

SECTION 453 Mix Production

453.1 Mix Design

The primary goal of a mix design is to determine a specific blend of aggregates and asphalt binder to produce an economical mixture that meets specifications. In order to provide the necessary performance, the mix must have sufficient asphalt content (AC%), air voids, quality of aggregate, and required compactive effort. The resulting HMA mix design is to as a job mix formula (JMF).

Virgin asphalt and aggregate materials used in HMA mix designs must be from approved sources. Refer to the following for the lists of approved materials:

<https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrcs/tools/appr-prod/default.aspx>

Region staff responsible for materials quality should furnish the QV team with the following:

- Asphalt binder must conform to the Combined State Binder Group (CSBG) Method of Acceptance for Asphalt Binders available at:

<https://engineering.purdue.edu/~csbg/method.html>

- Coarse aggregate materials must be from an approved source and conform to the requirements of [standard spec 460.2.2](#).

The contractor's HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technician develops and submits an asphaltic mixture design for each layer of HMA pavement according to [CMM 866.2](#) to the BTS, Truax Lab. The central materials laboratory reviews the quality of the aggregate and asphaltic mix design and issues a report to the contractor and copies the region office. The department also enters approved mix designs into the Materials Tracking System (MTS). Each approved mix design has a three-year life cycle. The current list of approved mix designs can be found on the [APL](#).

After production has begun, it may become necessary to adjust the job mix formula. The contractor's HTCP-certified Hot Mix Asphalt, Trouble Shooting, Process Control (HMA-TPC) technician or HMA-MD technician may submit a request for a JMF change according to [CMM 836](#).

453.2 Preconstruction, Start Up, and Production

CMM [CMM 836](#) provides a list of items that the QV team is responsible for obtaining before construction. Several of these items require communication with QC team personnel. In addition to these items, it is essential that a pre-pave meeting is held before paving to ensure each project is completed according to plans. General guidelines for pre-pave meetings are in [CMM 226](#). In addition to the state-wide [WS1030](#) Preconstruction Meeting Agenda, several regions have produced their own pre-pave meeting forms that should be used. Region-specific forms can be found at the WisDOT AASHTOWare Project Knowledge Base (AWPKB) website:

<https://awpkb.dot.wi.gov/Content/constr/Pantry/RegionSpecific.htm>

A department representative should be present at the QC laboratory on startup day. Procedures to follow are outlined in the quality assurance portion of [CMM 836](#). The specifications do not allow latitude in meeting the requirements due to start-up or initial mix productions.

[Standard spec 460](#) defines the quality management program that must be maintained during production. This includes QC and QV team responsibilities. CMM [CMM 836](#) goes on to describe the QV team's responsibilities during production related to sampling, testing, monitoring control charts, and documentation. This also includes instructions for trouble shooting and dispute resolution testing to use when testing results do not conform with specification limits.

453.3 Temperature of the Mix

[Standard spec 450](#) specifies the temperature at which the mixture must be prepared, stored, and delivered. Requirements for covering asphalt loads during inclement weather are also specified there.

The temperature at which HMA mixes are compacted is critical to achieving proper mat density. The amount of time available for compaction is based on several factors including:

- Mix temp.
- Layer thickness.
- Ambient air temp.
- Wind speed.
- Ground temp.

Multicool is an application, developed by the National Asphalt Paving Association (NAPA), that can determine the rate of cooling for an HMA mat during construction. It can be accessed at:

<http://www.asphaltpavement.org/multicool>

The HMA temperature determined by the contractor may need to be adjusted during construction to attain proper compaction.

Overheating can be as undesirable as under-heating. At no time should the temperature exceed the specified limits. The temperature at the paver hopper should be checked regularly. If loads appear too hot, as indicated by smoking or crackling sounds, corrective action needs to be taken.

453.4 Change in Asphalt Source

The contractor can obtain asphalt from the source or sources of their choice. The contractor can change asphalt sources as long as the source is department-approved and listed in the CSBG document.

453.5 Sampling and Testing

453.5.1 HMA Mixture

The volumetric properties of the HMA mixture determine how the mix will perform after placement. [Standard spec 460](#) and [CMM 836](#) provide requirements for mixture sampling and testing during production.

The contractor's QC program must outline sampling and testing activities and be shared with the QV team before production starts. Contractors sample mixtures at the production plant.

