ITEM 20

ASPHALT PAVEMENT

ITEM 20

ASPHALT PAVEMENTS

20.1 DESCRIPTION

This work shall consist of providing a bituminous mixture to be placed in one or more lifts over a prepared aggregate base or underlying subgrade as shown on the plans, or as directed by the **AGENCY**. The **CONTRACTOR** shall be responsible for Quality Control (QC) of the bituminous mixture; including the design, and control of the quality of the material incorporated into the project. The **AGENCY** will be responsible for Quality Assurance (QA); including testing, to assure the quality of the material incorporated into the project meet design parameters. The following specifications include general requirements applicable to all types of plant mixed asphaltic pavements. The work consists of one or more lifts of an asphalt mixture constructed on a prepared subgrade foundation. The work shall meet the requirements within the contract documents and in conformity with the lines, grades, thickness, and design cross sections as shown on the plans or established by the Agency's representative.

This specification is to provide a pavement with adequate thickness and quality to provide a serviceable life of at least 30 years. It is also the intent of this document to provide construction requirements in accordance with these specifications to a higher standard of practice. This item shall include all labor, equipment, and materials to manufacture, place, and compact asphaltic concrete for roadway pavement purposes.

A. Definition of Terms

Wherever the following abbreviations are used in the specifications or other contract documents, the intent and meaning will be interpreted as shown below:

AASHTO	American Association of State Highway & Transportation Officials
ASTM	American Society for Testing & Materials
HMA	Hot Mixed Asphalt
CP-##	Colorado Department of Transportation: Field Materials Manual (Colorado Testing Procedures)
CP-L ####	Colorado Department of Transportation: Laboratory Manual of Test Procedures (Lab Testing Procedures)
RAP	Reclaimed Asphalt Pavement
RAS	Reclaimed Asphalt Shingles
HMA	Hot Mix Asphalt Pavement
SMA	Stone Matrix Asphalt
WMA	Warm Mix Asphalt Pavement

B. Contractor Process Control

At least 30 days prior to placing any mixture on the project, the **CONTRACTOR** shall submit a mix design for acceptance.

The **CONTRACTOR** shall assume full responsibility for controlling all operations and processes such that the requirements of the Specifications are met at all

times. The **CONTRACTOR** shall perform any tests necessary at the plant and on site for process, control purposes and maintains a log of all process control testing. The Project Manager's representative will use both Quality Assurance (QA) and Quality Control (QC) test results when determining acceptability.

Prior to use on the project the **CONTRACTOR** shall submit a quality control plan that addresses production, sampling, testing, qualifications of testing personnel, timing, and methods for making adjustments to assure compliance with the specifications. The **CONTRACTOR** will provide a process or schedule for making corrections for material that was placed but does not meet specifications as well as obtain a follow up sample immediately after corrective actions are taken to assess the adequacy of the corrections. In the event the follow-up process control sample also fails to meet Specification requirements, the **CONTRACTOR** shall cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the QC Manager and Project Manager.

20.2 MATERIALS

Asphalt mixtures will consist of various aggregates, filler, hydrated lime, and asphalt binder. If stated in the contract document, Asphalt mixtures may contain Reclaimed Asphalt Pavement (RAP), Reclaimed Asphalt Shingles (RAS), as well as a variety of binders and additives.

A. Aggregate

Asphalt material aggregate shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel, or crushed slag. The material shall not contain clay balls, vegetable matter, rounded aggregate, or other deleterious substances, and shall meet the following requirements:

TABLE 20.2A-1
Aggregate Properties

Aggregate Test Property	Coarse: Retained on #4	Fine: Passing the #4
Fine Aggregate Angularity, CP-L 5113 Method A or AASHTO T 304 (Does not apply to RAP or RAS aggregates		45% Min
Two Fractured Faces, ASTM D 5821 SG Mixtures Top and Middle Lifts Bottom Lifts SMA Mixtures	 90% Min. 80% Min. 70% Min. 100% required	
LA Abrasion, AASHTO T 96	45% Max.	
Flat and Elongated (Ratio 5:1) %, AASHTO M 283	10% Max.	
Sand Equivalent. AASHTO-T 176		45% Min.
Micro Deval AASHTO T 327	18% Max for individual materials 20% Max. for combined sample	

TABLE 20.2A-2

Dense Graded Asphalt Material Gradation Range
(Percent by Weight Passing Square Mesh Sieves, AASHTO T 11 & T 27)

Mixture Grading	ST (3/8" Nominal)	SX (1/2" nominal)	S (3/4" nominal)	G (1" nominal)
Traffic Loading,	Repair Segregation Bike path Sidewalk	Low to Medium 0 to 300,000 Top Lift only	Medium To High >300,000	All Loading Lower lifts
Sieve Size	Control Points	Control Points	Control Points	Control Points
11/2"				100
1"			100	90-100
3/4"		100	90-100	@
1/2"	100	90-100	@	@
3/8"	90-100	@	@	@
#4	@	@	@	@
#8	28-58	28-58	23-49	19-45
#16	@	@	@	@
#30	@	@	@	@
#50	@	@	@	@
#200**	2.0-10.0	2.0-8.0	2.0-7.0	1.0-7.0

**These limits shall include the required 1% of lime by weight.

@ These sieve sizes used to determine the final Job Mix Formula (JMF) in accordance with Section 20.2B.

TABLE 20.2A-3

SMA Aggregate Gradation Range Properties
(Percent by Weight Passing Square Mesh Sieves, AASHTO T 11 & T 27)

Sieve Size	**Stone Mastic Grading Designation for Top Layer for Traffic Loading in High Range greater than 3.0 Million ESALs** (Percent by Weight Passing Square Mesh Sieves)	
	½" Nominal	**¾" Nominal**
25 mm (1")		100
19.0 mm (3/4")	100	90-100
12.5 mm (1/2")	90-100	50-88
9.5 mm (3/8")	50-80	25-60
4.75 mm (#4)	20-35	20-28
2.36mm (#8)	16-24	16-24
1.18mm (#16)	@	@
600 μm (#30)	12-18	12-18
300 μm (#50)	@	@
150 μm (#100)	@	@
75 μm (#200)	8-11	8-11

@ These sieve sizes used only to determine the final Job Mix Formula (JMF) in accordance with Section 20.2B.

B. Reclaimed Asphalt Pavement (RAP)

Material may be used only where specifically allowed and shall be of uniform quality and gradation with a maximum size no greater than the nominal aggregate size of the mix. Grading G shall not contain more than 35% RAP. All other gradations may contain up to 25% or as specified in the construction documents. The allowable percentage of RAP or recycled materials allowed will be listed in the construction documents and may vary by pavement layer. When RAP content is greater than 15%, the in-place properties of the binder will need to meet the required Performance-Graded Binder as tested using Dynamic Shear testing procedure TP 5. TP 5 shall be performed during the initial mix design and periodically throughout the paving season, at a suggested rate of one test per every 20,000 tons per mix design.

RAP if allowed in the Asphalt mixture shall be of uniform quality and gradation with a maximum size particle no greater than the maximum size allowed in the mixture. HMA mixtures containing RAP shall meet the same graduation requirements as a virgin HMA mix. The **AGENCY** may determine the allowable percentage of RAP to be utilized in the top lift, The **AGENCY** may allow a maximum of 25% RAP in mixture grading S may be allowed in layers below the

top lift or a maximum of 35% RAP in mixture grading G. RAP or RAS are not allowed in Stone Mastic Asphalt Mixtures.

The reclaimed asphalt pavement shall meet all the requirements for Asphalt Pavements, as contained herein. The **CONTRACTOR** shall have an approved mix design for HMA with RAP prior to placement and shall include the asphaltic binder and virgin aggregate that are to be used to meet the requirements contained herein.

The **CONTRACTOR** shall maintain separate stockpiles for each type of RAP material. All processed material shall be free of foreign materials and segregation shall be minimized. Any RAP material that cannot be readily broken down in the mixing process, and/or affects the paving operation, shall be processed prior to mixing with the virgin material.

Fine Aggregate Angularity requirements shall not apply to RAP aggregate. RAP shall not contain clay balls, vegetable matter, or other deleterious substances.

Verification testing for asphalt content and gradation will be performed on RAP at the frequencies listed on Table 20.2B-1, below. The Asphalt Supplier shall provide testing results on RAP, and RAP/RAS mixtures daily. The Asphalt Supplier shall provide results of tests for properties listed in this specification.

When RAP is allowed for use in Asphalt mixtures, the following additional conditions shall apply:

The aggregate obtained from the processed RAP shall be 100% passing the 1" sieve. The aggregate and binder obtained from the processed RAP shall be uniform in all the measured parameters to the mix design submitted in accordance with the following:

Table 20.2B-1
RAP Aggregate Uniformity Tolerances

Element	Uniformity*
Binder Content	0.5
% Passing ¾"	4.0
% Passing ½"	4.0
% Passing 3/8"	4.0
%Passing #4	4.0
% Passing #8	4.0
% Passing #30	3.0
% Passing #200	1.5

*Uniformity is the Maximum allowable Standard Deviation of test results of processed RAP.

C. Quality Control (QC) Plan for RAP

A QC plan details how the RAP will be processed and controlled shall be developed and followed by the Asphalt Producer/ Contractor and shall address the following:

A schematic diagram and narrative that explains their RAP processing techniques required for crushing, screening, rejecting, and stockpile operation for normal plant operation,

The control of RAP Asphalt Binder Content with a minimum testing frequency of 1/1,000 tons of processed RAP material (minimum 3 tests) for most recent production of the mix,
The control of RAP Gradation (AASHTO T-30) with a minimum testing frequency of 1/1,000 tons of processed RAP material (minimum 3 tests) for most recent production of the mix,

Process control charts shall be maintained for binder content and each screen when RAP material is added to the stockpile. Separate control charts for each RAP stockpile shall be maintained. These charts shall be displayed and shall be provided upon request.

