

## SECTION 460 HOT MIX ASPHALT PAVEMENT

### 460.1 Description

*Revise 460.1(1) to add warm mix asphalt. This change was implemented in ASP 6 effective with the Nov 2011 letting.*

- (1) This section describes HMA mixture design, providing and maintaining a quality management program for HMA mixtures, and constructing HMA pavement. **Unless specifically indicated otherwise, references within section 460 to HMA also apply to WMA.**

### 460.2 Materials

#### 460.2.1 General

*Revise 460.2.1(1) to add warm mix asphalt additives or processes. This change was implemented in ASP 6 effective with the Nov 2011 letting.*

- (1) Furnish a homogeneous mixture of coarse aggregate, fine aggregate, mineral filler if required, SMA stabilizer if required, recycled material if used, **warm mix asphalt additive or process if used**, and asphaltic material.

#### 460.2.2 Aggregates

##### 460.2.2.1 General.

- (1) Provide coarse aggregates from a department-approved source as specified under [106.3.4.2](#). Obtain the engineer's approval of the aggregates before producing HMA mixtures.
- (2) Furnish an aggregate blend consisting of hard durable particles containing no more than a combined total of one percent, by weight, of lumps of clay, loam, shale, soft particles, organic matter, adherent coatings, and other deleterious material. Ensure that the aggregate blend conforms to the percent fractured faces and flat & elongated requirements of [table 460-2](#). If the aggregate blend contains materials from different deposits or sources, ensure that material from each deposit or source has a LA wear percent loss meeting the requirements of [table 460-2](#).

##### 460.2.2.2 Freeze-Thaw Soundness

- (1) If the aggregate blend contains materials from different deposits or sources, ensure that material from each deposit or source has a freeze-thaw loss percentage meeting the requirements of [table 460-2](#) and [106.3.4.2.2](#).

##### 460.2.2.3 Aggregate Gradation Master Range

- (1) Ensure that the aggregate blend, including recycled material and mineral filler, conforms to the gradation requirements in table 460-1. The values listed are design limits; production values may exceed those limits.

**TABLE 460-1 AGGREGATE GRADATION MASTER RANGE AND VMA REQUIREMENTS**

SIEVE	PERCENTS PASSING DESIGNATED SIEVES						
	NOMINAL SIZE						
	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	SMA 12.5 mm	SMA 9.5 mm
50.0-mm	100						
37.5-mm	90 - 100	100					
25.0-mm	90 max	90 - 100	100				
19.0-mm	___	90 max	90 - 100	100		100	
12.5-mm	___	___	90 max	90 - 100	100	90 - 97	100
9.5-mm	___	___	___	90 max	90 - 100	58 - 72	90 - 100
4.75-mm	___	___	___	___	90 max	25 - 35	35 - 45
2.36-mm	15 - 41	19 - 45	23 - 49	28 - 58	20 - 65	15 - 25	18 - 28
75-µm	0 - 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	8.0 - 12.0	10.0 - 14.0
% MINIMUM VMA	11.0	12.0	13.0	14.0	15.0	16.0	17.0

- (2) Unless the contract designates otherwise, ensure that the nominal size of the aggregate used in the mixture conforms to [460.3.2](#) and the following:

PAVEMENT LAYER	NOMINAL SIZE
Lower layer pavement .....	19.0 mm
Upper layer pavement .....	12.5 mm

Stone matrix layer pavement ..... 12.5 mm

**460.2.3 Asphaltic Binders**

- (1) The department will designate the grade of asphaltic binder in the contract. The contractor may use virgin binder, modified binder, a blend of virgin and recovered binder, or a blend of modified and recovered binder. Ensure that the resultant asphaltic binder conforms to the contract specifications.

**460.2.4 Additives**

**460.2.4.1 Hydrated Lime Antistripping Agent**

- (1) If used in HMA mixtures, furnish hydrated lime conforming to ASTM C977 and containing no more than 8 percent unhydrated oxides. Percent added is by weight of the total dry aggregate.

**460.2.4.2 Liquid Antistripping Agent**

- (1) If used in HMA mixtures, add liquid antistripping agent to the asphaltic binder before introducing the binder into the mixture. Provide documentation indicating that addition of liquid antistripping agent will not alter the characteristics of the original asphaltic binder performance grade (PG).

**460.2.4.3 Stone Matrix Asphalt Stabilizer**

- (1) Add an organic fiber, an inorganic fiber, a polymer-plastic, a polymer-elastomer, or approved alternate stabilizer to all SMA mixtures. If proposing an alternate, submit the proposed additive system, asphaltic binder, and stabilizer additive, along with samples of the other mixture materials to the department at least 14 days before the project let date. The department will approve or reject that proposed alternate additive system no later than 48 hours before the project let date.
- (2) Use a single additive system for all SMA pavement in the contract.

*Add 460.2.4.4 to add requirements for warm mix asphalt. This change was implemented in ASP 6 effective with the Nov 2011 letting.*

**460.2.4.4 Warm Mix Asphalt Additive or Process**

- (1) Use additives or processes from the department's approved products list. Follow supplier or manufacturer recommendations for additives and processes when producing WMA mixtures.

