

Item 20

ASPHALT PAVEMENT MATERIALS

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ITEM 20

ASPHALT PAVEMENT MATERIALS

20.1 DESCRIPTION

This work shall consist of providing an Asphalt Paving Mixture (APM) to be placed as shown on the plans, or as directed by the **AGENCY**. The **CONTRACTOR** shall be responsible for Process Control (PC) of the APM; including the design, and control of the quality of the material incorporated into the project. The **AGENCY** will be responsible for Owners Acceptance (OA); 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 asphalt pavements. 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 maximize the service life of APM. It is also the intent of this document to provide construction requirements in accordance with these specifications to the standard of practice. This item shall include all labor, equipment, and materials to produce, place, and compact asphalt pavement.

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\
APM	Asphalt Paving Mixture
RAP	Reclaimed Asphalt Pavement
SMA	Stone Matrix Asphalt
WMA	Workability Mixture Additive (formerly known as Warm Mix Asphalt)

B. Contractor Process Control

At least 10 calendar 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 to meet the Specifications. The **CONTRACTOR** shall perform all tests necessary for process control purposes and maintain a log of all process control testing. Owners Acceptance (OA) and/or Process Control (PC) test results will be evaluated to determine 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 meet 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 **AGENCY**.

20.2 MATERIALS

Asphalt mixtures may consist of aggregate, filler, anti-strip agent, Recycled Asphalt Pavement (RAP), Workability Mixture Additive (WMA) and asphalt binder.

A. Aggregate

The Aggregate shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel. 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 aggregate)		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	
Flat and Elongated (Ratio 5:1) %, AASHTO M 283	10% Max.	
Sand Equivalent. AASHTO-T 176		45% Min.
Micro Deval (for combined samples) AASHTO T 327	18% Max for design 20% Max. for production	

**TABLE 20.2A-2
Dense Graded Mixture Gradation
(AASHTO T 11 & T 27)**

	ST (3/8" nominal)	SX (1/2" nominal)	S (3/4" nominal)	SG (1" nominal)
	Leveling, Maintenance, Bike Path, Sidewalk	Top and Bottom Lifts, Patching	Lower Lifts	Lower Lifts
Sieve Size				
1.5"				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

*Shall include 1% by total weight if lime is used as the anti-strip agent.

**TABLE 20.2A-3
SMA Mixture Gradation
(AASHTO T 11 & T 27)**

Sieve Size	1/2"	3/4"
(1")		100
(3/4")	100	90-100
(1/2")	90-100	50-88
(3/8")	50-80	25-60
(#4)	20-35	20-28
(#8)	16-24	16-24
(#16)		
(#30)	12-18	12-18
(#50)		
(#100)		
(#200)	8-11	8-11

B. Reclaimed Asphalt Pavement (RAP)

Allowable percentages of RAP in APM are shown in Table 20.2E-2.

**TABLE 20.2E-2
RAP Allowed in APM Mixtures**

Mix Grading	Max % RAP allowed
ST (3/8")	25%
SX (1/2")	25%
S (3/4")	25%
SG (1")	35%
SMA (1/2" & 3/4")	Not Allowed

Quality of RAP

RAP may be used where allowed and shall be of uniform quality and gradation with a maximum size no greater than the nominal aggregate size of the mix. RAP shall not contain clay balls, vegetable matter, or other deleterious substances.

Asphalt mixtures containing RAP shall meet the same gradation and physical requirements as in Table 20.2A-1.

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

The aggregate obtained from the processed RAP shall be based on the required gradation limits for the mixture being used. The aggregate and binder obtained from the processed RAP shall meet the tolerances provided in Table 20.2B-1.

**Table 20.2B-1
RAP Binder & Aggregate Uniformity Tolerances**

Element	Standard Deviation
Binder Content	0.5
% Passing 3/4"	4.0
% Passing 1/2"	4.0
% Passing 3/8"	4.0
% Passing #4	4.0
% Passing #8	4.0
% Passing #30	3.0
% Passing #200	1.5

Process Control (PC) Plan for RAP

A PC plan detailing how the RAP will be processed and controlled shall be developed and followed by the **ASPHALT PRODUCER/ CONTRACTOR** and shall address the following:

A plan that explains the **CONTRACTOR'S** processing techniques for crushing, screening, rejecting, and stockpile operation.