D. Reclaimed Asphalt Shingles (RAS)

When allowed by the construction documents RAS may be allowed in Asphalt Mixtures up to a maximum of 5 percent of the total weight of the mix for all lifts other than the top lift, provided all specifications for HMA are met. **Mixtures with more than 3 percent RAS shall not be used in the top lift of any asphalt pavement.** RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. Post-consumer (tear off) asphalt shingles shall be in accordance with AASHTO MP 15 and prepared by approved asbestos management facilities shall operate in accordance with this plan and maintain all necessary state issued operating facility permits as required. A copy of this letter shall be submitted to the **AGENCY**. Deleterious material present in post-consumer asphalt shingles shall be limited to the percentages stated in AASHTO MP 15. Pre-consumer and post-consumer asphalt shingles shall not be blended for use in HMA mixtures and shall be stockpiled separately from other materials.

The in-place properties of the binder will meet the required for the specified Performance-Graded Binder as stated in Table 20.2H-1

RAS material shall not contain clay balls or vegetative matter. Deleterious substances such as metals, glass, rubber, soil, brick, tar-paper, wood, or plastic shall not exceed 1.5% by weight as verified by test results run for every 5,000 tons of mix or fraction thereof. The **CONTRACTOR** shall provide test results verifying no asbestos has been detected in the RAS and certified as meeting EPA NESHAP requirements.

RAS will be ground to meet AASHTO PP 53 requirements. The RAS shall be sampled and tested for gradation at a frequency of every 5,000 tons or at least once per day during production.

RAS samples collected and analyzed, for the purpose of identifying properties of RAS as defined in this specification, shall be representative of the RAS that will be used in the HMA production.

The moisture content of the RAS shall at no time exceed 15% by mass.

The **CONTRACTOR** shall have an approved mix design for the amount of RAS to be used. The AC content of the RAS utilized in the **CONTRACTOR** RAS mix design shall be the average AC content determined in accordance with 1B below. The AC content of the RAS utilized in the mix design shall be determined in accordance with AASHTO T164, Method A or B. The **CONTRACTOR** may use both RAS and RAP in the mix design. The **CONTRACTOR** shall determine the total binder replacement by the binder in the RAS and RAP and the percentage of virgin binder in the HMA pursuant to AASHTO PP 53 methods and the following equation:

Total Binder Replacement = ((A x B) + (C x D)) x 100/E

Where: A= RAP% binder Content*
B= RAP% in Mix*
C=RAS % Binder Content*
D= RAS % in Mix*
E = Total Effective Binder Content*
*In decimal format

The Total Binder Replacement by the binder in the RAS and/or RAP shall not exceed 30% of the effective binder content of either the mix design or the production mix.

The **CONTRACTOR** may uniformly blend sand or fine aggregate with RAS in the stockpiles if needed to keep the processed material workable. The sand or fine aggregate added must be considered in the final gradation of the HMA design.

HMA with RAS and/or RAP shall be tested in accordance with the above section. Project verification testing for asphalt content and gradation will be performed at the frequency noted in the above section.

The **CONTRACTOR** shall have an approved Quality Control (QC) Plan that details how the RAS will be processed and controlled. The QC plan shall address the following:

RAS Processing Techniques:
This requires a schematic diagram and narrative that explains the processing (crushing, screening, and rejecting) and stockpile operation for the project.

Determination and Control of RAS Asphalt Binder Content shall be determined by (AASHTO T 164, Method A or B) at a frequency of 1/1,000 tons of processed RAS material.

Control of RAS Gradation (AASHTO T 30): Testing of RAS shall be at a frequency of 1/1,000 tons of processed RAS material.

Process Control Charts shall be maintained for binder content and gradation, during addition of any RAS material to the stockpile. The **CONTRACTOR** shall maintain separate control charts for each RAS stockpile. The control charts shall be displayed and shall be made available to the Agency upon request.

Asbestos content of RAS:

Test RAS sample for asbestos at a frequency of 1/1,000 tons of processed RAS material.

Moisture content of RAS:
Testing at a frequency of 1/day
Deleterious Material Frequency of 1/100 tons of RAS material utilized.

The processed RAS shall meet the following gradation requirements:

Table 20.2D-1
Shingle Aggregate Gradation

Sieve Size	Percent Passing by Mass
3/8 in	100
No.4	95
No.8	85
No. 16	70
No. 30	50
No. 50	45
No. 100	35
No. 200	25

The aggregate and binder obtained from the processed RAS shall be uniform in all the measured parameters to during production, the asphalt mixture shall be in accordance with the approved mix design and in accordance with the following:

Table 20.2D-2
Uniformity* Tolerances

Element	Uniformity*
Binder Content	0.5
% Passing 19 mm (¾")	4.0
% Passing 12.5 mm (½")	4.0
% Passing 9.5 mm (⅜")	4.0
%Passing 4.75 mm (#4)	4.0
% Passing 2.36 mm (#8)	4.0
% Passing 600 μm (#30)	3.0
% Passing 75 μm (#200)	1.5

*Uniformity is the Maximum allowable Standard Deviation of test results of processed
RAS.

The **CONTRACTOR** shall supply a Performance Graded Binder which meets the AASHTO MP-1 specifications for one temperature grade lower for both the high and low end than that specified in the contract when RAS is included in the mix. For example, if the Contract originally specified a PG 64-22, the **CONTRACTOR** shall supply a binder meeting the AASHTO MP-1 specifications for a PG 58-28, subject to **AGENCY** approval.

The **CONTRACTOR** shall supply the **AGENCY** with total binder grading tests from production samples collected when utilizing RAP and RAS.

Warm Mix Asphalt Provisions
Warm Mix Asphalt (WMA) is the generic term used to describe the reduction in production, paving and compaction temperatures achieved through the application of one of several WMA technologies. The producer shall submit a mix design for Warm Mix Asphalt production, or submit a statement that details production and testing items that require attention if the design is performed by standard HMA practice. All provisions for the production and placement of conventional hot mix asphalt (HMA) mixtures as stipulated in above sections except as noted below.

E. Mix Requirements:

One or a combination of several technologies involving hot mix asphalt plant foaming processes and equipment, mineral additives, or chemicals that allows the reduction of mix production temperatures by as much as 100°F. A WMA mixture design shall identify the technology to be used. The producer shall comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix. Comply with the manufacturer's recommendations regarding receiving, storage, and delivery of additives. Maintain supplier recommendations on file at the asphalt mixing plant, make available for reference while producing WMA, and be available to the **AGENCY** upon request.

F. Warm Mix Asphalt (Technologies):

WMA designs shall be developed using the specified additives or method. Each WMA design shall specify the production temperatures recommended by the WMA additive manufacturer to be used in production of Warm Mix Asphalt.
Chemical Modifiers to be considered are:

- The addition of a synthetic zeolite called Aspha-Min® during mixing at the plant to create a foaming effect in the binder.
- A two-component binder system called WAM-Foam® (Warm Asphalt Mix Foam), which introduces a soft binder and hard foamed binder at different stages during plant production.
- The use of organic additives such as Sasobit®, a Fischer-Tropsch paraffin wax and Asphaltan B®, a low molecular weight esterified wax.
- Plant production with an asphalt emulsion product called Evotherm™, which uses a chemical additive technology and a "dispersed asphalt technology" delivery system.
- The addition of a synthetic zeolite called Advera® WMA during mixing at the plant to create a foaming effect in the binder.

Foamed WMA technologies must be submitted to and approved by the **AGENCY** for use on a specific project or asphalt layer.

G. Mineral Filler

Mineral filler for use with Stone Matrix Asphalt (SMA) pavement may consist of limestone dust or any other material filler that will meet the requirements of this

subsection and have a maximum Plasticity Index (AASHTO T 90) of less than or equal to 4.0 %.

The **CONTRACTOR** shall submit hydrometer analysis (AASHTO T 88) for the gradation of mineral filler used in the SMA mixture.

H. Performance Graded Asphalt Binders

The **CONTRACTOR** shall provide to the **AGENCY** acceptable 'Certifications of Compliance' of each applicable asphalt binder grade from the supplier. Should testing or certificate show nonconformance with the specifications, the asphalt binder may be rejected**.** When production begins, the **CONTRACTOR** shall, upon request, provide to the **AGENCY** a one quart can of each specified asphalt binder for analysis. Additionally, the **CONTRACTOR** shall provide the refinery test results that pertain to the asphalt binders used during production.

Asphalt binder shall meet the requirements of the Superpave Performance-Graded Binders (PG) as presented in Table 20.2H-1.

