

2017 Project

STONE MATRIX WARM MIX ASPHALT (SMA) (Illinois Tollway)

Effective: January 11, 2012

Revised: June 15, 2017

Description. This Special Provision establishes and describes the responsibilities of the Contractor in producing and constructing Stone Matrix Asphalt (SMA) surface friction course, surface course and binder course, produced as a warm mix asphalt (WMA) mixture. This work shall be according to the applicable portions of Section 406, Section 1030, and Section 1032 of the Standard Specifications, and of the contract Illinois Tollway special provisions for Reclaimed Asphalt Pavement and Recycled Asphalt Shingles, and Surface Smoothness Testing for Pavement; except as modified herein.

Materials.

(a) Aggregates.

- (1) Coarse Aggregate. The coarse aggregate for the SMA surface friction course shall be crushed steel slag, quartzite, granite, or diabase / trap rock with the option to use up to 10% coarse portion Category 1 FRAP or up to 25% coarse portion of Category 1 FRAP from a friction SMA source. The coarse aggregate for the SMA surface course shall be crushed steel slag, quartzite, granite, diabase / trap rock or crushed gravel with the option to use up to 10% coarse portion Category 1 FRAP or up to 25% coarse portion of Category 1 FRAP from a friction SMA source. The coarse aggregate for the SMA binder course shall be crushed gravel, quartzite, granite, or diabase / trap rock with the option to use up to 10% coarse portion Category 1 FRAP containing no steel slag or up to 25% coarse portion of Category 1 FRAP from a friction SMA source. Blending of aggregates shall be allowed. All coarse aggregate shall meet the following additional requirements:

Gradation. No individual coarse aggregate gradation is specified. Blending of coarse aggregate shall be permitted. The coarse aggregate gradation(s) used shall be capable of being combined with FA 20 or FA 22 stone sand and mineral filler, or with the fine portion Category 1 or Category 2 FRAP to meet the approved mix design and the material and mix requirements noted herein.

Quality. All coarse aggregate shall be Class B Quality or better.

Coarse aggregate crushed gravel shall be as defined in Article 1004.01 (a) (3) of the Standard Specifications. Crushed gravel coarse aggregate shall meet the following additional requirements. Crushed particle content (%) shall comply with the current Bureau of Materials and Physical Research Policy Memorandum, "Crushed Gravel Producer Self-Testing Program" for category I/II coarse aggregate products. When tested in accordance with ASTM D 5821, the coarse aggregate angularity shall have a minimum of 100% "two fractured faces" per AASHTO M323-04. When tested in accordance with ASTM D 4791, the percentage of flat and elongated particles of the crushed gravel shall be no more than 10% per AASHTO M323-04, Table 5.

Crushed gravel in an SMA surface or binder course shall meet the following requirements:

- (a) LA Abrasion (ASTM C131) for the gravel source shall be less than 28.0 as determined by the Illinois Department of Transportation.
- (b) Micro-Deval (ASTM D6928)
 - (1) No individual coarse aggregate shall have a Micro-Deval value greater than 12.0
 - (2) The weighted average discussed below is by weight of aggregate of the coarse aggregates in the mixture.
 - (3) If the Micro-Deval weighted average of design proportions is greater than 11.5, the aggregate combination will be considered unacceptable.
 - (4) If the Micro-Deval weighted average of design proportions is less than 9.5, the aggregate combination shall be considered acceptable.
 - (5) If the Micro-Deval weighted average of design proportions is between 9.5 and 11.5, a mix design must be performed and a sample gyrated at optimal AC to N225. The Air Voids at N225 must be $\geq 2.0\%$

If the coarse portion Category 1 FRAP Friction SMA percentage is greater than 10.0 percent, the Micro-Deval (ASTM D6928) value for the coarse FRAP must be less than 9.0, and the Category 1 FRAP Friction SMA results must be included in the Micro-Deval weighted average design criteria.

All Micro-Deval testing must be performed by a laboratory with AMRL aggregate accreditation. The Engineer reserves the right to verify Micro-Deval testing.

Water Absorption. Each individual natural coarse aggregate shall have water absorption of no more than 2.5 percent based on the AASHTO T85 test method as performed by an AAP accredited laboratory. The total coarse aggregate blend in the mixture shall have water absorption of no more than 2.0 percent. Steel Slag sources shall follow the "Slag Producer Self-Testing Program" as established by the Illinois Department of Transportation. All steel slag aggregate shall have water absorption of no more than 2.0 percent.

- (2) **Fine Aggregate.** Fine aggregate shall be Class B Quality stone sand meeting gradation FA 20 or FA 22 in accordance with Section 1003 of the Standard Specifications, or when using FRAP, the fine portion Category 1 FRAP may be used separately or as proportioned with the stone sand. The fine portion of the FRAP shall be the portion of the processed FRAP passing the No. 4 sieve from a Category 1 source.

A Category 2 fine-FRAP source may be used in the mix design provided that a chemical extraction (Illinois Modified AASHTO T 164) of the FRAP is conducted, and the fine aggregate angularity (AASHTO T 304, Method A) of the fine FRAP sand equals 45 or greater.

- (a) Obtain five (5) samples to represent the Category 2 FRAP stockpile.

Split each sample into two parts. One portion of each split shall be tested by an independent AMRL accredited laboratory and one portion shall be retained for Tollway verification testing.