RAP shall be tested as shown in Table 20.2B-2.

**Table 20.2B-2
Test Frequency of Processed RAP**

Test	Minimum testing frequency (minimum 3 tests)
Asphalt Binder Content (AASHTO T-164)	1/1,000 tons
Gradation (AASHTO T-30)	1/1,000 tons

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.

C. WMA Technology:

The **CONTRACTOR** may choose to use a WMA Technology that is included on the CDOT approved products list (<https://www.codot.gov/business/apl/asphalt-warm-mix.html>).

WMA technologies (additive or foaming) used shall be identified on the mix design submitted and approved by the **AGENCY** for use on a project.

If a WMA technology is used, the discharge temperatures may be lowered during production at the discretion of the **CONTRACTOR** provided all specifications are achieved.

D. 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.

E. 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.

F. Asphalt Binder

Asphalt binder shall meet the requirements of the Performance-Graded Binders (PG) as presented in Table 20.2E-1 and consult www.LTTPbind.com when special circumstances arise.

**TABLE 20.2E-1
Properties of Performance Graded Binders**

Property of Binder Grade	PG 58-28	PG 64-22	PG 76-28
Flash Point Temperature, °C, AASHTO T 48	230 Min.	230 Min.	230 Min.
Viscosity at 135 °C, Pas, ASTM D 4402	3 Max.	3 Max.	3 Max.
Dynamic Shear, Temperature °C, where $C'/\sin \delta @ 10 \text{ rad/sec.} \geq 1.00 \text{ Kpa}$, AASHTO TP 5	58 ° C	64 ° C	76 ° C
<i>Rolling Thin Film Oven Residue Properties, AASHTO T 240</i>			
Mass Loss, %, AASHTO T 240	1.00 Max.	1.00 Max.	1.00 Max.
Dynamic Shear, Temperature °C, where $G'/\sin \delta @ 10 \text{ rad/sec.} \geq 2.20 \text{ Kpa}$, AASHTO TP 5	58 ° C	64 ° C	76 ° C
Elastic Recovery ¹ , 25°C, % Min.	N/A	N/A	50 Min.
<i>Pressure Aging Vessel Residue Properties, Aging Temperature 100 °C AASHTO R 28</i>			
Dynamic Shear, Temperature °C, where $G'/\sin \delta @ 10 \text{ rad/sec.} \leq 5,000 \text{ Kpa}$, AASHTO TP 5	19 ° C	25 ° C	28 ° C
Creep Stiffness, @ 60 sec. Test Temperature in °C, AASHTO TP 1	-18 ° C	-12 ° C	-18 ° 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.

G. Anti-Strip Additives

Anti-Strip shall be added into the APM. Anti-Strip agents may be liquids (added to the binder), lime (added to the aggregates) or other products, and shall be submitted for approval by the **AGENCY**.

The minimum value for Tensile Strength Ratio (TSR) shall be 80% for the mix design and 70% during production.

Liquid Anti-Strip

There are various types of liquid Anti-Strips. Amine and Organo-silane type liquid Anti-Strip additives are physically mixed with the asphalt binder.

Liquid Anti-Strip agents shall be added per the manufactures recommendations. Typical product dosages are provided in Table 20.2F-1.

**TABLE 20.2F-1
Liquid Anti-Strip Dosage Rates**

Type	Typical Dosage Rate
Amine	0.4% to 0.8%
Organo-silane	0.05% to 0.15%

WMA chemical products which display Anti-Stripping characteristics will be classified as a liquid Anti-Strip additive.

When a liquid Anti-Strip additive is used, the **CONTRACTOR** shall include the following information with the mix design submission:

- Information on the type of liquid Anti-Strip additive to be supplied, including product name, product manufacturer/supplier
- Additive rate
- TSR values for the treated mixes
- The proposed method for incorporating the additive into the plant produced mix.

