

Warm Mix Asphalt (WMA) Guide Specification for Highway Construction

Division 400 - Asphalt Pavements and Surface Treatments

SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENT

Warm mix asphalt (WMA) is the generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the application of one of several WMA technologies.

Some modifications to HMA plants may be necessary to accommodate the WMA technologies as noted in Section 4XX.03 Construction.

Production and paving temperatures may need to be increased for higher reclaimed asphalt pavement (RAP) contents, increased haul distances, decreased ambient temperatures, or other WMA project specific conditions.

All provisions for the production and placement of conventional HMA mixtures as stipulated in [\[applicable Agency specification\]](#) are in force except as noted below.

4XX.01 Description

Construct one or more courses of plant produced warm mix asphalt (WMA) pavement on a prepared foundation, using virgin aggregate or a combination of virgin and/or reclaimed aggregate material (RAM) and prescribed manufactured WMA additives and/or WMA plant process modifications. Use of RAP materials, consisting of cold milled, crushed, or processed bituminous asphalt mixture; and reclaimed asphalt shingles (RAS) are permitted at the current [\[Agency specified\]](#) percentages, provided that the mixture meets all the requirements of these specifications.

4XX.02 Material

WMA may be produced by one or a combination of several technologies involving HMA plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 185°F to 275°F. (*Note: The upper temperature range is appropriate for modified asphalt binders and WMA mixtures which include higher percentages of reclaimed asphalt pavement.*)

Provide materials as specified in:

Aggregate	Subsection XXX
Liquid Antistrips	Subsection XXX
Asphalt Binder	Subsection XXX
HMA Additives	Subsection XXX
Lime for Asphalt Mixtures	Subsection XXX
Mineral Filler	Subsection XXX
Reclaimed Asphalt Pavement	Subsection XXX
Reclaimed Aggregate Material	Subsection XXX
Reclaimed Asphalt Shingles	Subsection XXX

4XX.03 Construction

A. *Mix Design.* Develop and submit a job mix formula for each mixture according to AASHTO R 35 or [Agency specified procedure]. Each job mix formula must be capable of being produced, placed, and compacted as specified. Apply all mix design requirements for HMA to the development of the WMA mix design.

(Note to Contracting Agency: Recommended mix design practices specific to WMA have not been established. Job mix formulas for WMA mixtures are currently developed with conventional HMA mix design practices and the WMA technology process or additives are included afterward. The Contracting Agency and WMA producer must ensure the WMA technology does not adversely affect the asphalt binder performance grade and WMA mixture performance during the development and verification of the WMA job mix formula. All acceptance and performance testing must be conducted with the WMA technology added. A specific WMA mix design recommended practice is expected upon the completion of the National Cooperative Highway Research Program (NCHRP) Project 09-43 "Mix Design Practices for Warm Mix Asphalt" detailed at www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=977.)

Submit a written job mix formula for review and approval at least [XX] calendar days before production, or when sources of asphalt binder, aggregates, WMA additives, or other components of the mix change.

Submit the following information:

1. All information required in the report section of AASHTO R 35 or [Agency specified procedure].
2. WMA technology and/or WMA additives information.
3. WMA technology manufacturer's established recommendations for usage.
4. WMA technology manufacturer's established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.
5. WMA technology material safety data sheets (MSDS).
6. Documentation of past WMA technology field applications including project type, project owner, tonnage, location, mix design, mixture volumetrics, field density, and performance; or documentation of WMA technology listing on [Agency specified] approved products list.
7. Temperature range for mixing.
8. Temperature range for compacting.
9. Asphalt binder performance grade test data over the range of WMA additive percentages proposed for use.
10. WMA mixture performance test results [as required by the Contracting Agency].
11. Laboratory test data, samples and sources of all mixture components, and asphalt binder viscosity-temperature relationships.

(Note to Contracting Agency: Some WMA technologies may alter the asphalt binder grade and conventional performance grading may not be suitable to quantify the WMA technology effects.)