**460.2.5 Recycled Asphaltic Materials**

- (1) The contractor may use recycled asphaltic materials from FRAP, RAP, and RAS in HMA mixtures. Stockpile recycled materials separately from virgin materials and list each as individual JMF components.
- (2) Control recycled materials used in HMA by evaluating the percent binder replacement, the ratio of recovered binder to the total binder. Conform to the following:

**MAXIMUM ALLOWABLE PERCENT BINDER REPLACEMENT**

RECYCLED ASPHALTIC MATERIAL	LOWER LAYERS	UPPER LAYER
RAS if used alone	25	20
RAP and FRAP in any combination	40	25
RAS, RAP, and FRAP in combination[1]	35	25

<sup>[1]</sup> When used in combination the RAS component cannot exceed 5 percent of the total weight of the aggregate blend.

**460.2.6 Recovered Asphaltic Binders**

- (1) Establish the percent of recovered asphaltic binder from FRAP, RAP, and RAS for the mixture design according to AASHTO T164 using the appropriate dust correction procedure. If production test results indicate a change in the percent of recovered asphaltic binder, the contractor or the engineer may request a change in the design recovered asphaltic binder. Provide the department with at least 2 recent extraction samples supporting that change. Ensure that those samples were prepared according to [CMM 8-65](#) by a WisDOT qualified laboratory.
- (2) The contractor may replace virgin binder with recovered binder up to the maximum percentage allowed under [460.2.5](#) without changing the asphaltic binder grade. If using more than the maximum allowed under [460.2.5](#), furnish test results indicating that the resultant binder meets the grade the contract originally specified.

**460.2.7 HMA Mixture Design**

- (1) For each HMA mixture type used under the contract, develop and submit an asphaltic mixture design according to the department's test method number 1559 as described in [CMM 8-65.5](#) and conforming to

the requirements of [table 460-1](#) and [table 460-2](#). The values listed are design limits; production values may exceed those limits. The department will review mixture designs and report the results of that review to the designer according to the department's test method number 1559.

**TABLE 460-2 MIXTURE REQUIREMENTS**

Mixture type	E - 0.3	E - 1	E - 3	E - 10	E - 30	E - 30x	SMA
ESALs x 10 <sup>6</sup> (20 yr design life)	< 0.3	0.3 - < 1	1 - < 3	3 - < 10	10 - < 30	>= 30	___
LA Wear (AASHTO T96)							
100 revolutions(max % loss)	13	13	13	13	13	13	13
500 revolutions(max % loss)	50	50	45	45	45	45	40
Soundness (AASHTO T104) (sodium sulfate, max % loss)	12	12	12	12	12	12	12
Freeze/Thaw (AASHTO T103) (specified counties, max % loss)	18	18	18	18	18	18	18
Fractured Faces (ASTM 5821) (one face/2 face, % by count)	60 / ___	65 / ___	75 / 60	85 / 80	98 / 90	100/100	100/90
Flat & Elongated (ASTM D4791) (max %, by weight)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	20 (3:1ratio)
Fine Aggregate Angularity (AASHTO T304, method A, min)	40	40	43	45	45	45	45
Sand Equivalency (AASHTO T176, min)	40	40	40	45	45	50	50
Gyratory Compaction							
Gyrations for N <sub>ini</sub>	6	7	7	8	8	9	8
Gyrations for N <sub>des</sub>	40	60	75	100	100	125	65
Gyrations for N <sub>max</sub>	60	75	115	160	160	205	160
Air Voids, %V <sub>a</sub> (%G <sub>mm</sub> N <sub>des</sub> )	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)
% G <sub>mm</sub> N <sub>ini</sub>	<= 91.5 <sup>[1]</sup>	<= 90.5 <sup>[1]</sup>	<= 89.0 <sup>[1]</sup>	<= 89.0	<= 89.0	<= 89.0	___
% G <sub>mm</sub> N <sub>max</sub>	<= 98.0	<= 98.0	<= 98.0	<= 98.0	<= 98.0	<= 98.0	___
Dust to Binder Ratio <sup>[2]</sup> (% passing 0.075/P <sub>be</sub> )	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	1.2 - 2.0
Voids filled with Binder (VFB or VFA, %)	70 - 80 <sup>[4] [5]</sup>	65 - 78 <sup>[4]</sup>	65 - 75 <sup>[4]</sup>	65 - 75 <sup>[3] [4]</sup>	65 - 75 <sup>[3] [4]</sup>	65 - 75 <sup>[3] [4]</sup>	70 - 80
Tensile Strength Ratio (TSR) (ASTM 4867)							
no antistripping additive	0.70	0.70	0.70	0.70	0.70	0.70	0.70
with antistripping additive	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Draindown at Production Temperature (%)	___	___	___	___	___	___	0.30

<sup>[1]</sup> The percent maximum density at initial compaction is only a guideline.

<sup>[2]</sup> For a gradation that passes below the boundaries of the caution zone(ref. AASHTO MP3), the dust to binder ratio limits are 0.6 - 1.6.