Hydrated Lime

The hydrated lime for APM shall conform to the requirements of AASHTO M 303, Type I. In addition, the particle size requirements shall conform to AASHTO M 303 when tested in accordance with CP-L 4209 Physical Testing of Quicklime, Hydrated Lime, and Limestone. 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.

20.3 MIX DESIGN AND PRODUCTION REQUIREMENTS

There shall be no substitutions of materials allowed during production. All substitutions will require checkpoint verification. If 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 "Mix Design Requirements" Form 20, the criteria concerning mix design method, traffic level, binder type, mixture grading, and percent of RAP allowed.

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

A. Mixture Design Method

A Job Mix Formula (JMF) design shall be submitted for each mixture required, at least 10 calendar days prior to construction, for review by the **AGENCY**. The JMF design shall be determined using AASHTO T-312 for the Method of Mixture Design.

Mixture design and field control testing of dense graded asphalt mixes shall meet the requirements of Table 20.3A-1. For mixes requiring a design gyration of 100 (ESALs greater than 3 million) the Project Special Conditions should be used. This gyration is not recommended for the majority of roads within MGPEC agencies.

Mixture design and field control testing of SMA shall meet the requirements of Table 20.3A-2.

**TABLE 20.3A-1
Mixture Properties for Dense Graded Asphalt Mixtures**

Property	Traffic Level (ESALs)	
	<100,000	≥100,000 to 3 Million
Design gyrations, N_{design}	50	75
Air Voids (V_a) % at N_{design} (AASHTO T-132)	3.0 – 4.0	3.0 – 4.0
Hveem Stability (AASHTO T-246) (Grading ST, SX & S only)	28 Min.	28 Min.
Voids Filled with Asphalt (V_a), MS-2	70-80	65-80
Accelerated Moisture Susceptibility, tensile strength ratio, (Lottman) (AASHTO T-283 Method B)(for S,SX,SG mixes)	80 Min.	80 Min.
Dry Tensile Strength, psi (AASHTO T-283)	30 Min.	30 Min.
Voids in Mineral Aggregates (VMA) % (AASHTO PP-19)	Table 20.3A-3	

**Table 20.3A-2
Mixture Properties for SMA**

Property	Test Method	Value
Lab compaction (Gyrations) N_{Design}	AASHTO T-312	75
Air Voids (V_a) % at N_{Design}	AASHTO T-312	3.0 – 4.0
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 PP19	17
Drain Down at Production Temperature	AASHTO T-305	0.3 Max.

TABLE 20.3A-3
Minimum Voids in Mineral Aggregate (VMA)
Dense Graded & SMA mixes

Nominal Maximum Particle Size	Minimum VMA (%)		
	3.0% V _a	3.5% V _a	4.0% V _a
3/8" (ST)	15.5	15.6	15.7
1/2"(SX)	14.5	14.6	14.7
3/4" (S)	13.5	13.6	13.7
1" (SG)	12.5	12.6	12.7
SMA - 1/2"	17.0	17.0	17.0
SMA - 3/4"	17.0	17.0	17.0

B. Mixture Design Submittals

The **CONTRACTOR** shall submit all mix designs, Certificates of Compliance, and laboratory data to the **AGENCY** for approval at least 10 calendar days before construction is to begin.

Designs shall be developed and performed in a materials laboratory that meets the requirements set forth by AASHTO Materials Reference Laboratory (AMRL) for all testing procedures. , The design shall be stamped and signed by a Professional Engineer licensed in the State of Colorado. 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, optimum binder content.
- Mixing and compaction temperatures used.
- Mixture properties shall be determined with a minimum of four binder contents.

The **AGENCY** reserves the right to verify the asphalt supplier’s mix design for each APM design utilizing materials 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 APM used within three business day from the sampling date.

C. Change in Source or Grade

Should a change in the source of any material used in the production of APM (aggregate, mineral filler, lime, or performance graded asphalt binder) occur, a one point verification test (at optimum binder content) of the mix must be performed to verify that the applicable criteria shown on Table 20.3A-1 (dense graded APM), 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 APM is used.

D. Mix Production Verification

Production verification shall occur prior to the start of the project. Volumetric properties of the mix shall be verified by LabCAT Level C certified Technicians. 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 tolerances in Table 20.12-1. The mix verification test reports shall be submitted to the **AGENCY** prior to mix placement.

