

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
 - b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
 - c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
 - d. M140, Standard Specification for Emulsified Asphalt.
 - e. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.
 - f. M208, Standard Specification for Cationic Emulsified Asphalt.
 - g. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
 - h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
 - i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
 - j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
 - k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
 - l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
 - m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
 - n. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
 - o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.
 - p. T312, Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of a Superpave Gyrotory Compactor.

2. Asphalt Institute (AI):
 - a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
 - b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
3. ASTM International (ASTM):
 - a. D75, Standard Method of Test for Sampling of Aggregates.
 - b. D140, Standard Method of Test for Sampling Bituminous Materials.
 - c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures.
 - d. D2041, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - e. D2489, Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures.
 - f. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
 - h. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
 - i. E329 REV A, Standard Specification for Agencies Engaged in Construction Inspection Testing, or Special Inspection.

1.02 DEFINITIONS

- A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.
- C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.
- D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.
- E. Reclaimed Asphalt Pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.
- F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

- G. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.
- H. Warm Mix Asphalt (WMA): Generic term used to describe reduction in production, paving and compaction temperatures achieved through application of one or combination of several WMA technologies. Technologies involve HMA plant foaming processes and equipment, mineral additives, or chemicals that allow reduction of mix production to temperatures between 185 degrees F to 275 degrees F (85 degrees C to 135 degrees C).

1.03 DESIGN REQUIREMENTS

- A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this specification.
- B. Design Criteria:
 - 1. Superpave Method, AI SP-2, AASHTO R35:
 - a. Design Gyration, NDES: 75.
 - b. Coarse Aggregate Angularity, ASTM D5821
 - c. Fine Aggregate Angularity, AASHTO T304: 40.
 - d. Flat and Elongated Particles, ASTM D4791: 10 percent, maximum.
 - e. Clay Content, AASHTO T176: Minimum sand equivalent of 40 percent.
 - f. Voids in Mineral Aggregate: See Table 1.
 - g. Voids Filled with Asphalt: 70 percent to 80 percent.
 - h. Mixture Density as a Percentage of Theoretical Maximum Density at Initial Gyration Level: 89 percent, maximum.
 - i. Mix Density at Maximum Number of Gyration: Less than 98 percent of theoretical maximum density.
 - j. Dust Proportion: 0.8 to 1.6.
 - k. Air Voids: 4 percent.
 - l. Tensile Strength Ratio, AASHTO T283: 80 percent, minimum.

Table 1 Voids in Mineral Aggregate (VMA) Criteria	
Nominal Maximum Aggregate Size (mm)	Minimum VMA, Percent
3/8" (9.5)	15
1/2" (12.5)	14
3/4" (19.0)	13
1" (25.0)	12
1-1/2" (37.5)	11

C. Furnished Mix Tolerances:

1. Conform to asphalt concrete mix formula within the following, plus or minus:
 - a. Aggregate Passing No. 4 (4.76 millimeter) and Larger Sieves: 5 percent.
 - b. Aggregate Passing the No. 8 (2.38 millimeter) to No. 100 (150 µm) Sieves: 4 percent.
 - c. Aggregate Passing the No. 200 (75 µm) Sieve: 2 percent.
 - d. Bitumen Content: 0.3 percent of volume or batch weight of aggregate.
 - e. Temperature Leaving Mixer: 20 degrees F (11 degrees C).
 - f. Temperature in Paving Machine Hopper: 20 degrees F (11 degrees C).

1.04 WMA MIX CRITERIA

- A. Meet all the requirements for HMA.
- B. Binder grade shall be the same as for hot-mix asphalt (HMA) unless production temperatures are less than 100 degrees F lower than HMA, in which case a one-bump higher grade binder shall be used.
- C. 95 percent coating of coarse aggregate as determined by ASTM D2489.
- D. Gyration ratio of less than 1.25 by comparing number of gyrations to reach 92 percent relative density described below:
 1. Relative Density shall be determined using AASHTO T166, AASHTO T209, and AASHTO T312.
 2. Gyration Ratio (GR) is determined by the following equation:

$$GR = (N92)T-54/(N92)T$$

where: (N92)T-54 = gyrations to 92 percent relative density at 54 degrees F below the planned field compaction temperature
(N92) = gyrations to 92 percent relative density at the planned field compaction temperature.

1.05 SUBMITTALS

- A. Action Submittals:
 1. Samples:
 - a. Sample per ASTM D140 and ASTM D195.
 - b. Core Samples of Compacted Asphalt Concrete: 4 inches (100 millimeters).