<sup>[3]</sup> For 9.5mm nominal maximum size mixtures, the specified VFB range is 73 - 76%.

<sup>[4]</sup> For 37.5mm nominal maximum size mixes, the specified VFB lower limit is 67%.

<sup>[5]</sup> For 25.0mm nominal maximum size mixes, the specified VFB lower limit is 67%.

## **460.2.8 Quality Management Program**

### **460.2.8.1 General**

- (1) Provide and maintain a QC program defined as all activities, including mix design, process control inspection, sampling and testing, and process adjustments related to producing and placing HMA pavement conforming to the specifications. The contractor may also provide an optional CA program.
- (2) The department will provide product quality verification as follows:
  1. By conducting verification testing of independent samples.
  2. By periodically observing contractor sampling and testing.
  3. By monitoring required control charts exhibiting test results and control parameters.
  4. By the engineer directing the contractor to take additional samples at any time during production.
- (3) Refer to [CMM 8-36](#) for detailed guidance on sampling, testing, and documentation under the QMP.

### **460.2.8.2 Contractor Testing**

#### **460.2.8.2.1 Required Quality Control Program**

##### **460.2.8.2.1.1 Personnel Requirements**

- (1) Provide HTCP certified sampling and testing personnel. Provide at least one full-time HMA technician certified at a level appropriate for sampling and production control testing at each plant site furnishing material to the project. Before mixture production begins, provide an organizational chart in the contractor's laboratory. Include the names, telephone numbers, and current certifications of all personnel with QC or CA responsibilities. Keep the chart updated.
- (2) Ensure that sampling and testing personnel are minimally qualified as follows<sup>[1]</sup>:
  - HMA technician certified at a level appropriate for sampling and production control testing.
  - HMA ACT<sup>[2]</sup>.

<sup>[1]</sup> After informing the engineer, a non-certified person under the direct observation of a certified HMA technician may sample for a period not to exceed 3 calendar days.

<sup>[2]</sup> A certified HMA technician must coordinate and take responsibility for the work an ACT performs. No more than one ACT can work under a single certified technician.

- (3) Have a certified HMA technician ensure that all sampling and testing is performed correctly, analyze test results, and post resulting data.
- (4) Have an HMA technician certified at a level appropriate for process control and troubleshooting or mix design available to make necessary process adjustments.

##### **460.2.8.2.1.2 Laboratory Requirements**

- (1) Conduct QC testing in a facility conforming to the department's laboratory qualification program.
- (2) Ensure that the laboratory has at least 320 square feet of workspace and has a telephone for exclusive use by QMP personnel. Ensure that all testing equipment conforms to the equipment specifications applicable to the required testing methods.

##### **460.2.8.2.1.3 Required Sampling and Testing**

###### **460.2.8.2.1.3.1 Contracts with 5000 Tons of Mixture or Greater**

- (1) Furnish and maintain a laboratory at the plant site fully equipped for performing contractor QC testing. Have the laboratory on-site and operational before beginning mixture production.
- (2) Obtain random samples and perform tests according to [CMM 8-36](#). Obtain HMA mixture samples from trucks at the plant. Perform tests the same day taking the sample.
- (3) Retain the split portion of the contractor HMA mixture and blended aggregate samples for 14 calendar days at the laboratory site in a dry, protected area. The engineer may decrease this 14-day retention period. At project completion the contractor may dispose of remaining samples if the engineer approves.
- (4) Use the test methods identified below, or other methods the engineer approves, to perform the following tests at a frequency greater than or equal to that indicated:

Blended aggregate gradations:

Drum plants:

- Field extraction by department test method number 1560.
- Belt samples, optional for virgin mixtures, obtained from stopped belt or from the belt discharge using an engineer-approved sampling device and performed according to AASHTO T11 and T27.

Batch plants:

- Field extraction by department test method number 1560.

Asphalt content (AC) in percent:

AC by calculation.

AC by nuclear gauge reading, optional.

AC by inventory, optional.

Bulk specific gravity of the compacted mixture according to AASHTO T166.

Maximum specific gravity according to AASHTO T209.

Air voids ( $V_a$ ) by calculation according to AASHTO T269.

VMA by calculation according to AASHTO R35.

- (5) Test each design mixture at a frequency at or above the following:

TOTAL DAILY PLANT PRODUCTION FOR DEPARTMENT CONTRACTS in tons	SAMPLES PER DAY <sup>[1]</sup>
50 to 600	1
601 to 1500	2
1501 to 2700	3
2701 to 4200	4
greater than 4200	see footnote <sup>[2]</sup>

<sup>[1]</sup> Frequencies are for planned production. If production is other than planned, conform to [CMM 8-36](#).

<sup>[2]</sup> Add a random sample for each additional 1500 tons or fraction of 1500 tons.

- (6) Also conduct field tensile strength ratio tests according to ASTM D4867 on all mixtures requiring an antistripping additive. Test each full 50,000 ton production increment, or fraction of an increment, after the first 5000 tons of production. Perform required increment testing in the first week of production of that increment. If field tensile strength ratio values are either below the spec limit or less than the mixture design JMF percentage value by 20 or more, notify the engineer. The engineer and contractor will jointly determine a corrective action.

