460 Hot Mix Asphalt Pavement

460.1 Description

(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 460 to HMA also apply to WMA and SMA.

460.2 Materials

460.2.1 General

(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 binder. Design mixtures conforming to table 460-1 and table 460-2.

(2) Determine the target JMF asphalt binder content for production from the mixture design data corresponding to 3.0 percent air voids (97 percent Gmm) target at the design number of gyrations (Ndes). Add liquid asphalt to achieve the required air voids at Ndes.

(3) For SMA, determine the target JMF asphalt binder content for production from the mixture design data corresponding to 4.5 percent air voids (95.5 percent Gmm) target at Ndes.

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 when tested according to AASHTO T112. Ensure that the blend conforms to the percent fractured faces and flat & elongated requirements of table 460-2. If the blend contains materials from different deposits or sources, ensure that material from each deposit or source has an LA wear percent loss meeting the requirements of table 460-2.

(3) Furnish mineral filler conforming to AASHTO M17. Ensure that it is sufficiently dry to flow freely and is essentially free from agglomerations. Ensure that filler is free from organic impurities and has a plastic index of 4 or less when tested according to AASHTO T89 and AASHTO T90.

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 106.3.4.2.2.2.

460.2.2.3 Correct errata by adding US Standard equivalent sieves. ASP 6 Nov 21 let.

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	PERCENT PASSING DESIGNATED SIEVES							
	NOMINAL SIZE							
	No. 1 (37.5 mm) (1 1/2 inch)	No. 2 (25.0 mm) (1 inch)	No.3 (19.0 mm) (3/4 inch)	No. 4 (12.5 mm) (1/2 inch)	No. 5 (9.5 mm) (3/8 inch)	No. 6 (4.75 mm) (3/16 inch)	SMA No. 4 (12.5 mm) (1/2 inch)	SMA No. 5 (9.5 mm) (3/8 inch)
50.0-mm (2-inch)	100							
37.5-mm (1 1/2-inch)	90 - 100	100						
25.0-mm (1-inch)	90 max	90 - 100	100					
19.0-mm (3/4-inch)	___	90 max	90 - 100	100			100	
12.5-mm (1/2-inch)	___	___	90 max	90 - 100	100		90 - 97	100
9.5-mm (3/8-inch)	___	___	___	90 max	90 - 100	100	58 - 80	90 - 100
4.75-mm (No. 4)	___	___	___	___	90 max	90 - 100	25 - 35	35 - 45
2.36-mm (No. 8)	15 - 41	19 - 45	23 - 49	28 - 58	32 - 67	90 max	15 - 25	18 - 28
1.18-mm (No. 16)	___	___	___	___	___	30 - 55	___	___
0.60-mm (No. 30)	___	___	___	___	___	___	18 max	18 max
0.075-mm (No. 200)	0 - 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	6.0 - 13.0	8.0 - 11.0	8.0 - 12.0
% VMA	11.0 min	12.0 min	13.0 min	14.0 min[1]	15.0 min[2]	16.0 - 17.5	16.0 min	17.0 min

[1] 14.5 for LT and MT mixes.

[2] 15.5 for LT and MT mixes.

460.2.3 Asphaltic Binders

(1) The department will designate the grade of asphaltic binder in the HMA Pavement bid item. Use the binder grade the bid item specifies. Do not change the PG binder grade without the engineer's written approval. The department will designate the grade of virgin asphaltic binder in the contract, however, the contractor may use virgin binder, modified binder, a blend of virgin and recovered binder, or a blend of modified and recovered binder.