Verification testing for binder content, gradation and physical properties shall be performed at the frequencies listed in Table 20.14-1.

E. Pre-Paving Meeting

The **AGENCY** may require a pre-paving meeting of all parties that are directly involved in the project. Traffic control, transport, sequence of paving and construction plans may be reviewed and discussed.

20.4 PRODUCTION

A. Preparation of Aggregates

Heating and drying of the aggregates shall be accomplished without damaging the aggregate. An Anti-Strip additive shall be added to achieve uniform coating of the aggregate, in accordance with Section 20.2F Anti-Strip Additives.

B. Mixing

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

Discharge temperatures are shown in Table 20.4-1.

**TABLE 20.4-1
Mixture Discharge Temperatures**

Binder Grade	Minimum Discharge Temperature	Maximum Discharge Temperature
PG 58-28	275° F	305° F
PG 64-22	290° F	320° F
PG 76-28	320° F	330° F
Workability Mixture Additive (WMA)	If a WMA technology (additive or foaming) is used, the discharge temperatures may be lowered during production at the discretion of the CONTRACTOR provided all specifications are achieved.	

To protect the properties of the binder, APM shall be produced at the lowest temperature within the specified range that produces a workable mix and provides for uniform coating of aggregates, and that allows the **CONTRACTOR** to achieve the required compaction.

C. Transportation

Colorado Statutes require that each truck shall be covered. This will also help protect the mix during transport from contamination and weathering. The **AGENCY** may reject any uncovered APM which demonstrates it has been impacted by contamination and/or weather.

20.5 TACK COAT

Prior to placement of APM, a tack coat shall be applied to all existing concrete and asphalt surfaces.

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

The tack coat shall be applied at a rate of 0.1 to 0.3 gallons per square yard. The surface receiving the tack coat shall be dry and clean, and dust, debris, and foreign matter shall be removed. Tack coat shall be applied uniformly. The **CONTRACTOR** shall allow the tack coat to cure (dehydrate) prior to the placement of APM. If the tack becomes contaminated during construction, it shall be cleaned, and if necessary, additional tack coat shall be reapplied and allowed to cure before paving resumes.

**TABLE 20.5-1
Tack Coat Application Rates**

Pavement Condition	Application Rate (gal/yd ²)		
	Residual	Undiluted	Diluted (1:1)
New asphalt	0.03 - 0.04	0.05 - 0.07	0.10 - 0.13
Oxidized asphalt	0.04 - 0.06	0.07 - 0.10	0.13 - 0.20
Milled Surface (asphalt)	0.06 - 0.08	0.10 - 0.13	0.20 - 0.30
Milled Surface (PCC)	0.06 - 0.08	0.10 - 0.13	0.20 - 0.30
Portland Cement Concrete	0.04 - 0.06	0.07 - 0.10	0.13 - 0.20

20.6 EQUIPMENT

A. Transport Equipment

Trucks used for transporting APM shall be free of debris, and should be treated with approved release agents. Petroleum distillates such as kerosene or fuel oil will not be permitted as a release agent. The **AGENCY** may reject any APM which demonstrates it has been contaminated from a petroleum distillate release agent.

B. Material Transfer

Placement of SMA shall require the use of a Material Transfer Vehicle (MTV) or Material Transfer Device (MTD). The MTV shall be a self-propelled unit with on board storage of material. An MTD is a non-self-propelled unit. Both MTV and MTD are capable of receiving material from trucks or from the ground, transferring the material from the unit to a paver hopper insert via a conveyor system.

C. APM Pavers

Self-propelled pavers shall be capable of placing the APM to the desired width, thickness and a satisfactory mat texture.

Pavers shall be equipped with automatic screed controls, the sensors may be contact or non-contact type devices. The controls shall be capable of maintaining the screed at the specified transverse slope within $\pm 0.1\%$.

20.7 PLACEMENT

APM shall be placed on properly constructed surfaces that are free from debris, frost, snow, or ice. APM shall be placed in accordance with the temperature limitations of Table 20.7-1. In-place density for APM shall be 94% of maximum theoretical specific gravity (Rice - AASHTO T 209). The allowable variance shall be $\pm 2\%$. Test results shall be reported to the nearest whole number.

