (REOB) shall not be used in any PGAB.

401.02.3 Mix Design. HMA mixes shall conform to AASHTO M 323, "Standard Specification for Superpave Volumetric Mix Design". The design procedure shall follow AASHTO R 35 "Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)". The optimum binder content (OBC) shall be determined as follows:

a. The design VMA, VFA, air voids and minimum optimum binder content (OBC) shall meet the following criteria:

Table 1 – HMA Properties

Class of Mix	VMA (minimum)	VFA	Air Voids	Minimum OBC
4.75	17.5%	70% - 80%	4%	7.0
9.5	16.5%	70% - 80%	4%	6.0
12.5	15.5%	70% - 80%	4%	5.5
19.0	14.5%	70% - 80%	4%	5.0

401.02.4 Quality Assurance.

a. Process Control. The Contractor shall exercise process control over all production operations. This shall require the constant monitoring of equipment, materials, and production activity such as testing and analysis to ensure that the HMA meets all applicable requirements and is produced within the allowable tolerances.

b. Acceptance Testing. Acceptance testing will be conducted by the Engineer. Samples shall be taken by the Contractor at the direction and in the presence of the Engineer in accordance with AASHTO T 168. The Engineer will take immediate possession of the samples. Samples not provided to the Engineer immediately will not be used for acceptance. Contractor personnel shall be certified by NETTCP (Northeast Transportation Training and Certification Program) as an HMA Plant Technician and subject to RIDOT Independent Assurance Sampling and Testing.

1. Gradation, Binder Content and Air Void Content

Gradations will be performed in accordance with AASHTO T 30. The requirements in Table 2 apply to mixes with and without pay adjustments:

Table 2 – Gradation Requirements

	Class 19.0	**Class 12.5**	**Class 9.5**	**Class 4.75**
25.0mm (1”)	100%	100%	100%	100%
19.0mm (3/4”)	90% - 100%	100%	100%	100%
12.5mm (1/2”)	90% max	90% - 100%	100%	100%
9.5mm (3/8”)	-	90% max	90% - 100%	95% - 100%
4.75mm (#4)	-	-	90% max	85% - 100%
2.36mm (#8)	± 5% from design	± 5% from design	± 5% from design	-
1.18mm (#16)	-	-	-	±5% from design
0.075mm (#200)	≥2%	≥2%	≥2%	≥2%
Control Sieve	2.36mm (#8)	2.36mm (#8)	2.36mm (#8)	1.18mm (#16)

During production of a specific mix, if two consecutive tests do not meet the gradation requirements of Table 2 or one test exceeds double the tolerance on the control sieve, the plant shall cease production of that HMA mix. Production will be allowed to resume after the Contractor completes a successful trial batch for that class of mix, as approved by the Engineer. Acceptance sampling will resume with the subsequent sublot or as determined by the Engineer.

Binder content will be determined in accordance with AASHTO T 308. Air voids will be determined in accordance with AASHTO T 269. The plant shutdown criteria in Table 3 shall apply for binder content and air voids that exceed the following tolerances:

Table 3 – Plant Shutdown Criteria

Pay Adjustments	**Shutdown Criteria**	**One Test**	**Two Consecutive Tests**
With Pay Adjustments	Optimum Binder Content	±0.6%	-
	Design Air Voids	±2.0%	-
Without Pay Adjustments	Optimum Binder Content	±0.6%	±0.4%
	Design Air Voids	±2.0%	±1.0%

Any combination of gradation, binder content and voids that exceed specifications on two consecutive tests requires the Contractor to shut down the plant. Trial batches shall not be sampled by the Contractor until acceptance testing is complete. Production will be allowed to resume after the Contractor completes a successful trial batch for that class of mix, as approved by the Engineer.

2. Mix Production – Lots and Sublots.

A standard sublot is 600 tons for HMA sampled at the plant for each production run. A standard lot for each mix is ten sublots. A sample will be randomly selected and tested for each sublot. At least five sublots will be used when calculating pay adjustments.