B. *Additives.* Use anti-stripping additives, silicone additives, WMA additives, and WMA technologies as specified. Comply with approved mix design quantities. Confirm the addition rate through field tests performed during production.

(Note to Contracting Agency: Silicon additives are historically used as both an antifoam and defoamer to inhibit foaming in asphalt binder applications. Ensure silicon additive compatibility when asphalt binder foaming processes are used to produce WMA.)

Comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of additives.

Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference while producing WMA.

C. *Sampling.* Perform sampling according to the following standards:

1. *Aggregate.* AASHTO T 2 or [Agency specified procedure].
2. *Asphalt Binder.* AASHTO T 40 or [Agency specified procedure].
3. *Warm Mix Asphalt (WMA) Plant Mix.* AASHTO T 168 or [Agency specified procedure].

D. *Weather Limitations.*

1. Place WMA mixtures only on dry, unfrozen surfaces and only when weather conditions allow for proper production, placement, handling, and compacting.
2. Meet [agency specified] placement temperatures.

(Note to Contracting Agency: The minimum HMA delivery, placement, and compaction temperatures should be reviewed to accommodate the WMA reduced temperature and achieve workability and density requirements. Documentation that demonstrates a proven history of the WMA technology's ability to be placed and compacted at the reduced temperatures may be required. A test strip or initial production verification requirement can be used to demonstrate placement and compaction at the reduced temperature. Minimum ambient paving temperature requirements may be lowered 20°F from normal temperature requirements. Do not lower ambient paving temperatures to below freezing.)

E. *Equipment.* Use equipment and WMA technologies capable of producing an asphalt mixture that meet specification requirements and is workable at the minimum placement and compaction temperature desired, regardless of storage or haul distance considerations.

1. *Asphalt Mixing Plant.* Meet AASHTO M 156 or [as further modified by the Agency].

Modify the asphalt mixing plant as required by the manufacturer to introduce the WMA technology.

Plant modifications may include additional plant instrumentation, the installation of asphalt binder foaming systems and/or WMA additive delivery systems, tuning the plant burner and adjusting the flights in order to operate at lower production temperatures and/or reduced tonnage.

(Note: Implementation of best management practices in the control of aggregate moisture content prior to introduction to the drying or mixing drum is highly recommended in order to achieve the maximum benefit of WMA technology.)

(Note to Contracting Agency: It may be beneficial to produce an HMA mixture at conventional HMA temperatures immediately before WMA production at the lower temperatures in order to bring the plant up to temperature and ensure proper baghouse operating temperature. The following references published by the National Asphalt Pavement Association detail specifics related to plant modifications and operational changes in order to maximize the benefits of WMA production, especially regarding reduced fuel usage and reduced emissions: Quality Improvement Series 125 (QIP 125), "Warm Mix Asphalt: Best Practices",

Quality Improvement Series 126 (QIP 126), "Energy Conservation in Hot Mix Asphalt Production," and Environmental Council 101 (EC-101), "Best Management Practices to Minimize Emissions During HMA Construction")

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

2. *Hauling Equipment.* Furnish equipment with tight, clean, smooth metal beds to haul WMA mixture. Keep beds free of petroleum oils, solvents, or other materials that would adversely affect the mixture. Apply a thin coat of approved release agent to beds as necessary to prevent mixture sticking. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mix.

Be prepared to cover and insulate hauling beds. Equip each truck with a waterproof and windproof cover of suitable material and sufficient size to protect the mix from the weather. Securely fasten covers when necessary to maintain temperature. Ensure that covers do not allow water to enter the bed, paver, or mix transfer device during mix unloading. Use insulated truck beds when necessary to maintain temperature.

