Section 2303. Hot Mix Asphalt Mixtures

2303.01 DESCRIPTION.

A. Design, produce, place, and compact HMA 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.

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 the climate, traffic, and pavement conditions. Use asphalt binder meeting the 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 the 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) If 40% or more of the total aggregate is a limestone, ~~U~~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~~ 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) If less than 40% 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, 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) 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 Pavement.

1. 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 HMA mix design purposes, the Contracting Authority will test samples of the RAP. The aggregate gradation and amount of asphalt binder in the RAP will be based on the Contracting Authority's extraction tests. When the amount of recycled binder binder exceeds 20% of the total asphalt binder, change the asphalt 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 the +4 proportion of 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.
   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 Usage[2]		
		Unclassified RAP	Certified RAP	Classified RAP
HMA 100K S	B	0%	10%	15% (min. 70% virgin binder)[1]
HMA 100K I	B	10%	20%	No Limit
HMA 100 K B	B	10%	20%	No Limit
HMA 300K S	B	0%	10%	15% (min. 70% virgin binder) [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%	15% (min. 70% virgin binder) [1]
HMA 1M S	A	0%	0%	15% (min. 70% virgin binder) [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%	15% (min. 70% virgin binder) [1]
HMA 3M S L-3	A	0%	0%	15% (min. 70% virgin binder) [1]
HMA 3M S	A	0%	0%	15% (min. 70% virgin binder) [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%	15% (min. 70% virgin binder) [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%	15% (min. 70% virgin binder) [1]
HMA 30M S L-2	A	0%	0%	15% (min. 70% virgin binder) [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%	15% (min. 70% virgin binder) [1]
HMA 100M I	A	0%	0%	No Limit
HMA 100M B	B	10%	20%	No Limit

Note:

1. More than 15% of Classified RAP may be used for the surface course when there is quality control sampling, testing, and reporting of the RAP meeting the requirements in Materials I.M. 505. At least 70% of the total asphalt binder in the surface mix shall be virgin.
2. Maximum percentages shown are not to be combined.

D. Hot Mix Asphalt 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 the JMF gradation is within the control points specified for the particular mixture designated. Use the 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 the asphalt binder in the total mixture. Apply the values in Table 2303.03-1, based on mixture size and type.

3. If the 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) 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.

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 HMA 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.

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. Prepare gyratory HMA mixture designs for base, intermediate, and surface mixtures. Follow the procedure outlined in Materials I.M. 510. Submit mix design complying with Materials I.M. 510.

7. Use gyratory compacter for design and field control meeting the AASHTO protocol for Superpave gyratory compactors. 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.** On Interstate and Primary highways designed for 30,000,000 ESALS and higher, perform a moisture sensitivity evaluation of the proposed asphalt mixture design in accordance with ~~Appendix B of this specification~~ Materials I.M. 507.
   - **b.** On all other Interstate and Primary highways, perform a moisture sensitivity evaluation in accordance with ~~Appendix B of this specification~~ Materials I.M. 507 of the proposed asphalt mixture design if 25% or more of the plus No. 4 (4.75 mm) (virgin and RAP) aggregates or more than 40% of the total (virgin and RAP) aggregates is:
     - Quartzite.
     - Granite.

- Other siliceous aggregate (not a limestone or dolomite) which is obtained by crushing from ledge rock.

c. Moisture susceptibility testing will not be required for base repair, patching, or temporary pavement.

d. 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. 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 ~~of this specification~~ for additional information.

f. When the Contractor's mix design TSR results are below 80.0%, an anti-strip agent will be required. Plant produced material with anti-strip shall be tested to verify the minimum TSR is achieved. See Materials I.M. 510 Appendix C ~~of this specification~~ for additional information.

g. When there is a "significant mix change", the Engineer may require a re-evaluation of the test method in ~~Appendix B of this specification~~ Materials I.M. 507.

h. Tthe 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. See Materials I.M. 510 Appendix C ~~of this specification~~ for additional information.