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 a cellulose fiber stabilizing additive to SMA mixtures according to the dosage rate specified in AASHTO M 325. Feed the stabilizing additive through a separate system that uniformly proportions the required amount of stabilizer. Ensure that the system has low-level and no-flow indicators and is capable of providing a printout of the feed rate in pounds per minute. Also ensure that the stabilizer supply is visible to observe flow and feed consistency. During mixture design submittal and before approval, submit a certificate of compliance stating fibers conform to the following:

CELLULOSE FIBER QUALITY

PROPERTY	REQUIREMENT
SIEVE ANALYSIS	
METHOD A – ALPINE SIEVE ANALYSIS:	
Fiber Length	6 mm (0.25 in) maximum
Passing 0.150-mm (No. 100) sieve	70 +/- 10 percent
METHOD B – MESH SCREEN ANALYSIS:	
Fiber Length	6 mm (0.25 in) maximum
Passing 0.850-mm (No. 20) sieve	85 +/- 10 percent
Passing 0.425-mm (No. 40) sieve	65 +/- 10 percent
Passing 0.106-mm (No. 140) sieve	30 +/- 10 percent
OTHER PROPERTIES	
Ash Content	18 +/- 5 percent non-volatiles
pH	7.5 +/- 1.0
Oil Absorption	5.0 +/- 1.0 (times fiber mass)
Moisture Content	Less than 5 percent (by mass)

(2) If necessary to avoid drain down, add additional organic fiber, inorganic fiber, polymer-plastic, polymer-elastomer, or department-approved alternate stabilizer to the SMA mixture design for the remainder of the contract.

460.2.4.4 Warm Mix Asphalt Additive or Process

(1) Use additives or processes from the APL. 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] [2]	35	25

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

[2] The maximum allowable percent binder replacement, from RAS, RAP, and FRAP in combination, in an SMA mixture is 15.0 percent.

460.2.6 New procedure for recovered binder testing. ASP 6 Nov 21 let.

460.2.6 Recovered Asphaltic Binders

(1) Establish the percent of recovered asphaltic binder from FRAP, RAP, and RAS for the mixture design using automated extraction according to ASTM D8159 as modified in CMM 836.6.3.1 or according to AASHTO T164 method A or B 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 documentation of at least 2 extraction samples collected and tested within 2 months of the request unless the department approves otherwise. Submit using form “Recycled Asphaltic Binder Change Request” to a department HTCP-certified HMA Technician for production process change review as outlined in CMM 836.2. Contact BTS for the current form. Ensure that those samples were prepared 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 further testing. When the design percent asphalt binder replaced exceeds the allowable limits in 460.2.5, the contractor must:

- Document adjustments made to the mixture design in the mixture design submittal.

- Submit test results that indicate the mixture's asphaltic binder meets or exceeds the upper and lower temperature grade requirements the bid item designates.
    - If only one recycled asphaltic material source is used, furnish one of the following:
        - Test results from extracted and recovered binder from the resultant mixture.
        - Blending charts that indicate the resultant mixture's high and low temperature PG as an interpolation of the percent binder replaced between the virgin binder's and the recycled asphaltic material source binder's high and low temperature PG.
    - If two or more recycled asphaltic material sources are used, furnish test results from extracted and recovered binder from the resultant mixture.

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 CMM 866 and conforming to the requirements of table 460-1 and table 460-2. Ensure that SMA mixture designs adhere to AASHTO R 46 and AASHTO M 325 in addition to the required test procedures outlined in CMM 866 table 1 and CMM 866 table 2. Determine the specific gravity of fines or super fines used as a mineral filler or additional stabilizer in SMA designs according to AASHTO T 100. 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 CMM 866.

