
2 Mix Composition

Quality Control/Quality Assurance

Quality Control Plan

Quality Assurance Procedures

Materials

Design Mix Formula/Job Mix Formula

Hot Mix Asphalt

Quality Control

Pay Item

Design Mix Formula/Job Mix Formula

Miscellaneous Mix Criteria

Acceptance of Mixtures

Stone Mastic Asphalt

CHAPTER TWO:

MIX COMPOSITION

A HMA pavement is composed of binder and aggregate blended together to form various lifts of mixture. The individual material properties of each component may affect the overall performance of the pavement. If pavements are to perform long term and withstand specific traffic and loading, the materials making up the pavements are required to be of high quality.

This section covers the material requirements relating to HMA mixtures.

QUALITY CONTROL/QUALITY ASSURANCE

The Contractor is responsible for Quality Control (QC), of all phases of asphalt operations under Section **401**. This Section also includes the tolerances that are required to be met by the Contractor during the production and paving operations. To ensure that the Contractor's QC procedures provide a finished product with properties within the defined tolerances, INDOT uses Quality Assurance (QA) procedures. These procedures are designed to provide for inspection of the Contractor's QC processes and random sampling of the material placed. The QA process is completed by the testing of the mixture and core samples by District Testing personnel.

QUALITY CONTROL PLAN

The contract specific steps that the Contractor intends to use in the paving operations to ensure the construction of a quality pavement are included in the Quality Control Plan (QCP). The QCP is required to be prepared in accordance with **ITM 803** and submitted by the Contractor in accordance with Section **401.02**.

QUALITY ASSURANCE PROCEDURES

QA procedures require plate samples to be obtained from the pavement after placement by the paver. The samples are then transported to District Testing laboratory facilities for testing to determine the following volumetric properties:

- 1) Binder Content
- 2) Air Voids
- 3) Voids in Mineral Aggregate (VMA)

In addition, cores are taken to determine the in-place density of each compacted mixture.

District Testing personnel will provide QA test results for volumetric properties and density. These results will be forwarded to the PE/S and the Contractor as soon as possible after they become available.

Pavement smoothness is another parameter which requires QA review. On some contracts, longitudinal profile is measured by a profilograph. A 16 ft straightedge is used to verify the longitudinal profile for pavement segments that are exempt from profilograph measurement.

On contracts that do not include the profilograph pay item, the 16 ft straightedge is used to verify longitudinal profile of the constructed pavement.

Regardless of the instrument used to measure the longitudinal profile, a 10 ft straightedge is used to verify the slopes transverse to the mainline direction of traffic. This includes longitudinal profiles of all public road approaches and median crossovers.

MATERIALS

All QC/QA HMA mixtures are required to be produced by a certified HMA plant in accordance with **ITM 583**.

Pay Item

QC/QA HMA pay items have a standardized format that provides information about the type of material required. For example, a QC/QA HMA, 3, 70, Surface 9.5 mm pay item provides the following information:

- 1) "QC/QA HMA" represents Quality Control, Quality Assurance Hot Mix Asphalt
- 2) The "3" in the pay item reflects the ESAL category for the mixture. The ESAL category is a measure of the truck traffic that is anticipated on the roadway. There are five ESAL categories and larger numbers indicate higher anticipated truck volumes. Therefore, higher ESAL category mixtures require more durable aggregates to carry these additional anticipated loads.
- 3) The "70" in the pay item reflects the PG binder grade that is required for the mixture. Typical PG binder grades that appear in pay item descriptions include 58, 64, 70, and 76. Larger PG binder numbers indicate stiffer binders. These stiffer binders are typically required at locations subjected to higher loads or where higher pavement temperatures are anticipated. Therefore, PG 70 and PG

76 are usually used in the upper courses of the pavement and are more common in pavements in the southern portion of the state. PG 76 binders are also used in open graded mixtures to prevent draindown of the binder.

- 4) The "Surface" in the pay item indicates the mixture type. Base, intermediate, and surface courses are the types of mixtures utilized in pavement. Base courses are usually placed on treated subgrades, but occasionally may be placed on a milled existing pavement as part of a three lift, or structural overlay. Intermediate courses are typically placed on underlying base courses or on a milled pavement as part of a two lift, or functional overlay. Surface mixtures are usually placed on underlying intermediate courses or on a milled pavement surface in a preventive maintenance overlay, sometimes referred to as a mill and fill.
- 5) The "9.5 mm" in the pay item reflects the nominal aggregate size utilized in the mixture. The available nominal aggregate sizes are 4.75 mm, 9.5 mm, 12.5 mm, 19.0 mm, and 25.0 mm. Mixtures with larger nominal aggregate size designations include larger particle sizes. However, the maximum particle size in a mixture is larger than the size noted in the nominal aggregate designation (refer to Section **401.05** for gradation range information).