- (b) The fine aggregate angularity (AASHTO T 304, Method A) of all five (5) samples shall be equal to or greater than 45.
- (c) Once a stockpile has been approved for use in a SMA, the stockpile will be considered sealed, and no additional fine FRAP shall be added to the approved stockpile.

- (3) Mineral Filler. Mineral filler shall be commercially manufactured mineral filler meeting Article 1011.01 of the Standard Specifications.

As an option, collected baghouse dust may be used in lieu of manufactured mineral filler, provided: 1) there is enough available for the production of the SMA mix for the entire project, and 2) a mix design was prepared with collected bag-house dust.

- (b) Fiber Additive. If the SMA mix design drain down measured in accordance with AASHTO T 305 exceeds the 0.3% maximum, a fiber additive shall be added to the SMA mixture. The drain down shall be determined at the job mix formula asphalt binder content at the mixing temperature of 350° F. A fiber additive shall be included in all SBS/SBR Polymerized SMA mixtures. The actual dosage rate will be determined by the Engineer.

- (1) Cellulose or Mineral Fiber. The fiber additive shall comply with the requirements of AASHTO MP-8.

The dosage rate for cellulose shall be approximately 0.4% by total mixtures mass and sufficient to prevent draindown from exceeding 0.3%. For mineral fiber, the dosage rate shall be approximately 0.5% by total mixture mass and sufficient to prevent draindown.

- (2) Reclaimed Asphalt Shingles (RAS). RAS may be used as a fiber additive in Stone Matrix Asphalt (SMA) mixtures if the mix design with RAS prevents draindown from exceeding 0.3%. The RAS shall be from a certified source that produces either pre-consumer or post-consumer RAS material in accordance with the special provision for RAS. The percent RAS to be added to the mix shall not exceed 5.0% by mass or an amount that will maintain the binder replacement of the mix design at 40 percent or less.

- (c) Reclaimed Asphalt Pavement (RAP). The coarse portion Category 1 FRAP will be permitted at a maximum of 10 percent in binder, surface, or surface friction course SMA mixtures. The coarse portion Category 1 FRAP from a friction SMA source will be permitted up to 25% in binder, surface, or surface friction course SMA, as long as it meets Micro-Deval criteria. When used in SMA mixtures containing RAS, or RAS and fine portion Category 1 or 2 FRAP, the amount of coarse portion Category 1 FRAP shall be to maintain the binder replacement 40 percent or less. When used in SMA mixtures containing fine portion Category 1 or 2 FRAP with no RAS, the amount of coarse portion Category 1 or 2 FRAP shall be to maintain the binder replacement of the mix design at 25 percent or less.

The fine portion Category 1 or 2 FRAP having a minimum average asphalt content of 6.0 percent by weight shall be permitted at a maximum of 20 percent or at a lesser amount that will maintain the virgin binder replacement at no more 40 percent of the total binder in any WMA mix.

- (d) Asphalt Binder (AB). At the contractor's option, the contractor shall use a SBS/SBR polymer, a terminal blend ground tire rubber (GTR), or a dry process GTR to modify the asphalt mixture. The asphalt binder requirements for the mixture will vary depending upon the amount and type of recycled asphalt binder contained in the mix design. This table summarizes these requirements:

Reclaimed Material	Binder Replacement, %	Asphalt Binder Options
None	0	SBS/SBR PG 76-22 GTR PG 76-22 PG 64-22 10% Dry GTR
Category 1 or 2 FRAP only	Less than 20	SBS/SBR PG 76-22 GTR PG 76-22 PG 64-22 10% Dry GTR
	20 to 25	SBS/SBR PG 70-28 ✓ GTR PG 70-28 ✓ PG 58-28 10% Dry GTR ✓
RAS (By itself, or with FRAP)	up to 40	SBS/SBR PG 70-28 GTR PG 70-28 PG 58-28 10% Dry GTR

The asphalt binder modification technology shall be on the Illinois Tollway's Approved List of Stone Matrix Asphalt Modification Technologies.

- (1) SBS/SBR PG 76-22, PG 70-22, or PG 70-28 Binder. The SBS/SBR PG 76-22, PG 70-22, or PG 70-28 binder shall meet the requirements of Article 1032.05(b) of the Standard Specifications. In addition, the elastic recovery of the Asphalt Binder used shall be a minimum of 80.
- (2) Terminal Blend GTR Binder. The base asphalt binder that is blended with the GTR shall be a performance-grade (PG) binder that is at least two high temperature grades lower than the required high temperature grade, as based on the recycled binder type and amount included in the mix design. The required base PG binder shall meet the requirements of Article 1032.05 of the Standard Specifications. The GTR shall be produced from processing automobile and/or truck tires by the ambient grinding method. Heavy equipment tires, uncured or de-vulcanized rubber will not be permitted. The GTR shall not exceed 1/16 in. in length and shall contain no free metal particles. Detection of free metal particles shall be determined by thoroughly passing a magnet through a 2 oz. sample. Metal embedded in rubber particles will be permitted.

The GTR shall be stored in a dry location protected from the rain. When the

GTR is combined with the asphalt cement, the moisture content of the GTR shall not cause foaming of the blend.

When tested in accordance with Illinois-modified AASHTO T-27, a 2 oz. sample of the GTR shall conform to the following gradation requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 8 (2.36 mm)	100
No. 16 (1.18 mm)	98 ± 2
No. 30 (600 µm)	95 ± 5
No. 50 (300 µm)	50 ± 10
No. 100 (150 µm)	10 ± 5
No. 200 (75 µm)	2 ± 2

A mineral powder (such as talc) meeting AASHTO M17, Mineral Filler for Bituminous Paving Mixtures, requirements may be added, up to a maximum of 4% by weight of GTR particles, to reduce sticking and caking of the GTR particles.