For non-PWL projects, the required frequency of QC testing is based on the total daily plant production. At the beginning of each day, the contractor must anticipate the quantity to be produced and inform the engineer. The frequency of sampling is then determined based on the anticipated daily plant production. The final tonnage and resulting number of tests may need to be adjusted if the actual tonnage produced each day exceeds the anticipated tonnage. The results of these quality control tests will be reported on daily control charts. In addition to quality control tests, the contractor is encouraged to conduct additional process control tests for their internal records during production.

For non-PWL projects, the minimum number of department tests is based on the total tonnage for each mix design. The QV team must witness and take immediate possession of any samples collected for department testing. Additional QV samples may be taken at the discretion of the engineer. Samples collected for the development of ignition oven correction factors are not required to be witnessed by the QV team. However, if the sample will be from plant produced material, the QV team must be notified before production so they have the opportunity to witness the sampling.

PWL projects are sampled and tested at the frequency specified in the PWL specification.

Asphalt binder samples collected during production according to [CMM 850](#) are collected by the contractor and witnessed by the QV team.

No testing is required during production for asphaltic surface placed under [standard spec 465](#).

453.5.2 HMA Density

HMA mat density is one of the most important factors when producing a durable and impermeable pavement. [Standard spec 460](#) specifies pavement density and [CMM 815](#) provides guidance for density testing. In general, projects are either tested and accepted by the QV team alone or, if a QMP density special provision is included in the contract, by QC testing verified by the QV team.

453.6 Acceptance

Under the standard spec acceptance of HMA Pavement mixtures is based on the results of the contractor's and department's random testing.

To accept HMA mixtures, the running average of 4 QC tests is compared with the control limits for aggregate gradation, AC%, air voids, and VMA. Each individual AC%, air voids, and VMA QV test is also evaluated for acceptance.

Acceptance of virgin asphaltic material is based on CSBG requirements. Asphaltic materials included in salvaged or reclaimed asphaltic pavements are accepted as a part of the asphaltic mixture.

453.7 Measurement

HMA mix is either produced one batch at a time in a batch plant or continuously in a drum mix plant. [Standard spec 450](#) provides requirements for plant scales, recording batch weights, recording truck loads, and the information required on each printed or digital record. Weigh tickets showing the net weight of each load are supplied to the engineer.

453.8 Corrective Action

[Standard spec 460](#) specifies corrective action the contractor must take based on QC test results compared with the control limits. This corrective action should be communicated to the engineer. An open line of communication between the contractor and engineer helps to minimize problems with material conformance.

453.9 Reduced Payment

The standard spec specifies reduced payment for various non-conforming items that are allowed to remain in place. The department uses the administrative items in [CMM 238](#) to reduce pay.

The running average of 4 QC tests is compared with the control limits given in [standard spec 460](#) to determine if reduced payment is necessary. Also detailed in this specification is reduced payment, and removal and replacement of unacceptable material based on QC testing data.

If a QV test result indicates material is outside the acceptable verification parameter limits specified in [standard spec 460](#), BTS will test the material in question and use BTS test data in the dispute resolution process to determine the appropriate payment factor or mix acceptability according to [CMM 836](#).

453.10 Temperature/Volume/Mass Conversions

Emulsified asphaltic materials are measured by volume in gal or by tons. The volume of asphaltic materials in storage tanks is measured and converted to volume at 60 F, or to weight, to get an accurate estimate. This conversion is calculated as specified in [standard spec 455](#). The density for the asphaltic material can be obtained from test report data required under standard spec 455.

453.11 Mixture Appearance

453.11.1 Uniformity

Mixtures should be uniform in appearance and uniform in texture.

Nonuniform appearance may be caused by:

- Improper or insufficient mixing.
- Improper proportioning of aggregate, asphalt, or salvaged material.
- Improper blending of aggregate.
- Incomplete breakdown of salvaged material.
- Slugging, masses of unmixed ingredients, in the aggregate bins or feed.
- Bad screens or bad screening procedures.

Nonuniform texture may be caused by:

- Segregation of aggregate in stockpiles, bins, or feeds.
- Improper mixing of aggregates.
- Insufficient heating, dispersion, or mixing of salvaged asphaltic pavement with virgin aggregate and virgin asphaltic material.
- Segregation in the mixer or mixer discharge.
- Nonuniform blending of aggregates.
- Slugging, masses of unmixed ingredients, in the aggregate bins or feed.
- Bad screens or bad screening procedures.