TABLE 20.2H-1
Properties of Performance Graded Binders

Usage for each Binder Grade	**PG 58-28**	**PG 64-22**	**PG 76-28**
Traffic Loading, Total 18 kip ESALs Over Design Life (20 to 30 Years)	Low Volume (0-300,000)	>300,000 to <3.0 Million	>3.0 Million
Superpave Compactor Design gyrations Recommended Usage	N_{design} = 50	N_{design} = 75	N_{design} = 100
Property of Binder Grade	**PG 58-28**	**PG 64-22**	**PG 76-28**
Flash Point Temperature, ºC, AASHTO T 48	230 Min.	230 Min.	230 Min.
Viscosity at 135 ºC, Pas, ASTM D 4402	3 Max.	3 Max.	3 Max.
Dynamic Shear, Temperature ºC, where C*/Sin δ @ 10 rad/sec. ≥ 1.00 Kpa, AASHTO TP 5	58 º C	64 º C	76 º C
Rolling Thin Film Oven Residue Properties, AASHTO T 240			
Mass Loss, %, AASHTO T 240	1.00 Max.	1.00 Max.	1.00 Max.
Dynamic Shear, Temperature ºC, where G*/Sin δ @ 10 rad/sec. ≥ 2.20 Kpa, AASHTO TP 5	58 º C	64 º C	76 º C
Elastic Recovery1, 25°C, % Min.*	N/A	N/A	50 Min.
Pressure Aging Vessel Residue Properties, Aging Temperature 100 ºC AASHTO PP1			
Dynamic Shear, Temperature ºC, where G*/Sin δ @ 10 rad/sec. ≤ 5,000 Kpa, AASHTO TP 5	19 º C	25 º C	28 º C
Creep Stiffness, @ 60 sec. Test Temperature in ºC, AASHTO TP 1	-18 º C	-12 º C	-18 º C
S, Mpa, AASHTO TP 1	300 Max.	300 Max.	300 Max.
m-value, AASHTO TP 1	0.300 Min.	0.300 Min.	0.300 Min.
**Direct Tension Temperature in ºC, @ 1.0 mm/min., Where Failure Strain >1.0%, AASHTO TP 3	-18 º C	-12 º C	-18 º C

*Elastic Recovery by Task Force 31, Appendix B Method
** Direct tension measurements are required when needed to show conformance to AASHTO MP.1
*** Agency is to determine PG Binder

I. Additives

Hydrated Lime shall be added at the rate of 1% by dry weight of the aggregate and shall be included in the amount of material passing the No. 200 sieve. Hydrated lime for aggregate pretreatment shall conform to the requirements of ASTM C 207, Type N. In addition, the residue retained on a No. 200-mesh sieve shall not exceed 10% when determined in accordance with ASTM C 110. Drying of the test residue in an atmosphere free from carbon dioxide will not be required.

Use of any other additives used in the production of asphalt mixtures shall be approved by the **AGENCY**.

20.3 DESIGN AND PRODUCTION REQUIREMENTS

There shall be no substitutions of materials allowed during production. All substitutions will require checkpoint verification it the checkpoint differs from the Job Mix Formula (JMF) a new mix design will be required. Upon request of the **AGENCY**, the binder grade may be changed by one available binder grade level without requiring a new mix design.

The **AGENCY** shall indicate on "**Mixture Design Requirements for Hot Mix Asphalt Pavements"** form provided in the appendix project specification documents the criteria concerning mix design method, traffic level, binder type, mixture grading, and maximum amount of RAP allowed. This information form is provided on MGPEC Form "**Mixture Design** Requirements for Hot Mix Asphalt **Pavements"**, or other Contract bidding documents.

Grading SG (1-inch nominal aggregate) shall only be designed using the 150 mm Superpave molds. Hveem Stability and Lottman test are not required for Grading G mixtures. Grading ST, SX, and S shall be designed using 100 mm Superpave molds.

A. Superpave Mixture Design Method

A JMF design shall be submitted for each mixture required, at least seven (7) days prior to construction. The JMF design shall be determined using AASHTO T-312 for the Superpave Method of Mixture Design.

Mixture design and field control testing shall meet the following of Table 20.3A-1 for Dense Graded Asphalt Mixes.

Mixture design and field control testing of SMA shall meet the following requirements of Table 20.3A-2 for Stone Matrix Asphalt.

TABLE 20.3A-1

Superpave Mixture Properties for Dense Graded Asphalt Mixtures

Property or Test	Traffic Level		
Traffic Loading, Total 18 kip ESALs Over Design Life (20 to 30 Years)	Low (0-300,000)	Medium >300,000 to 3.0 Million	High >3.0 Million
Design gyrations, N_{design} (Air Void: 3.5% to 4.5%) (See Note 1,2)	50	75	100
Air Voids in Total Mix (VTM) AASHTO T-312 (See Note 1)	3.5-4.5	3.5-4.5	3.5-4.5
Hveem Stability AASHTO T-246 (Grading S & SX only) (See Note 3)	N/A	28 Min.	30 Min.
Voids Filled with Asphalt, MS-2	70-80	65-78	65-75
Lottman, Tensile Strength Ratio, % Retained, AASHTO T-283, Method B	80 Min.	80 Min.	80 Min.
AASHTO T-283 Dry Tensile Strength, psi	30 Min.	30 Min.	30 Min.
Voids in Mineral Aggregates (VMA) %. AASHTO PP 19 (See notes 2,3,4)	A minimum VMA criterion applies to the mix design only (Table 20.2-3). The minimum VMA criteria shall be linearly interpolated based on actual air voids. See 20.12-1 for production tolerances		

Note 1: Target Optimum asphalt binder content of mix: Choose target % as close to 4.0 air voids as possible (3.5% to 4.5% air voids)..
VTM is also referred to as Pax in CPL 5115, and %Gmmx in AASHTO T 312
Note2: Maximum Theoretical Specific Gravity of mix is to be determined by AASHTO T 209.
Note 3: Refer to Section 20.2B for production tolerances.
Note 4: VMA shall be based on tests of the Bulk Specific Gravity of the Compacted Mix (AASHTO T 166) and Aggregate (AASHTO T 84 & T 85), and calculated according to AASHTO PP 19. All mixes shall meet the minimum VMA specified in Table 20.3A-3.

Table 20.3A-2
Superpave Mixture Properties for Open Graded SMA

Property	Test Method	Value for SMA
Lab compaction (Revolutions) N_{Design}	AASHTO T-312	100
Air Voids, percent at: N_{Design} (See Note 1)	AASHTO T-312	3.0 – 4.0
Hveem Stability	AASHTO T-245 75 Blows	1400 psi Min.
Accelerated Moisture Susceptibility, tensile strength Ratio, (Lottman)	AASHTO T 283, Method B	80 Min.
Dry Split Tensile Strength, psi	ASHTO T 283, Method B	30 Min.
Grade of Asphalt Binder	n/a	PG 76-28
Voids in the Mineral Aggregate (VMA) %, minimum	AASHTO PP 19	17 (See Note 5)
Draindown at Production Temperature	AASHTO T305	0.3 maximum
% VCA^{1}_{MIX} (See Note 2)	AASHTO PP41-02	Less than VCA_{DRC}[2]

Note1: Copies of AASHTO PP 41-02 and MP 8-02 (designing SMA mixes) can be obtained from the CDOT Region Materials or the Agency
Note 2: Select target Job Mix Optimum Binder Content for SMA grading at 3.0% to 4.0% air voids
Note 3:Voids in the Coarse Aggregate
Note 4: Dry-rodded condition
Note 5: The formula for VMA can be developed as follows based on the weight volume relationship. It is recommended that the bulk specific gravity of aggregate be used for calculating VMA.

$$\mathbf{VMA = \{\{VT - V_{Agg}\ (bulk)\}/VT\ \}*100}$$

TABLE 20.3A-3
Minimum Voids in Mineral Aggregate (VMA)for
Dense Graded & Open Graded (SMA), %

Nominal Maximum* Particle Size	Air Voids ++		
	3.5%	4.0%	4.5%
1"	12.2	12.7	13.2
¾"	13.2	13.7	14.2
½"	14.2	14.7	15.2
SMA	17.0	17.0	17.0

*Nominal Maximum Particle Size is defined as one sieve size larger than the first sieve to retain more than 10%, but shall not exceed the 100% passing size. The Nominal Maximum Particle Size can vary during mix production even when the 100% passing size is constant.

++ Minimum VMA criteria apply to the mix design only. The minimum VMA criteria shall be linearly interpolated based on actual air voids. See Section 20.2B for tolerances.

20.4 MIXTURE DESIGN SUBMITTALS

A. General Requirements:

The **CONTRACTOR** shall submit all mix designs, Certificates of Compliance, and laboratory data to the **AGENCY** for approval at least 7 calendar days before construction is to begin. The mix design (Proposed Design Job Mix) must be approved by the **AGENCY** prior to the start of construction.

Designs shall be developed and performed in a materials laboratory that meets the requirements set forth by AASHTO Materials Reference Laboratory (AMRL) for all required testing procedures and be under the direct supervision of and be stamped and signed by a Professional Engineer licensed in the State of Colorado and practicing in this field. In addition, the **CONTRACTOR** shall submit, as part of the mixture design, laboratory data documents to verify the following:

- Gradation, specific gravity, source and description of individual aggregates and the final blend.
- Aggregate physical properties.
- Source and Grade of the Performance Graded Binder
- Proposed Design Job Mix: aggregate and additive blending, final gradation shown on 0.45 power graph, optimum asphalt content.
- Mixing and compaction temperatures used.
- Mixture properties shall be determined with a minimum of four asphalt contents and interpolated at optimum and graphs showing mixture properties versus asphalt content.

CONTRACTOR shall obtain approval of all mix designs for any Asphaltic Pavement Material (HMA, WMA, or SMA) by **AGENCY** prior to placement. The Project Manager reserves the right to verify the asphalt supplier's mix design for each Asphaltic Material grading utilizing materials actually produced and stockpiled. The asphalt supplier shall provide, at no cost, a sufficient quantity of

each aggregate, mineral filler, RAP, and additive for the required laboratory tests, as well as all Certificates of Conformance/ Compliance at any time on any material used. The Asphalt Supplier shall provide copies of quality control testing results during the production of asphaltic mixtures used within one (1)-business day from the sampling date.

B. Change in Source or Grade:

Should a change in the source of any material used in the production of asphaltic pavement material (Aggregate, Mineral filler, Lime, or Performance Graded Asphalt Binder) occur, a one point verification test (at optimum asphalt content) of the mix must be performed to verify that the applicable criteria shown on Table 20.3A-1 (Dense Graded Asphalt Mix)), Table 20.3A-2(SMA), and Table 20.3A-3 (VMA), is still met. If this testing shows noncompliance, the **CONTRACTOR** shall establish a new Job Mix Design and obtain approval by the **AGENCY** before the new Asphaltic Material is used.