GTR shall have a specific gravity of 1.15 ± 0.05 when tested in accordance with ASTM D-1817, Standard Test Method for Rubber Chemicals-Density.

Extender Oils or Polymeric Additions. With approval of the Engineer, compatible extender oils and/or polymers may be added to the GTR or if the material is compounded into a homogenous blend before the modification additive is added to the asphalt. The additional costs for the extender oils and/or polymer additions shall be borne by the Contractor. The Contractor shall provide material product information along with usage rates for approval.

The GTR blended asphalt shall comply with the specified PG Grade in accordance Table 1 of Article 1032.05 (b) of the Standard Specifications with exception to the Tests on Residue from Rolling Thin Film Oven Test (AASHTO T 240). Dynamic Shear Rheometer tests shall use a 2.00mm gap for 25mm plates. In addition, the elastic recovery shall be a minimum of 70.

- (3) Dry Process GTR. The base asphalt binder that is used in a dry process GTR mix shall be a performance-grade (PG) binder as based on the recycled binder type and amount included in the mix design. The required base PG binder shall meet the requirements of Article 1032.05 of the Standard Specifications.

The dry process GTR shall be produced from processing automobile and/or truck tires by ambient or cryogenic grinding methods. Heavy equipment tires, uncured or de-vulcanized rubber will not be permitted. The GTR shall not exceed 1/20 in. in diameter and shall contain no free metal particles. Detection of free metal particles shall be determined by thoroughly passing a magnet through a 2 oz. sample. Metal embedded in rubber particles will be permitted.

The dry process GTR shall be packaged and shipped in closed-top, water resistant bulk bags. The dry process GTR bags shall be stored in a dry location protected from the rain before use in the field. When the GTR is combined with the asphalt cement and aggregate, the moisture content of the GTR shall not cause foaming of the blend.

When tested in accordance with Illinois-modified AASHTO T-27, a 2 oz. sample of the dry process GTR shall conform to the following gradation requirements:

Sieve Size	Percent Passing
No. 20	100
No. 30 (600 μm)	99 ± 1
No. 40 (300 μm)	60 ± 10
No. 100 (150 μm)	10 ± 5

A mineral powder (such as talc) meeting AASHTO M17, Mineral Filler for Bituminous Paving Mixtures, requirements may be added, up to a maximum of 4% by weight of GTR particles in order to reduce sticking and caking of the GTR particles.

The dry process GTR shall have a specific gravity of 1.15 ± 0.05 when tested in accordance with ASTM D-1817, Standard Test Method for Rubber Chemicals-Density.

No extender oils or polymeric additions (elastomers, plastomers) shall be included in the dry process GTR.

(e) Warm Mix Additives / Processes. The warm mix technology used shall be on the Illinois Tollway's Approved List of Warm-Mix Asphalt (WMA) Technologies. A recognized additive / process with at least three successful projects constructed nationally or internationally that allow for a reduction in the temperature at which the SMA mixtures are produced and placed. Warm mix additives/processes that may be considered for Illinois Tollway approval and Contractor use include the following:

- (1) Organic Additives (requiring minor plant modifications)
- (2) Chemical Additives (requiring minor plant modifications)
- (3) Water Injection Foaming Processes

For SMA containing RAS or more than 20 percent binder replacement, a chemical additive shall be used as the WMA technology.

Equipment.

Sections 406 and 1030 of the Standard Specifications shall govern the requirements for equipment; the preparatory work; mix design criteria; and the preparation,

transportation, placement and compaction of SMA mixtures, except as modified herein.

Add the following to the list of specific references to Article 406.03 of the Standard Specifications.

Material Transfer Device	Illinois Tollway special provision for Material Transfer Device
RAP Processing Equipment	Illinois Tollway special provision for Reclaimed Asphalt Pavement"

Rollers. The Contractor shall provide a minimum of two steel-wheeled tandem rollers for breakdown (TB) and one finish steel-wheeled roller (TF) meeting the requirements of Articles 406.07 and 1101.01(e) of the Standard Specifications except the minimum compression for all of the rollers shall be 315 lb/in.

Upon approval of the Engineer, the Contractor may use a vibratory roller for the first 2 passes of the SMA. The vibratory roller (V_D) shall meet the requirements of Articles 406.07 and 1101.01(e) of the Standard Specifications and be operated at high frequency and low amplitude.

Pneumatic-tired rollers will not be permitted.

Plant Requirements.

(a) Asphalt Cement.

- (1) SBS/SBR Polymerized PG 76-22, PG 70-22, or PG 70-28 Binder. The polymer modified asphalt cement shall be shipped, maintained and stored at the mix plant according to the manufacturer's requirements. Polymer asphalt cement shall be placed in an empty tank and not blended with other asphalt cements.

- (2) Terminal Blend GTR Binder. Terminal blend GTR binder shall be blended with the asphalt cement, forming a consistent, homogeneous blend, prior to being added to aggregates. The Terminal Blend GTR binder shall be blended and reacted with the asphalt cement at the asphalt refinery or terminal.

The GTR shall be blended with the asphalt cement and reacted for a minimum of 45 minutes at a temperature of 325°F to 375°F.