If the quantity of HMA needed to finish a production run is projected by the Contractor to be less than the standard sublot size of 600 tons, the projected tonnage may be used to select a random sample. If the projected tonnage is not produced or a random sample is unable to be taken, the Engineer may select a sample at the end of the run or at the paver. If no sample is taken, the tonnage will be added to the previous sublot.

Additional samples may be taken at the discretion of the Engineer.

Gyratory cores and theoretical maximum density samples will be retained by the Engineer for two weeks after the results are reported to the Contractor.

3. Adustments to Lots.

If less than five sublots are tested after the end of the final standard lot, they will be added to that lot. Five or more sublots tested after the end of the final standard lot will constitute a separate lot.

4. Plant Pay Adjustments.

(a) If a class of HMA is designated with "Pay Adjustments", the pay adjustments for deviation from the optimum binder content (established by the mix design) in Table 4 and the design air void content in Table 5 will apply:

Table 4 – OBC Pay Adjustments

Deviation from Optimum Binder Content	Pay Adjustment
Less than or equal to 0.1 %	+2%
0.2%	+1%
0.3%	0%
0.4%	-5%
0.5%	-15%
0.6%	-30%
0.7%	-40%
Greater than 0.7 %	-50% or Remove and Replace*

Table 5 – Air Void Pay Adjustments

Deviation from Design Air Void Content	Pay Adjustment
Less than or equal to 0.5%	+1%
0.6% to 1.0%	0%
1.1% to 1.5%	-5%
1.6% to 2.0%	-10%
2.1% to 2.5%	-30%
2.6% to 3.0%	-40%
Greater than 3.0%	-50% or Remove and Replace*

* The decision to make 50% payment or Remove and Replace will be made by the Engineer

Note: All deviation values will be rounded to the nearest 0.1% before applying pay adjustments.

(b) Calculation of Pay Adjustments for Production Binder and Air Void Content.

For each test, absolute deviations will be used when determining binder and air void content

pay adjustments. Absolute deviations are the values of deviation regardless of sign (±).

The average of the absolute deviations from the optimum binder content of all of the sublots in each lot will be used to determine the appropriate pay adjustments for the lots. The same will apply for air void content. No payment will be made for any pavement that is removed.

All other tolerances shall conform to the RI Standard Specifications.

c. Independent Assurance Testing. This testing will be performed by the Department in accordance with the Rhode Island Department of Transportation publication entitled "Schedule for Sampling, Testing and Certification of Materials."

401.03 CONSTRUCTION METHODS.

401.03.1 HMA Mixing Plant. Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed production of HMA. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

401.03.6 Compaction. Immediately after the HMA has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

a. In-Place Density for classes of HMA designated as "with Pay Adjustments"

Compaction density will be measured using cores of in-place pavement taken in accordance with AASHTO R 67. All cores shall be taken by the Contractor under the direction of and witnessed by the Engineer. Cores not taken under the direction of and witnessed by the Engineer will not be used for acceptance. The location of all cores will be determined by the Engineer. Each lot and sublot for in-place density cores will be matched as near as practical to each production lot and sublot used at the plant.

All cores shall be extracted after completion of rolling operations and before the paved section is open to traffic. The Engineer will take immediate possession of the cores upon extraction. If the Contractor does not obtain cores before a sublot is open to traffic, no bonus (pay adjustment resulting in more than 0%) will be paid for the sublot but disincentives will still apply.

Bulk specific gravities will be determined in accordance with AASHTO T 166, regardless of whether the absorption exceeds 2.0%. The cores will be retained by the Engineer for 4 weeks after the results are reported to the Contractor.

For HMA designated as "for Bridge Decks" cores will not be required or allowed.

The Contractor may extract its own cores for QC purposes to monitor in-place density and production quality; such cores will not be used for acceptance.

1. Mat Density

A standard sublot shall be 600 tons. A non-standard sublot shall be the quantity of HMA placed if there is less than 600 tons in the paving session or after the final standard sublot.