TABLE 460-2 MIXTURE REQUIREMENTS

Mixture type	LT	MT	HT	SMA
LA Wear (AASHTO T96)				
100 revolutions(max % loss)	13	13	13	13
500 revolutions(max % loss)	50	45	45	35
Soundness (AASHTO T104) (sodium sulfate, max % loss)	12	12	12	12
Freeze/Thaw (AASHTO T103 as modified in CMM 860.2.7) (specified counties, max % loss)	18	18	18	18
Fractured Faces (ASTM D5821 as modified in CMM 860.7.2) (one face/2 face, % by count)	65	75 / 60	98 / 90	100/90
Flat & Elongated (ASTM D4791) (max %, by weight)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	20 (3:1 ratio)
Fine Aggregate Angularity (AASHTO T304, method A, min)	40[1]	43[1]	45	45
Sand Equivalency (AASHTO T176, min)	40	40[2]	45	50
Clay Lumps and Friable Particle in Aggregate (AASHTO T112)	<= 1%	<= 1%	<= 1%	<= 1%
Plasticity Index of Material Added to Mixture Design as Mineral Filler (AASHTO T89/90)	___	___	___	<= 4
Gyratory Compaction				
Gyrations for Nini	6	7	8	7
Gyrations for Ndes	40	75	100	65
Gyrations for Nmax	60	115	160	100
Air Voids, %Va (%Gmm Ndes)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.5 (95.5)
% Gmm Nini	<= 91.5[3]	<= 89.0[3]	<= 89.0	___
% Gmm Nmax	<= 98.0	<= 98.0	<= 98.0	<= 98.0
Dust to Binder Ratio[4] (% passing 0.075/Pbe)	0.6 - 1.2[5]	0.6 - 1.2[5]	0.6 - 1.2[5]	1.2 - 2.0
Voids filled with Binder (VFB or VFA, %)	68 - 80[6] [8]	65 - 75[6] [7] [9]	65 - 75[6] [7] [9]	70 - 80
Tensile Strength Ratio (TSR) (AASHTO T283)[10] [11]				
no antistripping additive	0.75 min	0.75 min	0.75 min	0.80 min
with antistripping additive	0.80 min	0.80 min	0.80 min	0.80 min
Draindown (AASHTO T305) (%)	___	___	___	<= 0.30
Minimum Effective Asphalt Content, Pbe (%)	___	___	___	5.5

[1] For No 6 (4.75 mm) nominal maximum size mixes, the specified fine aggregate angularity is 43 for LT and 45 MT mixes.

[2] For No 6 (4.75 mm) nominal maximum size mixes, the specified sand equivalency is 43 for MT mixes.

[3] The percent maximum density at initial compaction is only a guideline.

[4] For a gradation that passes below the boundaries of the caution zone (ref. AASHTO M323), the dust to binder ratio limits are 0.6 - 1.6.

[5] For No 6 (4.75 mm) nominal maximum size mixes, the specified dust to binder ratio limits are 1.0 - 2.0 for LT mixes and 1.5 - 2.0 for MT and HT mixes.

[6] For No. 6 (4.75mm) nominal maximum size mixes, the specified VFB is 67 - 79 percent for LT mixes and 66 - 77 percent for MT and HT mixes.

[7] For No. 5 (9.5mm) and No. 4 (12.5 mm) nominal maximum size mixtures, the specified VFB range is 70 - 76 percent.

[8] For No. 2 (25.0mm) nominal maximum size mixes, the specified VFB lower limit is 67 percent.

[9] For No. 1 (37.5mm) nominal maximum size mixes, the specified VFB lower limit is 67 percent.

[10] WisDOT eliminates freeze-thaw conditioning cycles from the TSR test procedure.

[11] Run TSR at asphalt content corresponding to 3.0% air void regressed design, or 4.5% air void design for SMA, using distilled water for testing.

460.2.8 Quality Management Program

460.2.8.1 General

(1) Provide and maintain a QC program defined as all activities, including mixture design, process control inspection, sampling and testing, and process adjustments related to producing and placing HMA pavement conforming to the specifications.

(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.

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 technician minimally qualified as an HTCP-certified Hot Mix Asphalt, Technician I, Production Tester (HMA-IPT) 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 personnel with QC responsibilities. Keep the chart updated.

(2) Ensure that sampling and testing personnel are minimally qualified as follows[1]:

- HMA technician certified at a level appropriate for sampling, Transportation Materials Sampling Technician (TMS).
- HMA technician certified at a level appropriate for production control testing (HMA-IPT).
- Assistant Certified Technician (ACT)[2].

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

[2] An HTCP-certified HMA technician must coordinate and take responsibility for the work an ACT performs. No more than one ACT can work under a single HTCP-certified technician.

(3) Have an HMA-IPT technician ensure that sampling and testing is performed correctly, analyze test results, and post resulting data.