Terminal Processing and Storage

- (i) At the asphalt production facility for Terminal Processing, a separate agitated storage tank shall be required, with continuous mixing and recirculation of the asphalt-rubber blend to react the GTR with the asphalt cement. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 325°F to 375°F for a minimum of 45 minutes.

- (ii) Once the Terminal Processing of GTR and asphalt cement produces a

homogeneous blend at the production facility, test samples shall be obtained by the Illinois Tollway for testing.

- (iii) Terminal Blended GTR modified asphalt may be stored at the asphalt production facility for up to 30 days at 300°F to 350°F with continuous mixing.
- (iv) If Terminal Blended GTR modified asphalt cement is used, a dedicated storage tank for "terminal blended GTR" shall be required at the hot mix plant. The GTR binder shall be placed in an empty tank and not blended with other asphalt cements. This tank shall be equipped with a mechanical agitator, capable of providing continuous mixing and/or recirculation of the asphalt-rubber blend. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 300°F to 350°F for a maximum of 3 days.
- (v) During SMA production, monthly random split samples of the GTR asphalt shall be taken under Illinois Tollway supervision by the supplier from the port of the asphalt plant. The supplier shall submit the samples to both to the Illinois Tollway and to an independent ARML certified lab for testing to certify specification compliance.

The type of plant used for the manufacture of SMA mixtures may be either a batch or drier drum plant meeting the requirements of Article 1102.01 of the Standard Specification, with the following exceptions:

- (b) Mineral Filler System. The mineral filler system shall accurately proportion the large amounts of mineral filler required for the mixture. Alteration or adjustment of the current system may be required. Positive dust control must be used.
- (c) Fiber Additive. Adequate dry storage shall be provided for the fiber additive of any type. A separate feed system shall be provided to proportion the fiber into the mixture uniformly and in desired quantities. The feed system shall be interlocked with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. The proportion of fibers shall be controlled accurately to within $\pm 10\%$ of the amount of fibers required. Flow indicators or sensing devices for the fiber system shall be provided and interlocked with plant controls so mix production shall be interrupted if fiber introduction fails.
 - (1) Batch Plant. Loose fiber shall be pneumatically added through a separate inlet directly into the weigh hopper above the pugmill. The addition of fiber shall be timed to occur during the hot aggregate charging of the hopper. Adequate mixing time will be required to ensure proper blending of the aggregate and fiber additive. Both the wet and dry mixing times shall each be increased a minimum of 5 seconds. The actual mixing time increase shall be determined by the Engineer based on individual plant characteristics. The batch size shall not exceed 75% of pugmill size as rated by IDOT.
 - (2) Drum Mix Plant. Loose fiber shall be introduced using specialized equipment which mixes asphalt cement with the loose fiber at the time of introduction into

the drum mixer. This equipment shall be approved by the Engineer. Care shall be taken to ensure the loose fiber does not become entrained in the exhaust system of the drier or plant.

- (3) Fiber Supply System: When fiber stabilizing additives are required as an ingredient of the mixture, a separate feed system shall be utilized to accurately proportion by weight the required quantity into the mixture in such a manner that uniform distribution will be obtained. The fiber system shall be interlocked with the aggregate feed or weigh system so as to maintain the correct proportions for all rates of production and batch sizes. The proportion of fibers shall be controlled accurately to within plus or minus 10 percent of the amount of fibers required and the fiber system shall automatically adjust the feed rate to maintain the material within this tolerance at all times. The fiber system shall provide in-process monitoring consisting of either a digital display or output or a printout of feed rate, in pounds per minute to verify feed rate. Flow indicators or sensing devices for the fiber system shall be provided and interlocked with plant controls so that mixture production will be interrupted if introduction of the fiber fails, or if the output rate is not within the tolerances given above.

When a batch type plant is used, the fiber shall be added to the aggregate in the weigh hopper or as approved and directed by the Engineer. The fibers are to be uniformly distributed prior to the injection of asphalt cement into the mixes.

When a continuous or drier-drum type plant is used, the fiber shall be added to the aggregate and uniformly dispersed prior to the injection of asphalt cement. The fiber shall be added in such a manner that it will not become entrained in the exhaust system of the drier or plant.

- (d) Dry process GTR. Dry process GTR shall be controlled with a feeder system using a proportioning device that is accurate to within ± 3 percent of the amount required. The system shall automatically adjust the feed rate to maintain the material within this tolerance at all times, and shall have a convenient and accurate means of calibration. The system shall provide in-process monitoring, consisting of either a digital display of output or a printout of feed rate, in pounds per minute, to verify feed rate. The supply system shall report the feed in 1 lb increments using load cells that will enable the user to monitor the depletion of the GTR. Monitoring the system volumetrically will not be allowed. The feeder shall interlock with the aggregate weigh system and asphalt binder pump to maintain the correct proportions at all production rates.

Flow indicators or sensing devices for the system shall be interlocked with the plant controls to interrupt the mixture production if the GTR introduction output rate is not within the ± 3 percent tolerance given above. This interlock will immediately notify the operator if the targeted rate exceeds introduction tolerances. All plant production will cease if the introduction rate is not brought back within tolerance after 30 seconds. When the interlock system interrupts production and the plant has to be restarted, upon restarting operations; the modifier system shall run until a uniform feed can be observed on the output display. All mix produced prior to obtaining a uniform feed shall be rejected.