C. Mix Production Verification:

Production verification shall occur prior to the start of the project. Technicians that have current LabCAT Level C certification shall verify the volumetric properties of the mix. Certified technicians shall maintain current Certification to verify the volumetric properties of the mix. If the mix was produced for another project within the last 90 days, data from that project can be submitted for verification. Volumetric properties for mix verification testing shall be within the following tolerances compared to the Proposed Design Job Mix. The mix verification test reports shall be submitted to the **AGENCY** prior to mix placement.

TABLE 20.4C-1
Mix Design Verification Tolerances

Air Voids	+/- 1.2%
VMA	+/- 1.2%
Asphalt Binder Content	+/-0.3%
Stability	Applicable minimum

The tolerances in this table are for mix design verification only. See Section 20.2B for production tolerances.

Project Verification Testing for asphalt content and gradation will be performed at the frequencies listed in Table 20.15-1

Table 20.4C-2
Minimum Quality Control Sampling and Testing for Bituminous Mixtures

	AASHTO	ASTM	Minimum Frequency of Tests
Sampling*	T 168	D 979 D 3665	One per 1,000 tons or fraction thereof (not less than one test per day)
Hveem properties	T 245 T 247 T 166	D 1559 D 1561	One per 1,000 tons or fraction thereof (not less than one test per day)
In-place density		D 1188 D 2950	One per 250 linear lane feet per layer
Asphalt content	T 164 T 269 TP 53	D 2172 D 3203 PS 90	One per 1,000 tons or fraction thereof (not less than one test per day)
Maximum Specific Gravity of HBP	T 209	D 2041	One per 1,000 tons or fraction thereof (not less than one test per day)
Air voids and VMA	T 269	D 3203	One per 1,000 tons or fraction thereof (not less than one test per day)
Thickness		D 3549	One for each 250 linear lane feet
Aggregate Gradation	T 27	C 136	One per 1,000 tons or fraction thereof (not less than one test per day)
Binder Performance-Graded, Dynamic Shear	TP 5		One test per every 15,000 tons or fraction thereof

*Contractor shall provide plant split samples to the appropriate testing Agency.

D. Pre-paving Meeting:

The AGENCY may require a pre-paving meeting of all parties that are directly involved in supply, haul, laydown, inspection, quality control, and quality assurance of asphalt pavement are required. Traffic control, haul, direction, sequence of paving and construction (joint) plan will be reviewed and discussed at the pre-paving meeting, see Section 20.9 and Section 20.10 for joint requirements. MGPEC Asphalt Design Requirements Form provided in this document or online at: http://www.mgpec.org/sitebuildercontent/sitebuilderfiles/form92012.doc .
The Asphalt Index of this specification is an example of a pre-paving meeting agenda. Areas of responsibility and contact names and numbers **should** be shared.

A minimum of seven (7) days prior to the proposed use of any Asphalt pavement on the project, a pre-paving conference may be conducted at the Agency's discretion. Two (2) weeks prior to the meeting, the **CONTRACTOR** shall submit, a mix design for all proposed asphaltic materials specified in the projects specification and will meet the appropriate materials specification requirements.

20.5 MANUFACTURE

A. Preparation of Aggregates:

Heating and drying of the aggregates shall be accomplished without damaging the aggregate. Hydrated lime shall be added to achieve complete and uniform coating of the aggregate, in accordance with one of the following methods:

1) Lime Slurry Added to Aggregate: The hydrated lime shall be added to the aggregate in the form of slurry and then thoroughly mixed in an approved pugmill. The slurry shall contain a minimum of 70 percent water by weight.

2) Hydrated Lime Added to Wet Aggregate: The hydrated lime shall be added to wet aggregate (a minimum of three percent above saturated surface dry) and then thoroughly mixed in an approved pugmill. The lime-aggregate mixture may be fed directly into the hot plant after mixing or it may be stockpiled for not more than 90 days before introduction into the plant for mixing with the asphalt binder. The hydrated lime may be added to different sized aggregates and stockpiled by adding 75 percent of the lime to the aggregate passing the No. 4 sieve and 25 percent to the aggregate retained on the No. 4 sieve.

A minimum of 1 percent hydrated lime by weight of the combined aggregate shall be added to the aggregate for all Dense Graded and Open Graded Stone Matrix Asphalt mixtures.

B. Mixing:

The dried aggregates and asphalt binder shall be combined in the mixer in the quantities required to meet the design job mix. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt binder is uniformly distributed throughout the aggregate, Baghouse fines may be fed back to the mixing plant in a uniform and continuous manner to maintain uniformity in the mixture.

The minimum temperature of HMA or SMA mixtures when discharged from the mixer shall be according to refinery recommendations or as shown in the following table:

TABLE 20.5B-1
Mixture Discharge Temperatures

HMA and SMA Asphalt Grade	Minimum Discharge Temperature	Maximum Discharge Temperature
PG 58-28	275º F	310º F
PG 64-22	290º F	325º F
PG 76-28*	318º F	326º F
WMA	212° F	280° F

*Contractor or Binder supplier must supply production temperature as required by their product

HMA mix shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95 percent minimum in accordance with AASHTO T 195), and that allows the required compaction to be achieved.

Asphaltic mixtures may be stored provided that any and all characteristics of the mixture are not altered by storage. Unsuitable mixture shall be removed and disposed of at the Contractor **'s** expense.

When placing hot mix asphalt over bridge decks covered by waterproofing membrane, the minimum temperature of the mixture, when rolling operations begin, shall be 250 ° F. The job mix temperature may be increased up to 30 ° F to obtain this temperature.

Mineral filler for SMA shall be stored in a separate silo and added automatically in the correct proportion.

The SMA mineral filler shall be added at the same point the asphalt binder

C. Hauling:

Each truck shall be completely covered (non-porous tarps preferred) to completely protect the mix during transport at all times. The **AGENCY** can reject any mix which was transported through adverse weather or shows an excess or deficiency of asphalt cement, damage due to burning or overheating, when it arrives on the jobsite uncovered.

20.6 TACK COAT

The emulsified asphalt, for Tack Coat emulsion shall meet the specification for emulsified asphalt, consisting of CSS-1h or SS-1h and conform to AASHTO M208 or M140, respectively.

Prior to placement of HMA, a tack coat shall be applied to all existing concrete and asphalt surfaces. The material shall be in accordance with 20.2. The emulsified asphalt shall be applied per Table 20.6-1 The surface prior to receiving the tack coat shall be dry and clean. All dust, debris, and foreign matter shall be removed. Tack coat shall be applied uniformly by distributor. Prior to paving, all water shall have evaporated from the tack coat, the time required between the application of the tack coat and the application of the asphalt may require 20 minutes or greater to achieve a set. Areas where the tack becomes contaminated during construction shall be cleaned and tack coat shall be reapplied and allowed to cure before paving resumes.

TABLE 20.6-1
Tack Coat Application Rates

Pavement Condition	Application Rate (gal/yd^2)		
	Residual	Undiluted	Diluted (1:1)
New HMA	0.03 - 0.04	0.05 – 0.07	0.10 – 0.13
Oxidized HMA	0.04 – 0.06	0.07 – 0.10	0.13 – 0.20
Milled Surface (HMA)	0.06 – 0.08	0.10 – 0.13	0.20 – 0.27
Milled Surface (PCC)	0.06 – 0.08	0.10 – 0.13	0.20 – 0.27

Portland Cement Concrete	0.04 – 0.06	0.07 – 0.10	0.13 – 0.20

Per NCHRP Report 712

20.7 EQUIPMENT

A. Mixing Plant

The mixing plant shall be capable of producing a uniform material, have adequate capacity, and be maintained in good mechanical condition. Defective parts shall be replaced or repaired immediately if they adversely affect the proper functioning of the plant or plant units, or adversely affect the quality of the HMA.

The mixing plant shall meet all air quality requirements in the "Colorado Air Quality Control Act," Title 25, Article 7, CRS and any other applicable regulations promulgated there under for dust, smoke, or other contaminants and shall be controlled at the plant and project site. As well as all acceptable safety equipment required by OSHA to accommodate sampling and testing.

B. Hauling Equipment:

Trucks used for hauling HMA material shall have tight, clean, smooth beds or functional and maintained conveyor belt bottom that is thinly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent. **Petroleum distillates such as kerosene or fuel oil will not be permitted**. Each truck shall have a cover of canvas or other suitable material to protect the mixture from the weather and excessive temperature loss or cooled layers of mix in the truck, as covered in Section 20.5C hauling.

C. Material Transfer Vehicle (MTV):

Will be required for placement of SMA, a MTV shall be a self-propelled storage unit capable of receiving material from trucks, storing the material and transferring the material from the unit to a paver hopper insert via a conveyor system. The required paver hopper insert and unit shall have a combined minimum storage capacity of 15 tons. Prior to placing the asphalt material on the roadway surface, the storage unit or paver hopper insert must be able to remix the material in order to produce a uniform, non-segregated mix, having a uniform temperature.

D. Bituminous Pavers:

Self-propelled pavers shall be provided for full lane width paving capable of spreading and finishing the HMA material in full lane widths applicable to the typical section and thicknesses as discussed at the prepaving conference or shown in the Contract documents and shall be equipped with:

- Anti-segregation devices.
- A vibratory screed assembly capable of being heated.

Pavers used for shoulders, patching and similar construction, not requiring fine grade control, shall be capable of spreading and finishing courses of asphalt to the required widths and depths as shown in the Contract without segregation.

The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and shall have an automatic distribution system that will place and spread the mixture uniformly in front of the screed.

The paver shall be capable of operating at forward speeds consistent with uniform and continuous placement of the mixture. Stop and go operations of the paver shall be avoided. The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, segregating, or gouging the mixture. Self-propelled pavers shall be equipped with automatic screed controls with sensors capable of detecting grade provided by a source of reference line, and maintaining the screed at the specified longitudinal grade and transverse slope. The sensors may be contact or non-contact type devices. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices when they are required for the situation:

- Grade control device at least 30 feet in length.
- Joint matching device
- Adequate length of control line and stakes, if no other type of geometric control is present
- A straight edge at least 10 feet in length will be available to verify the crown on the screed, at the request of the **AGENCY.**

The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent. Automatic mode should be used where possible. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.