#### **460.2.8.2.1.3.2 Contracts with Less Than 5000 Tons of Mixture**

- (1) Conform to [460.2.8.2.1.3.1](#) modified as follows:
- The contractor may conduct QC tests in an off-site laboratory.
  - No field tensile strength ratio testing is required.

#### **460.2.8.2.1.3.3 Contracts with Less Than 500 Tons of Mixture**

- (1) The engineer may waive QC testing on contracts with less than 500 tons of mixture. If testing is waived, acceptance will be by visual inspection unless defined otherwise by contract change order.
- (2) If HMA density testing is waived under [460.3.3.3](#), QC testing is also waived.

#### **460.2.8.2.1.3.4 Temporary Pavements**

- (1) The engineer may waive all testing for temporary pavements, defined for this purpose as pavements that will be placed and removed before contract completion.

#### **460.2.8.2.1.4 Documentation**

##### **460.2.8.2.1.4.1 Records**

- (1) Document all observations, inspection records, mixture adjustments, and test results daily. Note observations and inspection records in a permanent field record as they occur. Record all process adjustments and JMF changes. Submit copies of the running average calculation sheets for blended

aggregate, mixture properties, and asphalt content along with mixture adjustment records to the engineer each day. Submit testing records and control charts to the engineer in a neat and orderly manner within 10 days after paving is completed.

- (2) Continue charts, records, and testing frequencies, for a mixture produced at one plant site, from contract to contract.

#### 460.2.8.2.1.4.2 Control Charts

- (1) Maintain standardized control charts at the laboratory. Record contractor test results on the charts the same day as testing. Post CA test results on the charts as data becomes available. Record data on the standardized control charts as follows:
  - Blended aggregate gradation tests in percent passing. Of the following, plot those sieves the design specifications require: 37.5-mm, 25.0-mm, 19.0-mm, 12.5-mm, 9.5-mm, 2.36-mm, and 75- $\mu$ m.
  - Asphalt material content in percent.
  - Air voids in percent.
  - VMA in percent.
- (2) Plot both the individual test point and the running average of the last 4 data points on each chart. Show QC data in black with the running average in red and CA data in blue. Draw the warning limits with a dashed green line and the JMF limits with a dashed red line. The contractor may use computer generated black-and-white printouts with a legend that clearly identifies the specified color coded components.

#### 460.2.8.2.1.5 Control Limits

*Revise 460.2.8.2.1.5(1) to tighten VMA limits based on national research. This change was implemented in ASP 6 effective with the June 2012 letting.*

- (1) Conform to the following control limits for the JMF and warning limits based on a running average of the last 4 data points:

ITEM	JMF LIMITS	WARNING LIMITS
Percent passing given sieve:		
37.5-mm	+/- 6.0	+/- 4.5
25.0-mm	+/- 6.0	+/- 4.5
19.0-mm	+/- 5.5	+/- 4.0
12.5-mm	+/- 5.5	+/- 4.0
9.5-mm	+/- 5.5	+/- 4.0
2.36-mm	+/- 5.0	+/- 4.0
75- $\mu$ m	+/- 2.0	+/- 1.5
Asphaltic content in percent	+/- 0.4	+/- 0.3
Air voids in percent	+/- 1.3	+/- 1.0
VMA in percent <sup>[1]</sup>	- 0.5	- 0.2

<sup>[1]</sup> VMA limits based on minimum requirement for mix design nominal maximum aggregate size in [Table 460-1](#).

- (2) Warning bands are defined as the area between the JMF limits and the warning limits.

#### 460.2.8.2.1.6 Job Mix Formula Adjustment

- (1) The contractor may request adjustment of the JMF according to the department's test method number 1559. Have an HTCP HMA technician certified at a level appropriate for process control and troubleshooting or mix design submit a written JMF adjustment request. Ensure that the resulting JMF is within specified master gradation bands. The department will have an HMA technician certified at level III review the proposed adjustment and, if acceptable, issue a revised JMF. The department will not allow adjustments exceeding specified JMF tolerance limits. Have an HMA technician certified at level II make related process adjustments.
- (2) If mixture redesign is necessary, submit a new JMF, subject to the same specification requirements as the original JMF.
- (3) Do not reduce the JMF asphalt content unless the production VMA meets or exceeds the minimum VMA design requirement for the mixture produced as defined in [table 460-1](#).