(4) Have an HTCP-certified Hot Mix Asphalt, Trouble Shooting, Process Control (HMA-TPC) technician or HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technician 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 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 836. 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 contract 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 the frequency indicated:

Blended aggregate gradations:

Drum plants:

- Field extraction by ignition oven according to AASHTO T308 as modified in CMM 836.6.3.6, chemical extraction according to AASHTO T-164 method A or B; or automated extraction according to ASTM D8159 as modified in CMM 836.6.3.1. Gradation of resulting aggregate sample determined according to AASHTO T30.

- 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 ignition oven according to AASHTO T308 as modified in CMM 836.6.3.6, chemical extraction according to AASHTO T-164 method A or B; or automated extraction according to ASTM D8159 as modified in CMM 836.6.3.1. Gradation of resulting aggregate sample determined according to AASHTO T30.

Asphalt content (AC) in percent:

AC by ignition oven according to AASHTO T308 (CMM 836.6.3.6), by chemical extraction according to AASHTO T-164 method A or B; or by automated extraction according to ASTM D8159 as modified in CMM 836.6.3.1. Gradation of resulting aggregate sample determined according to AASHTO T30.

Bulk specific gravity of the compacted mixture:

According to AASHTO T166 as modified in CMM 836.6.5.

Theoretical maximum specific gravity:

According to AASHTO T209 as modified in CMM 836.6.6.

Air voids (Va) by calculation according to AASHTO T269.

VMA by calculation according to AASHTO R35.

(5) Test each design mixture at the following frequency:

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

[1] Frequencies are for planned production. If production is other than planned, conform to CMM 836.

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

(6) Conduct TSR tests during mixture production according to CMM 836.6.14. 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 production TSR values are below the limit specified in CMM 836.6.14, 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 for bid items with less than 500 tons of mixture. If testing is waived, acceptance will be by visual inspection unless defined otherwise by change order.

460.2.8.2.1.3.4 Temporary Pavements

(1) The engineer may waive 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 observations, inspection records, mixture adjustments, and test results daily. Note observations and inspection records in a permanent field record as they occur. Record 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 each mixture design, 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. Record data on the standardized control charts as follows:

- Blended aggregate gradation tests in percent passing. Of the following, plot sieves required in table 460-1: 37.5-mm, 25.0-mm, 19.0-mm, 12.5-mm, 9.5-mm, 4.75-mm, 2.36-mm, 1.18-mm, 0.60-mm, and 0.075-mm.
- 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. 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

(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
4.75-mm	+/- 5.0	+/- 4.0
2.36-mm	+/- 5.0	+/- 4.0
1.18-mm	+/- 4.0	+/- 3.0
0.60-mm	+/- 4.0	+/- 3.0
0.075-mm	+/- 2.0	+/- 1.5
Asphaltic binder content in percent	- 0.3	- 0.2
Air voids in percent[1]	+1.3/-1.0	+1.0/-0.7
VMA in percent[2]	- 0.5	- 0.2

[1] For SMA, JMF limits are +/-1.3 and warning limits are +/-1.0.

[2] VMA limits are based on requirements for each mixture design nominal maximum aggregate size in table 460-1. For No. 6 (4.75mm) mixes, JMF limits are +/- 0.5 and warning limits are +/- 0.2.

(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 CMM 836.6.13.1. Have an HTCP-certified Hot Mix Asphalt, Trouble Shooting, Process Control (HMA-TPC) technician or HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technician submit a written JMF adjustment request. Ensure that the resulting JMF is within specified master gradation bands. The department will have an HMA-MD technician review the proposed adjustment and, if acceptable, issue a revised JMF.

(2) The department will not allow adjustments that do the following:

- Exceed specified JMF tolerance limits.
- Reduce the JMF asphalt content unless the production VMA running average meets or exceeds the minimum VMA design requirement defined in table 460-1 for the mixture produced.

(3) Have an HMA-TPC technician make related process adjustments. If mixture redesign is necessary, have an HMA-MD technician submit a new JMF, subject to the same specification requirements as the original JMF.