B. Informational Submittals:

1. Asphalt Concrete Mix Formula:
 - a. Submit minimum of 15 days prior to start of production.
 - b. Submittal to include the following information:
 - 1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
 - 2) Bulk specific gravity for each aggregate constituent.
 - 3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
 - 4) Properties as stated in this section for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
 - 5) Percent of asphalt lost due to absorption by aggregate.
 - 6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
 - 7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
 - 8) Optimum mixing temperature.
 - 9) Optimum compaction temperature.
 - 10) Temperature-viscosity curve of asphalt cement to be used.
 - 11) Brand name of any additive to be used and percentage added to mixture.
2. Test Report for Asphalt Cement:
 - a. Submit minimum 10 days prior to start of production.
 - b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following materials:
 - a. Aggregate: Gradation, source test results as defined in this section.
 - b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
 - c. Prime Coat: Type and grade of asphalt.
 - d. Tack Coat: Type and grade of asphalt.
 - e. Additives.
 - f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
 - a. Mix design.
 - b. Asphalt concrete core.
 - c. Gradation and asphalt content of uncompacted mix.
 - d. Field density.
 - e. Quality control.
6. WMA Mix Design Information: All information required per AASHTO R35.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329 REV A.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F (10 degrees C) or air temperature is lower than 40 degrees F (4 degrees C). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.
- B. WMA may be applied at temperatures ambient temperatures of 35 degrees F (2 degrees C) or higher and rising. Provide documentation demonstrating proposed WMA technology can successfully place and compact mix at site temperatures and perform control strip or initial production testing and verification.
- C. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat:

1. Physical Characteristics: Cutback asphalt.
2. Functional Characteristics: Grade MC-70 conforming to AASHTO M82.
3. Performance Characteristics: None.

B. Tack Coat:

1. Physical Characteristics: None.
2. Functional Characteristics:
 - a. Emulsified Asphalt for Tack Coat or Seal Coat: Grade SS-1, SS-1h conforming to AASHTO M140.
3. Performance Characteristics: None.

C. Sand for Blotter Material or Sand Seal:

1. Physical Characteristics:
 - a. Clean.
 - b. Dry.
 - c. 100 percent passing No. 4 (4.75-millimeter) sieve.
 - d. Maximum of 10 percent passing No. 200 (75- μ m) sieve.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.02 ASPHALT CONCRETE MIX

A. Physical Characteristics:

1. Hot-plant mix of aggregate.
2. Paving grade: PG 70-22 asphalt cement.
3. The several aggregate fractions shall be:
 - a. Sized.
 - b. Uniformly graded.
 - c. Combined in such proportions that resulting mixture meets grading requirements of mix formula.
4. Coarse Aggregate:
 - a. Material retained on a No. 8 (2.36-millimeter) sieve.
 - b. Minimum 75 percent by weight of individual pieces having two or more fractured faces, and 90 percent by weight having at least one fractured face.
5. Fine Aggregate:
 - a. Material passing a No. 8 (2.36-millimeter) sieve.
 - b. Clean, sound, durable, angular shaped particles produced by crushing.
6. Natural Sand: May be used to a maximum of 15 percent by weight of total aggregate.

B. Functional Characteristics:

1. Mineral filler if required.
2. Fine Aggregate:
 - a. Plasticity Index: Maximum 6.
 - b. Liquid Limit: Maximum 25, when tested in accordance with ASTM D4318.
3. Mineral Filler: In accordance with AASHTO M17.
4. WMA Information:
 - a. Anti-stripping additives, silicone additives, WMA additives, and WMA technologies used.
 - b. Comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix.

- c. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of additives.
- C. Performance Characteristics:
 - 1. Mix formula shall not be modified except with written approval of Contracting Officer.
 - 2. Source Changes:
 - a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
 - b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Contracting Officer to confirm that properties are in compliance with design criteria.
 - c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.
 - 3. WMA Information: Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference while producing WMA.

PART 3 EXECUTION

3.01 GENERAL

- A. Traffic Control:
 - 1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
 - 2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.
- B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

- A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.
- B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

- A. Use equipment and WMA technologies capable of producing asphalt mixture that meets specification requirements and is workable at the minimum placement and compaction temperature desired, regardless of storage or haul distance considerations.

- B. Provide haul trucks with insulated beds and waterproof and windproof covers of suitable material and sufficient size to protect WMA from weather. Securely fasten covers to maintain temperature and prevent water from entering truck bed.