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~~ ~~of this specification~~ for additional information.

3. Sand for Tack Coats.
Use sand meeting the requirements of Gradation No. 1 of the Aggregate Gradation Table in Section 4109.02.

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

2303.03 CONSTRUCTION.

A. General.

1. The 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 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 of 1000 tons (1000 Mg) or less.

B. Equipment.

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

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/m^2). The 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/m^2). 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 the same asphalt binder grade used in the HMA and applied at a rate of 0.20 to 0.25 gallons per square yard (0.9 to 1.1 L/m^2). 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. 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 Contactor 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) Coating aids may be added with the Engineer's approval.

3) Operate the mixer so that the mixture is of consistently uniform temperature, and when discharged from the mixer does not vary more than 20ºF (11ºC).

4) Unless the Engineer approves, do not allow the temperature of the mixtures to exceed 330ºF (165ºC).

5) 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.

6) 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.

7) Ensure mixture temperature allows for the specified compaction and density to be attained. Do not discharge HMA into the paver hopper when its temperature is less than:

- 245°F (120°C) for a nominal layer thickness of 1 1/2 inches (40 mm) or less, or
- 225°F (110°C) for a nominal layer thickness of more than 1 1/2 inches (40 mm).

8) 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 HMA Mixtures

Nominal Thickness - inches (mm)	Road Surface Temperature, ºF (ºC)
1 1/2 (40)	40 (4)
2 - 3 (50 - 80)	35 (2)
Over 3 (Over 80)	25 (-4)

Table 2303.03-2: Surface Course Lifts of HMA Mixtures

Nominal Thickness - inches (mm)	Road Surface Temperature, ºF (ºC)
1 (30)	50 (10)
1 1/2 (40)	45 (7)
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.

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 Interstate, Primary, and Secondary highways.

b) For Class I compaction, the quality characteristic is in-place air void content and will be based on the theoretical maximum specific gravity (Gmm) 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 course placement.

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. 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 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.

c. Fixtures in the Pavement Surface.

1) Adjust ~~utility accesses~~ 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).

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 1 compaction (Article 2303.03, C, 5, b), or
   c) Same rolling pattern established for adjoining mainline or ramp driving lane~~s~~, as determined by density coring.
2) Shoulder area will not be included in 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 each HMA mixture bid item of more than 1000 tons (1000 Mg), apply requirements of this article.

HMA mixture bid items 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.

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%.
- A single occurrence of an asphalt content change greater than 0.2%.
- 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

i) Use cold feed 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.

ii) 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.

iii) 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.

iv) Secure aggregate gradation samples transported to the lab for determination of the ignition oven correction factor in accordance with ~~Appendix A of this specification~~ Materials I.M. 511.

3) Uncompacted Asphalt Mixture

i) 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 ~~Appendix A of this specification~~ Materials I.M. 511.

ii) 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

iii) 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.

iv) 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.

v) 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.

vi) For PWL analysis of laboratory voids, lot size is defined as follows:

- **a)** No less than 8 and no more than 20 sequential tests will constitute a lot (exceptions stated below).
- **b)** 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.
- **c)** 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.
- **d)** When determining PWL lot size for lab voids, Sunday through Saturday defines a week.
- **e)** 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.
- **f)** 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.
- **g)** Test strips will be considered a separate lot.

vii) Test the quality control sample of each production paired sample as follows:

- **a)** Prepare and compact two gyratory specimens according to Materials I.M. 325G.
- **b)** 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} at N_{design} will be determined by compacting specimens to N_{max} and back calculating the bulk specific gravity at N_{design}. Average the results.
- **d)** Determine the Theoretical Maximum Specific Gravity of the uncompacted mixture according to Materials I.M. 350.
- **e)** Determine laboratory air voids for each sample according to Materials I.M. 501.

viii) Use the target laboratory voids listed in Materials I.M. 510 Appendix A unless otherwise specified in the contract documents.

ix) Determine PWL for each lot as defined in Material 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.

x) Determine the pay factor using the absolute average 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 weekly lots:

- Asphalt mixture produced and placed on gores, detours, 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 (10,000 square yards for items bid in square yards) in a single day.