460.2.8.2.1.7 Corrective Action

(1) When running average values trend toward the warning limits, consider taking corrective action. Document corrective action undertaken. Include 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, 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) 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.

(7) If the air voids running average of 4 exceeds the JMF limits, the material is nonconforming. Remove and replace unacceptable material. The engineer will determine the quantity of material to replace based on the testing data using the methods in CMM 836 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 as specified in 460.5.2.1. For SMA, if one QC air voids test falls outside of the JMF limits, notify the department and consider corrective action. If two or more individual QC air voids tests within the four-point running average exceed the JMF limits, the material is nonconforming and subject to pay adjustment as 460.5.2.1(5) footnote 3 specifies.

(8) If the running average of 4 exceeds the JMF limits for other properties, and the engineer allows the mixture to remain in place, the department will pay for the mixture as specified in 460.5.2.1. The engineer will determine the quantity of material subject to pay reduction based on the testing data and an inspection of the completed pavement.

460.2.8.3 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 HTCP-certified Transportation Materials Sampling Technician (TMS) technician to observe QV sampling of project mixtures.

(2) An HTCP-certified Hot Mix Asphalt, Technician I, Production Tester (HMA-IPT) or an HMA ACT working under the HTCP-certified technician, will split samples and do the testing. An HMA-IPT technician will 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-IPT technician will ensure that 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 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. 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 836. 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 specified in 460.2.8.3.1.4(3), 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 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 (Va) by calculation according to AASHTO T269.

VMA by calculation according to AASHTO R35.

Asphalt content by ignition oven according to AASHTO T308 as modified in CMM 836.6.3.6, chemical extraction according to AASHTO T-164 method A or B, or automated extraction according to ASTM D8159 as modified in CMM 836.6.3.1.

(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 5,000 tons	one test
More than 5,000 tons	add one test for each additional 5,000-ton increment

460.2.8.3.1.5 Documentation

(1) The engineer will document observations during QV sampling, and review QC mixture adjustments and QC 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:

- Va is within a range of 2.0 to 4.3 percent. For SMA, Va is within a range of 3.2 to 5.8 percent.
- VMA is within minus 0.5 of the minimum requirement for the mixture design nominal maximum aggregate size.
- Asphalt content is within minus 0.3 percent of the JMF.

(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 836. 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 for 100 percent pay, the BTS AASHTO accredited laboratory and certified personnel will referee test the retained portion of the QV sample and the retained portion of the required forward and backward QC retained samples according to CMM 836.

(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 according to CMM 836.

460.2.8.3.1.8 Corrective Action

(1) Remove and replace unacceptable material.

(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 point. The department will pay for the affected mixture as specified in 460.5.2.1.

(3) Remove and replace areas of SMA where excessive bleeding problems, fat spots, or segregation occur. If these areas are identified before or during inspection of the completed pavement, the department will determine the amount of material affected. If the contractor disputes the engineer's assessment, the engineer will refer the dispute to BTS. If disputed, the engineer will document the

areas of affected pavement within 24 hours of identification and provide that documentation to BTS as soon as available. The engineer's documentation will include but is not limited to the following:

- Pictures of the material in question.
- Station locations.
- Lanes affected.
- Length and width of the affected area.
- Other relevant information.

460.2.8.3.2 Independent Assurance Testing

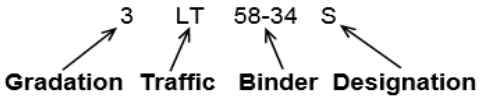
(1) The department will evaluate both the contractor and department testing personnel and equipment as specified in 106.3.4.3.4.

460.3 Construction

460.3.1 General

(1) Construct HMA pavement of the type the bid item indicates encoded as follows:

COMBINED BID ITEM ENCODING



GRADATIONS (NMAS)		TRAFFIC VOLUME		BINDER DESIGNATION LEVEL	
1	37.5 mm	LT	Low	S	Standard
2	25.0 mm	MT	Medium	H	Heavy
3	19.0 mm	HT	High	V	Very Heavy
4	12.5 mm	SMA[1]		E	Extremely Heavy
5	9.5 mm				
6	4.75 mm				

[1] SMA mixtures are limited to nominal size No. 4 (12.5 mm) or No. 5 (9.5 mm) and binder designation levels H, V, or E.

