



**SUPPLEMENTAL SPECIFICATIONS
FOR
FLEXIBLE PAVEMENT**

**Effective Date
January 16, 2013**

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SUPPLEMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

Replace Section 2303 of the Standard Specifications and GS-12001 with the following:

Section 2303. ~~Hot Mix Asphalt Mixtures~~ Flexible Pavement

2303.01 DESCRIPTION.

- A.** Design, produce, place, and compact flexible paving (HMA and warm mix asphalt (WMA)) mixtures. Use proper quality control practices for the construction of surface, intermediate, or base course on a prepared subbase, base, or pavement to the dimensions specified in the contract documents.
- B.** A surface course is the upper lift for a wearing surface of a designated thickness. An intermediate course is the next lower lift or lifts of a designated thickness. Use intermediate course mixtures for leveling, strengthening, and wedge courses. A base course is the lift or lifts placed on a prepared subgrade or subbase.
- C.** WMA refers to asphalt concrete mixtures produced at temperatures approximately 50°F (28 °C) or more below those typically used in production of HMA, but no higher than 280°F (135 °C) that shown in Article 2303.03, C, 3, d, 3, a. Temperature reductions may be achieved through additives or water injection systems approved by the Bituminous Engineer. The goal with WMA is to produce mixtures with similar or better strength, durability, and performance characteristics as HMA using substantially reduced production temperatures.
- D.** Unless explicitly stated, produce and place WMA mixtures meeting the same requirements established for HMA mixtures. Equivalent WMA mixtures may be substituted for HMA mixtures unless it is prohibited by the specifications.

2303.02 MATERIALS.

Use materials meeting the following requirements:

- A. Asphalt Binder.**

The Performance Graded asphalt binder, PG XX-XX, will be specified in the contract documents to meet climate, traffic, and pavement conditions. Use asphalt binder meeting requirements of Section 4137. Unless otherwise specified in the contract documents, use PG 58-28 for shoulder mixtures.
- B. Aggregates.**
 - 1. Individual Aggregates.**
 - a.** Use virgin mineral aggregate as specified in Materials I.M. 510 and meeting requirements of Section 4127.

- b. When frictional classification of the coarse aggregate is required, the contract documents will specify the friction level and location. Furnish friction aggregate from sources identified in Materials I.M. T203. Limestone aggregate sources defined as containing less than 15% magnesium oxide (MgO) are identified in Materials I.M. T203.

1) Friction Classification L-2.

- a) On Interstates and all mixtures designed for 30,000,000 ESALS and higher (cross-overs and detours with posted speeds below 60 mph excluded), if 40% or more of the total aggregate is a limestone, use a combined aggregate such that:
- 1) At least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate,
 - 2) At least 30% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 2 or better friction aggregate,
 - 3) At least 25% of the combined aggregate passing the No. 4 (4.75 mm) sieve is Type 2 or better friction aggregate, and
 - 4) The fineness modulus of the combined Type 2 aggregate is at least 1.0. Calculations for fineness modulus are shown in Materials I.M. 501.
- b) For all other mixtures that do not satisfy Article 2303.02, B, 1, a, use a combined aggregate such that:
- 1) At least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate, and
 - 2) At least 25% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 2 or better friction aggregate, and
 - 3) For Interstates and all mixtures designed for 30,000,000 ESALS and higher, the fineness modulus of the combined Type 2 aggregate is at least 1.0. Calculations for fineness modulus are shown in Materials I.M. 501.

2) Friction Classification L-3.

Use a combined aggregate such that:

- At least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate, and
- At least 45% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 3 or better friction aggregate, or if Type 2 is used in place of Type 3, at least 25% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 2.

3) Friction Classification L-4.

Use a combined aggregate such that at least 50% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate.

2. Blended Aggregates.

- a. Use a blended aggregate meeting the combined aggregate requirements in Materials I.M. 510.
- b. When mixtures include RAP, use a blended mineral aggregate gradation consisting of a mixture of RAP aggregate combined with virgin aggregate.

C. Recycled Asphalt Materials.

1. Recycled Asphalt Materials (RAM) includes Recycled Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS). RAP is salvaged asphalt pavement. Use RAP from a source designated in the contract documents, or furnish Classified RAP, Certified RAP, or Unclassified RAP from the Contractor's stockpile. The designations Classified, Certified, and Unclassified are exclusively for the use of RAP in HMA.
2. Identify each RAP stockpile and document Classified and Certified RAP stockpiles as directed in Materials I.M. 505. Include the following information when documenting Classified RAP material in a stockpile for future use in HMA:
 - Identification of the project from which the material was removed,
 - Mix data from the original project including mixture type,
 - Aggregate classification,
 - Location and depth in the pavement structure,
 - Extracted gradation information, if available, and
 - Description of stockpile location and quantity.

Do not add material to a Classified or Certified RAP stockpile without the approval of the District Materials Engineer.

3. The Engineer may reject a RAP stockpile for non-uniformity based on visual inspection. Work the stockpiles in such a manner that the materials removed are representative of a cross section of the pile.
4. Place stockpiles of RAP on a base sufficient to prevent contamination, as directed in Materials I.M. 505. Do not use RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or environmentally restricted materials. RAP stockpiles may include PCC (not to exceed 10% of the stockpile) from patches or composite pavement that was milled as part of the asphalt pavement. Track equipment may operate on the stockpile during its construction.
5. When RAP is taken from a project, or is furnished by the Contracting Authority, the contract documents will indicate quantity of RAP expected to be available and test information, if known. Salvage this material. Unless otherwise specified in the contract documents, RAP not used in HMA becomes the property of the Contractor.
6. For mix design purposes, the Contracting Authority will test samples of the RAM. The aggregate gradation and amount of asphalt binder in the RAM will be based on the Contracting Authority's extraction tests. For mixtures containing RAM, adjust the contract binder grade as directed in Materials I.M. 510. No adjustments will be made to the contract unit price for required changes to the asphalt binder grade.
 - a. **Classified RAP.**
 - 1) Classified RAP is from a documented source with the aggregate meeting the appropriate quality requirements in Materials I.M. 510, and properly stockpiled.
 - 2) Classified RAP may be used in the base, intermediate, and surface mixtures for which the RAP aggregate qualifies. Classified RAP may be used in accordance with Table 2303.02-1.
 - 3) Credit for frictional aggregate may be given for virgin aggregates used in the original pavement to be reclaimed. Types 4 and 5 frictional aggregate content in the RAP may be given full credit, while Types 2 and 3 content may be given credit for half the proportion in the original pavement. Credit may be used toward the total frictional aggregate requirement. No frictional credit shall be given beyond one generation of the RAP's service life.
 - 4) Credit may be given for crushed particles in the original pavement to be reclaimed as determined in the paving history (or mix design when paving history is unavailable).
 - b. **Certified RAP.**
Any stockpiled RAP not meeting the requirements of Classified RAP or from an unknown source may be given a Certified status when meeting quality control sampling, testing, and reporting requirements in Materials I.M. 505. Certified RAP may be used in accordance with Table 2303.02-1.
 - c. **Unclassified RAP.**
 - 1) Any stockpiled RAP not meeting the requirements of Classified RAP or Certified RAP shall be designated as Unclassified RAP. Unclassified RAP may be used in accordance with Table 2303.02-1. No frictional aggregate credit or aggregate crushed particles credit will be given for Unclassified RAP.
 - 2) When an Unclassified RAP stockpile is characterized by sampling and testing for mix design, no material can be added to the stockpile until the project is completed.

Table 2303.02-1: Allowable RAP Usage

Mix Designation	Aggregate Quality Type	Maximum Allowance Allowable Usage		
		Unclassified RAP	Certified ² RAP	Classified RAP
HMA 100K S	B	0%	10%	No limit ¹
HMA 100K I	B	10%	20%	No Limit
HMA 100 K B	B	10%	20%	No Limit
HMA 300K S	B	0%	10%	No limit ¹
HMA 300 K I	B	10%	20%	No Limit
HMA 300K B	B	10%	20%	No Limit
HMA 1M S L-4	A	0%	0%	No limit ¹
HMA 1M S	A	0%	0%	No limit ¹

HMA 1M I	B	10%	20%	No Limit
HMA 1M B	B	10%	20%	No Limit
HMA 1M B (shoulder)	B	10%	20%	No Limit
HMA 3M S L-4	A	0%	0%	No limit ¹
HMA 3M S L-3	A	0%	0%	No limit ¹
HMA 3M S	A	0%	0%	No limit ¹
HMA 3M I	A	0%	0%	No Limit
HMA 3M B	B	10%	20%	No Limit
HMA 10M S L-3	A	0%	0%	No limit ¹
HMA 10M I	A	0%	0%	No Limit
HMA 10M B	B	10%	20%	No Limit
HMA 30M S L-3	A	0%	0%	No limit ¹
HMA 30M S L-2	A	0%	0%	No limit ¹
HMA 30M I	A	0%	0%	No Limit
HMA 30M B	B	10%	20%	No Limit
HMA 100M S L-2	A	0%	0%	No limit ¹
HMA 100M I	A	0%	0%	No Limit
HMA 100M B	B	10%	20%	No Limit
Note: 1. At least 70% of the total asphalt binder in the surface mix shall be virgin. 2. Certified RAP meeting Type A quality for alumina per Section 4127 shall have the same maximum allowable usage as Classified RAP for all mixes.				

7. Pre-consumer or post-consumer shingles that have been processed, sized, and ready for incorporation into an asphalt mixture constitute RAS material.
8. Up to 5% RAS by weight of total aggregate may be used in the design and production of an asphalt mixture. The percentage of RAS used is considered part of the maximum allowable RAP percentage. Unless explicitly stated otherwise in this specification or Materials I.M. 505, use RAS according to the same requirements as prescribed for RAP material.
9. RAS shall be certified from an approved supplier designated in Materials I.M. 506. Material processed prior to DOT source approval will not be certified.

D. Flexible Paving Mixture.

1. The job mix formula (JMF) is the percentage of each material, including the asphalt binder, to be used in the HMA mixture. Ensure JMF gradation is within control points specified for particular mixture designated. Use JMF to establish a single percentage of aggregate passing each required sieve size.
2. The basic asphalt binder content is the historical, nominal mixture asphalt binder content, expressed as percent by weight (mass) of asphalt binder in total mixture. Apply values in Table 2303.03-1, based on mixture size and type.
3. If asphalt binder demand for the combination of aggregates submitted for an acceptable mix design exceeds the basic asphalt binder content (see Table 2302.02-1 2303.02-2) by more than 0.75%, include an economic evaluation with the mix design. ~~Base this evaluation on past job mix history, possible aggregate proportion changes, and aggregate availability and haul costs for any changes or substitutions considered.~~ For economic evaluation, provide an alternate mix design utilizing aggregates which results in an optimum binder content not exceeding basic asphalt binder content by more than 0.75% and documentation of costs associated with hauling both proposed aggregates and alternate aggregates to plant site. Alternate JMF shall meet requirements of Section 2303.