4) Moisture Susceptibility

i) The Engineer may obtain samples for moisture susceptibility testing in accordance with ~~Appendix B of this specification~~ Materials I.M. 507 at any time for mixtures requiring moisture sensitivity testing to verify the minimum TSR has been achieved.

ii) 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:

a) 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.

b) 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.

c) Run the test method in ~~Appendix B of this specification~~ Materials I.M. 507 during production. If unable to certify or test for the presence and quality, run the test method in ~~Appendix B of this specification~~ Materials I.M. 507 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.

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)]
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.

(e) Restricted to an asphalt film thickness as specified for the level of HMA mixture.

(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 ~~Appendix A of this specification~~ Materials I.M. 511. Keep the charts current and available showing both individual sample results and moving average values. Base moving average values on four consecutive sample results. 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.
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.

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 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) The Engineer may waive sampling for field voids in the following situations, provided compaction has been thorough and effective:
- When the day's operation is not more than 2500 square yards (2500 m^2),
- When the day's operation is not more than 500 tons (500 Mg),
- When the mixture is being placed in irregular areas, or
- When placing wedge or strengthening courses.

4) The Engineer will obtain and test ~~8~~ 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 minimum number of cores is 8.~~ 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 sublot.
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) Determine PWL, as defined in Materials I.M. 501, for each lot using a lower specification limit (LSL) of 3.5% voids and an upper specification limit (USL) of 8.5% voids.
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

b. Thickness.

1) The Engineer will measure the cores, exclusive of sealcoat, according to Materials I.M. 337. All areas of uniform and similar thickness and width for the project will be divided into lots.

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.

3) 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)

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

(Metric)

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

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 m^2) 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, the Engineer may declare the lot or parts of the lot defective.

c. Smoothness.

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 m^2) or greater. Apply Section 2316 to all other Primary projects with a surface course and when specifically required for other projects.

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 ~~Appendix A of this Specification~~ 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 sublot.

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, the Daily Plant Report to the Engineer and the designated laboratory daily. At project completion, provide the Engineer a copy of the electronic file 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. A single sample shall represent no more than 10,000 tons of mixture. 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~~ Appendix A of this specification~~.

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 ~~Appendix A of this specification~~ 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.

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. 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 mixture on any project.

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.

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 m^2).
   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 m^2), will be shown in the contract documents.

~~**G. Adjustment of Fixtures.**~~
~~The Engineer will count the number of fixtures adjusted to the finished grade.~~

H. 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,

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).

2. Payment for surface course test strip placement in an intermediate lift will be the contract unit price for Hot Mix Asphalt Mixture, Surface Course, per ton (megagram).

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.

4. 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

5. 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.

6. When moisture susceptibility testing in accordance with ~~Appendix B of this specification~~ 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.

1. Payment will be the contract unit price per ton (megagram) for the number of tons (megagrams) of asphalt binder used in the work.

2. Payment for asphalt binder will be for new asphalt binder and the asphalt binder in the RAP which is incorporated in the mixture. The quantity of asphalt binder in RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP. This will be based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction test.

3. 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.

1. 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 results from the field produced mixture meet or exceed the minimum requirement. Payment will be made at the rate of $2.00 per ton (megagram) of asphalt mixture in which the anti-strip agent is incorporated. For HMA mix designs 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%.

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. Adjustment of Fixtures.**~~

~~**1.** Payment will be the contract unit price for each.~~

~~**2.** If the contract contains no price for Adjustment of Fixtures, this work will be paid for as provided in Article 1109.03, B.~~

H. 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.