With a drum mixing plant, introduce the dry process GTR prior to the injection of asphalt cement. The point of introduction in the drum mixer will be approved by the Engineer prior to production. Ensure the GTR will not become entrained in the exhaust system of the drier or plant and will not be exposed to the drier flame at any point after induction.

During operations, the asphalt plant shall record feed records daily from the feeder unit for the purposes of verifying dry process GTR inputs into the process.

- (e) Warm Mix Additives/Processes. When a mix is produced using an approved warm mix asphalt technology, the asphalt mixing plant shall be modified as required by the additive or process manufacturer to introduce the technology and produce a WMA SMA mixture meeting the volumetric properties specified herein. Plant modifications may include additional plant instrumentation, the installation of asphalt binder foaming systems and/or WMA additive delivery systems, tuning the plant burner and adjusting the flights in order to operate at lower production temperatures and/or reduced tonnage.

All metering devices will meet the current IDOT requirement for liquid or mineral additives. Document the integration of plant controls and interlocks when using WMA additive metering devices.

(f) General

- (1) Storage and Conveyance. Silo storage of SMA shall not exceed 6 hours. SMA containing steel slag aggregate shall have a minimum of two hour silo storage.
- (2) Plant modification. The use of GTR modified asphalt may require additional plant modifications. The Engineer will have final approval of the plant.
- (3) Plant Calibration. The asphalt plant shall be calibrated and approved by The Illinois Department of Transportation Bureau of Materials and Physical Research or the Illinois Tollway before production of the SMA.

Mix Design. The Contractor will provide mix designs for each type of required mixture. Mix designs shall be developed by a QC/QA Level III Technician in accordance with all IDOT mix design procedures and the following:

The draindown shall be determined at the Job Mix Formula asphalt binder content at 350°F mixing temperature. Draindown shall be measured using AASHTO T 305.

The SMA mix designer shall determine to what extent an additive is needed in the SMA mix to prevent stripping. The determination will be made on the basis of moisture sensitivity testing (IL Modified AASHTO T 283) on production ingredient materials sampled at the HMA plant. The results will inform the contractor of the amount or type of anti-strip additive in the SMA mix based on the following minimums that apply to any mix design: 1) have a conditioned tensile strength of 115 psi or better with no TSR requirements, or 2) have a conditioned tensile strength of 100 psi or better with a TSR of

at least 0.85, or 3) no visual stripping of the coarse or fine aggregate in the broken faces shall be observed.

The additive may be hydrated lime, slaked quicklime, or a liquid additive, at the Contractor's option.

If Dry Process GTR is to be used, GTR binder to be used for the mix design shall be produced by adding the dry process GTR to the required PG binder preheated to 350°F, and blending using a high shear blender operating at 3,000 rpm for 30 minutes.

Each specific SMA mixture design shall be submitted to and verified by the Illinois Tollway as detailed in IDOT's current "Hot-Mix Asphalt Mixture Design Verification Procedure". The Contractor shall submit samples of all appropriate mixture design verification materials to the Illinois Tollway at least two weeks prior to production. Each specific SMA mixture design without the use of a WMA technology shall be identified as the HMA SMA mix design for the specific mix type.

The Contractor shall supply the average gradation and the gradation ranges (including the Master Band on the critical sieve, if required) for each aggregate designated for use in the mixture.

The Gsb of the fine portion of fractionated RAP, if used, shall be determined as defined in the contract special provision for Reclaimed Asphalt Pavement.

The mix design shall meet the following Gyratory Design (80-Gyrations) parameters:

Design Air Voids	3.5 % @ 80 Gyrations
VFA	75-85%
VMA - for specific gravity of coarse aggregate < 2.76	16.0 % minimum
VMA for specific gravity of coarse aggregate ≥ 2.76	17.0 % minimum
Draindown (%)	0.3 maximum

The surface friction, surface and binder mixture gradation shall be according to the requirements in the following table for the mixture specified on the plans.

Stone Matrix Asphalt Gradation

Mixture Gradation Target Value Range		
Sieve	Percent Passing	
	IL-12.5 mm	IL-9.5 mm
3/4" (19.0 mm)	100	
1/2" (12.5 mm)	82 – 100	100
3/8" (9.5 mm)	65 max	90 – 100
No. 4 (4.75 mm)	20 – 30	36 – 50
No. 8 (2.36 mm)	16 – 24	16 – 32
No. 30 (600 µm)	12 – 16	12 – 18
No. 50 (300 µm)	10 – 15	
No. 200 (75µm)	8 – 10	7.5 – 9.5

The mixture design for the WMA SMA shall be developed based on a lab produced HMA SMA mix design modified as a WMA SMA mix design through trial batch production of the WMA mixture and test strip placements. The original HMA SMA mix design to be modified shall be designed and submitted to the Engineer without including the WMA additive or technology. When a WMA SMA using an additive is to be used, document the additive used and recommend the dosage rate on a resubmittal of the original HMA SMA mix design that is to be modified as a WMA mix design. The Illinois Tollway Engineer and Contractor will verify the original HMA SMA mix design with any WMA technology use based on plant produced samples taken from the WMA test strip. A field TSR test will be performed on a production sample of the proposed WMA SMA mix and compared to the HMA SMA TSR value. Any mix design adjustments needed will apply to the finalization of the WMA SMA binder, surface, or surface friction course mix design.