Table 2303.02-2: Basic Asphalt Binder Content (%)

Size	Aggregate Type	1 inch (25 mm)	3/4 inch (19 mm)	1/2 inch (12.5 mm)	3/8 inch (9.5 mm)
Intermediate and Surface	Type A	4.75	5.50	6.00	6.00
Intermediate and Surface	Type B	5.25	5.75	6.00	6.25
Base	Type B	5.25	6.00	6.00	6.25

4. Use a mixture design meeting gyratory design and mixture criteria corresponding to the design level specified in the contract documents. The Engineer may approve the substitution of any mixture which meets requirements for a higher mixture than specified in the contract documents, at no additional cost to the Contracting Authority. When a commercial mix is specified, use a 1/2 inch (12.5 mm) 300K surface mixture or higher for JMF approval.
5. Use 1,000,000 ESAL HMA base mixture for shoulders placed as a separate operation. For outside shoulders on Interstate projects, the Contractor has the option to substitute the mainline intermediate or surface mixture for a specified base mixture, at the Contractor's expense.
6. Unless otherwise indicated on the contract documents, use a 1/2 inch (12.5 mm) or 3/4 inch (19 mm) 1,000,000 ESAL HMA Base mixture (or higher ESAL) for base widening. When an adjoining surface is designed for 300,000 ESALS or less and is paved during same project, use a base mixture at same ESAL level used in surface mixture.
7. Prepare gyratory mixture designs for base, intermediate, and surface mixtures. Follow the procedure outlined in Materials I.M. 510. Submit a mixture design complying with Materials I.M. 510. Propose both a production and a compaction temperature between 215°F (102°C) and 280°F (138°C) for WMA mixture designs.
8. Use a gyratory compactor for design and field control meeting the protocol for Superpave gyratory compactors AASHTO T 312. Compactors for which compliance with this protocol is pending may be used at the discretion of the District Materials Engineer.

E. Other Materials.

1. Tack Coat.

Tack coat may be SS-1, SS-1H, CSS-1, or CSS-1H. Do not mix CSS and SS grades. RC-70 and MC-70 may also be used after October 1, at the Contractor's option.

2. Anti-strip Agent.

- a. Perform a moisture sensitivity evaluation of the proposed asphalt mixture design in accordance with Materials I.M. 507 Appendix A of this specification for the following mixtures when placed in travelled lanes:
 - 1) Mixtures for Interstate and Primary highways designed for 30,000,000 ESALS and higher
 - 2) Mixtures for Interstate and Primary highways containing quartzite, granite, or other siliceous (not a limestone or dolomite) aggregate obtained by crushing from ledge rock in at least 40% of the total aggregate (virgin and recycled) or at least 25% of the plus No. 4 (4.75 mm).
 - 3) All WMA mixtures placed in travel lanes designed for 10,000,000 ESALS and higher. For the purpose of evaluating moisture sensitivity of a proposed mix design, the Contractor may test the proposed JMF from plant produced material placed off-site at no additional cost to the contracting authority.

For the purpose of evaluating moisture sensitivity of a proposed mix design, Contractor may test proposed JMF from plant produced material placed off-site at no additional cost to the Contracting Authority.
- b. Sample and test plant produced mixture for moisture susceptibility in accordance with Materials I.M. 204 and Materials I.M. 507 Appendix A of this specification for bid item plan quantities of more than 1000 tons (1000 Mg) as follows:
 - 1) For mixtures satisfying Article 2303.02, E, 2, a,
 - 2) For conditions satisfied in Article 2303.02, E, 2, g f.

- c. Moisture susceptibility testing of plant produced mixture will not be required for base repair, patching, temporary pavement, or paved shoulders. Moisture susceptibility testing for mixture bid items of 1000 tons (1000 Mg) or less is only required on the mix design for mixtures satisfying Article 2303.02, E, 2, a.
- d. Use the following minimum stripping inflection point (SIP) requirements for plant produced material:

PG High Temperature, °C	SIP, Number of Passes ¹	
	< 3,000,000 ESALS	≥ 3,000,000 ESALS
58	10,000	14,000
64	10,000	14,000
70	10,000	14,000

Note 1: If ratio between creep slope and stripping slope as defined in Appendix A of this specification is less than 2.00, the SIP is invalid.

A minimum tensile strength ratio (TSR) of 80.0% is required on plant produced mixture. When notified of non-compliant results, the Engineer may suspend paving operations until an approved "significant mix change" is implemented.

- e. For mixture bid items of more than 1000 tons (1000 Mg), when the Contractor's mix design TSR results are greater than or equal to 80% and less than 90%, an anti-strip agent will be required until the Contracting Authority's TSR results on the plant produced mixture are equal to or exceeding 80%. Plant produced material without anti-strip shall be tested without penalty to confirm the need for an anti-strip agent. See Materials I.M. 510 Appendix C for additional information.
 - f. When the Contractor's mix design TSR SIP results are below 80.0% the minimum specified in Article 2303.02, E, 2, d, an anti-strip agent will be required. Plant produced material with anti-strip shall be tested to verify the minimum TSR SIP is achieved. See Materials I.M. 510 Appendix C for additional information.
 - g. The Engineer may require an evaluation of the test method in Materials I.M. 507 Appendix A of this specification for plant produced mixture as follows:
 - 1) When there is a "significant mix change" to a mix satisfying Article 2303.02, E, 2, a.
 - 2) When there is contamination and/or coating of the aggregate for any mixture placed in a travel lane.
 - 3) When aggregates are inadequately dried during production of any mixtures placed in a travel lane.
 - h. The following anti-strip agents may be used:
 - 1) **Hydrated Lime.**
Meet the requirements of AASHTO M 303, Type I or ASTM C 1097, Type S. Do not apply Section 4193. Hydrated lime will not be considered part of the aggregate when determining the job mix formula and the filler/bitumen ratio.
 - 2) **Liquid Anti-strip Additives.**
For each JMF, obtain approval for liquid anti-strip additives blended into the binder. Approval will be based on the following conditions:
 - a) The asphalt binder supplier provides test results that the additive does not negatively impact the asphalt binder properties, including short term and long term aged properties.
 - b) The design is to establish the optimum additive rate when comparing the dry strength of specimens prepared with asphalt binder not containing the anti-strip additive to conditioned specimens prepared with asphalt binder containing the anti-strip additive that produces the optimum (maximum) SIP value. See Materials I.M. 510 Appendix C for additional information.
 - c) A dosage rate can be selected such that the conditioned indirect tensile strength can be improved by at least 10% while meeting all other requirements.
 - 3) **Polymer-based Liquid Aggregate Treatments.**
For each JMF, obtain approval for polymer-based liquid aggregate treatments. Approval will be based on the design establishing the optimum additive rate when comparing the dry strength of specimens prepared without the anti-strip additive to conditioned specimens prepared with asphalt binder containing the anti-strip additive. See Materials I.M. 510 Appendix C for additional information.
3. **Sand for Tack Coats.**
Use sand meeting the requirements of Gradation No. 1 of the Aggregate Gradation Table in Article 4109.02.

4. Fabric Reinforcement.

Use fabric reinforcement meeting the requirements of Article 4196.01, B, 4.

5. WMA Technologies.

Chemical additives, organic additives, or water injection systems approved by the Bituminous Engineer may be used at the rate established by the mixture design in the production of WMA. Once production of a bid item has begun with a WMA technology, continue its use throughout the remainder of the bid item's production unless otherwise approved by the District Materials Engineer.

2303.03 CONSTRUCTION.**A. General.**

1. Contractor is responsible for all aspects of the project.
2. Provide quality control management and testing, and maintain the quality characteristics specified.
3. Apply Quality Management - Asphalt (QM-A) to asphalt mixture bid items when the plan quantity is greater than 1000 tons (1000 Mg) and all Interstate contracts. Follow the procedures and meet the criteria established in Articles 2303.02 and 2303.03, B; Section 2521; and Materials I.M. 510 and 511.
4. Apply Article 2303.03, E, for asphalt mixture bid items that have a plan quantity of 1000 tons (1000 Mg) or less as well as any patching bid items. For items bid in square yards (m^2), apply Article 2303.03, E when the plan quantity by weight (estimated with a unit weight of 145 pounds per cubic foot (2323 kg/m^3) unless otherwise stated on the plans) does not exceed 1000 tons (1000 Mg). Article 2303.03, E applies to Interstate patching as well as Interstate bid items of less than 1000 tons (1000 Mg), all of which are placed in a non-travel lane.

B. Equipment.

Provide sufficient equipment of the various types required to produce, place, and compact each layer of mixture as specified, such that the mixture is workable at the minimum placement and compaction temperature desired, regardless of storage or haul distance considerations.

Modify the asphalt mixing plant as required by the manufacturer when introducing a WMA technology. Plant modifications may include additional plant instrumentation, the installation of water injection 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.

Use equipment meeting the requirements of Section 2001 with the following modifications:

1. Plant Calibration.

- a. Calibrate each plant scale and metering system before work on a contract begins. Use calibration equipment meeting the manufacturer's guidelines and Materials I.M. 508.
- b. The Engineer may waive calibration of permanent plant scales when a satisfactory operational history is available. The Engineer may require any scale or metering system to be recalibrated if operations indicate it is necessary.
- c. Make calibration data available at the plant.
- d. Calibrate each aggregate feed throughout an operating range wide enough to cover the proportion of that material required in the JMF. Make a new calibration each time there is a change in size or source of any aggregate being used.
- e. For continuous and drum mixing plants, calibrate the asphalt metering pump at the operating temperature and with the outlet under pressure equal to that occurring in normal operations.

2. Paver.

Apply Article 2001.19. Spreaders described in Article 2001.13, D, may be used to place paved shoulders. Spreaders used to place the final lift of paved shoulders shall meet additional requirements of Article 2001.19.

3. Rollers.

- a. For initial and intermediate rolling, use self-propelled, steel tired, pneumatic tired, or vibratory rollers meeting the requirements of Article 2001.05, B, C, or F. Their weight (mass) or tire pressure may be adjusted when justified by conditions.

- b. For finish rolling, use self-propelled, steel tired rollers or vibratory rollers in the static mode that meet the requirements of Article 2001.05, B, or F.

4. Scales.

Apply Article 2001.07, B, to paving operations regardless of the method of measurement.

C. HMA Construction.

1. Maintenance of the Subgrade and Subbase.

- a. Maintain completed subgrade and subbase to the required density, true cross section, and smooth condition, prior to and during subsequent construction activities.
- b. If rutting or any other damage occurs to the subgrade or subbase as a result of hauling operations, immediately repair the subgrade and subbase. Such repair will include, if necessary, removal and replacement, at no additional cost to the Contracting Authority.
- c. Should traffic by others authorized to do work on the project be specifically permitted by the Engineer to use loads which exceed the Contractor's established limit, the Contracting Authority will pay repair costs for repairs directed by the Engineer.