If the **CONTRACTOR** fails to obtain and maintain the specified thickness or surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made. Placement of HMA on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering the situation is corrected. Material placed that does not meet thickness ore smoothness requirements shall be removed and replaced or diamond ground at the owners discretion at the Contractor s expense.

20.8 PLACEMENT

Bituminous pavement shall be placed on approved, properly constructed surfaces that are free from loose material, water, frost, snow, or ice. HMA and tack coat shall be placed in accordance with the temperature limitations of Table 20.8-1 and only when weather conditions permit the pavement to be properly placed, finished, and compacted in accordance with the project specifications. Placement temperature shall be increased by 5 ºF for each 10 miles per hour wind velocity to a maximum increased placement temperature of 70 ºF as measured at the laydown location. In-place density for Asphaltic Pavement Material shall be 94 ± 2 percent of the Asphalt Mix maximum specific gravity as measured according to Maximum Theoretical Value (Rice) (AASHTO T 209). Test results will be reported to the nearest tenth of a percent, under no circumstance shall results be rounded to the nearest whole number.

TABLE 20.8-1
Minimum Air and Surface Temperatures for placement of (HMA or SMA)

Compaction Layer Thickness	Top Layer of Pavement*		Lower Layers *	
	PG 58-28 PG 64-22	PG 76-28	PG 58-28 PG 64-22	PG 76-28
<2 inches (not recommended)	60 ºF	75 ºF	N/A	N/A
2 inches to <3 inches	50 ºF	65 ºF	40 ºF	50 ºF
> 3 inches	50 ºF	50 ºF	40 ºF	40 ºF
SG mix only	N/A	N/A	38 ºF	38 ºF

*Air and surface (subgrade base or previously placed AC lift) temperatures are to be taken in the shade where applicable.

The **AGENCY** shall not waive the above temperature limitations for PG 76-28.
WMA minimum ambient paving temperature requirements can be lowered 20°F but not at or below freezing. Air and surface temperatures are important and become more critical when modified binders are used.

The internal temperature of HMA and SMA shall not be placed at a temperature lower than 245 ºF during placement for mixes containing PG 58-28 or PG 64-22 binder, and 290 °F for mixes containing polymer modified binder PG 76-28. Mix that is too cold or damaged by weather will be rejected.

The mixture shall be placed on an approved surface, spread and struck off to obtain the required grade and elevation after compaction. The minimum lift thickness shall be **at least three times (preferably four times) the nominal particle size**. The un-compacted mixture should be placed approximately 10-25 percent thicker than the existing surrounding mat to account for compaction based on the materials being placed.

Redistribution of the mixture using hand tools is only permitted when necessary around utilities and in areas inaccessible to equipment. Casting or raking that causes any segregation will not be permitted.

In areas where the use of mechanical spreading and finishing equipment is impractical; the mixture shall be carefully dumped, uniformly spread, raked, screeded, and luted by using hand tools to the required compacted thickness plus approximately 25 percent based on the materials being placed. Carefully move or minimally work the HMA mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt binder require more rapid completion of handwork areas than for normal mixtures.

Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Bituminous pavers shall be used to distribute the mixture over the entire width or

over such partial width as may be practical. Echelon paving is encouraged. Excessive starting and stopping shall not be allowed. A construction joint shall be placed any time the paver stops, or when the screed drops enough to cause a surface dip in violation of section 20.2B, surface tolerances; or when the mat temperature falls below what is allowed in section 20.2A.

Placement of HMA on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering. Use of a vibratory roller will not be allowed to obtain compaction when placement of bituminous pavement on bridge deck utilizing a waterproof membrane.

A. SMA Pre-Placement:

Before proceeding with SMA placement, the **CONTRACTOR** shall demonstrate the ability to produce and place a satisfactory mix. The actual work may proceed when a full lane width demonstration control strip, having a minimum length of 1,000 feet has been successfully placed. The **CONTRACTOR** shall determine properties VMA, Voids, in-place density, and Marshall Stability of the project produced mix that is used in the demonstration control strip and provide the results to the Project Manager. No other SMA production or placement will be allowed until densities are determined. If the material in the demonstration control strip is not in close conformity with the specifications, the demonstration control strip will be removed and replaced at the Contractor's expense. The Project Manager will designate the location of the control strip.

The **CONTRACTOR** shall submit a plan for a Roller Pass Study (RPS) to the Project Manager for acceptance. Upon acceptance by the Project Manager, the **CONTRACTOR** shall perform a RPS. The plan for the RPS shall include, but is not limited to the following:

- Number, size, and type of rollers.
- Amplitude, frequency, size and speed of vibratory rollers.
- Temperature of mixture being compacted.
- Roller patterns.

For SMA the in-place density shall be determined through the completion of a Roller Pass Study (RPS) to be conducted during placement of the required 1,000 feet demonstration control strip. The RPS will determine the necessary roller compaction process needed to produce a minimum pavement density of 9562 percent of Theoretical Maximum Density (Rice).

Density will be determined daily using the same method as during the RPS for each day of production to confirm pavement density. If a daily density check shows density below 93 percent of Rice, the **CONTRACTOR** shall stop production and the **CONTRACTOR** will again complete a RPS to establish the necessary compaction process. All subsequent daily checks that identify locations having density below 93 percent of Rice shall be removed and replaced at the Contractor's expense. A new RPS shall be completed and approved prior to resuming production.

B. SMA Placement:

SMA mixture shall be transported and placed with the use of a MTV, see Section 20.8, on the roadway without drain-down or flushing. All flushed areas shall be removed immediately. If there are more than 50 square feet of flushed areas within the pavement, operations shall be discontinued until the source of the flushing has been found and corrected. The **AGENCY** will designate the depth and area of all flushed areas requiring removal and replacement. All costs associated with the removal and replacement of the flushed areas shall be at the **CONTRACTOR's** expense.

SMA Pavement shall be placed and compacted in accordance with the temperatures listed in Table 20.8-1 or as revised for the project during the pre-paving meeting.

The relative compaction for all Asphaltic Pavement Material will be measured based on cores in accordance with AASHTO T 166, Method B, unless the material being placed is on a structure (bridge deck) in which case the **AGENCY** may allow nuclear gauge measurements used.

When cores are used, the **CONTRACTOR** shall provide all labor and equipment for the coring and repair of the core holes. When nuclear density gauges are used, the tests will be performed in accordance with ASTM D 2950 and AASHTO T 230.

C. 2WMA Construction Requirements

Asphalt Manufacturing:
The asphalt manufacturing plant may be modified as required by the producer of the WMA technology.

Equipment:
WMA technology shall be capable of producing an asphalt mixture that meet specification requirements and is workable at the minimum placement and compaction temperature.

Placement:
Placement shall be the same as HMA but at lower production and placement temperatures. No pavement operations will be done when ambient paving temperatures is to below freezing.

Compaction Test Section:
A test section shall be constructed to verify compaction requirements are being met at the lower placement temperatures and the appearance of the mixture is acceptable to the **AGENCY**.

20.9 LONGITUDINAL JOINTS

Longitudinal joints in all pavement layers shall offset the joint in the layer immediately below by a minimum of six (6) inches. The joint in any pavement layer shall not fall in or between wheel paths. Joints in the top layer of new pavement shall be located on lane lines unless otherwise shown on the plans. Longitudinal joints shall be minimized with wide paving pulls, if paver is equipped with heated adjustable screed plates with augers and the ability to provide initial compaction. Hydraulic screed extensions that just strike

off the mixture are not acceptable or echelon paving. Joints shall be parallel to the flow of traffic and shall not cross any centerline, lane line, or edge line. Prior to the pre-paving meeting the **CONTRACTOR** shall submit a joint plan and pavement marking plan showing locations and the methods to establish the paving control lines. The **plan must be acceptable to the AGENCY and be developed based on the lane lines shown on the final stripping plan** prior to paving. The **CONTRACTOR** shall use a continuous string line to delineate longitudinal joints during paving. When applicable, string lines shall be removed at the end of each day's paving.

All paving shall be placed parallel to the roadway centerline and as straight as possible,**.** All joints shall receive a coat of tack prior to placement of adjacent paving.

When placing a layer of pavement against a previously compacted layer in an adjacent lane of pavement the edge of new layer shall not overlap the compacted layer by more than 1.5 inches. Overlap or excess thickness shall not be cast onto the new un-compacted layer but shall be pulled away from the joint and removed. The hot edge shall be bumped in a vertical smooth line consistent with the previous longitudinal edge. A minimal amount of raking will be allowed around manholes and other utilities. Longitudinal joints should be rolled from the hot side and overlap the cold joint by approximately six (6) inches.

20.10 TRANSVERSE JOINTS

Prior to paving, the **CONTRACTOR** shall submit a joint plan showing locations and the methods to be used to construct transverse joints. The **plan must be acceptable to the AGENCY** prior to paving. In areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to meet the elevation of the adjacent pavement. Placing of the HMA shall be continuous with a minimum of transverse joints, and rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints before additional mixture is placed against the previously compacted material.

Transverse joints shall be located so they will be constructed with a full head of mix in front of the screed. When butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges, and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted. When a temporary tapered joint is required for temporary traffic access, the ramp shall be removed back to a full depth section before paving is restarted.

When paving operations are to resume the screed of the paver should be placed on thin strips of material on the completed pavement. The strips should be of sufficient thickness so that adequate grade and compaction can be achieved on starting the paving operation. The screed should be nulled (angle removed) when starting from blocks and set in an up angle of attack. Proper head of mix should be introduced into the paver prior to starting. The new compacted (downstream) side of the joint may be up to 3/16 inches higher than the old (upstream) side. Raking of this joint shall a bump is not created by the transverse joint The surface tolerance at the transverse joint must be verified by the **CONTRACTOR** with a 10- foot straight edge before the paver is more than 50 feet from the joint. If the surface tolerance is not within the 3/16", the

CONTRACTOR shall stop the paver and make corrections to the joint before proceeding.