In addition to the HMA SMA mix design, for WMA SMA mix designs proposed using organic or chemical additives, Hamburg Wheel testing according to Illinois Modified AASHTO T324 shall be conducted on a laboratory mixed sample at the recommended WMA additive dosage rate. The Hamburg Wheel testing requirements from this sample are a maximum of 6 mm rut depth at 20,000 passes. Also, WMA SMA mix designs proposed using organic or chemical additives shall also conduct a Disk-Shaped Compact Tension Test [DC(T)] test per ASTM D7313. The result of the DC(T) test shall greater than 600 J/m² when tested at -12°C.

For any WMA SMA mix design, additional draindown testing of the WMA SMA test strip sample will be required. The minimum TSR requirement shall be 0.85 for the design and production tests. Any mix design adjustments needed will apply to the development of WMA SMA mix design. The final design for the WMA SMA mix design shall be submitted for approval with the following information included:

- 1) All information required for HMA SMA mix design.
- 2) WMA technology and/or WMA additives information.
- 3) WMA technology manufacturer's established recommendations for usage.
- 4) WMA technology manufacturer's established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.
- 5) WMA technology material safety data sheets (MSDS).
- 6) Documentation of at least 3 past WMA technology field applications including project type, project owner, tonnage, location, mix design, mixture volumetrics, field density, and performance.
- 7) Temperature range for mixing.
- 8) Temperature range for compacting.
- 9) Asphalt binder performance grade test data over the range of WMA additive percentages proposed for use.
- 10) WMA mixture QC/QA test results measured from the test strip samples specific to the Contractor's proposed WMA technology.
- 11) Laboratory test data, samples and sources of all mixture components, and asphalt binder viscosity-temperature relationships.
- 12) Lab and/or production TSR results for WMA SMA mix.

The Illinois Tollway may accept an existing SMA mixture design with a WMA technology previously used on a Illinois Tollway project and may waive the test strip trial batch required to verify the WMA SMA mix design.

Construction Requirements

Weather Requirements. The SMA mixtures shall be placed on a dry surface and when the temperature of the roadbed is above 50°F, and when the ambient air temperature in the shade is at least 50°F and rising unless the SMA mixture is produced using an approved WMA technology. The WMA SMA binder mixtures shall be placed on a dry and clean surface when the temperature of the roadbed is above 40°F, and when the ambient air temperature in the shade is at least 32°F and rising. The WMA SMA surface or surface friction mixtures shall be placed on a dry and clean surface when the temperature of the roadbed is above 40°F and when the ambient air temperature in the shade is 35°F and rising.

Mix Production. SMA mixtures with a WMA technology shall be produced at a temperature range recommended by the technology manufacturer and verified through a QC/QA mixture test strip. It may be necessary to initially produce HMA mixes at conventional HMA temperatures immediately before WMA production at lower temperatures in order to prime the plant for proper operating temperatures.

When new equipment is provided for adding fibers or RAS into the mix, a representative from supplier/manufacturer of the equipment shall be present for calibration and first day of production (test strip).

When using GTR in the mix, the Contractor shall ensure that a Technical Representative from the GTR supplier is present during the first day of production and placement of a WMA SMA.

A WMA QC/QA mixture test strip will be required. The test strip shall be constructed at a location approved by the Engineer to determine the mix properties, density, and laydown characteristics. These test results and visual inspections on the mixture shall be used to make corrective adjustments if necessary. A field TSR test of the mix produced for any WMA SMA test strip will be required.

Prior to the start of mix production and placement, The Engineer will review and approve all test strip results and rolling pattern.

The test strip will be performed as follows:

- (a) Team Members. The start-up team, if required, shall consist of the following:
 - (1) Resident Engineer
 - (2) Illinois Tollway Project Manager, or representative
 - (3) Illinois Tollway Materials Engineer, or representative
 - (4) Construction Manager's Nuclear Density Gauge Specialist
 - (5) Contractor's QC Manager
 - (6) Construction Manager's QA representative
 - (7) Contractor's Density Tester
 - (8) AC Supplier representative
- (b) Communication. The Contractor shall advise the team members of the anticipated start time of production for the test strip. The QC Manager shall direct the activities of the test strip team. An Illinois Tollway-appointed representative from the start-up team will act as spokesperson for the Illinois Tollway.
- (c) The Test Strip shall consist of approximately 400 tons. It shall contain two growth curves which shall be compacted by a static steel-wheeled roller and tested as outlined herein.
 - (1) Mix Information. On the day of construction of the Test strip, the Contractor shall provide the start-up team documentation of test data showing the combined hot-bin or the combined aggregate belt sample and mineral filler at a drier-drum plant.
 - (2) Mix and Gradation Test Strip Samples. The first and second sets of mixture and gradation samples shall be taken by the Contractor at such times as to represent the mixture between the two growth curves and the rolling pattern area, respectively. All test strip samples shall be processed by the Contractor for determination of mix composition and Superpave properties including air voids. This shall include washed gradation tests. This information shall then be compared to the JMF and required design criteria.
 - (3) Compaction Equipment. It shall be the responsibility of the start-up team to verify roller compliance before commencement of growth curve construction.

All paving and rolling equipment intended for use on a project shall be utilized on the test strip.

Upon approval of the Engineer, the Contractor may use a vibratory roller for the first 2 passes of the SMA. The vibratory roller (V_D) shall be operated at high frequency and low amplitude.