#### 460.2.8.2.1.7 Corrective Action

- (1) When running average values trend toward the warning limits, consider taking corrective action. Document all corrective actions undertaken. Include all test results in the contract files and in running average calculations.
- (2) Notify the engineer if running average values exceed the warning limits. If two consecutive running average values exceed the warning limits, stop production and make adjustments. Do not restart production until after notifying the engineer of the adjustments made. Do not calculate a new running average until the fourth test after the required production stop.
- (3) If the process adjustment improves the property in question so that the running average after 4 additional tests is within the warning limits, the contractor may continue production with no reduction in payment.
- (4) If the adjustment does not improve the properties and the running average after 4 additional tests stays inside the warning bands, the mixture is nonconforming and subject to pay adjustment.
- (5) If the contractor fails to stop production and make adjustments when required, all mixture produced from the stop point to the point when the running average is back inside the warning limits is nonconforming and subject to pay adjustment.
- (6) The department will reduce payment for nonconforming QMP HMA mixtures, starting from the stop point to the point when the running average is back inside the warning limits, as follows:

ITEM	PAYMENT FOR MIXTURE <sup>[1] [2]</sup>	
	PRODUCED WITHIN WARNING BANDS	PRODUCED OUTSIDE JMF LIMITS
Gradation	90%	75%
Asphalt Content	85%	75%
Air Voids	70%	50%
VMA	90%	75%

<sup>[1]</sup> For projects or plants where the total production of each mixture design requires less than 4 tests refer to [CMM 8-36](#).

<sup>[2]</sup> Payment is in percent of the contract unit price for both the HMA Pavement and Asphaltic Material bid items. The department will reduce pay based on the nonconforming property with lowest percent pay. The asphaltic material quantity is based on the JMF asphalt content. The department will administer pay reduction under the Nonconforming QMP Asphaltic Material and the Nonconforming QMP HMA Mixture administrative items.

- (7) If the running average values exceed the JMF limits, stop production and make adjustments. Do not restart production until after notifying the engineer of the adjustments made. Continue calculating the running average after the production stop.
- (8) If the air voids running average of 4 exceeds the JMF limits, the material is nonconforming. Remove and replace unacceptable material at no additional expense to the department. The engineer will determine the quantity of material to replace based on the testing data using the methods in [CMM 8-36](#) and an inspection of the completed pavement. If the engineer allows the mixture to remain in place, the department will pay for the mixture and asphaltic material at 50 percent of the contract price.
- (9) If the running average of 4 exceeds the JMF limits for other properties, the department will pay 75 percent of the contract price for mixture and asphaltic material if the engineer allows the mixture to remain in place. The engineer will determine the quantity of material subject to pay reduction based on the testing data and an inspection of the completed pavement.

#### 460.2.8.2.2 Optional Contractor Assurance

##### 460.2.8.2.2.1 General

- (1) CA testing is optional and is conducted to further validate production testing. The contractor may offer CA data to provide an additional piece of information for the following:
  1. Process control decisions.
  2. Troubleshooting possible sampling, splitting, or equipment problems.
  3. Limiting liability, as defined in [CMM 8-36](#), for nonconforming product as a result of department verification testing. These provisions do not supersede department's rights under [107.16](#).

#### 460.2.8.2.2.2 Personnel Requirements

- (1) Ensure that an HMA technician certified under HTCP at a level appropriate for mixture production control testing performs all CA testing and data analysis. Personnel performing CA testing cannot perform QC testing for the same materials.

#### 460.2.8.2.2.3 Laboratory Requirements

- (1) Conduct CA testing in a facility conforming to the department's laboratory qualification program. Furnish and maintain a laboratory fully equipped for performing selected CA tests. If the a single laboratory is providing CA and QC data for the same materials, ensure that a separate set of equipment is used to prepare CA samples and run CA tests.

#### 460.2.8.2.2.4 Testing

- (1) For the CA program, use the test methods enumerated here in 460.2.8.2.2.4, other engineer-approved methods, or other methods the industry and department HMA technical team recognizes. The contractor may select tests at its option. If using tests in limiting liability, as provided in [CMM 8-36](#), data must exist for the property in question.
- (2) Perform selected testing as follows:
  - Bulk specific gravity (Gmb) of the compacted mixture according to AASHTO T166 based on the average of 2 specimens.
  - Maximum specific gravity (Gmm) according to AASHTO T209.
  - Air voids (Va) by calculation according to AASHTO T269.
  - VMA by calculation according to AASHTO R35.
- (3) There is no specified frequency for CA testing.
- (4) The department will compare CA samples to QC samples. Obtain CA samples by retaining a QC split portion conforming to the "rule of retained" requirements, as provided in [CMM 8-36](#). Alternatively the contractor may have CA personnel take an additional sample during production.

#### 460.2.8.2.2.5 Documentation

- (1) Report CA test results to the engineer and the contractor's field staff within 2 business days after receiving the samples.

#### 460.2.8.2.2.6 Allowable Differences

- (1) Differences between the QC and CA split sample test results are acceptable in limiting liability, as provided in [CMM 8-36](#), if within the following limits:

ITEM	ALLOWABLE DIFFERENCES
Percent passing 12.5 mm sieve	6.0
Percent passing 9.5 mm sieve	6.0
Percent passing 4.75 mm sieve	5.0
Percent passing 2.36 mm sieve	4.0
Percent passing 600- $\mu$ m sieve	3.5
Percent passing 75- $\mu$ m sieve	2.0
Bulk specific gravity of the compacted mixture	0.030
Maximum specific gravity	0.020

### 460.2.8.3 Department Testing

#### 460.2.8.3.1 Quality Verification Program

##### 460.2.8.3.1.1 General

- (1) The engineer will conduct QV tests to determine the quality of the final product and measure characteristics that predict relative performance.