20.11 SEGREGATION

Segregated areas may be determined visually, by density or gradation. The extent of the segregation will be determined visually. The **CONTRACTOR** will remove and replace or repair segregated areas at their expense to the satisfaction of the **AGENCY**.

The asphalt mixture shall be transported and placed on the roadway without segregation. All segregated areas shall be removed immediately and replaced with specification material before the initial rolling. If more than 50 square feet of segregated pavement is removed and replaced in any continuous 500 linear feet of paver width paving shall be discontinued until the source of the segregation has been corrected.

20.12 COMPACTION

The temperature of the mixture immediately behind the screed shall be sufficient to allow for proper compaction of the HMA layer and at least 245 ° F for PG 58-28 or PG 64-22 binder and between 297°F and 305° F for PG 76-28 binder. The breakdown compaction should be completed as quickly as possible after placement occurs and before the mixture temperature drops 20°F from placement temperature.

The HMA shall be compacted by rolling. Both steel wheel and pneumatic tire rollers will be required. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and continued until the required density is obtained. Final compaction shall be obtained using steel wheel rollers.

Pavement operations shall be suspended when density requirements are not met and the surface temperature falls below 165 °F, or when there is obvious surface distress or breakage; further compaction effort shall not be applied unless approved. If the mixture contains modified asphalt cement (PG 76-28, PG 70-28, or PG 64-28) and the surface temperature falls below 230 °F, further compaction effort shall not be applied unless approved.

The minimum compaction temperatures may be adjusted according to the asphalt binder supplier recommendations. Adjusted minimum compaction temperatures must be shown on the approved mix design or on other asphalt binder supplier documents and be available on the job site. Pay Reduction criteria in Section 20.2D shall still apply in such cases of substandard compaction, but within the range of acceptability.

All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted during surface course final rolling and will not be permitted on bridge decks covered with waterproofing membrane.

The **CONTRACTOR** shall establish a rolling pattern or procedure during the beginning of paving operations, which will achieve the required compaction and surface tolerances.

This procedure may be re-evaluated by the **CONTRACTOR** and **AGENCY** throughout the paving operations.

All HMA paving shall be compacted to **94.0 ± 2** percent of Maximum Theoretical (Rice) Density, (AASHTO T 209: Maximum Specific Gravity of Bituminous Paving Mixtures) as determined by ASTM D 2950. Rice values shall be used in calculating Relative Compaction according to AASHTO T 166. Rice value(s) will be based on a three (3) production day's average. The **CONTRACTOR** shall provide the producer's Rice value, which shall be used for production until the actual day's Rice value is determined by the testing firm of record for the project.

All joints shall be compacted to minimum of 92.0 ± 2 percent of Rice, taken six (6) inches on each side of joint, every 200 Linear Feet. Rice values shall be used in calculating Relative Compaction according to AASHTO T 166, cores if needed will be used to verify compaction results.

The **CONTRACTOR** shall core the pavement, as required by the **AGENCY;** for field density tests in accordance with AASHTO T 230, Method B, or for field calibration of nuclear density equipment in accordance with the ASTM D 2950. At a minimum, cores for nuclear density equipment calibration shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation. Untested areas during placement will also require cores to verify compaction.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with uncontaminated hot mixture and compacted to conform to the surrounding area at the expense of the **CONTRACTOR**.

Compaction requirements for SMA are covered in Section 20.8. Rollers shall not be used in a vibratory mode on SMA unless they are first used successfully in the demonstration control strip. Pneumatic wheel rollers shall not be used on SMA Mix.

20.13 PRODUCTION TOLERANCES

A. Top Lift Surface Tolerances:

Surface variation between any two contacts shall not exceed 3/16 inch in 10 feet for full lane width paving. For patching surface tolerances, the variation shall not exceed 3/8 inch in 10 feet. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material or by overlaying (patching) as directed by the **AGENCY**. The final pavement surface shall not vary from the specified cross section by more than one (1) inch at any point. Irregularities exceeding the specified tolerance shall be corrected at the **CONTRACTOR's** expense. Transverse measurements for variations shall exclude breaks in the crown sections. Roadway smoothness testing will not be measured or paid for separately, but shall be included in the work.

The final surface pavement adjacent to concrete gutter shall be finished from 1/8-inch to 3/8-inches above the lip of the gutter into which it drains. Any surface pavement that is above the lip more than 3/8 inch shall be removed and replaced

to the specified height. Any pavement surface that is below the lip of the gutter shall be corrected as directed by the Project Manager. This provision does not apply to "tipped" or standard median gutter but does apply to median "catch" gutters used on super-elevated roadways, but the final surface pavement adjacent to these gutters shall be finished level to the lip.

Prior to placing the surface course, the **CONTRACTOR** shall adjust all manholes, valve boxes, and survey range boxes so they are from 1/8 to 1/2- inch below finish grade after the final surface course is placed. The **CONTRACTOR** shall notify the **AGENCY** of the timing of adjustments to all manholes and valve boxes so he may observe. The **CONTRACTOR** shall remove any foreign matter introduced into all manholes and valve boxes during construction. It shall also be the Contractor**'s** responsibility to insure proper compaction around all manholes and valve boxes after they have been raised. At no time shall manholes and valve boxes be covered up or buried. Valve boxes and manholes are to be maintained fully accessible at all times for emergency and maintenance operation by City personnel. The cost of adjusting valve boxes, manholes, and survey range boxes shall be included in the work, unless otherwise specified in the Special Conditions or Proposal. The **CONTRACTOR** shall be responsible for any cost incurred by the **AGENCY** to provide access to the covered manholes or valve boxes. Valve boxes, manholes, and survey range boxes shall be clean when work is completed. Valve boxes, manholes, and survey range boxes shall be adjusted to match the slope of the roadway. Final adjustment of all utility access points shall be completed within seven (7) days of from the time the roadway pavement was placed.

B. Job Mix Formula Tolerances:

For production test results that deviate from the design job mix by more than shown in the following table are subject to this section:

TABLE 20.13B-1
Job Mix Formula Tolerances

Mixture Grading	ST (3/8" Nominal)		SX (1/2" nominal)		S (3/4" nominal)		SG (1" nominal)	
Traffic Loading,	Repair Segregation Bike path Sidewalk		Low To Medium 0 to 300,000		Medium To High >300,000		Lower lifts	
Sieve Size	Control Points	Tolerance	Control Points	Tolerance	Control Points	Tolerance	Control Points	Tolerance
11/2"							100	+ 1%
1"					100	+ 1%	Design	± 6%
3/4"			100	+ 1%	Design	± 6%	Design	± 6%
1/2"	100	+ 1%	Design	± 6%	Design	± 6%	Design	± 6%
3/8"	Design	± 6%	Design	± 6%	Design	± 6%	Design	± 6%
#4	Design	± 5%	Design	± 5%	Design	± 5%	Design	± 5%
#8	Design	± 5%	Design	± 5%	Design	± 5%	Design	± 5%
#16	Design	± 4%	Design	± 4%	Design	± 4%	Design	± 4%
#30	Design	± 4%	Design	± 4%	Design	± 4%	Design	± 4%
#50	Design	± 4%	Design	± 4%	Design	± 4%	Design	± 4%
#200	Design	± 2%	Design	± 2%	Design	± 2%	Design	± 2%
Air Voids	Design	3.0-5.0%	Design	3.0-5.0%	Design	3.0-5.0%	Design	3.0-5.0%
VMA	Design	± 1.2%	Design	± 1.2%	Design	± 1.2%	Design	± 1.2%
Hveem Stability	See Table 20.3A-1							
Asphalt Content	Design	± 0. 3%	Design	± 0. 3%	Design	± 0. 3%	Design	± 0. 3%

(Note 1) There is 1.0 percent tolerance for the maximum sieve size.
(Note 2) Mixes with passing No. 200 sieve material produced over 7.0 percent are allowed only when the above Air Voids and VMA tolerances are still met.
(Note 3) Hveem Stability must meet the minimum value specified in Table 20.3A-2
(Note 4) When calculating VMA, use the most current aggregate specific gravity $G_{sb,}$

When disagreements concerning determination of specification compliance occur, only valid tests from all testing parties may be considered. Valid tests are those in which sampling and testing have been performed according to referenced procedures and the results are within applicable precision statements. When disagreements occur with asphalt content and gradation tests results,

solvent extracted aggregate testing shall take precedence over burn off oven extracted aggregate, which shall take precedence over cold feed belt testing.

20.14 CONFORMITY WITH PLANS AND SPECIFICATION

A. General

All work performed and all materials furnished shall conform to the lines, grades, cross sections, dimensions, and material requirements, including tolerances, shown or stated in the contract documents.

When tolerances are not specified, the **CONTRACTOR** shall perform the work in a manner consistent with reasonable and customary manufacturing and construction practices.

When the **AGENCY** finds that the materials furnished, the work performed, or the finished product does not conform with the contract, but that reasonably acceptable work has been produced, the **AGENCY** shall determine the extent of the work to be accepted and remain in place.

Cost reduction, when allowed, shall be accomplished by adjusting pay quantities as indicated herein and applying contract unit prices to the reduced quantities. If the work is to be accepted, the **AGENCY** will:

- Document the basis for acceptance by “Cure Notice” which may provide for an appropriate adjustment in the payment quantity for such work or materials not otherwise provided for in this section.
- Notify the **CONTRACTOR** in writing that the payment may be adjusted in accordance with this section when “**P"** is 25 or less, or require appropriate remediation to be performed.

In lieu of cost (quantity) adjustment, permit correction or replacement of the finished product provided the correction or replacement does not adversely affect the work or the **AGENCY**.