2. Preparation of Existing Surfaces.

a. Cleaning.

Clean and prepare existing surface according to Article 2212.03, B, 1.

b. Tack Coats.

- 1) Apply tack coats when the entire surface area on which the coat is to be applied is free of moisture. Do not apply them when the temperature on the surface being covered is less than 25°F (-4°C).
- 2) Place a tack coat to form a continuous, uniform film on the area to be covered. ~~Unless directed otherwise, spread the tack coat at an undiluted rate of 0.02 to 0.05 gallon per square yard (0.1 to 0.2 L/m²). The tack coat may be diluted with water to improve application. Unless directed otherwise, spread tack coat at the following undiluted rates:~~
 - New HMA Surface 0.03 to 0.05 gallon per square yard (0.14 to 0.23 L/m²)
 - Milled HMA Surface 0.05 to 0.07 gallon per square yard (0.23 to 0.32 L/m²)
 - PCC/Existing HMA Surface 0.04 to 0.06 gallon per square yard (0.18 to 0.27 L/m²)

Tack coat may be diluted with water to improve application.
- 3) Allow tack coat to adequately cure prior to placement of HMA to assure bond to the underlying surface and avoid damage of the HMA being placed. If tack coat surface becomes dirty from weather or traffic, thoroughly clean and, if necessary, retack. A light application of sand cover may also be required, but this is anticipated only for excessive application rates, breakdowns, and short sections remaining at the end of a day's run.
- 4) On highways being constructed under traffic, use procedures that provide safety and convenience to the public (without soiling their vehicles) as controlling factors. Limit tack coat application lengths to minimize inconvenience to the public. Keep applications within the hot mixture placing work area that is controlled by flaggers at each end. Plan applications so they will be covered with hot mixture when the work area is opened to traffic at the end of the day's work.
- 5) Tack the vertical face of exposed, longitudinal joints as a separate operation at a rate from 0.10 to 0.15 gallon per square yard (0.5 to 0.7 L/m²). Tack before the adjoining lift is placed. Lightly paint or spray vertical surfaces of all fixtures, curbs, bridges, or cold mixture with which the hot mixture will come in contact to facilitate a tight joint with the fresh mixture.

c. Fabric Reinforcement.

- 1) When fabric reinforcement is required, the locations will be designated in the contract documents.
- 2) Do not place fabric on wet or damp surfaces, or when the road surface is less than 50°F (10°C).
- 3) Apply fiberglass fabric only with an adhesive recommended by the manufacturer.
- 4) Place fabrics with an adhesive backing according to the manufacturer's recommendations.
- 5) Place other fabrics with a heavy coat of asphalt binder at a rate of 0.20 to 0.25 gallons per square yard (0.9 to 1.1 L/m²). Use the same binder grade used in the asphalt concrete mixture. For binders containing a WMA technology, place at a temperature between 260°F and 315°F (127°C and 160°C), otherwise place at a temperature between 295°F and 315°F (145°C and 160°C).
- 6) Place fabric reinforcement according to the contract documents (full width or individual crack or joint treatment). Place fabric immediately following the adhesive or asphalt binder placement

under the fabric. Placement may be by hand or by a mechanical method designed for this purpose.

- 7) Take precautions to avoid wrinkles in the fabric and to ensure that air bubbles are removed without breaking the fabric. Cut and lap wrinkles or folds which cannot be removed by brushing in order to provide a smooth surface.
- 8) Additional adhesive or asphalt binder may be required to produce a tight, bonded surface. When applied full lane width, use a minimum 12 inch (300 mm) transverse and longitudinal lap.
- 9) Avoid applying tack coat over longitudinally placed fabric.
- 10) To avoid damage to fabric, do not allow traffic over fabric during placement and during curing of the adhesive material. A light application of HMA mix may be hand sprinkled on the fabric to prevent damage from necessary equipment traffic.
- 11) When directed by the Engineer, repair damaged or soiled fabric prior to HMA overlay, at no additional cost to the Contracting Authority. The Engineer may also require sanding during this period, at no additional cost to the Contracting Authority.

3. Handling, Production, and Delivery.

Ensure plant operation complies with the following requirements:

a. Handling Mineral Aggregate and RAP.

- 1) Keep various aggregate products used separate from one another. Make adequate provisions to prevent intermingling.
- 2) Handle stockpiling and processing in a manner to ensure uniform incorporation of the aggregate into the mix.
- 3) Feed various aggregates separately in their proper proportions using feeders to the cold elevator. Feed them at a rate to permit correct and uniform temperature control of heating and drying operations.

b. Handling Asphalt Binder.

Bring asphalt binder to a temperature of 260°F to 330°F (125°C to 165°C) before being measured for mixing with the aggregates. The temperature between these limits may be further regulated according to the characteristics of the mixture, method of proportioning, and viscosity of the asphalt binder. Heat modified asphalt binder according to the supplier's recommendations.

c. Handling Anti-strip Agents.

1) Hydrated Lime.

Accurately proportion lime using a method acceptable to the Engineer.

a) Added to a Drum Mixer.

- (1) Add hydrated lime at the rate of 0.75% by weight (mass) of the total aggregate (virgin and RAP) for Interstate and Primary projects. Add hydrated lime to a drum mixer using one of the following methods:
 - (a) Add to virgin aggregate on the primary feed belt, as a lime water slurry.
 - (b) Thoroughly mix with the total combined aggregate if the aggregate contains at least 3% total moisture.
 - (c) Add to the outer drum of a double drum system away from heated gas flow and prior to the addition of the virgin asphalt binder.
- (2) Alternative methods for mixing will be allowed only with the Engineer's approval. Do not introduce hydrated lime directly into a single drum mixer by blowing or by auger.

b) Added to a Batch Plant.

Add hydrated lime at the rate of 0.5% by weight (mass) of the total aggregate (virgin and RAP) for Interstate and Primary projects. Introduce it to a batch plant using one of the methods below. In any case, introduce the lime prior to the start of the dry mix cycle.

- (1) Place on the recycle belt which leads directly into the weigh hopper.
- (2) Add directly into the pugmill.
- (3) Add directly into the hot aggregate elevator into the hot aggregate stream.

c) Added to the Aggregate Stockpile.

Add hydrated lime at a rate established by the ~~AASHTO T 283 test~~ optimization of the SIP as determined by Appendix A of this specification. ~~The instructions for establishing the rate are discussed in Materials I.M. 510.~~ Add it to the source aggregates defined in Article 2303.02, E, 2, thoroughly mixed with sufficient moisture to achieve aggregate coating, and then place in the stockpile.

2) Liquid.

- a) When liquid anti-strip additives are used, employ equipment complying with the anti-strip manufacturer's recommended practice to store, measure, and blend the additive with the binder.

- b) The additive may be injected into the asphalt binder by the asphalt supplier or the Contractor. If the Contractor elects to add the liquid anti-strip agent, they assume the material certification responsibilities of the asphalt binder supplier. Ensure the shipping ticket reports the type and amount of additive and time of injection.
 - c) Ensure the asphalt supplier provides the Contractor and Engineer with the shelf life criteria defining when the anti-strip additive maintains its effectiveness. Do not use binder that has exceeded the shelf life criteria.
 - d) When using polymer-based aggregate treatment, comply with the manufacturer's recommended specifications and guidelines.
- d. Production of Hot Mix Asphalt Mixtures.**
- 1) Regulate the exact proportions of the various materials to be within the limits specified to produce a satisfactory bituminous coating and mixture. First dry mix the aggregates, then add the asphalt binder.
 - a) In batch plants, add the asphalt binder in an evenly spread sheet over the full length of the mixer box.
 - b) In continuous plants, spray the asphalt binder evenly into the aggregate within the first 30% of the length of the mixer box using a positive pressure spray.
 - c) In drum mixing plants, spray the asphalt binder evenly into the aggregate using a positive pressure spray.
 - 2) Operate the mixer so that the mixture is of consistently uniform temperature, and when discharged from the mixer does not vary more than 20°F (11°C).
 - 3) Do not allow the temperature of the mixtures to fall outside the following parameters:
 - a) Keep the production temperature of WMA mixtures between 215°F (102°C) and 280°F (138°C) until placed on the grade. Maximum production temperature for WMA is 330°F (165°C) after October 1st.
 - b) Do not produce WMA mixtures more than 10°F (6°C) below the target temperature designated in the JMF without the approval of the Engineer.
 - c) Keep the production temperature of HMA mixtures between 225°F (102°C) and 330°F (165°C) until placed on the grade. Do not discharge HMA into the hopper when its temperature is less than:
 - (1) 245 °F (118°C) for a nominal layer thickness of 1 1/2 inches (40 mm) or less, or
 - (2) 225 °F (102°C) for a nominal layer thickness of more than 1 1/2 inches (40 mm).
 - d) Flexible paving mixtures not meeting these requirements will be rejected.
 - e) Production temperature limits apply starting at point of discharge from mixer.
 - 4) Use a rate of production that will not exceed the manufacturer's rated capacity for the mixer and will provide uniform coating. For batch mixers, use a dry mixing time of no less than 5 seconds and a wet mixing time of no less than 25 seconds. For continuous mixers, use a mixing time of no less than 30 seconds.
 - 5) Control handling and manipulation of the hot mixture from the mixer to the final spread on the road in order to maintain uniform composition and minimize segregation of coarser particles. Minimize segregation to the extent that it cannot be visibly observed in the compacted surface. Apply only approved release agents to trucks and equipment, as specified in Article 2001.01.
 - 6) Except for an unavoidable delay or breakdown, provide continuous and uniform delivery of hot HMA to any individual spreading unit. Deliver at a rate sufficient to provide as continuous an operation of the spreading unit as practical. Keep the paver hopper sufficiently full at all times to prevent non-uniform mixture flow to the screed.
- 4. Placement.**
- a. Clean the surface of each layer according to Article 2212.03, B, 1. If necessary, retack to provide bond with the succeeding course.
 - b. Prior to placing the final lift, correct bumps or other significant irregularities that appear or are evident in the intermediate course or other lower course.
 - c. Do not place HMA mixtures under the following circumstances:
 - 1) On a wet or damp surface.
 - 2) When road surface temperature is less than that shown in Tables 2303.03-1 and 2303.03-2.