(2) 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)	MAX LOWER LAYER THICKNESS (in inches)	MAX UPPER LAYER THICKNESS (in inches)	MAX SINGLE LAYER THICKNESS[3] (in inches)
No. 1 (37.5 mm)	4.5	6	4.5	6
No. 2 (25.0 mm)	3.0	5	4	6
No. 3 (19.0 mm	2.25	4	3	5
No. 4 (12.5 mm)[1]	1.75	3[2]	2.5	4
No. 5 (9.5 mm)[1]	1.25	3[2]	2	3
No. 6 (4.75 mm)	0.75	1.25	1.25	1.25

[1] SMA mixtures use nominal size No. 4 (12.5 mm) or No. 5 (9.5 mm).

[2] SMA mixtures with nominal sizes of No. 4 (12.5 mm) and No. 5 (9.5 mm) have no maximum lower layer thickness specified.

[3] For use on cross-overs and shoulders.

(2) Place leveling layers using No. 4 (12.5 mm), No. 5 (9.5 mm), or No. 6 (4.75 mm) mixtures. Leveling layers may be thinner than the minimum lower layer thickness for the mixture used.

(3) Place wedging layers as the contract specifies or engineer directs. Wedging layers have no specified minimum or maximum thickness.

460.3.3 HMA Pavement Density Maximum Density Method

460.3.3.1 Minimum Required Density

(1) Compact No. 6 mixtures in lower layers as specified in 450.3.2.6.2 and in upper layers as specified in 450.3.2.6.3. For other HMA mixtures, compact layers to the density table 460-3 specifies.

TABLE 460-3 MINIMUM REQUIRED DENSITY[1]

LOCATION	LAYER	PERCENT OF TARGET MAXIMUM DENSITY		
		MIXTURE TYPE		
		LT and MT	HT	SMA
TRAFFIC LANES[2]	LOWER	93.0[3] [5]	93.0[4] [5]	___
	UPPER	93.0	93.0	93.0
SHOULDERS & APPURTENANCES	LOWER	91.0[5]	91.0[5]	___
	UPPER	92.0	92.0	92.0

[1] 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 will investigate the acceptability of that material according to CMM 815.11.

[2] Includes side roads, crossovers, turn lanes, ramps, parking lanes, bike lanes, and park-and-ride lots as defined by the contract plans.

[3] Minimum reduced by 2.0 percent for a lower layer constructed directly on cold in-place recycle (CIR), crushed aggregate, or recycled base courses.

[4] Minimum reduced by 1.0 percent for a lower layer constructed directly on cold in-place recycle (CIR), crushed aggregate or recycled base courses.

[5] Minimum reduced by 1.0 percent for a 1.25-inch thick No.5 mix lower layer constructed on a paved or milled surface.

460.3.3.2 Pavement Density Determination

(1) The engineer will determine the target maximum density using department procedures described in CMM 815. The engineer will determine density as soon as practicable after compaction and before placement of subsequent layers or before opening to traffic.

(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 815 and placed within a single layer for each location and target maximum density category indicated in table 460-3. The lot density is the average of samples taken for that lot. The department determines the number of tests per lot according to CMM 815.

(4) An HTCP-certified Nuclear Density Technician I (NUCDENSITYTEC-I) or a nuclear density ACT working under a NUCDENSITYTEC-I technician, will locate samples and perform the testing. A NUCDENSITYTEC-I technician will coordinate and take responsibility for the work an ACT performs. No more than one ACT can work under a single NUCDENSITYTEC-I technician. The responsible NUCDENSITYTEC-I 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 impracticable 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.