3. *Asphalt Pavers.* Provide self-propelled asphalt pavers with activated, heated, adjustable, vibratory screed assemblies to spread and finish to the specified section widths and thicknesses. Provide full width screw augers and provide auger extensions to ensure the paver's distribution system places the mixture uniformly, maintaining a consistent head of material in front of the screed. Screed or strike-off the surface without segregating, tearing, shoving, or gouging the mixture.

Operate the paver at consistent speeds and in a manner that results in an even, continuous layer. Avoid and minimize stop and start operation or allowing the paver to remain stationary during operation.

Equip pavers with automatic screed controls with sensors capable of continuously sensing grade, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope. Control the screed to maintain the grade and transverse slope according to plan.

The Contractor may operate equipment manually in irregularly shaped, narrow, and minor areas.

If automatic controls fail, operate equipment manually only for the remainder of the work day and only if specified results are obtained.

Suspend paving if the specified surface tolerances are not met. Resume only after correcting the situation.

4. *Rollers.* Use rollers as required to achieve *[Agency specified]* pavement density and capable of reversing direction without shoving or tearing the mixture.

Operate rollers according to manufacturer's recommendations. Only use vibratory rollers equipped with separate energy and propulsion controls. Select equipment that will not crush the aggregate or displace the mixture.

F. *Mixing and Holding.* Heat the asphalt binder within the specified temperature range. Ensure a continuous supply of heated asphalt binder to the mixer.

Heat and dry aggregates to the required temperature. Avoid damaging or contaminating the aggregate.

Combine and mix the dried aggregates and asphalt binder to meet the job mix formula. Ensure a minimum of 95 percent uniform coating of aggregates according to AASHTO T 195 or [Agency specified procedure].

Correct procedures if storing or holding causes segregation, excessive heat loss, or a reduced quality mixture. Properly dispose of mixture which does not meet specifications.

G. Preparing Base or Existing Surface. Clear surface of debris and deleterious material. Apply and cure tack coat before placing the WMA. Apply a tack coat on all surfaces, curbs, gutters, manholes, or other structure surfaces, that will be in contact with the WMA.

Repair damaged areas of the base or existing surface. Restore the existing surface or base to a uniform grade and cross section before placing the mix.

H. Pre-paving Requirements. Prior to placing any WMA mix, produce a sufficient amount of WMA mix to properly calibrate the plant and procedures using the mix design approved for mainline construction. The Engineer will sample and test the WMA mix thus produced for the following:

1. voids in mineral aggregate (VMA);
2. asphalt binder content;
3. gradation;
4. air voids; and
5. tensile strength ratio (or Hamburg wheel tracking test for moisture damage)

Heat WMA field samples, transported to the laboratory, to the field production temperature, or lower, when reheating is required for WMA mixture testing.

(Note: Field produced WMA loose mix samples which are immediately compacted and tested, without reheating, may produce lower voids in mineral aggregate and lower air voids test results when compared to reheated samples. This should be validated during the test strip or initial production lot. One possible remedy is to cool the WMA sample to room temperature and reheat to a temperature that is less than or equal to the WMA field production temperature before laboratory compaction. This will minimize the WMA technology's effects on the test results and ensures the sample is not excessively aged.)

Place no WMA mixture that fails to meet specification requirements. WMA mixture not meeting the requirements may be used in the construction of temporary facilities when approved by the Engineer.

Construct a control strip or initial production lot with production materials and equipment. Select compacting methods to meet the specified density. The Engineer will take random loose mix and core samples to verify compliance with job mix and specification requirements. Reconstruct the test strip or initial production lot if the job mix formula, the compacting method, or compacting equipment changes, or if results do not meet specifications.

I. Spreading and Finishing. Spread and finish the mixture with asphalt pavers to specified grade and thickness.

Hand place material in areas inaccessible to mechanical spreading and finishing equipment. Maintain a consistent supply of mixture to ensure uninterrupted paving.

Minimize inconvenience to traffic and protect existing and finished surfaces. Leave only short lane sections, normally less than [26 ft (8 m)], where the abutting lane is not placed the same day, or according to [*Agency specified*] traffic safety requirements.