Table 2303.03-1: Base and Intermediate Course Lifts of Asphalt Mixtures

Nominal Thickness - inches (mm)	Road Surface Temperature, °F (°C)
1 1/2 (40)	40 (4)
2 - 3 (50 - 80)	35 (2)
Over 3 (Over 80)	35 (2)

Table 2303.03-2: Surface Course Lifts of Asphalt Mixtures

Nominal Thickness - inches (mm)	Road Surface Temperature, °F (°C)
1 (30)	HMA: 50 (10) / WMA: 40 (4)
1 1/2 (40)	HMA: 45 (7) / WMA: 40 (4)
2 and greater (50 and greater)	40 (4)

- 3) After November 15, except with the Engineer's approval.
- d. The Engineer may further limit placement if, in the Engineer's judgment, other conditions are detrimental to quality work.
- e. When placing the mixture, maintain a finishing machine forward speed that will provide a continuous uniform operation. Minimize stopping.
- f. Use a wire or string line to guide finishing machine and maintain alignment. Correct edge alignment irregularities immediately.
- g. The contract documents will show the total thickness to be placed. Spread the mixture at a rate such that, when compacted, the layer(s) will be the required thickness.
- h. Base the minimum layer thickness on Table 2303.03-3. Minimum layer thickness does not apply to leveling/scratch courses.

Table 2303.03-3: Minimum Lift Thickness

Design Mix Size - inches (mm)	Minimum Lift Thickness - inches (mm)
3/8 (9.5)	1 (25)
1/2 (12.5)	1 1/2 (40)
3/4 (19)	2 (50)
1 (25)	3 (75)

- i. Ensure the compacted thickness of the top layer does not exceed 3 inches (75 mm). This restriction does not apply to HMA shoulders.
- j. The maximum compacted thickness of lower layers may exceed 4 inches (100 mm) if it is demonstrated that the thicker layers have satisfactory density. The riding characteristics of the thicker layers must be within conformance to that expected from a 3 inch (75 mm) layer.
- k. Complete each layer to full width before placing succeeding layers.
- l. While operating on the road surface, do not use kerosene, distillate, other petroleum fractions, or other solvents, for cleaning hand tools or for spraying the paver hopper. Do not carry containers of cleaning solution on or near the paver. When a solvent is used, do not use the paver for at least 5 hours after cleaning. Collect and remove all cleaning materials and cleaning residue from the project and plant site. The cleaning material and residue becomes the property of the Contractor.
- m. Whenever practical, spread mixtures using a finishing machine. Irregular areas may be spread by hand. Spread the hot mixture uniformly to the desired depth with hot shovels and rakes. Do not dump loads faster than they can be spread properly. Do not allow workers to stand on the loose mixture while spreading.
- n. After spreading, carefully smooth to remove all segregated coarse aggregate and rake marks. Use rakes and lutes designed for use on HMA mixtures.
- o. Unless stated elsewhere in the contract documents, when placing two adjacent lanes, pave no more than 1 day of rated plant production before paving the adjacent lane(s). Place the adjacent lane to match the first lane during the next day of plant production.
- p. Do not spread more mixture than can be compacted in the specified working hours of the same working day.
- q. At the close of each working day, clear all construction equipment from the roadbed.
- r. Prior to opening a lane to traffic, place fillets or full width granular shoulders according to Article 2121.03, C, 4. Place the material adjacent to and equal in thickness to the resurfacing. Fillet removal is incidental to the HMA mixture.

5. Compaction.

a. General.

- 1) Promptly and thoroughly compact each layer. Use mechanical tampers for areas inaccessible to the rollers.

- 2) Use a rolling procedure and compactive effort that will produce a surface free of ridges, marks, or bumps. Obtain the Engineer's approval for the rolling procedure and compactive effort.
 - b. **Class I Compaction.**
 - 1) **Applications.**
 - a) Use Class I compaction for base, intermediate, and surface courses for the traffic lanes, ramps, and loops on all roadways.
 - b) For Class I compaction, the quality characteristic is in-place air void content and will be based on the theoretical maximum specific gravity (G_{mm}) obtained from the Quality Control Program for that day's mixture.
 - 2) **Test Strip Construction for Class I Compaction.**
 - a) For the purpose of evaluating properties of the HMA mixtures and for evaluating an effective rolling pattern:
 - (1) Construct a test strip of the surface mixture prior to its placement on the surface course for Interstate highways, Primary highways, and ramps connecting Interstate and Primary highways.
 - (2) Construct a test strip of the intermediate mixture at the start of its placement on the intermediate course for Interstate highways, interstate-to-interstate ramps.
 - (3) Test strips for base mixtures may be constructed, but are not required.
 - b) When the contract documents specify both intermediate and surface courses and a test strip is required, place a surface course test strip in lieu of intermediate mixture in a section of the intermediate course prior to actual surface placement. If surface course and intermediate course are not placed the same calendar year, then place test strip at beginning of surface mix production.
 - c) Test strips are not required when the entire production of the mixture bid item is placed in a single day.
 - d) The quantity of HMA mixture subject to the test strip production, will be pre-established with the Engineer and limited to a half day's production:
 - e) Only one test strip will be allowed for each mixture and shall be declared to the Engineer prior to placement. The Engineer may require additional test strips if a complying HMA mixture or rolling pattern was not established.
 - f) Use procedures and documentation during test strip construction that allow the Engineer and Contractor to confirm mixture design properties and effectiveness of compaction procedures.
 - g) Use test strip production control that meets the requirements of Article 2303.03, D, 3, c. The test strip will be an independent lot. Determine sublots in accordance with Table 2303.03-4.
 - c. **Class II Compaction.**

Intended for paved shoulders, temporary crossovers, onsite detours, and other situations where Class I is not specified.

 - 1) For all rollers, make initial contact with the hot mixture using the power driven wheels or drum.
 - 2) Perform initial rolling at a temperature so the mixture will compact without excessive distortion. Except on longitudinal joints and super-elevated curves, begin rolling with the initial roller at the outer edges of the pavement. With each successive pass, progress inward toward the center. For each reverse trip, lap all but 4 to 6 inches (100 to 150 mm) of the previous track. When reversing direction, stop the initial roller at an angle with the longitudinal direction.
 - 3) Following the initial rolling, give the layer an intermediate rolling with a pneumatic tired roller before the temperature falls below 225°F (110°C). Cover the area no less than six times with the intermediate roller.
 - 4) Use a finish, steel tired roller to smooth out all marks and roughness in the surface.
 - 5) For areas inaccessible to rollers, use mechanical tampers or other approved compaction methods.
6. **Joints and Runouts.**
 - a. Construct longitudinal joints for courses on resurfacing projects directly above the longitudinal joint in the existing pavement. Limit the offset distance between longitudinal joints in succeeding full depth HMA paving courses to 3 inches (75 mm) or less. Adjust hot mixture spreading along longitudinal joints to secure complete joint closure and full compression of the mixture with a smooth surface and joint after compaction.
 - b. Separate transverse construction joints in succeeding courses by at least 6 feet (1.6 m). Do not use wood or metal headers to form joint edge during rolling of the fresh mixture. Saw header to a straight line at right angles to the center line to provide a full thickness vertical edge before continuing paving. Provide a 10 foot (3 m) straightedge for checking transverse construction joints

for smoothness. Before compaction, use hand methods to correct surface variations at transverse construction joints indicated by the straightedge.

- c. When a transverse construction joint is open to traffic, install a temporary runout 10 feet (3 m) long per 1 inch (25 mm) of lift thickness. Use suitable paper or burlap (not sand, dirt, or wood) under the taper to prevent adhesion.
- d. When required to end paving for winter shutdown, locate runouts adjacent to each other. Install a winter shutdown runout 25 feet (8 m) long per 1 inch (25 mm) of lift thickness.
- e. For temporary runouts open to traffic for periods greater than 4 weeks or winter shutdown runouts, the Contractor may reduce the amount of top size aggregate in the transition taper. Remove temporary runouts and winter shutdown runouts before commencing paving. Runout removal is incidental to the HMA mixture.

7. Miscellaneous Operations.

a. Leveling and Strengthening Courses.

- 1) The contract documents will show course thickness. Place strengthening and leveling courses as indicated in the contract documents. Use the same mixture specified for the base or intermediate course.
- 2) When the width of strengthening or leveling course is 8 feet (2.4 m) or more, spread using a finishing machine.
- 3) Compact leveling courses and intermediate mixtures placed as leveling/scratch courses (less than or equal to 1 inch (25mm) plan thickness) using Class II compaction, except make all passes with a pneumatic roller.

b. Wedge Courses.

- 1) Use the base or intermediate mixture to construct wedge courses used to secure desired curve super-elevation. When possible, spread using a finishing machine.
- 2) Place wedge courses in compacted layers no thicker than 3 inches (75 mm). Avoid crushing the coarse aggregate. Place wedge courses to the full width of the pavement.
- 3) On super-elevated curves which require wedge course placement, stage the shoulder construction. After completing each day's wedge placement operations and prior to suspending that day's construction activities, construct a full width shoulder on the high side up to the completed wedge course elevation. Shoulder construction staging will be considered incidental to shoulder construction.
- 4) The Engineer may waive field void sampling for wedge courses provided compaction has been thorough and effective.

c. Fixtures in the Pavement Surface.

- 1) Adjust manholes, intakes, valve boxes, or other fixtures encountered within the area to be covered by HMA to conform to the final adjacent finished surface. Payment for adjustment of manholes or intakes will be per Section 2435. Payment for adjustment of valve boxes and other fixtures will be per Section 2554. Unless specified otherwise in the plans, adjust fixtures:
 - Between placing the surface course and the layer preceding the surface course, or
 - After placing the surface course using a composite patch or PCC patch.
- 2) Use PCC and HMA patch material complying with the requirements of Section 2529. Make patches large enough to accommodate the structure being adjusted.
- 3) Construct patches to be square. Orient them diagonally to the direction of traffic flow. Ensure the elevation of the adjusted fixture and patch does not differ from the elevation of the surrounding pavement surface by more than 1/4 inch (6 mm).
- 4) When shaping and compacting resurfacing near inlets to storm sewer intakes, shape to ensure maximum drainage into intakes.

d. Fillets for Intersecting Roads and Driveways.

- 1) Shape, clean of loose material, and tack coat the surface adjacent to the pavement being surfaced when fillets are designated in the contract documents for driveways to homesteads and commercial establishments and at intersecting roads. On the tack coated surface, place and compact the hot mixture in layers equal to the adjacent layer. Extend from the edge of the pavement as shown on the plans.
- 2) Place and compact fillets at intersecting roads at the same time as the adjacent layer.
- 3) Entrance fillets that are 8 feet (2.4 m) or wider may be placed as a separate operation. Pave fillets which are 8 feet (2.4 m) or wider with a self propelled finishing machine described in Article 2001.19.
- 4) The Engineer may approve other equipment for placement of fillets, based on a demonstration of satisfactory results.

e. Stop Sign Rumble Strips.

If the plans include the bid item Rumble Strip Panel (In Full Depth Patch), apply Section 2529. To meet the requirements of placing Stop Sign Rumble Strips before opening roadway sections to traffic, the Contractor may construct temporary rumble strip panels meeting the final pattern and location of the Stop Sign Rumble Strip indicated in the plans

f. Paved HMA Shoulders.