When the **AGENCY** determines that the material furnished, work performed, or the finished product is not in conformity with the contract and has resulted in inferior or unsatisfactory product, the finished product or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the **CONTRACTOR**.

Materials shall be sampled and tested by a qualified testing laboratory in accordance with the sampling, testing schedules, and procedures contained in the Section 20.2D Testing and Inspection. The approximate maximum quantity represented by each sample shall be as set forth in the testing schedule. An additional number of samples, in relation to the quantity of materials represented, may be selected and tested at the Agency**’s** discretion. The quantity represented by five consecutive random samples shall constitute a lot, whenever production schedules and material continuity permits. When it is necessary to represent short production runs, significant material changes, or other unusual characteristics of the work, the **AGENCY** may establish a lot consisting of the quantity represented by any number of consecutive random samples from one to

seven inclusive. Testing results that are determined to have sampling or testing errors, as determined by the **AGENCY**, shall not be used.

B. Pavement Thickness Deficiencies

If the full depth cores indicate a thickness deficiency, additional cores will be taken by the Contractor to be given to the Agency so that price reductions can be determined per Lot. A Lot encompasses 250 lineal lane feet or the quantity between tests, and a price reduction shall be determined as a percentage of the bid unit cost of the Asphalt Pavement.

Asphalt Pavement thickness will be determined from cores secured from each sub-lot for this purpose. Such cores will be taken and measured by the Asphalt Concrete Coring Method.. Each core location will be patched by the party responsible for the testing.

(1) If the pavement thickness is deficient from the target thickness by 0.25 inches or less, it will be paid for at the contract unit price. If the pavement thickness deficiency is greater than 0.25 inches and the contracting **AGENCY** is not the owner (i.e. permits) the following steps will apply: If the core thickness indicate a deficiency in the pavement exceeds 0.25 inch, the limits of the deficient area will be isolated evaluated by coring at maximum intervals of 100 feet from the deficient core. The thicknesses of the original deficient core will be averaged with the thicknesses of the cores taken from 100 feet on each side of it to determine compliance with the acceptance requirements**. If the resulting average thickness deficiency is greater than 0.25 inch, then Table 20.14H-1 shall apply to the sub-lot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.**

(2) If the pavement thickness from step one above deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, corrective action will be required. This corrective action will consist of application of a Type II slurry seal coat in accordance to Item 26 (Slurry Seal). The **CONTRACTOR** may present an engineering analysis outlining other proposed remedial measures for the consideration of the Engineer. The Engineer will review the engineering analysis and decide within 30 working days whether to accept the proposed remedial measures.

(3) If the pavement thickness from step one above deviates from the target thickness by more than 0.50 inch, corrective action will be required. The deficient area will be overlaid with no less than 1 inch thick lift, for the full width of the pavement to meet or exceed the designed thickness, with the appropriate end and edge milling, with a mixture approved by the Engineer. The **CONTRACTOR** may present an engineering analysis outlining other proposed remedial measures for the Engineer's consideration. The Engineer will review the engineering analysis and decide within 10 working days whether to accept the proposed remedial measures. If the Engineer chooses to reject the engineering analysis, the indicated overlay will be constructed by the **CONTRACTOR** at no additional cost to the Owner.

If the pavement thickness deficiency is greater than 0.25 inches and the contracting **AGENCY** is the owner, Table 20.14H-1 will apply.

C. Use of Cores to determine acceptable asphalt thickness

All cores shall be no more than 0.25-inch deficient than the required thickness shown on plans or pavement design report for full payment or acceptance. A minimum of 90% of all the pavement thickness cores must equal or exceed the required thickness shown on plans or pavement design report for full payment or acceptance... Any deficient pavement thickness shall be dealt with is listed on Table 20.14H-1

D. Verification of Thickness and Remedial Action

When the **AGENCY** determines that deficient thickness exists, the **CONTRACTOR** may define the deficient section boundaries by any means acceptable to the **AGENCY**, and then verify the boundaries to the satisfaction of the **AGENCY** at the boundary, or by direct measurement when cutting the pavement.

When the **AGENCY** determines that they do not want the top lift cored, they shall require the **CONTRACTOR** to use non-destructive survey techniques to determine top lift thickness. This shall be combined with core information taken from lower lifts to determine total pavement thickness.

The **CONTRACTOR** will be responsible for coring of the Asphaltic Pavement and notifying the **AGENCY** of the coring operations**,** so they may be present to observe. Duplicate cores will be required. The **CONTRACTOR** will retain one set and the Agency shall receive the other set for comparison testing.

Referee: In the event the **CONTRACTOR** elects to question the acceptance test results for either asphalt binder content, laboratory air voids, density, thickness, or a combination thereof for a lot, the **CONTRACTOR** may make a written request for additional testing of that lot. Any request for referee testing must describe the Contractor's reasons for questioning the validity of the original acceptance results and must clearly describe which set of acceptance tests are in question. The **CONTRACTOR** will engage an independent laboratory (at the their own expense) who is accredited by AMRL in all of the acceptance test methods. The independent laboratory shall be acceptable to the engineer and shall perform a complete new set of acceptance tests (as required to represent the area or set of tests in question). The results of these determinations will be binding on both the **CONTRACTOR** and the **AGENCY**. If the test results obtained by the independent laboratory result in elimination or reduction of the magnitude of the applicable penalty the contracting **AGENCY** will bear the cost of the referee testing. If the applicable penalty remains unchanged or increases, the cost for verification testing will be deducted from payments that were to be made to the **CONTRACTOR**.

These tests may include asphalt binder content, aggregate gradation, Gyratory unit weight, maximum theoretical unit weight, laboratory air voids, and in-place

air voids (compaction). Samples for referee testing shall come from representative samples obtained from the completed pavement.

The number of samples taken will be the same as specified. The independent laboratory shall compile the test results and transmit them to both the **AGENCY** and the **CONTRACTOR**. The independent laboratory shall include a report signed by an engineer registered in the State of Colorado, who is experienced in asphalt concrete testing and mix design development. The signed report shall give an opinion that the material evaluated either does or does not comply with project specifications, will clearly describe any deficiencies, and the results will be binding between all parties.

E. Price Reductions on Thickness

Price reductions shall not be allowed for Thickness deficiencies on projects to be accepted from developers. Remedial action is required of the **CONTRACTOR** to the satisfaction of the **AGENCY** to meet the design thickness requirements. Extended warranty will not be an acceptable alternate to remedial action.

For an Agency's Capital Project, the **AGENCY** may elect to apply a linear price reduction based on pavement thickness in lieu of remedial action using a base number that equates to 4% deficiency in thickness to 25% reduction of traffic capacity over the design life hence justification for a similar payment reduction.

F. Average Core Thickness

If the average core thickness is greater than or equal to the specified core thickness, the **AGENCY** **will not apply a payment reduction/incentive**. If the average thickness is less than the specified thickness, but is greater than or equal to the specified thickness minus 1/4 inch, the Agency will determine payment reduction by the following formula:

$$\text{Payment Reduction} = Q \times BP \times PPR$$

Where:

Q = Thickness Lot Quantity (Tons or square yard)

BP = Bid Price ($/ton)

T_S = Specified thickness.

T_A = Average thickness

$$PPR = \text{Percent payment reduction} = \frac{T_S - T_A}{T_S}$$

G. Individual Core Thickness

When more than 2 individual cores in the lot are less than the specified thickness minus 1/4 inch, the Agency will determine the payment reduction using for the above noted formula and using an initial PPR = 2 percent.

H. Remove and Replace

If the average thickness is less than the specified thickness minus 1/2 inch, the Agency will require that the lot be removed and replaced.

TABLE 20.14H-1
Price Reduction – Thickness

Thickness and Remedial action	ACTION TO BE TAKEN
Average core thickness is greater than or equal to the specified core thickness.	**NO payment reduction/incentive will apply**
Average thickness is less than the specified thickness, but is greater than or equal to the specified thickness minus 1/4 inch	**Determine payment reduction by the following formula or remediation of pavement**
If the average thickness is less than the specified thickness minus 1/2 inch.	**Remove and Replace**

* Price reductions are not applicable to developer projects, as a financial deterrent, but may be used as a determination for acceptance.

I. Cost Reduction Formula

Materials or work shall only be evaluated for price adjustment when deviations from specifications occur on any of the individual tests for the lot. Several individual test values shall be averaged and the percentage of cost (quantity) reduction for the lot shall be determined by applicable formula. This shall apply only when a cost reduction factor "F" for the element is listed in Table 20.13-3.
When the Lot is represented by three through seven Tests the formula in (1) and (2) below shall be used.

1) **P = (Xn + aR -Tu) * F** Shall be used if a maximum limit only is specified or; when the average of the several test values is above the midpoint of the specification band or above the job-mix formula value.

2) **P = (TL + aR - Xn) * F** shall be used if the minimum limit only is specified or; when the average of the several test values is below the midpoint of the specification band or below the job-mix formula value.

When the lot is represented by fewer than three tests, **the** materials shall be evaluated for cost (quantity) reduction by the following procedure: Lots represented by two tests shall be divided into two separate lots represented by one test each, as determined by the Agency. Each lot that deviates from the specifications shall be cost adjusted by one of the following formulas.

3) **P = 0.76 * (To -Tu) * F** When a maximum limit only is specified or the test value is above the maximum specified limit.

4) **P = 0.76 * (TL -To) * F** When a minimum limit only is specified or the test value is below the minimum specified limit.

Where:

P is the percentage of reduction in payment quantity.