Under the direction of and witness by the Engineer, two stratified, randomly selected cores (4" +0"/- 0.25" diameter) shall be extracted from the mat by the Contractor for each standard sublot. One core shall be taken for sublots less than 450 tons. Table 6 will be used to determine the minimum number of cores extracted from the mat. The center of each core used to determine mat density will be at least one foot away from the edge of pavement, transverse or longitudinal joints or drainage structures.

Table 6 – Mat Density Core Quantities

Expected Daily Production Tonnage	Minimum Number of Mat Cores
450 or Less	1
451 - 750	2
751 - 1050	3
1051 – 1350	4
1351 – 1650	5
1651 – 1950	6
1951 - 2250	7
2251 - 2550	8
2551 - 2850	9
2851 - 3150	10

2. Joint Density

One joint density core shall be extracted for every 3000' or less when a joint is formed. Joint cores shall be extracted so that the center is within two inches of the middle of the sloped portion of a notched-wedge joint or within one inch of the middle of a butt joint.

3. In-Place Density Pay Adjustments

In-place density will be measured and reported as a percent of theoretical maximum density. The pay adjustments from Table 7 will be made for in-place mat density:

Table 7 – Mat Density Pay Adjustments

In-Place Mat Density	**Pay Adjustment**
95.0% and greater	+2%
94.0% to	+1%
93.0% to	0%
92.0% to	-5%
91.0% to	-15%
90.0% to	-25%
89.0% to	-35%
Below 89.0%	Remove and Replace

The pay adjustments from Table 8 will be made for in-place joint density:

Table 8– Joint Density Pay Adjustments

In-Place Joint Density	Pay Adjustment
93.0% and greater	+2%
92.0% to	+1%
91.0% to	0%
90.0% to	-5%
89.0% to	-15%
88.0% to	-25%
87.0% to	-35%
Below	-100%

Note: All density values will be rounded to the nearest 0.1% before applying pay adjustments.

In the event material is required to be removed and replaced, the Engineer will determine the limits of the removal. The required in-place density will be 1% less for the first lift placed on gravel subbase that has not been reclaimed.

4. Calculation of Pay Adjustments for In-Place Density

(a) Mat Density:

For each sublot, the bulk specific gravity (G_{mb}) of the mat density core(s) will be averaged and then compared to the corresponding plant theoretical maximum specific gravity (G_{mm}) to calculate the in-place density for each sublot. The average of the sublot densities in a lot will be used to determine the appropriate pay adjustment for that lot. Lot pay adjustments will be applied to the respective quantity of HMA in each lot**.**

(b) Joint Density:

For joint density pay adjustment purposes, a joint lot will be defined as 10 joint density results. However, if less than five joint density results are remaining after the final full joint lot is formed, they will be added to the previous joint lot. Five or more joint density results remaining after the final full joint lot will constitute a separate joint lot.

Calculation of in-place joint density will be determined using the G_{mb} of joint density cores and the project average plant G_{mm} of the respective mix. The average of the individual joint density results in a joint lot will be used to determine the appropriate pay adjustment for that joint lot. The calculation of material quantity used to construct the joints will be based on the joint core density, the specified thickness, a width of one foot and the total length of the joints on the project. This quantity will be deducted from the total tonnage.

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401.03 METHOD OF MEASUREMENT.

401.04.1 Measurement of HMA Pavement. HMA Pavements will be measured by the number of tons actually placed in accordance with the Plans and/or as directed by the Engineer.

401.05 BASIS OF PAYMENT. The accepted quantity of the HMA will be paid for at its respective contract unit price per ton as listed in the Proposal. The price so-stated constitutes full and complete compensation for all labor, materials and equipment, and for all incidentals required to finish the work, complete and accepted by the Engineer.

Pay adjustments for binder content, air voids and in-place density will be added together to determine a final pay adjustment for both the mat and the joint. If more than one pay adjustment is negative then only the most negative adjustment will be added to the remaining non-negative adjustments to determine the final pay adjustment. Pay adjustments will be applied to the unit bid price for the applicable item code.