- 1) Compact paved HMA shoulders using one of the following methods:
 - a) Class II compaction (Article 2303.03, C, 5, c),
 - b) Rolling pattern established during the first day of shoulder placement to achieve Class I compaction (Article 2303.03, C, 5, b), or
 - c) Same rolling pattern established for adjoining mainline or ramp driving lane, as determined by density coring.
- 2) Shoulder area will not be included in Percent Within Limits (PWL) calculations for field voids on adjoining mainline or ramp driving lane. A price adjustment may be applied to shoulder areas that do not adhere to the established roller pattern.

D. Quality Assurance Program.

~~For interstate mixtures placed in a travel lane and~~ For each mixture bid item that has a plan quantity of more than 1000 tons (1000 Mg) (patching excluded) apply requirements of this article.

For items bid in square yards (m^2), apply the requirements of this article when the plan quantity by weight (estimated with a unit weight of 145 pounds per cubic foot ($2323 \text{ kg}/m^3$) unless otherwise specified in the plans) exceeds 1000 tons (1000 Mg).

HMA mixture bid items with plan quantities of 1000 tons (1000 Mg) or less and patching bid items are both defined as small quantities. For those bid items, meet the requirements of Article 2303.03, E. For items bid in square yards (m^2), when the plan quantity by weight (estimated with a unit weight of 145 pounds per cubic foot ($2323 \text{ kg}/m^3$) unless otherwise specified in the plans) does not exceed 1000 tons (1000 Mg), meet the requirements of Article 2303.03, E.

1. General.

Follow the procedures and meet the criteria established in Articles 2303.02 and 2303.03, B, Section 2521, and Materials I.M. 510 and 511.

2. Mix Design - Job Mix Formula.

- a. The Contractor is responsible for the JMF for each mixture.
- b. Submit a completed JMF, using the computer format of Form 956, for approval to the materials lab designated by the Contracting Authority. Submit supporting documentation demonstrating the design process was followed and how the recommended JMF was determined. Include an economic evaluation when required. Include trial and final proposed aggregate proportions (Form 955) and corresponding gyratory data. In addition, submit sufficient loose mixture and individual material samples for approval of the design.
- c. Personnel preparing the JMF shall be Iowa DOT certified in bituminous mix design.
- d. If the JMF is not satisfactory, submit another JMF for review. An approved JMF will be required prior to beginning plant production. The Contractor will be charged \$1000 for each JMF approval requested and performed which exceeds two per mix size, type, and proposal item on any individual project or group of tied projects.

3. Plant Production.

a. General.

- 1) Perform sampling and testing to provide the quality control of the mixture during plant production. Certified Plant Inspection according to Section 2521 is required.
- 2) Personnel performing production quality control testing shall be Iowa DOT certified for the duties performed.
- 3) Provide easy and safe access for Iowa DOT staff to the location in the plant where samples are taken.
- 4) All of the following qualify as a "significant mix change":
 - A single occurrence of an aggregate interchange of greater than 5%.
 - An aggregate interchange of greater than 5% from last approved JMF.
 - A single occurrence of an asphalt content change greater than 0.2%.
 - An asphalt content change greater than 0.2% from last approved JMF.
 - A deletion or introduction of a new material into the mix.

- A change of additive dosage rate.
- A change of binder, aggregate, or additive source.

b. Sampling and Testing.

Submit a testing plan meeting the requirements of Materials I.M. 511, Appendix D prior to the preconstruction meeting.

1) Asphalt Binder

Sample and test asphalt binder to verify the quality of the binder grade. Take asphalt binder samples at random times as directed and witnessed by the Engineer according to Materials I.M. 204.

2) Aggregate Gradation

- a) Use cold feed or ignition oven gradation for aggregate gradation control to assure materials are being proportioned according to the specifications. Take aggregate quality control samples at random times in accordance with Materials I.M. 204.
- b) Take a minimum of one aggregate gradation for each day's production that exceeds 100 tons (Mg). Higher testing frequencies may be used when defined by a pre-determined quality control plan approved by the Engineer. When more than one sample in a day's production is tested, use the average gradation to determine compliance of the daily lot.
- c) Engineer will verify Contractor gradation with an ignition oven or a split cold feed sample. When cold feed quality control is verified with the ignition oven, split a cold feed sample with the Engineer on the first day's production of each mixture. The Engineer will determine the need for a correction factor for the cold feed gradation based on the Engineer's cold feed gradation and ignition oven results. The Engineer may require additional cold feed split samples to evaluate the need or value of a correction factor for the cold feed and ignition oven gradation.
- d) Secure aggregate gradation samples transported to the agency lab for determination of the ignition oven correction factor testing in accordance with Materials I.M. 511.

3) Uncompacted Asphalt Mixture

- a) Sample the hot HMA mixture at random locations as directed and witnessed by the Engineer according to Materials I.M. 322. Secure and test the samples according to Materials I.M. 511. Modify sampling location to include placement with mix stored from a prior day's production.
- b) Sampling frequency will be determined by the estimated daily production of each mixture placed. The number of sublots is defined in Table 2303.03-4:

Table 2303.03-4: Uncompacted Mixture Sublot Size

Estimated Daily Production, Tons (Mg)	Number of Sublots
101-500	1
501-1250	2
1251-2000	3
2001-4500	4
Over 4500	5

- c) The Contractor may request to have a quality control plan that indicates a higher testing frequency if pre-approved by the Engineer at the preconstruction meeting.
- d) Assist the Engineer with material sampling for verification testing. When the Engineer provides notification that a sample is to be taken, initiate sampling within 15 minutes. Sampling should normally be completed within 30 minutes of notification.
- e) Do not take paired samples from the first 100 tons (100 Mg) of mix produced each day or the first 100 tons (100 Mg) of mix following a significant mix change. When paving operations are staged so each day of placement is less than 100 tons (100 Mg) for the entire production of the bid item, establish a sampling plan with the Engineer that includes a minimum of one sample per 2500 tons (2500 Mg).
- f) For PWL analysis of laboratory voids, each mixture bid item will constitute a lot. Lot size is defined as follows:
 - (1) No less than 8 and no more than 20 sequential tests will constitute a lot (exceptions stated below).
 - (2) After the 8th test, all subsequent samples collected over the remainder of that week will also be included in the lot up to a maximum of 20.
 - (3) Once a lot has been established with at least 8 tests, a new lot will begin at the start of the following week or the day following the 20th sample, whichever occurs first. Lots shall not contain partial days. When the 20th sample is reached, include all samples taken that day in the lot.

- (4) When determining PWL lot size for lab voids, Sunday through Saturday defines a week.
 - (5) If the bid item's production has ended and fewer than 8 tests are available, those tests may be combined with the previous lot provided the maximum lot size has not already been reached. When combining results, if the day to be combined contains the 20th sample, include all samples for that day. Do not combine partial day's results.
 - (6) If samples cannot be combined with the previous lot due to maximum lot size restrictions or if fewer than 8 tests are available for the entire production of a bid item, combine those tests into a single lot and use the AAD analysis in Materials I.M. 501.
 - (7) Test strips will be considered a separate lot.
 - (8) When the same mix type is produced for multiple bid items in one day, assign all box samples to each bid item's existing PWL lot for lab voids. Assign the quantity of each bid item produced to its respective lot.
- g) Test the quality control sample of each production paired sample as follows:
- (1) Prepare and compact two gyratory specimens according to Materials I.M. 325G. Compact loose WMA field samples, transported to the laboratory, at 240°F (115°C).
 - (2) Determine the the bulk specific gravity of compacted mixture (G_{mb}) at N_{design} for each specimen according to Materials I.M. 321. G_{mb} will be determined by compacting specimens to N_{design} . Average the results.
 - (3) Determine the Theoretical Maximum Specific Gravity of the uncompacted mixture according to Materials I.M. 350.
 - (4) Determine laboratory air voids for each sample according to Materials I.M. 501.
- h) Use the target laboratory voids listed in Materials I.M. 510 Appendix A unless otherwise specified in the contract documents.
- i) Use the following methods of acceptance for laboratory voids:
- (1) For base widening, non-high speed ramps, ~~non-interstate~~ shoulders, recreational trails, and other mixture bid items not placed in travel lanes of a permanent pavement, acceptance for laboratory voids will be based on a moving average absolute deviation (AAD) from target as defined in Materials I.M. 501. Use the production tolerance in Table 2303.03-5. At any time, if more than 100 tons (100 MG) of the bid item is placed in an area not listed above, apply Article ~~2303.03, D, 3, b, 3, ix, b~~ 2303.03, D, 3, b, 3, i, 2, for entire production of bid item.
 - (2) For all other mixture bid items, determine PWL for each lot as defined in Materials I.M. 501. Use 1.0% below the target air voids as the lower specification limit and 1.0% above the target air voids as the upper specification limit. Lot size is defined in Article ~~2303.03, D, 3, b, 3, vi~~ 2303.03, D, 3, b, 3, f. When the same mix type is placed in both PWL and AAD areas in a single day, include all samples for that day in the PWL lot as well as the quantity of the mixture bid item produced and placed in the PWL area.
 - (3) When same mix type is produced for multiple bid items in a single day from a single plant, apply all samples for that day to the lot for each bid item.
- j) For mixture bid items in a PWL lot, determine the pay factor using the average absolute deviation (AAD) procedure described in Materials I.M. 501 for proportions of a mixture bid item which are produced in irregular intervals and placed in irregular areas. The following items qualify as such and shall be combined into a single lot:
- Asphalt mixture produced and placed on gores, detours, cross-overs, temporary pavements, turning lanes, and fillets,
 - Asphalt mixture produced and placed on ramps that are not high-speed ramps,
 - Asphalt mixture produced and placed on ~~non-interstate~~ shoulders.
- To be considered irregular, the production rate for mixture bid items described above is not to exceed 1000 tons (1000 Mg) ~~(10,000 square yards (8400 m²))~~ for items bid in ~~square yards~~ in a single day.
- 4) **Moisture Susceptibility**
- a) The Engineer may obtain plant produced samples for moisture susceptibility testing in accordance with ~~Materials I.M. 507 Appendix A of this specification~~ at any time for mixtures identified in Article 2303.02, E, 2, A a or Article 2303.02, E, 2, ~~G f~~, to verify the minimum ~~TSR~~ requirement in Article 2303.02, E, 2, d, has been achieved.
 - b) When liquid anti-strip additives are added by the Contractor at the plant, satisfy one of the following methods to regulate the quantity of additive:
 - (1) Present certification that the equipment used to measure and blend the liquid anti-strip additive:
 - Meets the anti-strip supplier's recommended practice,
 - Is directly tied to the asphalt binder supply system, and

- Has been calibrated to the equipment manufacturer’s guidelines.
- (2) Test the binder to measure the quantity of liquid anti-strip additive in the binder for every 5000 tons (5000Mg) of HMA production. Obtain the Engineer’s approval for the supplier’s test method prior to use of the test.
- (3) Run the test method in Materials I.M. 507 Appendix A of this specification during production. If unable to certify or test for the presence and quality, run the test method in Materials I.M. 507 Appendix A of this specification each 10,000 tons (10,000 Mg) of production to measure the effectiveness of the additive. Ensure test results satisfy 80% TSR when compared to the dry strength of specimens prepared with asphalt binder containing the additive the minimum requirement in Article 2303.02, E, 2, d.

c. Production Control.