##### 460.2.8.3.1.2 Personnel Requirements

- (1) The department will provide at least one HMA technician, certified under HTCP at a level appropriate for sampling and mixture production control testing, to observe QV sampling of project mixtures.
- (2) An HMA technician certified at a level appropriate for sampling and mixture production control testing, or an HMA ACT working under the HMA certified technician, will split samples and do the testing. An HMA technician certified at a level appropriate for sampling and mixture production control testing must

coordinate and take responsibility for the work an ACT performs. No more than one ACT can work under a single certified technician.

- (3) An HMA technician certified at a level appropriate for sampling and mixture production control testing will ensure that all sampling and testing is performed correctly, analyze test results, and post resulting data.
- (4) The department will make an organizational chart available at the testing laboratory and to the contractor before mixture production begins. The department's chart will include names, telephone numbers, and current certifications of all QV testing personnel. The department will update the chart with appropriate changes, as they become effective.

#### **460.2.8.3.1.3 Laboratory Requirements**

- (1) The department will furnish and maintain a facility for QV testing conforming to the department's laboratory qualification program requirements and fully equipped to perform QV testing. In all cases, the department will conduct testing in a separate laboratory from the contractor's laboratory.

#### **460.2.8.3.1.4 Department Verification Testing Requirements**

- (1) HTCP certified department personnel will obtain random samples by directly supervising HTCP certified contractor personnel sampling from trucks at the plant. The department will sample according to [CMM 8-36](#). Sample size must be adequate to run the appropriate required tests in addition to one set of duplicate tests that may be required for dispute resolution. The engineer will split the sample for testing and retain the remaining portion for additional testing if needed.
- (2) The department will verify product quality using the test methods enumerated here in 460.2.8.3.1.4(2), other engineer-approved methods, or other methods the industry and department HMA technical team recognizes. The department will identify test methods before construction starts and use only those methods during production of that material unless the engineer and contractor mutually agree otherwise.

- (3) The department will perform all testing conforming to the following standards:

Bulk specific gravity ( $G_{mb}$ ) of the compacted mixture according to AASHTO T166.

Maximum specific gravity ( $G_{mm}$ ) according to AASHTO T209.

Air voids ( $V_a$ ) by calculation according to AASHTO T269.

VMA by calculation according to AASHTO R35.

- (4) The department will randomly test each design mixture at the following minimum frequency:

FOR TONNAGES TOTALING:

Less than 501 tons ..... no tests required

From 501 to 30,000 tons..... one test

More than 30,000 tons..... add one test for each additional 30,000-ton increment

#### **460.2.8.3.1.5 Documentation**

- (1) The engineer will document all observations during QV sampling, and review QC mixture adjustments and QC/CA test results daily. The engineer will note results of observations and inspection records in a permanent field record as they occur.

#### **460.2.8.3.1.6 Acceptable Verification Parameters**

- (1) The engineer will provide test results to the contractor within 2 mixture-production days after obtaining the sample. The quality of the product is acceptably verified if it meets the following limits:
  - $V_a$  is within a range of 2.7 to 5.3 percent.
  - VMA is **within minus 0.5 of the minimum requirement** for the mix design nominal maximum aggregate size.
- (2) If QV test results are outside the specified limits, the engineer will investigate immediately through dispute resolution procedures. The engineer may stop production while the investigation is in progress if the potential for a pavement failure is present.
- (3) If production continues for that mixture design, the engineer will provide additional retained sample testing at the frequency provided for in [CMM 8-36](#). This supplemental testing will continue until the material meets allowable differences or as the engineer and contractor mutually agree.

#### 460.2.8.3.1.7 Dispute Resolution

- (1) When QV test results do not meet the specified limits, the bureau's AASHTO accredited laboratory and certified personnel will referee test the retained portion of the QV sample and the retained portion of the nearest available previous QC sample.
- (2) The department will notify the contractor of the referee test results within 3 business days after receipt of the samples.
- (3) The department will determine mixture conformance and acceptability by analyzing referee test results, reviewing mixture project data, and inspecting the completed pavement all according to [CMM 8-36](#).

#### 460.2.8.3.1.8 Corrective Action

- (1) Remove and replace unacceptable material at no additional expense to the department.
- (2) The department will reduce pay for the tonnage of nonconforming mixture, as determined during QV dispute resolution, if the engineer allows that mixture to remain in place. If production of that mixture design continued during the investigation, the department will also adjust pay for that mixture forward to the next conforming QV or QC/CA point. The department will pay for the affected mixture at 50 percent of the contract price. The department will adjust pay for both the mixture and the asphaltic material.

#### 460.2.8.3.2 Independent Assurance Testing

- (1) The department will evaluate both the contractor and department testing personnel and equipment as specified in [106.3.4.3.4](#).

### 460.3 Construction

#### 460.3.1 General

- (1) Construct HMA pavement conforming to the general provisions of [450.3](#).