J. *Compacting*. Compact immediately after spreading and before the WMA mixture falls below the minimum job mix design compaction temperature. Discontinue paving if unable to achieve the specified density before the mixture cools below the minimum recommended WMA job mix design compaction temperature.

Provide the number, weight, type, and sequence of rollers necessary to compact the mixture without displacing, cracking, or shoving. Roll the WMA mixture parallel to the centerline. Begin rolling superelevated curves at the low side and continue to the high side, overlapping longitudinal passes parallel to the centerline.

Maintain a uniform roller speed with the drive wheels nearest the paver. Operate vibratory rollers uniformly at the manufacturer's recommended speed and frequency.

Continue rolling to eliminate all roller marks and to achieve the minimum [*Agency specified*] percent of theoretical maximum density or the recommended [*Agency specified*] percent of laboratory density as determined according to [*Agency-specified method*].

(Note to Contracting Agency: Air void and density requirements are important to provide long term performance of asphalt pavements. Due to the potential for increased workability of WMA mixtures and therefore increased density, it is important to monitor rolling operations to ensure excessive compaction does not occur and minimum air void requirements and/or the upper limit on percent of maximum density are not exceeded.)

Maintain the line and grade of the edge during rolling.

Prevent the mixture from adhering to the rollers by using very small quantities of detergent or other approved release material.

Hand compact areas inaccessible to rollers.

The Engineer will take random tests of the compacted pavement to verify specification compliance. At no cost to the Agency, remove and replace mixture that does not meet specification requirements or that becomes contaminated with foreign materials. Remove defective materials for the full thickness of the course by saw cutting the sides perpendicular and parallel to the direction of traffic. Coat saw cut edges with bituminous materials and replace the defective material with specification materials.

K. *Joints*. Protect ends of a freshly laid mixture from damage by rollers. Form transverse joints to expose the full depth of the course. Apply a tack coat on transverse and longitudinal joint contact surfaces immediately before paving. Construct all longitudinal joints within 12 in. (300 mm) of the lane lines. Offset longitudinal and transverse joints on succeeding lifts 6 inches (150 mm) to 12 inches (300 mm) from the joint in the layer immediately below. Create the longitudinal joint in the top layer along the centerline of two-lane highways or at the lane lines of roadways with more than two lanes.

L. *Surface Tests*. The Engineer will test pavement surfaces to verify compliance with [*Agency specified*] smoothness and texture requirements.

Correct pavement surfaces that do not meet specification requirements by cold milling, diamond grinding, overlaying, or removing and replacing according to the following:

a. *Diamond Grinding.* Diamond grind final pavement surfaces exposed to vehicle traffic to the required surface tolerance and cross section. Remove and dispose of all waste material.

b. *Cold Milling.* Cold mill intermediate pavement surfaces to the required surface tolerance and cross section. Remove and dispose of all waste materials.

c. *Overlaying.* Use specification materials for overlays. Overlay the full width of the underlying pavement surface. Place a minimum recommended overlay thickness of [1.6 in. (40 mm)]. Use only one overlay.

d. *Removing and Replacing.* Replace rejected areas with WMA pavement materials that meet specification requirements. Test the corrected surface area. Complete all corrections before determining pavement thickness.

4XX.04 Measurement

The Engineer will measure work acceptably completed as specified in Subsection XXX and as follows:

A. The Engineer will base quantities of asphalt binder on the theoretical mass incorporated into accepted product as verified by samples taken according to Subsection XXX.

4XX.05 Payment

Include costs of plant startup operations, considering both labor and materials, in the price bid for the mixture in place.

The Agency will pay for accepted quantities at the contract unit price as follows:

Pay Item Pay Unit

(A) Asphalt Binder ton (Mg), gal (L)

(B) WMA Plant Mix—Type _____ ton (Mg), yd² (m²)

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.