- 1) After the JMF is established, the combined aggregate furnished for the project, the quantity of asphalt binder, and the laboratory air voids should consistently comply with the JMF, as target values. Control them within the production tolerance given in Table 2303.03-5.

Table 2303.03-5: Production Tolerances

Measured Characteristic	Target Value (%)	Specification Tolerance (%) ^(a)
Cold feed gradation No. 4 (4.75 mm) and larger sieves	by JMF	± 7.0
Cold feed gradation No. 8 (2.36 mm)	by JMF	± 5.0
Cold feed gradation No. 30 (600 µm)	by JMF	± 4.0
Cold feed gradation No. 200 (75 µm)	by JMF	± 2.0 ^(b)
Field laboratory air voids absolute deviation from target ^(c)	0.0	≤ 1.0
Daily asphalt binder content	by JMF	± 0.3
VMA ^(e)	by JMF	± 1.0 ^(f)
(a) Based on single test unless noted otherwise. (b) Maintain the filler/bitumen ratio of the plant produced mixture between 0.6 and 1.4. (c) When lab voids acceptance is not based on PWL. (e) Restricted to an asphalt film thickness as specified for the level of HMA mixture. May be waived per Materials I.M. 510, Appendix A. (f) Based on the daily lot average.		

- 2) Control plant production so that the plant produced HMA mixture will meet mixture design criteria (within the test tolerances given in Table 2303.03-5) for Air Voids and VMA at N_{design} gyrations of the gyratory compactor. Monitor the slope of the gyratory compaction curve of plant produced material. Slope variations in excess of ±0.40 of the mixture design gyratory compaction curve slope may indicate potential problems with uniformity of the mixture.
- 3) The gyratory mix design gradation control points for the size mixture designated in the project plans will not apply to plant production control.
- 4) Strive for the target value of the percent air void and asphalt binder by adjusting gradation and asphalt binder content.
- 5) Produce a uniform composition mixture complying with the JMF.
- 6) Adjustments to the JMF target gradation and asphalt binder content values may be made.
 - a) The Contractor determines from quality control testing that adjustments are necessary to achieve the specified properties.
 - b) Consult with the Engineer regarding adjustments to the JMF.
 - c) Notify the Engineer if the average daily gradation for a mixture bid item is outside the production tolerances. If other production tolerances and mixture requirements of Materials I.M. 510 Appendix A are acceptable, a change in gradation target can be requested.
 - d) If filler/bitumen ratio exceeds the limits listed in Table 2303.03-5, change the JMF at the start of the next day’s production for that mixture.

- e) The Contractor's adjustment recommendations prevail, provided all specifications and established mix criteria are being met for plant production.
- 7) Measure estimated film thickness and voids in the mineral aggregate (VMA) for specification compliance every day of HMA production.
- 8) Prepare quality control charts according to Materials I.M. 511. Keep the charts current and available showing both individual sample results and moving average values for both lab voids and absolute deviation from target. Base moving average values on four consecutive sample results. The moving average absolute deviation from target may restart only in the event of a mandatory plant shutdown for failure to maintain the average within the production tolerance. Include the target value and specification tolerances on control charts.
- 9) Calculate laboratory voids for individual samples according to Materials I.M. 501. Use the individual density and individual maximum specific gravity determined for each sample. To determine the moving average of laboratory voids, use the average of the last four individual sample laboratory voids. Calculate absolute deviation from target lab voids according to Materials I.M. 501 of this specification. To determine the moving average absolute deviation from target laboratory voids, use the average of the last four individual sample absolute deviations from target laboratory voids.
- 10) Monitor the test results and make mix adjustments, when appropriate, to keep the mixture near the target values. Notify the Engineer whenever the process approaches a specification tolerance limit. When acceptance for lab voids is not based on PWL, cease operations when the moving average point for absolute deviation from target lab voids is outside the specification tolerance limit. Assume responsibility to cease operations, including not incorporating material which has not been placed. Do not start the production process again until notifying the Engineer of the corrective action proposed.

4. Construction.

a. Field Voids for Class I Compaction.

- 1) Take samples to determine field voids from the compacted mixture and test no later than the next working day following placement and compaction.
- 2) A lot is considered to be one layer of one mixture bid item placed during a day's operation. The Engineer may approve classifying multiple layers of construction placed during a single day as a lot provided only one mixture was used.
- 3) For the following situations sampling for field voids may be waived by the Engineer provided compaction has been thorough and effective, or sampling may be modified by mutual agreement to include more than one day's production provided samples are taken prior to trafficking:
 - When the day's operation is not more than 2500 square yards (2500 m²) excluding areas deducted from the field voids lot,
 - When the day's operation is not more than 500 tons (500 Mg) excluding quantities deducted from the field voids lot,
 - When the mixture is being placed in irregular areas, or
 - When placing wedge or strengthening courses.
- 4) The Engineer will obtain and test samples for each lot according to Materials I.M. 204 Appendix F. The Contractor may request to have a quality control plan that indicates a higher testing frequency at no additional cost to the Contracting Authority if pre-approved by the Engineer at the preconstruction meeting. The Engineer will determine the core locations. The length laid in each lot will be divided into approximately equal sublots. Obtain one sample at a random location, as directed and witnessed by the Engineer, in each subplot. Determine a new random location for the subplot when the designated core location falls on a runout taper at an existing pavement, bridge, or bridge approach section where the thickness is less than the design thickness.
- 5) If a sample is damaged or measures less than 70% or more than 150% of the intended thickness, an alternate sampling location will be determined and used. Take samples from no less than 1 foot (300 mm) from the edge of a given pass of the placing equipment, from run-outs, or from day's work joints or structures.
- 6) Use the following methods of acceptance for field voids:
 - a) For mixture bid items placed in the following areas:
 - Base widening placed in a travel lane,
 - Non high-speed ramps,
 - Bridge approaches placed as a separate operation,
 - Non-interstate travel lanes intended to be in service for fewer than 12 months,
 - State Park and Institutional roadways,

- Recreational trails,
- Irregular areas identified by the Engineer that may include areas not suitable for continuous paving, and
- Wedges,

the Engineer will accept the field voids lot based on the average test results or an established effective rolling pattern when approved by the Engineer. Do not exceed 8% average field voids. The Engineer may modify the sample size and frequency provided compaction is thorough and effective. The Engineer may apply the pay schedule in 2303.05, A, 3, b, 3 to areas where thorough and effective compaction is not achieved.

- b) For all other areas of Class I compaction, determine PWL, as defined in Materials I.M. 501, for each lot using a lower specification limit (LSL) of 3.5% voids (96.5% of G_{mm}) and an upper specification limit (USL) of 8.5% voids (91.5% G_{mm}).
- 7) When the PWL falls below 80.0, use the procedure outlined in Materials I.M. 501 to identify outliers with 1.80 as the quality index criterion. Only one core may be considered an outlier in a single lot. If an outlier is identified, recalculate the PWL with the results of the remaining cores and determine whether the PWL is improved. Use the larger of the original and recalculated PWL to determine the pay factor.
- 8) When the PWL falls below 50.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.
- 9) Use maximum specific gravity (G_{mm}) results in field voids calculations as follows:
 - a) When cores represent one day's production and more than one G_{mm} test result is available, use the average G_{mm} in the field voids calculation for all cores.
 - b) When cores represent one day's production and only one G_{mm} test result is available, use the single G_{mm} test result in the field voids calculation for all cores.
 - c) When the cores represent more than one day's production, use the average of all G_{mm} test results from all days corresponding with the cores.

b. Longitudinal Joint Compaction.

- 1) When PWL is used for Class I field voids acceptance and placement of lot results in the formation of a longitudinal joint(s) matching one or more lanes, obtain and test samples taken directly on each joint created.
- 2) Using random core locations determined for field voids lot, Engineer will randomly select four of these locations to be sampled for joint density. At each of the four locations (longitudinal station/milepost), obtain one sample for each longitudinal joint being formed as directed and witnessed by the Engineer. Take samples using a 6 inch (150 mm) diameter bit centered on top of the visible line between the two lanes.
- 3) Do not sample when matching new paving to pre-existing lanes.
- 4) Use average of all validated G_{mm} test results from all days corresponding with the cores, when calculating field voids of the joint(s).
- 5) Include results on daily plant report.

b c. Thickness.

- 1) The Engineer will measure cores, exclusive of sealcoat, according to Materials I.M. 337. All areas of uniform thickness and width for the project will be divided into lots. Sampling frequency and lot definitions are as follows:
 - a) Thickness cores sampled from completed course shall be taken full depth and divided into lots based on areas of uniform thickness and width. Use frequency specified for taking density samples from surface lift.
 - b) Density cores sampled as part of a field voids lot will be combined into daily lots based on cores' intended thickness.
- 2) Use the frequency specified for taking G_{mb} samples from the surface lift when measuring for completed thickness. Samples for thickness not tested for G_{mb} , because they are less than 70% of the intended thickness, are included for thickness. In these particular instances, do not measure the thickness of additional sufficiently thick samples used to determine field voids. Take thickness samples full depth of the completed course. After measurement, remove the G_{mb} samples for the top layer from the core. When measuring density of top lift from a full depth core, measure thickness before trimming core for density testing.
- 3) For full depth cores taken from completed course, intended thickness is designated in the contract documents. For all other cores, intended thickness is established by the Contractor meeting requirements in Articles 2303.03, C, 4, h through j. If any of the measurements for a lot is less than the designated thickness, the quality index for thickness of that lot will be determined by the following formula:

(English)

$$QI_{\text{Thickness}} = \frac{\text{Average Thickness}_{\text{Measured}} - (\text{Thickness}_{\text{Plan Intended}} - 0.5)}{\text{Maximum Thickness}_{\text{Measured}} - \text{Minimum Thickness}_{\text{Measured}}}$$

(Metric)

$$QI_{\text{Thickness}} = \frac{\text{Average Thickness}_{\text{Measured}} - (\text{Thickness}_{\text{Plan Intended}} - 12.7)}{\text{Maximum Thickness}_{\text{Measured}} - \text{Minimum Thickness}_{\text{Measured}}}$$

- 4) Provided there is reasonable assurance that the pavement complies with the required thickness, the Engineer may waive sampling for thickness for the following situations:
 - a) When the day's operation is 2500 square yards (2500 m²) or less.
 - b) When the mixture is being placed in irregular areas.
 - c) When the mixture is being placed next to structures.
- 5) When the quality index falls below 0.00 and final lift of the course has been placed, the Engineer may declare the lot or parts of the lot defective.

c. Smoothness.