- (4) Construction of the Test Strip. After the Contractor has produced the mix, transported the mix, and placed approximately 100 to 150 tons of mix, placement of the mix shall stop, and a growth curve shall be constructed. After completion of the first growth curve, paving shall resume for 50 to 100 tons of mix, placement shall stop, and the second growth curve shall be constructed within this area. Additional growth curves may be required if an adjustment/plant change is made during the test strip. The Contractor shall use the specified rolling procedures for all portions of the test strip except for the growth curve areas which shall be compacted as directed by the Engineer.
- (5) Location of Test Strip. The test strip shall be located on a pavement type similar to the contract pavement and acceptable to the Engineer. It shall be on a relatively flat portion of the roadway. Descending/Ascending grades or ramps shall be avoided.
- (6) Compaction Temperature. For WMA SMA mixtures, the temperature of the mix at the beginning of the growth curve shall be within the additive / process manufacturer's recommended temperature range for compaction, with the lowest compaction temperature no less than 250°F.
- (7) Compaction and Testing. The QC Manager will specify the roller(s) speed and number of passes required to obtain a completed growth curve. The nuclear gauge shall be placed near the center of the hot mat and the position marked for future reference. With the bottom of the nuclear gauge and the source rod clean, a 15 seconds nuclear reading (without mineral filler) shall be taken after each pass of the roller. Rolling shall continue until the maximum density is achieved and three consecutive passes show no appreciable increase in density or no evidence of destruction of the mat. The growth curve shall be plotted.
- (8) Evaluation of Growth Curves. Mixtures which exhibit density potential less than 94 percent or greater than 97 percent of the maximum theoretical density (D) shall be considered as sufficient cause for mix adjustment. If a mix adjustment is made, an additional test strip may be constructed. The Illinois Tollway will pay half the cost of the contract unit price for a test strip if additional one is required. The information shall then be compared to the AJMF and required design criteria.

If the nuclear density potential of the mixture does not exceed 91 percent, the operation will cease until all test data is analyzed or a new mix design is produced.

In addition, other aspects of the mixture, such as appearance, segregation, texture, or other evidence of mix problems, should be noted and corrective action taken at this time.

- (d) Documentation. The Test Strip and rolling pattern information (including growth curves) will be tabulated by the contractor with copies provided to each team member, and the original submitted to the Engineer. Any change to the rolling pattern shall be approved by the Engineer.
- (e) Density. For acceptance, mat density shall be measured either by correlated nuclear gauge or from cores obtained by the Contractor at random locations. For SMA surface course containing steel slag aggregate, acceptance will be by coring.
- (g) Tensile Strength Ratio (TSR). The WMA SMA mix shall be sampled and tested in accordance with AASHTO T 283 and comply with the following minimums: 1) have a conditioned tensile strength of 115 psi or better with no TSR requirements, 2) have a conditioned tensile strength of 100 psi or better with a TSR of at least 0.85, or 3) no visual stripping of the coarse or fine aggregate in the broken faces shall be observed. On the first day of production one split sample will be taken by the Contractor and compared with the samples taken from the test strip. If any TSR value falls below the minimums specified above, plant operations shall cease until corrective measures are taken. Should it become necessary for the Contractor to modify the SMA mix design due to low TSR values measured during field production or due to the occurrence of visual stripping during field production of the mix after the design tests indicated that the same mix met the aforementioned TSR minimum requirements, such work will be at no additional cost to the Illinois Tollway.
- (h) Draindown. Draindown shall be measured using AASHTO T 305 on a sample obtained during production, and tested at the maximum recommended WMA production temperature. If the draindown of the production sample exceeds 0.3 percent, additional mix production shall not occur without a corrective action being submitted by the contractor and approved by the Engineer.
- (i) Disk-Shaped Compact Tension Test [DC(T)]. DC(T) shall be measured using ASTM D7313 on a sample obtained during production. The result of the DC(T) test shall be greater than 600 J/m² when tested at -12°C.

Placement and Compaction. Any modified SMA asphalt mixture produced with a WMA technology shall be placed at a minimum compaction temperature as recommended by the technology manufacturer after the WMA SMA test strip has been placed and tested. In no case shall SMA produced above 350°F be acceptable for placement.

The paver speed shall not exceed 25 ft/min during placement.

Compaction shall commence immediately after the mixture has been placed. Compaction for WMA SMA mixes shall be completed before the mix falls below the minimum WMA job mix design compaction temperature. Discontinue paving if the contractor is unable to achieve the specified density before the mixture cools below the minimum recommended WMA job mix design compaction temperature.

The addition of a non-foaming detergent to the roller water will be allowed to prevent sticking, if necessary.

During laydown, the contractor will determine the mat density in accordance with Illinois-modified ASTM D 2950, Standard Test Method for Determination of Density of Bituminous Concrete in Place by Nuclear Methods.

Hauling/laydown Equipment. The Contractor shall provide a release agent that minimizes sticking to equipment and is acceptable to the Engineer. The Contractor shall furnish a laborer to ensure that all truck beds are clean and no excess release agent is used prior to being loaded. Do not use petroleum derivatives or other coating materials that contaminate or alter the characteristics of the SMA mix. All trucks shall be tarped when hauling the mixture to the paver.

Control Charts/Limits. Control charts/limits shall be according to QC/QA requirements except as follows:

Parameter	Individual Test	Moving Average
3/8 (9.5 mm)	± 4%	± 3%
No. 8 (2.36 mm)	± 4%	± 2%
Asphalt Content	± 0.2%	± 0.1%
Density	93.5 – 97.4%	
Air Voids	± 1.2% (of design)	± 1.0% (of design)

Opening To Traffic. Traffic will not be permitted on SMA until the temperatures of the mat has dropped below 140°F.