$\mathbf{X_n}$ is the average of the several test values from samples taken from the lot, with "n" indicating the number of values.

a is a variable factor to be used if "n" changes according to the following:

TABLE 20.14I-1
Cost Reduction Factors

when "n" is	**"a"** equals
3	0.45
4	0.38
5	0.33
6	0.30
7 or greater	0.28

R is the difference between the highest and lowest values in the group of several test results from the lot.
$\mathbf{T_u}$ is the upper or maximum tolerance limit permitted by the specifications.
$\mathbf{T_L}$ is the lower or minimum tolerance limit permitted by the specifications.
$\mathbf{T_o}$ is the test value of the test that deviates from the specifications.
F is the cost reduction factor to be applied for each element as shown in Table 20.14I-2

TABLE 20.14I-2
Price Reduction Factors

ELEMENT	**FACTOR "F"**
100 percent size sieve	1
1/2 inch sieve and larger	1
3/8 inch sieve, #4, #8, #30 sieves No. 100	3
No. 200 sieve	6
Density of Hot Mix Asphalt	8
Asphaltic Cement Binder content (all asphalt-aggregate mixtures)	10
Total air voids	5
Voids in mineral aggregate	Informational Only
Stability	5

If "**P**" is less than three (3) or a negative quantity, the material shall be accepted as being in conformity. In cases where one or more elements show a positive "**P**" value, such positive values shall be added and the resulting sum shall be used to determine whether the material is in conformity. If the total "**P**" value is between 3 and 25, the **AGENCY** may require correction or may accept the material at a reduced cost. If "**P**" is greater than 25, the **AGENCY** may:

Require complete removal and replacement with specification material at no additional cost to the **AGENCY**;
Require corrective action to bring the material into conformity at no additional cost to the **AGENCY**;
Where finished product is found to be capable of performing the intended purpose and the value of the finished product is not affected, permit the **CONTRACTOR** to leave the material in place with an appropriate cost adjustment to be based on the Agency**'s** evaluation but not less than that which would have occurred had an adjustment been made where "**P**" = 25.

If binder content, aggregate sieve analysis, or compaction deviates from the specification requirements and the total "**P**" is three or greater, the reduction shall apply to the contract cost (quantity) multiplied by 0.60 for aggregate base course and Hot Bituminous Pavement mixtures.

The **CONTRACTOR** shall not have the option of accepting a cost reduction in lieu of intentionally producing material not meeting specification. Continued production of non-specification material shall not be permitted. Material that is defective as identified by visual inspection shall be isolated and rejected without regard to sampling sequence or location within a lot.

20.15 TESTING AND INSPECTION

If any materials furnished or work performed fails to fulfill the specification requirements, such deficiencies shall be reported to the Agency immediately. Written field reports prepared by Geotechnical consultants and contractors of all tests taken and observation results shall be delivered to the **AGENCY** **within 3 business days** after samples were obtained or density testing performed. Reports of in place density using rice values from samples taken during construction or other test results that cannot be reported within 3 days of construction shall be provided to the **AGENCY** no later than 1 week following the testing.

Reports of all tests taken, including failing tests, shall be reported to the **AGENCY** no later than 1 week following the sampling. Density test results will be provided to the **AGENCY** at the time the testing occurs.

Failing Test results must reported to the **AGENCY** representative and CONTRACTOR **immediately.**

Testing of Hot Mix Asphalt Pavement shall be performed in accordance with Table 20.15-1 and Table 20.15-2. Laboratories shall be accredited by AASHTO for the material being tested . Technicians taking samples and conducting compaction tests must have a LabCAT Level A certification or equivalent. Technicians conducting tests of asphalt content and gradation must have a LabCAT Level B certification or equivalent. Technicians performing volumetric testing must have a LabCAT Level C certification or equivalent.

TABLE 20.15-1
Minimum Materials Sampling and Testing for all Asphalt Pavement

Test	Standard*	Minimum Frequency
Sampling	AASHTO T168, ASTM D 979 and ASTM D3665	1/1000 tons or fraction thereof (not less than one test per day)
Density	AASHTO T 166, T 238, T 230	One test for each 250 lineal feet per Lane
Thickness (Core)	ASTM D3549	One test for each 1000 lineal feet per Lane,
Air Voids & VMA	AASHTO T 166 & AASHTO PP 19	1/1000 tons or fraction thereof (not less than one test per day)Table 20.3A-2
Gradation	AASHTO T 27, T 11	1/1000 tons or fraction thereof (not less than one test per day)
Hveem/Marshall Stability As Applicable	AASHTO T 245, AASHTO T-246	1/1000 tons or fraction thereof (not less than one test per day)
Asphalt (AC) Content	AASHTO T 164 or other methods agreed upon between Agency and Contractor	1/1000 tons or fraction thereof (not less than one test per day)
Maximum Theoretical Specific Gravity (Rice)	AASHTO T 209	1/1000 tons or fraction thereof (not less than one test per day)
Lottman Stripping, TSR & Dry Density	AASHTO T 283	One per project per mix used.**
Micro Deval	AASHTO T 327	One per 5000 tons or 1 per project minimum
Determining the Rheological Properties of Asphalt Binder	AASHTO TP5	One per 20,000 tons or 1 per project minimum per mix designed used.

*Agency may determine the method used (CP vs. AASHTO).
**QC/QA must verify presents of lime used within mix. (by visual observation)

The **CONTRACTOR** shall provide assistance, at all facilities and at the job site, to inspectors whose duties shall include checking temperatures of mix in the truck and on pavement, segregation, rolling patterns and other construction means and methods that affect the performance of the pavement system. The **CONTRACTOR** shall provide assistance in sampling and testing at all facilities and at the job site.

The HMA or SMA mix design must be approved by the **AGENCY** before any pavement is placed on the project. In addition, the **CONTRACTOR** shall provide field control testing during production of the SMA mix and for the demonstration control strip. The

CONTRACTOR shall perform the following tests and provide the results to the **AGENCY** during production:

If a Superpave SMA mix design is used, the **CONTRACTOR** shall perform the following tests and provide the results to the **AGENCY** during production:

TABLE 20.15-2
Minimum Materials Sampling and Testing for SMA Pavement

Superpave Mix Property	Frequency
Draindown (AASHTO T 305)	1/1,000 tons or fraction thereof
Percent Voids in the total mix @ $N_{(design)}$	1/1,000 tons or fraction thereof
VMA (Percent Voids in the Mineral Aggregate) @ N_{design}	1/1,000 tons or fraction thereof
Lottman, AASHTO T 283, Method B	1/5,000 tons or fraction thereof
Dry Tensile Strength, AASHTO T 283	1/5,000 tons or fraction thereof
Percent AC & Aggregate Gradation AASHTO T 308	1/1,000 tons or fraction thereof

20.16 PAYMENT

HMA shall be measured by the square yard at the compacted depths specified on the plans or as directed by the Project Manager. Accepted quantities of hot bituminous pavement shall be paid for at the contract price per square yard of the type, grading, and thickness specified, complete and in place according to the Conformity with Plans and Specification. The contract price per square yard shall include full compensation for all labor, materials, and equipment necessary to complete the work. If the final pavement surface varies from the theoretical cross section by more than specified tolerances, 25% of the payment due for the entire pavement width and for the full depth of the pavement and base shall be withheld until corrections are made.

Mix design, furnishing, hauling, preparing, and placing all materials, including aggregates, asphalt binder, limestone dust, hydrated lime, tack coat, and approved demonstration control strip; labor, equipment tools, setting of lines and guides where specified, and all other work necessary to complete the item will not be paid for separately but shall be included in the work.

Emulsified asphalts and liquid asphalts shall be measured by the gallon. Emulsions will be measured prior to the addition of water.

TABLE 20.16-1
Payment

Item	Description	Payment
20.1	Asphalt Pavement Material	$ per SY of spec depth
		Tons placed
20.1a*	Emulsified Tack Coat	Inclusive to Pavement**
		$ per Gallon
20.2***	Stone Matrix Asphalt	$ per SY of spec depth
		Tons placed

*When the cost of the tack coat is a separate bid item.
**Cost of Tack Coat is to be inclusive within the Asphalt placement.
**Stone Matrix Asphalt will be measured by either Tons or SY of work completed and accepted.

Metropolitan Government Pavement Engineers Council (MGPEC)
Asphalt Design Equations Form

Agency:_____ **Date:**_____

Project Name:_____ **Project Number:**_____

This form shall be filled out by the AGENCY and is part of the Construction Documents. A copy of this form shall accompany each Mix Design submittal.

_____
Roadway Name, Number, Clasification or Location

_____
From To

→**Construction Application**: ❑ Top ❑ Intermediate ❑ Bottom
❑ Patching ❑ Other_____

→**Nominal Aggregate Size:**	❑ Grading SX	1/2" Nominal	≤1.5" layers
	❑ Grading ST	3/8" Nominal	≤1.125" layers
	❑ Grading S	3/4" Nominal	≤2.25" layers
	❑ Grading SG	1" Nominal	≤3" layers
	❑ SMA	1/2" Nominal	≤1.5" layers
	❑ SMA	3.4" Nominal	≤2.25" layers

→**RAP Maximum**: : ❑ 0% ❑ 15% ❑ 20%
❑ 25% ❑ 35% Grading SG Only

→**Warm Mix Additive or Method:**_____

→**Binder:** : ❑ PG 58-28 ❑ PG 64-22 ❑ PG 76-28
(Polymer modified binders are for the top lift)

→**Superpave Gyratory Mix Design:**

Design Level	Traffic Levels
❑ N_{design} = 50	❑ Low volume ≤300,000 EASL's
❑ N_{design} = 75	❑ 300,000 to <3 million EASL's
❑ N_{design} = 100	❑ High volume ≥3 million EASL's

A completed MGPEC Asphalt Design Requirement Form defining the specific requirements for Asphalt Pavements & Stone Matrix Asphalts shall be filled out by the AGENCY and be included in the contract or project documents. See MGPEC Specifications for details

MGPEC Asphalt Design Requirement Form 2014 Version to be used with MGPEC Pavement Design Standards and Construction Specifications.

MGPEC Asphalt Design Equations Form can be found at www.mgpec.org in the Resources section under Manual.