Construct pavement to have a smooth riding surface according to the following:

- 1) Apply Section 2317 to HMA surface mixture bid items of a Primary project if any individual HMA mixture bid item is 1000 tons (1000 Mg) or greater or 5000 square yards (4200 m²) or greater. Apply Section 2316 to all other Primary projects with a surface course and when specifically required for other projects.
- 2) When neither Section 2316 nor Section 2317 is applied to a project, periodically check the riding surface longitudinally with a 10 foot (3 m) straightedge. The surface shall not deviate from a straight line by more than 1/8 inch in 10 feet (3 mm in 3 m). If a deviation is present, correct the area according to Article 2316.03, B, 2.

5. Sampling and Testing.

a. General.

- 1) Maintain and calibrate the quality control testing equipment using prescribed procedures. Sample and test according to the specified procedures as listed in the applicable Materials I.M. and Specifications. When the results from a Contractor's quality control lab are used as part of product acceptance, the Contractor's quality control lab is required to be qualified.
- 2) Identify, store, and retain all quality control samples and field lab gyratory specimens used for acceptance until the lot is accepted. The Contracting Authority will prescribe the method of securing the identity and integrity of the verification samples according to Materials I.M. 511. Store verification samples for the Contracting Authority until delivery to the Contracting Authority's lab.
- 3) Identify all samples using a system the Engineer approves.

b. Individual Materials and Uncompacted Mixture.

- 1) Complete the following as designated by the Engineer:
 - Identify samples of asphalt binder, aggregate, and tack coat material.
 - Secure and promptly deliver the samples to the appropriate laboratory.
- 2) Take paired samples of uncompacted HMA mixture (each box of the pair weighing at least 30 pounds (14 kg)) according to Materials I.M. 322.
- 3) Conduct quality control tests for mixture properties using representative portions of the mix from the quality control sample of each subplot.
- 4) Split samples for specimen preparation according to Materials I.M. 357.
- 5) Paired sampling may also be accomplished by taking a bulk sample and immediately splitting the sample according to Materials I.M. 322 on the grade.
- 6) Record and document all test results and calculations on data sheets approved by the Contracting Authority. Record specific test results on the Daily Plant Report the Contracting Authority provides. Also include a description of the quality control actions taken (adjustment of cold feet percentages, changes in JMF, and so forth) on the Daily Plant Report.
- 7) ~~Facsimile, or deliver by other methods the Engineer approves,~~ Deliver Daily Plant Report to the Engineer and designated laboratory daily as directed in Materials I.M. 511. At project completion, provide Engineer a copy of electronic file(s) containing project information generated during the progress of the work.
- 8) When sampling for moisture susceptibility testing, obtain a 70 pound (35 kg) sample according to Materials I.M. 322. ~~If the Contractor's TSR results from the mixture design are less than 90%, sample at a minimum frequency of 1/10,000 tons of plant production until a complying test result is achieved, after which the minimum frequency may be reduced to 1/50,000 tons.~~

Each sample shall constitute a separate lot and include all quantities placed from beginning of bid item's production (or previous sampling point) to next sampling point (or 10,000 tons, whichever is less). The Engineer will select, at random, the sample location. Split the sample and deliver half to the Central Materials Laboratory.

c. Compacted Pavement Cores.

- 1) Cut and trim samples under the direction of and witnessed by the Engineer for tests of G_{mb} , thickness, or composition by using a power driven masonry saw or by drilling a minimum 4 inch (100 mm) nominal diameter core.
- 2) Restore the surfaces the same day. Dry, fill with the same material, and properly compact core holes.
- 3) Pavement core samples will be identified, taken possession of by the Engineer, and delivered to the Contractor's quality control field laboratory.
- 4) The Engineer may either:
 - Transport the cores directly to the lab, or
 - Secure the cores and allow the Contractor to transport the cores to the lab.
- 5) The compacted HMA pavement will be tested in a timely manner by the Engineer's personnel who are Iowa DOT Certified to perform the test.
- 6) Prepare and test the cores according to Materials I.M. 320, 321, and 337.

d. Verification and Independent Assurance Testing.

- 1) The Contractor's quality control test results will be validated by the Engineer's verification test results on a regular basis using guidelines and tolerances set forth in Materials I.M. 216 and 511.
- 2) If the Engineer's verification test results validate the Contractor's test results, the Contractor's results will be used for material acceptance. Disputes between the Contractor's and Engineer's test results will be resolved according to Materials I.M. 511.
- 3) The Engineer will randomly select one or more of the daily production verification samples. Some or all of the samples selected will be tested in the materials laboratory designated by the Engineer. The Engineer will use the verification test results to determine if the Contractor's test results can be used for acceptance.
- 4) The Engineer will test each lot of cores at the Contractor's field quality control laboratory. Cores may also be tested by the Contractor; however, the Contractor's test results will not be used for material acceptance.
- 5) Personnel and laboratories performing tests used in the acceptance of material are required to have participated in the statewide Independent Assurance Program according to Materials I.M. 208.

E. Quality Control for Small HMA Paving Quantities.

1. Mix Design.

Prepare the JMF. Prior to HMA production, obtain the Engineer's approval for the JMF. Comply with Article 2303.02 and Materials I.M. 510.

For mixtures meeting the criteria in Article 2303.02, E, 2, a:

- a. An anti-stripping agent is required when ~~TSR on mix design is less than 90%~~ the optimum dosage is greater than 0%.
- b. Use ~~Materials I.M. 507~~ Appendix A of this specification to optimize the design dosage rate.
- c. When prior-approved designs have demonstrated acceptable field ~~TSR SIP~~ values, the anti-stripping agent and dosage from the JMF may be used in lieu of optimization testing.

2. Plant Production.

- a. Ensure HMA production plant calibration for the JMF is current and no more than 12 months old.
- b. Use certified asphalt binder and approved aggregate sources meeting the JMF. Ensure the plant maintains an asphalt binder log to track the date and time of binder delivery. Ensure HMA delivery tickets identify the JMF.
- c. Monitor the quality control test results and make adjustments to keep the mixture near the target JMF values.

3. Construction.

- a. Take compacted mixture G_{mb} measurements, except when Class II compaction is specified, no later than the next working day following placement and compaction. Use the field quality control laboratory compaction for field G_{mb} control, as specified in Article 2303.03, D. The Engineer may accept the void content of the compacted layer based on cores or calculations from density gauge

measurements. The Engineer may waive field void sampling provided the compaction has been thorough and effective.

- b. For small quantities, a lot will be the entire quantity of each HMA mixture bid item.
- c. The PWL for field voids will not apply to small quantities.

4. Sampling and Testing.

- a. Material sampling and testing is for production quality control only. Acceptance of mixture is based on Contractor certification. Perform a minimum of one aggregate cold-feed and one uncompacted HMA test per lot. Sampling and testing of uncompacted HMA mixture is only required for mechanically placed mixture. Sample and test according to the Standard Specifications and Materials I.M.s using certified technicians and qualified testing equipment. The Engineer may approve alternative sampling procedures or may waive sampling of uncompacted mix and gradation if Contractor can provide plant reports from other recent project(s) demonstrating the JMF has been produced within specification. Take the sample between the first 100 to 200 tons (100 to 200 Mg) of production. No split samples for agency verification testing are required.
- b. Asphalt binder will be accepted based on the asphalt supplier's shipment certification. No binder sampling or testing is required.
- c. Material sampling or testing is not required for daily HMA production of less than 100 tons (100 Mg) of any small quantity mixture on any project bid item.
- d. Moisture susceptibility testing on plant produced mixture is not required.

5. Certification.

- a. Provide a certification for the production of any mixture in which the requirements in this article are applied. Place the test results and the following certification statement on the Daily HMA Plant Report (Form 800241).

"The HMA mixture contains certified asphalt binder and approved aggregate as specified in the approved mix design and was produced in compliance with the provisions of Article 2303.03, E."
- b. The Daily HMA Plant Report for certified HMA may be submitted at the end of the project for all certified HMA quantities, or submitted at intervals for portions of the certified quantity.

2303.04 METHOD OF MEASUREMENT.

A. Hot Mix Asphalt Mixture.

1. General.

- a. Removal of fillets is incidental to the contract unit price for the mixture.
- b. If the Contractor chooses to place intermediate or surface mixture in lieu of base for the outside shoulders, the quantity will be calculated from the pavement and shoulder template. If placed as a separate operation, the quantity will be calculated from scale tickets. If the substitute mixture placed on the shoulder is for an intermediate course fillet only, include the quantity in the fillet for payment in the quantity placed in the adjacent intermediate course.
- c. Payment for the quality control requirements for small quantities will not be measured separately.
- d. Unless stated otherwise, equivalent WMA mixtures may be substituted for specified HMA mixtures.

2. Measurement by Weight (Mass).

- a. The quantity of the type specified, expressed in tons (megagrams), will be determined from the weight (mass) of individual loads, including fillets, measured to the nearest 0.01 tons (0.01 Mg).
- b. Loads may be weighed in trucks, weigh hoppers, or from the weight (mass) from batch plants computed by count of batches in each truck and batch weight (mass). Article 2001.07 applies. Segregate the weights (mass) of various loads into the quantities for each pay item.

3. Measurement by Area.

- a. The quantity of the type specified, expressed in square yards (square meters), will be shown in the contract documents to the nearest 0.1 square yard (0.1 m²). The area of manholes, intakes, or other fixtures will not be deducted from the measured pavement area.
- b. When constructing shoulders on a basis of payment of square yards (square meters), inspection of the profile and elevation will be based on the completed work relative to the pavement edge. The Contractor is responsible for the profile and elevation of the subgrade and for thickness.

B. Asphalt Binder.

1. Measure the amount of asphalt binder used from batch plants, continuous plants, or drum mixing plants by stick measurement in the Contractor's storage tank or in-line flow meter reading, according to Article 2001.07, B.
2. Compute the asphalt binder quantity added to the storage tank using a supplier certified transport ticket accompanying each load.
3. The quantity of asphalt binder not used in the work will be deducted.
4. When the quantity of asphalt binder in a batch is measured by weight (mass) and is separately identified by automatic or semi-automatic printout, the Engineer may compute the quantity of asphalt binder used from this printout. By mutual agreement, this method may be modified when small quantities or intermittent operations are involved.
5. The Engineer will calculate and exclude the quantity of asphalt binder used in mixtures in excess of the tolerance specified in Article 2303.03, D, 3, c.
6. When payment for-HMA is based on area, the quantity of asphalt binder used will not be measured separately for payment.