A. Temperature

Surface temperatures shall be used to determine placement of APM. APM produced with documented WMA will be allowed a reduction in minimum surface temperatures for placement as provided in Table 20.7A-1. Ambient temperatures and other weather conditions shall be considered prior to placement.

TABLE 20.7A-1
Minimum Surface Temperatures for placement of APM

Compacted Layer Thickness (in.)	Minimum Surface Temperature (°F)			
	Top Layer		Layers Below the Top Layer	
Product	APM	with WMA	APM	with WMA
<1½	60	50	50	40
1½ - <3	50	45	40	35
3 or more	45	40	35	35

If the **CONTRACTOR** modifies the placement and compaction processes when ambient temperatures are below minimum surface temperatures in Table 20.7A-1, they shall demonstrate to the **AGENCY** the required in-place density has been achieved. APM cooling software such as PaveCool, or MultiCool can be used to determine placement and compaction times available.

B. SMA Placement

The **CONTRACTOR** shall establish and document a roller pattern for the SMA being placed. The roller pattern shall include, but is not limited to the following:

- Number, size, and type of rollers
- Amplitude, frequency, and speed of rollers
- Temperature of mixture being compacted during each process (break down, intermediate and finish)
- Number of roller passes for each phase

The in-place density shall be determined during placement of the first 1,000 feet with a minimum of 95% of Theoretical Maximum Density (Rice). The allowable variance shall be $\pm 2\%$. Test results shall be reported to the nearest whole number.

SMA mixture shall be placed with the assistance of a MTV or MTD. The **CONTRACTOR** should minimize flushing and drain down during the transport and placement of SMA. If more than 50 square feet of flushed area is observed, the **CONTRACTOR** shall provide a remedy to address the flushing and/or drain down.

In place density may be determined by nuclear gauge measurements in accordance with ASTM D 2950 and AASHTO T 230, or based on cores in accordance with AASHTO T 166, Method B. When

cores are used, the **CONTRACTOR** shall provide all labor and equipment for the coring and repair of the holes.

When the material being placed is on a structure (bridge deck), nuclear gauge measurements shall be used.

C. WMA Technology

WMA technologies (additive or foaming) may be used as a compaction aid and may allow for workability of the APM at lower temperatures.

The addition of WMA additives during production, including foaming, shall be controlled by a calibrated metering system interlocked with the plant's controls per the manufacturers' recommendation.

Additives may be added at the asphalt terminal at the dosage rate recommended by the WMA technology provider. The dosage rate and additive name shall be printed on the Bill of Lading for the asphalt binder.

The foaming process mixes water and binder to create microscopic steam bubbles. Typical water injection rate is $\leq 2\%$ of binder flow rate or per manufacturers' recommendation.

20.8 LONGITUDINAL JOINTS

The **CONTRACTOR** shall submit a joint plan and pavement marking plan showing the location of and the methods to establish the paving control lines. The plan shall be approved by the **AGENCY**. The **CONTRACTOR** shall use a method to delineate longitudinal joints during paving.

Longitudinal joints in all pavement layers shall offset the joint in the layer immediately below by a minimum of six 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. Joints shall be parallel to the flow of traffic and shall not cross any centerline, lane line, or edge line.

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.

20.9 TRANSVERSE JOINTS

The **CONTRACTOR** shall submit a joint plan. The plan shall be approved by the **AGENCY**. The **CONTRACTOR** shall use an approved plan to delineate transverse joints during paving. 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.

The surface tolerance at the transverse joint shall be verified by the **CONTRACTOR** with a 10 foot straight edge. If the surface tolerance exceeds 3/16" across the joint, measured in at least three locations, the **CONTRACTOR** shall make corrections to the joint before proceeding.

20.10 SEGREGATION

Visually segregated areas shall be corrected before the initial compaction process is applied. Segregated areas may be determined visually or by other acceptable means. The **CONTRACTOR** shall correct segregated areas to the satisfaction of the **AGENCY**.

20.11 COMPACTION

Equipment used for compaction of the APM will be at the discretion of the **CONTRACTOR**. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture.