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:

ITEM NUMBER	DESCRIPTION	UNIT
460.5000 - 5999	HMA Pavement (gradation) LT (binder)(designation)	TON

460.6000 - 6999	HMA Pavement (gradation) MT (binder)(designation)	TON
460.7000 - 7999	HMA Pavement (gradation) HT (binder)(designation)	TON
460.8000 - 8999	HMA Pavement (gradation) SMA (binder)(designation)	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 460.5.2.3.
3. Reduced payment for smoothness not conforming to 450.3.2.9.
4. Reduced payment for nonconforming QMP HMA mixtures as specified in 460.2.8.2.1.7.

(2) Payment for the HMA Pavement bid items is full compensation for providing HMA pavement including binder; for mixture design; for preparing the foundation; and for QMP and aggregate source testing. The department will pay separately for tack coat under the Tack Coat bid item as specified in 455.5.

(3) 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.

(4) The department will administer pay reduction for nonconforming QMP mixture under the Nonconforming QMP HMA Mixture administrative item. The department will reduce pay based on the contract unit price for the HMA Pavement bid item.

(5) The department will reduce pay for nonconforming QMP HMA mixtures as specified in 460.2.8.2.1.7, starting from the stop point to the point when the running average of 4 is back inside the warning limits. The engineer will determine the quantity of material subject to pay reduction based on the testing data and an inspection of the completed pavement. The department will reduce pay as follows:

PAYMENT FOR MIXTURE[1] [3] [4]

ITEM	PRODUCED WITHIN WARNING BANDS	PRODUCED OUTSIDE JMF LIMITS
Gradation	90%	75%
Asphalt Content[5]	___	___
Air Voids	70%	50%
VMA	90%	75%

[1] For projects or plants where the total production of each mixture design requires less than 4 tests refer to CMM 836.

[2] If SMA material is nonconforming for air voids as defined in 460.2.8.2.1.7(7), the department will pay 80% of the contract unit price for the material from the point where an individual test is outside the JMF limit until another individual QV or QC test is within the JMF limits.

[3] Payment is in percent of the contract unit price for the HMA Pavement bid item. The department will reduce pay based on the nonconforming property with lowest percent pay. If the quantity of material subject to pay adjustment based on the running average of 4 is also subject to pay adjustment resulting from dispute resolution under 460.2.8.3.1.7, or is nonconforming for air voids as defined in 460.2.8.2.1.7(7), the department will apply the single pay adjustment resulting in the lowest percent pay.

[4] In addition to any pay adjustment listed in the table above, the department will adjust pay for nonconforming binder under the Nonconforming QMP Asphaltic Material administrative item. The department will deduct 25 percent of the contract unit price of the HMA Pavement bid item per ton of pavement placed with nonconforming PG binder the engineer allows to remain in place.

[5] The department will not adjust pay based on a running average of 4 asphalt content tests; however, corrective action will be applied to nonconforming material according to 460.2.8.2.1.7.

(6) If during a QV dispute resolution investigation the department discovers unacceptable mixture defined by one or more of the following:

- Va less than 2.5 or greater than 6.5 percent for SMA, or for other mixes, less than 1.5 or greater than 5.0 percent.
- VMA more than 1.0 percent below the minimum or above the maximum specified in table 460-1.
- AC more than 0.5 % below the JMF target.

Remove and replace the material, or if the engineer allows the mixture to remain in place, the department will pay for the quantity of affected material at 50 percent of the contract price.

(7) 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.

(8) 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 administrative item. 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 the HMA Pavement bid item 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[1]	___

[1] 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) The department will not assess density disincentives for pavement placed in cold weather because of a department-caused delay as specified in 450.5.2(3).

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 QC and QV air voids test results for that mixture placed during the same day are within 2.5 - 4.0 percent, or for SMA 4.0 - 5.5 percent, 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[1]
From -0.4 to 1.0 inclusive	$0
From 1.1 to 1.8 inclusive	$0.40
More than 1.8	$0.80

[1] 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) 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.

(4) SMA lots containing an individual density test result greater than 97.0 percent Gmm will not be eligible for incentive pay adjustment.

(5) Only contracts subject to both density and mixture air void testing will be eligible for density incentive.