Recycled Asphalt Pavement

QC/QA HMA mixtures may also include recycled asphalt pavement (RAP) (Figure 2-1). There are maximum RAP amounts allowed in mixtures based on the course and ESAL category. The amount of RAP included in each mixture is identified in the Contractor's Design Mix Formula (DMF) or Job Mix Formula (JMF).



Figure 2-1. Recycled Asphalt Pavement (RAP)

Recycled Asphalt Shingles

QC/QA HMA mixtures may also include recycled asphalt shingles (RAS) (Figure 2-2) that are obtained from the waste from a shingle manufacturing or from post-consumer (tear-off) shingles. There are also maximum RAS amounts allowed in mixtures based on the course and ESAL category. The amount of RAS included in each mixture is identified in the Contractor's DMF or JMF. RAS and RAP may be used together in a HMA mixture.



Figure 2-2. Recycled Asphalt Shingles (RAS)

Dense Graded Mixtures

Dense graded mixtures are the structural component of the pavement. They consist of fine and coarse portions of the aggregate that are combined in the mixture. 4.75mm, 9.5mm, 12.5mm, 19.0mm, and 25.0mm are examples of dense graded mixtures. Section **401.05** includes the gradation limits for these mixtures.

Open Graded Mixtures

Open graded mixtures are used to drain the pavement structure and provide a means for water to reach the underdrain system, which is used in conjunction with these mixtures. OG 19.0 and OG 25.0 are the two open graded mixtures that are used. Section **401.05** includes the gradation requirements for these two mixtures.

Binder Replacement

The amount of RAP, RAS, or a combination of both that is allowed in HMA is based on the amount of binder in these recycled materials. Rather than specifying a maximum percentage of these recycled materials in the mixture, the amount of binder replacement of the virgin asphalt in the mixture is specified. The limits of the binder replacement in the mixture are specified in Section 401.06. Figure 2-3 is a graphical example of how the binder replacement requirement is applied.

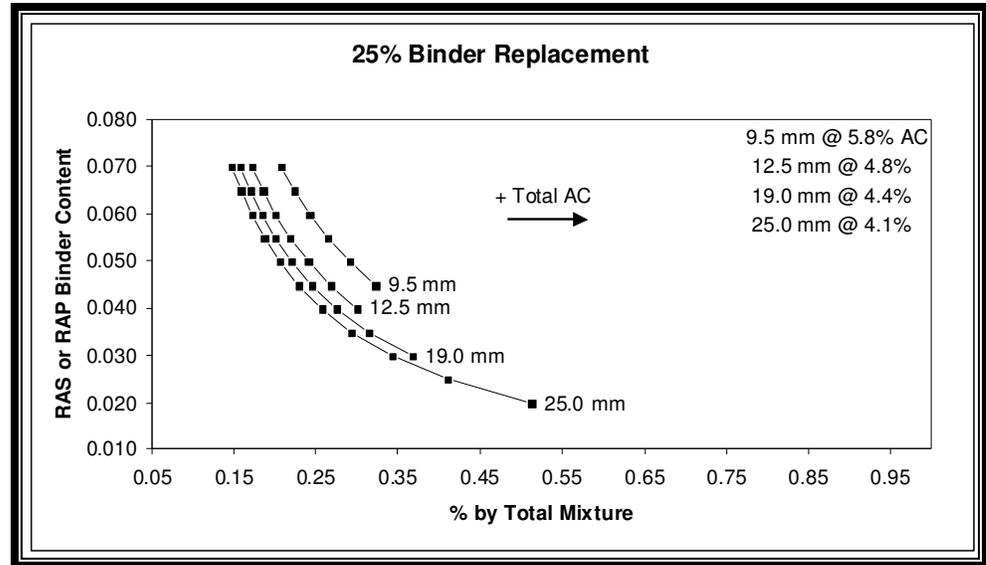


Figure 2-3. Binder Replacement

The amount of total binder replaced by binder in the recycled material is computed as follows:

$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E} \times 100 \%$$

where:

- A = RAP, % Binder Content
- B = RAP, % in Mixture
- C = RAS, % Binder Content
- D = RAS, % in Mixture
- E = Total, % Binder Content in Mixture