#### 460.3.2 Thickness

- (1) Provide the plan thickness for lower and upper layers limited as follows:

NOMINAL SIZE	MINIMUM LAYER THICKNESS in inches	MAXIMUM LOWER LAYER THICKNESS in inches	MAXIMUM UPPER LAYER THICKNESS in inches	MAXIMUM SINGLE LAYER THICKNESS <sup>[3]</sup> in inches
37.5 mm	3.5	5	4.5	6
25.0 mm	3.25	5	4	6
19.0 mm	2.25	4	3	5
12.5 mm <sup>[1]</sup>	1.75	3 <sup>[2]</sup>	2.5	4
9.5 mm <sup>[1]</sup>	1.5	3 <sup>[2]</sup>	2	3

<sup>[1]</sup> SMA mixtures use nominal size 12.5 mm or 9.5 mm.

<sup>[2]</sup> SMA mixtures with nominal sizes of 12.5 mm and 9.5 mm have no maximum lower layer thickness specified.

<sup>[3]</sup> For use on cross-overs and shoulders.

#### 460.3.3 HMA Pavement Density Maximum Density Method

##### 460.3.3.1 Minimum Required Density

- (1) Compact all layers of HMA mixture to the density table 460-3 shows for the applicable mixture, location, and layer.

**TABLE 460-3 MINIMUM REQUIRED DENSITY<sup>[1]</sup>**

LOCATION	LAYER	PERCENT OF TARGET MAXIMUM DENSITY		
		MIXTURE TYPE		
		E-0.3, E-1, and E-3	E-10, E-30, and E-30x	SMA <sup>[5]</sup>
TRAFFIC LANES <sup>[2]</sup>	LOWER	91.5 <sup>[3]</sup>	92.0 <sup>[4]</sup>	—
	UPPER	91.5	92.0	—
SIDE ROADS, CROSSOVERS, TURN LANES, & RAMPS	LOWER	91.5 <sup>[3]</sup>	92.0 <sup>[4]</sup>	—
	UPPER	91.5	92.0	—
SHOULDERS & APPURTENANCES	LOWER	89.5	89.5	—
	UPPER	90.5	90.5	—

<sup>[1]</sup> The table values are for average lot density. If any individual density test result falls more than 3.0 percent below the minimum required target maximum density, the engineer may investigate the acceptability of that material.

<sup>[2]</sup> Includes parking lanes as determined by the engineer.

<sup>[3]</sup> Minimum reduced by 2.0 percent for a lower layer constructed directly on crushed aggregate or recycled base courses.

<sup>[4]</sup> Minimum reduced by 1.0 percent for lower a layer constructed directly on crushed aggregate or recycled base courses.

<sup>[5]</sup> The minimum required densities for SMA mixtures are specified in the contract special provisions.

#### **460.3.3.2 Pavement Density Determination**

- (1) The engineer will determine the target maximum density using department procedures described in [CMM 8-15](#). The engineer will measure pavement density for either nuclear density or the density of sawed or cored samples. The engineer and contractor will decide which method to use before paving. A change to the method requires agreement between the engineer, contractor, and the department's quality management section. The engineer will determine density as soon as it is practical after compaction and before placement of subsequent layers or before opening to traffic. Cut pavement samples as the engineer directs and restore the surface with new, well compacted mixture.
- (2) Do not re-roll compacted mixtures with deficient density test results. Do not operate continuously below the specified minimum density. Stop production, identify the source of the problem, and make corrections to produce work meeting the specification requirements.
- (3) A lot is defined in [CMM 8-15](#) and placed within a single layer for each location and target maximum density category indicated in [table 460-3](#).
- (4) For nuclear density, the department will test 5 random samples on each lot. For the density of sawed or cored samples, the department will test 3 random samples, each with an area of at least 28 square inches, from each lot. The lot density is the average of all samples taken for that lot. The number of nuclear density tests required for legs of side roads at intersections, crossovers, turn lanes, and ramps with less than 750 tons per layer are specified in [CMM 8-15](#).
- (5) A certified nuclear density technician, or an nuclear density ACT working under a certified nuclear density technician, will locate samples and do the testing. A certified nuclear density technician certified must coordinate and take responsibility for the work an ACT performs. No more than one ACT can work under a single certified technician. The responsible certified technician will ensure that sample location and testing is performed correctly, analyze test results, and provide density results to the contractor weekly.

#### **460.3.3.3 Waiving Density Testing**

- (1) The engineer may waive density testing for one or more of the following reasons:
  1. It is not practical to determine density by the lot system.
  2. The contract contains less than 750 tons of a given mixture type placed within the same layer and target maximum density category.
- (2) If the department waives density testing notify the contractor before paving. The department will accept the mixture by the ordinary compaction procedure as specified in [450.3.2.6.2](#).

- (3) If HMA QC testing is waived under [460.2.8.2.1.3.3](#), density testing is also waived.

#### 460.4 Measurement

- (1) The department will measure the HMA Pavement bid items acceptably completed by the ton as specified in [450.4](#).