When the mixture contains unmodified asphalt binder (PG 58-28 or PG 64-22), and the surface temperature falls below 180°F, further compactive effort shall not be applied unless the **CONTRACTOR** can demonstrate that there is no damage to the finished mat.

If the mixture contains modified asphalt binder (PG 76-28) and the surface temperature falls below 230°F, further compactive effort shall not be applied unless the **CONTRACTOR** can demonstrate that there is no damage to the finished mat.

Use of rollers with the vibrator on will not be permitted on bridge decks covered with waterproofing membrane.

In-place density for APM shall be 94% of maximum theoretical specific gravity (Rice - AASHTO T 209). The allowable variance shall be $\pm 2\%$. Test results shall be reported to the nearest whole number. Rice values will be based on a three 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.

In place density for SMA shall be determined during placement of the first 1,000 feet with a minimum of 95% of theoretical maximum specific gravity Rice - AASHTO T 209). The allowable variance shall be $\pm 2\%$. Test results shall be reported to the nearest whole number.

All joints shall be compacted to 92% of Rice, taken six inches offset from the joint, at a minimum of one every 1000 linear feet or fraction thereof. The allowable variance shall be $\pm 2\%$. Test results shall be reported to the nearest whole number.

Cores may be used to verify compaction results. The **CONTRACTOR** shall core the pavement, as required by the **AGENCY**; 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 correlation shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall meet all project compaction specifications. Any mixture that is defective, shall be corrected to meet the project specifications at the expense of the **CONTRACTOR**.

20.12 PRODUCTION TOLERANCES

A. Wearing Course

Surface variation shall not exceed 3/16 inch in 10 feet for full lane width paving. For patching, the variation shall not exceed 3/8 inch in 10 feet. The final pavement surface shall not vary from the

specified cross section by more than one inch at any point. Transverse measurements for variations shall exclude breaks in the crown sections. Corrections shall be made at the **CONTRACTOR's** expense.

The final surface pavement adjacent to curb and gutter shall be finished from 1/8-inch to 3/8-inches above the lip for catch curb and shall not extend above the lip for spill curb.

The **CONTRACTOR** shall adjust all manholes, valve boxes, and survey range boxes 1/8 to 1/2- inch below final grade and adjusted to match the slope of the roadway. Valve boxes and manholes are to be maintained fully accessible at all times for emergency and maintenance operations. The cost of adjusting valve boxes, manholes, and survey range boxes shall be included in the work, unless otherwise specified. The **CONTRACTOR** shall be responsible for any cost incurred by the **AGENCY** to provide access to the covered manholes or valve boxes. Final adjustment of all utility access points shall be completed within seven days of from the time the APM was placed.

B. Job Mix Formula

Tolerances for gradation are presented in Table 20.2A-2 and Table 20.2A-3. APM volumetric tolerances are presented in Table 20.12-1.

**TABLE 20.12-1
Production Mix Tolerances**

Property	Tolerance
Air Voids	± 1.2%
VMA	± 1.2%
Asphalt Binder Content	± 0.3%

20.13 CONFORMITY WITH PLANS AND SPECIFICATIONS

A. Materials

Materials shall be sampled by and tested by a LabCAT certified technician(s) in an AMRL accredited testing laboratory in accordance with Section 20.14.

Test results that have sampling or testing errors shall not be used.

B. Pavement Thickness

A minimum of 90% of all the pavement thickness cores must equal or exceed the required thickness shown on plans or pavement design report.

If the pavement thickness deficiency is greater than 0.25 inches for individual cores, two additional cores will be taken by the **CONTRACTOR** 50 feet before and after each deficient core. The three core results will be averaged to determine if the results meet the required thickness.

When individual core thickness deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, remedial action will be required. The **CONTRACTOR** shall present proposed remedial measures for consideration by the **AGENCY**. The **AGENCY** will review the proposal within 10 working days to accept or modify the remedial measures. The remedial measures will be performed by the **CONTRACTOR** at no additional cost to the **AGENCY**.