Uncoated particles may be caused by excessive moisture, coatings (clay or silt) on the aggregate that interfere with the asphalt/aggregate bond, or aggregates that bond poorly to asphalt. Increased drying time, increased washing, or using anti-stripping chemical agents, may cure these problems.

453.11.2 Color and Texture

An acceptable mix is colored dark-brown to black, all particles are well coated in asphalt with fines evenly distributed within the coarse aggregate of the mix. A classic description of an acceptable mix is "wormy and alive", indicating that the mix appears to "crawl" when agitated and the general texture of the finer portions shows a sugary appearance. A mix that appears a lighter brown in color or dead, does not have a wormy appearance when disturbed, or segregates unduly on discharge, indicates a low asphalt content or wet aggregate. Items to check include mixture proportions, aggregate gradation for excessive fines, tare of asphalt bucket, or the calibration and operation of the asphalt pump. Also, the dryer or mixture temperature, cold feed settings, and moisture content of aggregate or mixture are possible causes.

A mix too rich in asphalt shows excessive asphalt coating. Fines tend to ball up instead of being evenly distributed or appearing sugary, and on discharge the mix tends to flatten out instead of building a mound. Items to check include mixture proportioning, aggregate gradation for lack of fines, tare of asphalt bucket, or the calibration and operation of the asphalt pump and distribution line within the drum.

Temperature of the mix should be within the range allowed by the specifications. There should be no odor of burned asphalt. If there is, the contractor should reduce the temperature of the plant's asphalt heater or mixer.

453.11.3 Segregation

Segregation can be caused by accumulations in the mixer, improper use of storage hoppers, dropping mixture into a truck from too great a height, or filling the truck completely from only one position. Segregation needs to be controlled to the greatest feasible degree at the plant, since it cannot be entirely corrected later.

453.12 Asphalt Mix Problems and Causes

Figure 453-1 provides a matrix, detailing common asphalt mix problems and the possible causes.

FIGURE 453-1 General Problems and Causes in Producing Asphaltic Plant Mixes

Types of Deficiencies That May Be Encountered in Producing Hot Plant-Mix Paving Mixtures.																																	
	Aggregates Too Wet	Inadequate Bunker Separation	Aggregate Feed Gates Not Properly Set	Over-rated Dryer Capacity	Dryer set too Steep	Improper Dryer Operation	Temp. Indicator Out of Adjustment	Aggregate Temperatures Too High	Worn Out Screens	Faulty Screen Operation	Bin Overflows Not Functioning	Leaky Bins	Segregation of Aggregates in Bins	Carryover in Bins Due to Overloading Screens	Aggregate Scales Out of Adjustment	Improper Weighing	Feed of Mineral Filler Not Uniform	Insufficient Aggregates in Hot Bins	Improper Weighing Sequence	Too Much Asphalt	Faulty Distribution of Asphalt to Aggregates	Asphalt Scales Out of Adjustment	Asphalt Meter Out of Adjustment	Undersize or Oversize Batch	Mixing time not proper	Improperly Set or Worn Paddles	Faulty Dump Gate	Asphalt and Aggregate Feed Not Synchronized	Occasional Dust Shake-down in Bins	Irregular Plant Operation	Faulty Sampling		
Asphalt Content Does Not Check Job Mix Formula			A																													A	
Aggregate Gradation Does not Check Job Mix Formula			A																														A
Excessive Fines in Mix			A																														A
Uniform Temperatures Difficult to Maintain																																	
Truck Weights Do Not Check Batch Weights																																	
Free Asphalt on Mix in Truck																																	
Free Dust on Mix in Truck																																	
Large Aggregates Uncoated																																	
Mixture in Truck Not Uniform																																	
Mixture in Truck Fat on One Side																																	
Mixture Flattens in Truck																																	
Mixture Burned																																	
Mixture Too Brown or Gray																																	
Mixture Too Fat																																	
Mixture Smokes in Truck																																	
Mixture Steams in Truck																																	
Mixture Appears Dull in Truck																																	

A—Applies to Batch and Drum Mix Plants. B—Applies to Batch Plants only. C—Applies to Drum Mix Plants only.