DESIGN MIX FORMULA/JOB MIX FORMULA

The Design Mix Formula is the format by which the Contractor submits the design for each QC/QA HMA mixture to District Testing. **ITM 583**, Certified Hot Mix Asphalt Producer Program, is the primary document that includes requirements related to the development of the DMF. The DMF includes the following information related to the mixture design:

- 1) Producer (Contractor)
- 2) Plant Location
- 3) Material Identification and Sources of the PG binder, coarse aggregates and fine aggregates
- 4) DMF number
- 5) Applicable ESAL Categories
- 6) Mixture Course and Nominal Aggregate Designation
- 7) Gradation Information
- 8) Specific Gravity
- 9) Lab and Plant Mixture Temperatures
- 10) RAP/RAS Content
- 11) Volumetric Properties
- 12) Mixture Adjustment Factor, MAF
- 13) Other Miscellaneous Design Information

Once a DMF is approved by the District Testing Engineer (DTE), the DMF is allowed an adjustment period each construction season that the design mix is used. The adjustment period is 5000 tons for base and intermediate mixtures and 3000 tons for surface mixes. During the adjustment period, the gradation and volumetric properties may be adjusted by the Contractor. At the completion of the adjustment period, all adjustments are required to be noted in the resulting JMF. The JMF is required to be submitted by the Contractor to District Testing within one working day after the test results for the mixture volumetric properties are available for the adjustment period.

If the Contractor elects to use an approved JMF from the beginning of a contract, there is no adjustment period for the approved mixture.

HOT MIX ASPHALT (HMA)

Hot Mix Asphalt (HMA) consists of base, intermediate, or surface mixtures placed in miscellaneous locations. These mixtures include rumble strips, wedge and level courses, temporary pavement, curbing mixtures, patching mixtures, and other mixtures in locations that the concepts of QC/QA acceptance are not practical. The requirements for HMA mixtures are specified in Section **402**.

QUALITY CONTROL

The QC requirements for HMA mixtures are identical to those required for QC/QA HMA mixtures. Additional information regarding QC may be found in Section **402.02**.

PAY ITEM

HMA mixture pay items include the design ESAL category for the mixture. For example, HMA Surface, Type A provides the following information:

The “Type A” portion of the pay item designates an ESAL category of 200,000. The ESAL categories range from Type A for the lowest anticipated truck traffic volumes to Type D for the pavements with the highest expected truck volumes. Unlike QC/QA HMA, HMA, mixture pay items do not include any reference to the PG binder required or a specific nominal aggregate size. Section **402.04** includes a minimum PG binder grade for each ESAL category and allows the Contractor to select the nominal aggregate size for each mixture.

DESIGN MIX FORMULA/JOB MIX FORMULA

A DMF for a QC/QA HMA mixture in accordance with Section **401** may be used for HMA in accordance with Section **402**. The source or grade of the binder may be changed; however, the high temperature grade of the binder is required to meet the requirements of Section **402.04**.

The JMF is required to be an approved JMF in accordance with Section **401.08** and be the same gyratory compaction effort category or higher.

The processing requirements for DMF/JMFs are identical to those included in Section **401** for QC/QA HMA mixes.

MISCELLANEOUS MIX CRITERIA

Section **402.07** includes the specific requirements for miscellaneous mixtures. These requirements include the type of mixture, restrictions on the aggregates, and exclusions for the MAF and RAP, depending on the type of mixture used.

ACCEPTANCE OF MIXTURES

The primary difference between HMA and QC/QA HMA mixtures is the method of acceptance. HMA mixes are accepted by a Type D Certification in accordance with Section **916**. The Frequency Manual designates the acceptance procedures for HMA mixtures in accordance with Section **402**. Because HMA mixtures are accepted by certification, no QA sampling or testing is required. The Producer is required to conduct QC Testing in accordance with the frequency designated in the Quality Control Plan for the plant (**ITM 583**) and the Quality Control Plan for the contract (**ITM 803**).

STONE MASTIC ASPHALT

Stone Mastic Asphalt (SMA) is a tough, stable, rut-resistant mixture that relies on coarse aggregate-to-coarse aggregate contact to provide strength and a rich mortar binder to provide durability. The coarse aggregate-to-coarse aggregate contact is obtained by designing with an aggregate skeleton that consists of a large percentage of very durable coarse aggregate. The mortar consists of asphalt binder, mineral filler (material passing the No. 200 sieve), and a stabilizing additive of either cellulose or mineral fibers.

The primary advantage of SMA is the expected extended life as compared to conventional dense-graded mixtures. This extended life is the result of providing better rut resistance and the potential to reduce reflection cracks. Other potential advantages are the reduction in tire splash and spray, and traffic noise.