3.04 PREPARATION

A. Prepaving Requirements:

1. Prior to placing any WMA mix, produce a sufficient amount of mix to calibrate the plant and procedures using the approved mix design. Sample and test WMA mix for the following:
 - a. Voids in mineral aggregate (VMA).
 - b. Asphalt binder content.
 - c. Gradation.
 - d. Air voids.
 - e. Tensile strength ratio.
2. Heat WMA field samples, transported to the laboratory, to the field production temperature, or lower, when reheating is required for WMA mixture testing.

B. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

C. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 1 inch (25 millimeters).
3. Paint edges of meet line with tack coat prior to placing new pavement.

D. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with this section.

B. Prime Coat:

1. Heat cutback asphalt prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.

3. Do not apply when moisture content of upper 3 inches (75 millimeters) of base exceeds optimum moisture content of base, or if free moisture is present.
4. Application Rate: 0.15 gallon to 0.5 gallon per square yard (70 liters to 2.28 liters per square meter) of surface area.
5. Remove or redistribute excess material.
6. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.

C. Tack Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
2. Do not apply more tack coat than necessary for the day's paving operation.
3. Touch up missed or lightly coated surfaces and remove excess material.
4. Application Rate:
 - a. 0.05 gallon per square yard to 0.15 gallon per square yard (0.25 liter per square meter to 0.7 liter per square meter) of asphalt (residual if diluted emulsified asphalt).
 - b. Apply at rate, within range specified, sufficient to assure good bonding, but not so heavy that surplus asphalt flushes into asphalt concrete being placed.

D. Pavement Mix:

1. Prior to Paving:
 - a. Sweep primed surface free of dirt, dust, or other foreign matter.
 - b. Patch holes in primed surface with asphalt concrete pavement mix.
 - c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in two equal lifts.
3. Compacted Lift Thickness:
 - a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch (25 millimeters).
 - b. Maximum: 4 inches (100 millimeters).
4. Total Compacted Thickness: As shown.
5. Sequence placement so that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
 - a. Offset edge of each layer a minimum of 6 inches (150 millimeters) so joints are not directly over those in underlying layer.

- b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
 - c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
- 8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
- 9. After placement of pavement, seal meet line by painting a minimum of 6 inches (150 millimeters) on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

E. Compaction:

- 1. Do not overcompact WMA mixtures above a density that will result in less than 3 percent air voids. Carefully monitor compaction procedures to establish rolling patterns and techniques to attain specified density without overcompaction.
- 2. Roll until roller marks are eliminated and density of 95 percent of measured maximum density determined in accordance with ASTM D2041 is obtained.
- 3. Roll until roller marks are eliminated and minimum density of 95 percent of mix design unit weight at optimum asphalt content is obtained.
- 4. Joint Compaction:
 - a. Place top or wearing layer as continuously as possible.
 - b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
 - c. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
 - d. Cut away waste material and lay new mix against fresh cut.

F. Tolerances:

- 1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
- 2. Completed Surface or Wearing Layer Smoothness:
 - a. Uniform texture, smooth, and uniform to crown and grade.
 - b. Maximum Deviation: 1/8 inch (3 millimeter) from lower edge of a 12-foot (3.6-meter) straightedge, measured continuously parallel and at right angle to centerline.
 - c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.
- 3. Transverse Slope Maximum Deviation: 1/4 inch (6 millimeters) in 12 feet (3.6 meters) from rate of slope shown.

4. Finished Grade:
 - a. Perform field differential level survey on maximum 50-foot (15-meter) grid and along grade breaks.
 - b. Maximum Deviation: 0.02 foot (6 millimeters) from grade shown.

G. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Contracting Officer.
2. Preparation:
 - a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
 - b. Seal in dry weather and when temperature is above 35 degrees F (2 degrees C).
3. Application:
 - a. Fill cracks over 1/16 inch (1.5 millimeters) in width with asphalt-sand slurry or approved crack sealer prior to sealing.
 - b. When sealing patched surfaces and joints with existing pavements, extend minimum 6 inches (150 millimeters) beyond edges of patches.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 3 inches (75 millimeters) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch (350 Newtons per linear centimeter to 525 Newtons per linear centimeter). Use hand tampers where rolling is impractical.

2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch (6 millimeters) or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
 - a. Asphalt Content, Aggregate Gradation: Once per every 500 tons (400 mg) of mix or once every 4 hours, whichever is greater.
 - b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons (900 mg) or once every 8 hours, whichever is greater.
2. Density Tests: Once every 500 tons (450 mg) of mix or once every 4 hours, whichever is greater.

END OF SECTION