C. Recycled Asphalt Pavement.

1. A completed Daily HMA Plant Report with the certification statement is required for measurement and payment for Contractor Certified HMA. The quantity of asphalt binder will be based on the approved JMF and any plant production quality control adjustments.
2. The quantity of asphalt binder in RAP incorporated into the mixture, will be calculated in tons (megagrams). This quantity shall be based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction tests.
3. The quantity of asphalt binder in RAP, which is incorporated into the mix, will be included in the quantity of asphalt binder used.

D. Anti-strip Agent.

Will not be measured separately. The quantity will be based on tons (megagrams) of HMA mixture with anti-strip agent added.

E. Tack Coat.

Will not be measured separately.

F. Fabric Reinforcement.

The quantity, in square yards (square meters) to the nearest 0.1 square yard (0.1 m²), will be shown in the contract documents.

G. Hot Mix Asphalt Pavement Samples.

Will not be individually counted for payment if furnished according to Article 2303.03, D, 5, or required elsewhere in the contract documents,

H. Recycled Asphalt Shingles.

67% of the asphalt binder from RAS which is incorporated into the mixture will be included in the quantity of asphalt binder used.

2303.05 BASIS OF PAYMENT.

The costs of designing, producing, placing, and testing bituminous mixtures and the cost of furnishing and equipping the QM-A field laboratory will not be paid for separately, but are included in the contract unit price for the HMA mixes used. The application of tack coat and sand cover aggregate are incidental and will not be paid for separately. Pollution testing is at the Contractor's expense. The installation of temporary Stop Sign Rumble Strips will not be paid for separately, but is incidental to the price bid for the HMA course for which it is applied.

The quality control requirements for small quantities are incidental to the items of HMA mixtures in the contract.

A. Asphalt Concrete Mixture.

1. Payment will be the contract unit price for Hot Mix Asphalt Mixture of the type specified per ton (megagram) or square yard (square meter). Unless stated otherwise, equivalent WMA mixtures may be substituted for specified HMA mixtures with no change in the contract unit price.
2. Payment for test strips will be the contract unit price for the test strip mixture bid item per ton (megagram) regardless of lift placement.
3. Payment will be adjusted by the following Pay Factor for field voids and laboratory voids determined for the lot.

Multiply the unit price for the HMA bid item by the Pay Factor rounded to 3 decimal places.

a. Laboratory Voids

- 1) Payment when PWL is used for acceptance:

PWL	Pay Factor
95.1 – 100.0	PF = 0.006000*PWL + 0.430
80.0 – 95.0	1.000
50.0 – 79.9	PF = 0.008333*PWL + 0.3333
Less than 50.0	0.750

When PWL is less than 50.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

- 2) Payment when AAD is used for acceptance:

AAD from Target Air Void	Pay Factor
0.0 to 1.0	1.000
1.1 to 1.5	0.900
1.6 to 2.0	0.750
Over 2.0	0.500 maximum

When the AAD is more than 2.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

- 3) Use the following payment schedule when a test strip is constructed:

AAD from Target Air Void	Pay Factor
0.0 to 1.5	1.000
1.6 to 2.0	PF = 2.5 - AAD
Over 2.0	0.500 maximum

When the AAD is more than 2.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

b. Field Voids

- 1) Payment when PWL is used for acceptance:

PWL	Pay Factor
95.1 – 100.0	PF = 0.008000*PWL + 0.240
80.0 – 95.0	1.000
50.0 – 79.9	PF = 0.008333*PWL + 0.3333
Less than 50.0	0.750

When PWL is less than 50.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

- 2) Payment when a test strip is constructed:

Average Field Voids (Pa), %	Pay Factor
0.0 to 9.0	1.000
9.1 to 9.5	PF = 10 - Pa
Over 9.5	0.500 maximum

When the average air void content from a test strip exceeds 9.5%, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

- 3) Payment when PWL is not used for acceptance:

Average Field Voids (Pa), %	Pay Factor
0.0 to 8.0	1.000
8.1 to 9.5	PF=(11-Pa)/3
Over 9.5	0.500 maximum

When the average air void content exceeds 9.5%, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

- When the basis of payment is by area, payment will be further adjusted by the appropriate percentage in Table 2303.05-2 below according to the quality index for thickness determined for that lot:

Table 2303.05-2: Payment Adjustment (by Area) for Thickness

Quality Index (Thickness) 8 Samples	Percent of Payment (Previously Adjusted for Field Voids)
Greater than 0.34	100
0.14 to 0.34	95
0.00 to 0.13	85
Less than 0.00	75 maximum

- Payment for courses for which quality index (thickness) is not determined because of size or shape, and courses which are found to be deficient in average width, will be according to Article 1105.04.
- ~~When moisture susceptibility testing in accordance with Materials I.M. 507 is performed on plant produced mixture, the payment for asphalt mixture will be adjusted according to Table 2303.05-3:~~

Table 2303.05-3: Asphalt Mixture Payment Adjustment for Moisture Susceptibility

Contracting Authority's Results (Percent TSR)	Pay Factor
TSR ≥ 80	1.00
70 < TSR < 80	PF = 0.025*TSR + 1
TSR ≤ 70	0.75 maximum

B. Asphalt Binder.

- Payment will be the contract unit price per ton (megagram) for the number of tons (megagrams) of asphalt binder used in the work.
- Payment for asphalt binder will be for new asphalt binder the asphalt binder in the RAP which is incorporated in the mixture, and 67% of the asphalt binder from RAS which is incorporated into the mixture. The quantity of asphalt binder in RAM, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAM. This will be based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction test.
- When the basis of payment for HMA is in square yards (square meters), compensation for asphalt binder will be included in the contract unit price per square yard (square meter).

C. Recycled Asphalt Pavement.

RAP owned by the Contracting Authority will be made available to the Contractor for the recycled mixture at no cost to the Contractor other than loading, hauling, and processing as required for incorporation into the mix.

D. Anti-strip Agent.

- When anti-strip agent is required, the incorporation of the anti-strip agent into the asphalt mixture will be considered as extra work ordered by the Engineer if the Contracting Authority's TSR test results from the field produced mixture meet or exceed the minimum requirement and the conditioned indirect tensile strength is improved by at least 10% over that from the plant mixture without anti-strip (or original JMF conditioned strength when plant mix without anti-strip is not available) established in Article 2303.02, E, 2, d. Payment will be made at the rate of \$2.00 per ton (megagram) of asphalt mixture in which the anti-strip agent is incorporated. WMA mixtures designed for 10,000,000 ESALS and higher must satisfy Articles 2303.02, E, 2, a, 1 or 2 to be eligible for anti-strip payment. For mix designs (small quantities excluded) with a TSR greater than or equal to 80%, payment will stop when the Contracting Authority's TSR results of the field produced mixture without the agent are greater than or equal to 80% and any remaining asphalt binder containing the agent in the current tank is consumed.

2. Payment will be full compensation for designing, adding, and testing for anti-strip agent.

E. Tack Coat.

Incidental to HMA.

F. Fabric Reinforcement.

1. Payment will be the contract unit price for Fabric Reinforcement per square yard (square meter).
2. Payment is full compensation for furnishing all materials, labor, and equipment necessary for installing the fabric as required, including the adhesive or heavy tack coat of asphalt binder used as the adhesive.

G. Hot Mix Asphalt Pavement Samples.

1. Payment will be the lump sum contract price for cutting HMA Pavement Samples to determine field voids or thickness according to the specifications, when either of these is the responsibility of the Contractor, and elsewhere when required by the contract documents.
2. Payment is full compensation for furnishing all such samples for all courses or items of work, and for delivery of samples as specified in Article 2303.03, D, 5.

APPENDIX A - MOISTURE SENSITIVITY TESTING OF ASPHALT MIXTURES

SCOPE

This test method identifies the Iowa DOT modifications to AASHTO T 324, Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA). Moisture susceptibility of asphalt paving mixtures is based on the stripping inflection point (SIP) calculated from test measurements.

REFERENCES

AASHTO R 30, Standard Practice for Mixture Conditioning of Hot-Mix Asphalt (HMA)
 Materials I.M. 322, Sampling Uncompacted Hot Mix Asphalt
 Materials I.M. 350, Determining Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
 Materials I.M. 325G, Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyrotory Compactor (SGC).
 AASHTO T 324, Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA)

APPARATUS

See AASHTO T 324, Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA)

SPECIMEN PREPARATION

For plant produced material, collect a 70 pound (32 kg) sample according to Materials I.M. 322. Prepare two gyratory test specimens according to Materials I.M. 325G for each test wheel conforming to the mold geometrics. Compact specimens to 7% ($\pm 1\%$) air voids (93% of G_{mm} per Materials I.M. 350). For Mix Design, age the specimens according to AASHTO R 30 prior to compaction.

PROCEDURE

1. Place molds containing the specimens into the mounting trays, compacted side up.
2. The test temperature shall be 50°C. Condition specimens for 30 minutes after achieving test temperature. At no time should specimens be submerged longer than 35 minutes prior to test initiation.
3. Lower wheel onto specimens
4. Set the wheel-tracker to shut off after 20,000 passes or when the maximum LVDT displacement is 20 mm.
5. Perform the HWT test as per equipment manufacturer's instructions.

STRIPPING INFLECTION POINT

Use the most current version of the Iowa DOT Hamburg Software to determine the SIP. For each sensor, the deformation curve is characterized by a 6th degree polynomial determined through least-squares multiple regression. If the curve has an R^2 greater than or equal to 98.0%, the creep and stripping slopes are calculated. If not, the sensor is considered invalid and is not used in the analysis.

The SIP, creep slope, and stripping slope are calculated for each valid sensor for each wheel. The final SIP and slopes are the average of both wheels provided both sides of the device contain the same mix. If the ratio between the average stripping slope and the average creep slope is less than 2.0, the SIP is invalid and the mix is considered passing.

Details: The creep slope represents the rate of rutting in the linear region of the deformation curve prior to the onset of tertiary flow. The stripping slope is the rate of rutting in the linear region of the post tertiary deformation curve to the end of the test. The stripping inflection point (SIP) is the point of intersection of these two slopes.

Stripping Slope: The stripping slope is calculated prior to the creep slope. First, the maximum rutting slope (absolute value) near the end of the test is found. This is accomplished by using Solver to find the pass number nearest the end of the test (strip pass) at which the first derivative of the deformation curve is smallest (rutting is a negative value). The slope of the curve is then evaluated at this pass number to give the stripping slope. The stripping slope intercept is then found using point slope form. Note: the first derivative is synonymous with slope.

Creep Slope: To calculate the creep slope, the pass at which the absolute value of the rutting slope is the smallest prior to the strip pass is first found. This is accomplished first using Solver to find the pass (creep pass) at which the second derivative is zero (prior to the strip pass). The first derivative of the deformation curve is then evaluated at the creep pass, resulting in the creep slope.

SIP: The intersection of the creep slope and the stripping slope is found mathematically setting the equations for both lines equal and solving for the pass number.