#### 460.5 Payment

##### 460.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
460.1100	HMA Pavement Type E-0.3	TON
460.1101	HMA Pavement Type E-1	TON
460.1103	HMA Pavement Type E-3	TON
460.1110	HMA Pavement Type E-10	TON
460.1130	HMA Pavement Type E-30	TON
460.1132	HMA Pavement Type E-30X	TON
460.1700	HMA Pavement Type SMA	TON
460.2000	Incentive Density HMA Pavement	DOL

##### 460.5.2 HMA Pavement

###### 460.5.2.1 General

- (1) The department will pay for the HMA Pavement bid items at the contract unit price subject to one or more of the following adjustments:
1. Disincentive for density of HMA pavement as specified in [460.5.2.2](#).
  2. Incentive for density of HMA pavement as specified in or [460.5.2.3](#).
  3. Reduced payment for nonconforming smoothness as specified in [450.3.2.9](#).
  4. Reduced payment for nonconforming QMP HMA mixtures as specified in [460.2.8.2.1.7](#).

*Revise 460.5.2.1(2) and 460.5.2.1(3) to incorporate warm mix asphalt. This change was implemented in ASP 6 effective with the Nov 2011 letting.*

- (2) Payment for HMA Pavement Type E-0.3, E-1, E-3, E-10, E-30, and E-30x is full compensation for providing HMA mixture designs; for preparing foundation; for furnishing, preparing, hauling, mixing, placing, and compacting mixture; for QMP testing and aggregate source testing; **for warm mix asphalt additives or processes**; and for all materials except asphaltic materials.
- (3) Payment for HMA Pavement Type SMA, is full compensation for providing HMA mixture designs; for preparing foundation; for furnishing, preparing, hauling, mixing, placing, and compacting the mixture; for QMP testing and aggregate source testing; and for all materials including asphaltic materials **and warm mix asphalt additives and processes**; for stabilizer, hydrated lime, and liquid antistripping agent if required.
- (4) If provided for in the plan quantities, the department will pay for a leveling layer, placed to correct irregularities in an existing paved surface before overlaying, under the pertinent paving bid item. Absent a plan quantity, the department will pay for a leveling layer as extra work.
- (5) Except for SMA mixes, the department will pay for asphaltic materials separately under the Asphaltic Materials bid items as specified in [455.5](#). Except for SMA mixes, hydrated lime or liquid antistripping agent, when required, is included in the contract price for the asphaltic material.
- (6) If the department waives density testing under [460.3.3.3](#), the department will not adjust pay under either [460.5.2.2](#) or [460.5.2.3](#).
- (7) Restore the surface after cutting density samples as specified in [460.3.3.2\(1\)](#) at no additional cost to the department.

###### 460.5.2.2 Disincentive for HMA Pavement Density

- (1) The department will administer density disincentives under the Disincentive Density HMA Pavement and the Disincentive Density Asphaltic Material administrative items. If the lot density is less than the specified minimum in [table 460-3](#), the department will reduce pay based on the contract unit price for both the HMA Pavement and Asphaltic Material bid items for that lot as follows:

**DISINCENTIVE PAY REDUCTION FOR HMA PAVEMENT DENSITY**

PERCENT LOT DENSITY BELOW SPECIFIED MINIMUM	PAYMENT FACTOR (percent of contract price)
From 0.5 to 1.0 inclusive	98
From 1.1 to 1.5 inclusive	95
From 1.6 to 2.0 inclusive	91
From 2.1 to 2.5 inclusive	85
From 2.6 to 3.0 inclusive	70
More than 3.0 <sup>[1]</sup>	_____

<sup>[1]</sup> Remove and replace the lot with a mixture at the specified density. When acceptably replaced, the department will pay for the replaced work at the contract unit price. Alternatively the engineer may allow the nonconforming material to remain in place with a 50 percent payment factor.

- (2) If the engineer directs placing HMA mixtures between October 15 and May 1 for department convenience as specified in [450.3.2.1\(5\)](#), the department will not assess a density disincentive on pavement the department orders the contractor to place when the temperature, as defined in [450.3.2.1\(2\)](#), is less than 36 F.

**460.5.2.3 Incentive for HMA Pavement Density**

- (1) If the lot density is greater than the minimum specified in [table 460-3](#) and all individual air voids test results for that mixture placed during the same day are within +1.0 percent or - 0.5 percent of the design target in [table 460-2](#), the department will adjust pay for that lot as follows:

**INCENTIVE PAY ADJUSTMENT FOR HMA PAVEMENT DENSITY**

PERCENT LOT DENSITY ABOVE SPECIFIED MINIMUM	PAY ADJUSTMENT PER TON <sup>[1]</sup>
From -0.4 to 1.0 inclusive	\$0
From 1.1 to 1.8 inclusive	\$0.40
More than 1.8	\$0.80

<sup>[1]</sup> The department will prorate the pay adjustment for a partial lot.

- (2) The department will adjust pay under the Incentive Density HMA Pavement bid item. Adjustment under this item is not limited, either up or down, to the bid amount the schedule of items shows.
- (3) The department will restrict incentive payment for shoulders paved integrally with the traffic lane, if the traffic lane does not meet incentive requirements, the department will not pay incentive on the integrally paved shoulder.