When individual core thickness deviates from the target thickness by more than 0.50 inch, corrective action shall be required. The deficient area will overlaid with no less than one inch thick lift to meet the design thickness. The **CONTRACTOR** will mill to match existing facilities prior to corrective overlay. The mixture proposed shall be approved by the **AGENCY**. Corrective action will be performed by the **CONTRACTOR** within 15 working days.

If the **AGENCY** does not want the top lift cored, they may require the **CONTRACTOR** to use non-destructive survey techniques to determine APM thickness.

C. Smoothness

Smoothness criteria is typically not applicable for local agency roads. Impacts of curb and gutter, utilities, cross streets, and intersections will cause deviation from plane making smoothness measurements inaccurate.

However, if the **AGENCY** elects to set smoothness criteria it should only be established for roadways with speed limits 35 mph or greater. When specified, the **CONTRACTOR** shall profile the roadway prior to the work taking place and immediately after the work has ended. The **CONTRACTOR** will be required to maintain or improve the ride quality. If the ride quality decreases, the **CONTRACTOR** will be required to restore the ride to the levels it was prior to the work taking place.

D. Acceptance

If the **CONTRACTOR** does not meet the project specifications, but acceptable work has been produced, the **AGENCY** shall determine the extent of the work to be accepted. If the **AGENCY** determines the work is not acceptable, the **CONTRACTOR** shall correct the work, as approved by the **AGENCY**, at the expense of the **CONTRACTOR**.

20.14 TESTING AND INSPECTION

If any materials furnished or work performed fails to meet the specification requirements, such deficiencies shall be documented and reported to the **AGENCY**. Field reports shall be delivered to the **AGENCY** within three business days. Test results that cannot be completed within three days shall be provided to the **AGENCY** no later than one week after the sample was obtained.

Testing of APM shall be performed in accordance with Table 20.14-1. Laboratories shall be accredited by AASHTO Materials Reference Laboratory (AMRL) for the tests being performed. Technicians obtaining samples and conducting compaction tests must have a LabCAT Level A certification. Technicians conducting tests of asphalt content and gradation must have a LabCAT Level B certification. Technicians performing volumetric testing must have a LabCAT Level C certification. Inspectors on APM projects shall be LabCAT Inspector Certified (Level I).

TABLE 20.14-1
Minimum Materials Sampling and Testing
for Process Control and Owners Acceptance

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)
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)
Binder 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.

20.15 PAYMENT

Accepted quantities of APM shall be paid at the contract price when complete and in place according to the Plans and Specifications. The contract price per contract and shall include labor, materials, and equipment necessary to complete the work.

TABLE 20.15-1
Payment

Description	Payment
Asphalt Pavement Material	\$ / Ton Placed
Emulsified Tack Coat – (measured prior to the addition of water)	\$ / Gallon
Stone Matrix Asphalt	\$ / Ton Placed

Form 20

Mix Design Requirements V. 9/2017

Agency: _____ Date: _____

Project: _____

Details: _____ APM (tons): _____
(To / From, Length)

Classification Arterial Collector Local Other _____

APM Placement Wearing course Intermediate lift Bottom lift Patching

ASPHALT MIX DESIGN

Design / Traffic $N_{design} = 50$ gyrations <100,000 ESALs
 $N_{design} = 75$ gyrations ≥100,000 to <3 million ESALs

Binder PG 58-28 PG 64-22 PG 76-28 (Top lift only)

	<u>Minimum Lift (3x)</u>	<u>Maximum Lift (5x)</u>
<input type="checkbox"/> ST (3/8")	1 1/8"	2 1/4"
<input type="checkbox"/> SX (1/2")	1 1/2"	2 1/2"
<input type="checkbox"/> S (3/4")	2"	4 1/4"
<input type="checkbox"/> SG (1")	3"	5"
<input type="checkbox"/> SMA (1/2")	1 1/2"	2 1/2"
<input type="checkbox"/> SMA (3/4")	3"	4 1/4"

Anti - Strip Liquid Lime

BEST PRACTICES to include in Mix Design

RAP 25% 35% (Grading SG only)

WMA Additive Foaming

AGENCY EXCEPTIONS

- No RAP in wearing course**
- No RAP allowed in mixture**

- No WMA allowed in mix**