Penalties. The compacted SMA can be prone to bleeding or flushing if consistent production, delivery and placement do not occur. One or more of these factors has shown to cause this problem:

- Lack of mineral filler or fibers in the mix, at both production start-up and during mixture production switches between SMA and other HMA mixtures.
- Inconsistent delivery, often due to lack of trucks, causing delays in the paving operation.
- Excessive screed vibration.
- Overuse of release agents on paving equipment and trucks.
- Inconsistent mixture temperature.

The contractor shall address in the HMA QC Addendum the steps that will be taken to avoid this issue during construction. If bleeding or flushing occurs in any SMA course, regardless of the cause, areas of bleeding larger than one square foot within a five-foot length of pavement shall result in a deduction of 2 tons in the tonnage of SMA mixture measured for payment as specified. If bleeding or flushing occurs in any SMA course, regardless of the cause, areas of bleeding larger than 10 square feet within a five-foot length of pavement shall result in the entire area affected to be removed and replaced for the full width of the paving lane with a fresh SMA course mixture at no additional cost to the Illinois Tollway.

Pavement Surface Smoothness. The contractor shall provide smoothness testing of the finished construction asphalt surface according to the requirements of the Illinois Tollway Special Provision for Surface Smoothness Testing for Pavement, except where modified herein.

Acceptable Smoothness Limits. Each pavement segment shall be reported and compared to the acceptable smoothness limit based on International Roughness Index (IRI) and Localized Roughness (LR) as provided in the table below:

Pavement Surface	Maximum IRI (in/mi)	Maximum LR (in/mi)
Friction Course	80	125
Surface Course	80	125
Binder Course*	90	130
Ramp (design speed < 40 mph)	120	145
Ramp (design speed 40 to 50 mph)	110	140
Ramp (design speed > 50 mph)	100	135

*Only to be used if roadway is opened to traffic prior to placement of Friction or Surface Course

Corrective Actions. For each pavement segment that exceeds the maximum acceptable initial IRI value, there are two potential methods for proceeding:

- (1) Remove and replace the pavement that exceeds the IRI limit, or
- (2) Grind the segment to bring the IRI into conformance with the acceptable limits (without adversely affecting the required thickness of the pavement structure).

Either of the above options shall be applied to each rejectable segment as directed by the Engineer. Once remediation has been completed, smoothness testing will be performed again.

The Contractor shall notify the Engineer at least 24 hours prior to commencement of the corrective work. The Contractor shall not commence corrective work until the methods, procedures and limits have been approved in writing by the Engineer.

All smoothness corrective work shall be for the entire lane width. Pavement cross slope shall be maintained through areas where corrective action is performed.

Surface corrections shall be made prior to placing permanent pavement markings. In the event that permanent pavement markings are damaged or destroyed during corrective work, they will be replaced at no cost to the Illinois Tollway.

A sufficient length of pavement will be corrected to address areas of unacceptable smoothness without producing additional high or low points. Retesting of the segments after corrective action shall include the segment prior and four segments after the corrected segment.

Exceptions. The following pavement areas will not be subject to longitudinal profile data collection under this special provision:

- (1) Shoulder areas.
- (2) Pavement associated with ramps, loops, or acceleration/deceleration lanes.
- (3) Bridge decks and associated pavements within 50 ft of the bridge.

The Engineer may request longitudinal profiling to be performed in any of these areas if deficient materials are found to have been placed in these areas.

The Engineer may require any portion of or the total project to be retested if the results provided by the Contractor are questioned. The Engineer will decide whether the Illinois Tollway, an independent testing firm, or the Contractor will retest the roadway surface.

Method of Measurement. This work will be measured for payment in tons.

Basis of Payment. This work will be paid at the contract unit price per ton for STONE MATRIX WARM MIX ASPHALT SURFACE FRICTION COURSE, IL12.5 N80, STONE MATRIX WARM MIX ASPHALT SURFACE COURSE, IL12.5 N80 and STONE MATRIX WARM MIX ASPHALT BINDER COURSE, IL-12.5 N80, STONE MATRIX WARM MIX ASPHALT SURFACE FRICTION COURSE, IL9.5 N80, STONE MATRIX WARM MIX ASPHALT SURFACE COURSE, IL9.5 N80 and STONE MATRIX WARM MIX ASPHALT BINDER COURSE, IL-9.5 N80.

The test strip will be paid for at the contract unit price per each for TEST STRIP (STONE MATRIX ASPHALT), which price shall not include the 400 tons of mix, as well as the appropriate testing, which will be paid for at the unit price in the contract for the item being placed. If an additional test strip is required due to a mixture change, the additional test strip will be paid for in accordance with Article 406.14 of the Standard Specifications.

Pay Item Number	Designation	Unit of Measure
J1406035	TEST STRIP (STONE MATRIX ASPHALT)	EACH
J1406046	STONE MATRIX WARM MIX ASPHALT BINDER COURSE, IL-12.5, N80	TON
J1406047	STONE MATRIX WARM MIX ASPHALT SURFACE COURSE, IL-12.5, N80	TON
J1406048	STONE MATRIX WARM MIX ASPHALT SURFACE FRICTION COURSE, IL-12.5, N80	TON