

**SECTION M.04
BITUMINOUS CONCRETE MATERIALS**

M.04.01--Bituminous Concrete Materials: These materials shall consist of coarse aggregate, fine aggregate, mineral filler if necessary, and designated bitumen, combined to meet the composition limits by mass and other characteristics, as shown in Article M.04.03--Bituminous Concrete Mixtures.

The fraction actually retained between any two consecutive sieves shall be not less than 4 percent. Mixtures found to have characteristics requiring a bitumen content which is more or less than the bitumen range must be adjusted.

Classes 5, 5A*, and 5B* must be capable of being stockpiled and must be workable at all times. An approved, nonstripping compound shall be used in accordance with manufacturer's recommendations to give the asphalt more affinity to the aggregate.

*Mixtures containing fibers (see Article M.04.03).

1. Materials: The materials for this work shall conform to the following requirements:

(a) Coarse Aggregate: The coarse aggregate shall consist of clean, hard, tough, durable fragments of crushed stone or crushed gravel of uniform quality throughout. It shall not contain more than one percent of material such as crusher dust, sand, elongated or soft, disintegrated pieces. It shall be free of mud, dirt, organic or other injurious materials. When tested by means of the Los Angeles Machine using AASHTO Method T 96, the loss shall not exceed 40 percent.

When tested with magnesium sulphate solution for soundness, using AASHTO Method T-104, coarse aggregate shall not have a loss of more than ten percent (10%) at the end of five cycles.

(b) Fine Aggregate: The fine aggregate shall consist of natural sand or of sand prepared from stone, slag or gravel, or combinations thereof. Up to 50 percent stone screenings or slag may be used for a combined grading meeting AASHTO M 29, grading No. 1. All fine aggregates shall consist of hard, tough grains, free from injurious amounts of clay, loam, or other deleterious substances.

The fine aggregate or the blended fine aggregates shall conform to Grading No. 1 shown below (AASHTO M 29 modified):

Fine Aggregate Grading Requirements:

| Passing Sieve Size | Grading No. 1 |
|---------------------------|----------------------|
| 9.5 mm | 100 |
| 4.75 mm | 95 to 100 |
| 2.36 mm | 70 to 100 |
| 600 μm | 20 to 65 |
| 300 μm | 7 to 40 |
| 75 μm | 0 to 10 |

In addition, the fine aggregate shall consist of natural or manufactured sand, a combination of both, or a combination of the above with stone screenings or slag and shall be composed of clean, tough, rough-surfaced and angular grains.

The Director of Research and Materials reserves the right to reject material which does not conform to the requirements of Subarticle M.02.06-2 for plasticity. When screenings are blended, they shall be free from coatings of fine dust after drying.

Except where sand is mixed with stone screenings, the use of sand manufactured from stone will be permitted provided it meets all the physical requirements specified for sand for the item under which it is used; further provided the stone from which it is made shall have a loss of not more than 40 percent when tested by means of the Los Angeles Machine, using AASHTO T 96.

(c) Mineral Filler: Mineral filler shall consist of finely divided mineral matter such as rock dust including limestone dust, slag dust, hydrated lime, hydraulic cement, or other suitable mineral matter. At the time of use it shall be sufficiently dry to flow freely and essentially free from agglomerations.

Mineral filler shall conform to the requirements of AASHTO M 17.

Mineral filler shall be graded within the following limits:

| Sieve | Mass Percentage Passing |
|-------------------|--------------------------------|
| 600 μm | 100 |
| 300 μm | 95 — 100 |
| 75 μm | 70 — 100 |

(d) Bituminous Materials:

- (1) Classes 1, 2, 3, 4, 12 and 14:
The asphalt cement shall be in conformance with AASHTO MP1.
- (2) Class 5, 5A and 5B: The liquid asphalt shall be MC-250 conforming to AASHTO M 82.
- (3) Class 8: The liquid asphalt shall be MC-3000 conforming to AASHTO M 82.
- (4) The cationic emulsified asphalt shall conform to the requirements of AASHTO M 208, Grades CRS-1, CRS-2, CMS-2, CSS-1 and CSS-IH except that the settlement and demulsibility test will not be performed unless deemed necessary by the Director of Research and Materials. Tack coat materials shall be Grades CSS-1, or CSS-IH, or as approved by the Director of Research and Materials.
- (5) The emulsified asphalts shall conform to the requirements of AASHTO M 140, Grades RS-1, RS-2, MS-1, MS-2, and SS-1. Tack coat materials shall use SS-1, or SS-IH, or as approved by the Director of Research and Materials.

An adequate supply of each size aggregate mineral filler and bituminous materials shall be maintained at the bituminous concrete plant site at all times while the plant is in operation to assure the material can meet the job-mix formulas submitted. An adequate supply shall be determined on an individual plant basis dependent upon the plant's production capacity and approval of the Director of Research and Materials.

(e) Reclaimed Asphalt Pavement (RAP): This section covers the material requirements for reclaimed asphalt pavement (RAP) for use in asphalt pavement recycling:

Material Requirements: The aggregate component of the RAP shall meet the requirements of Subarticle M.04.01-1. The bitumen component of the RAP shall be asphalt cement and shall be free of significant contents of solvents, tars of other contaminating substances that will make the RAP unacceptable for recycling as determined by the Department. The RAP shall be separated according to specific pavement source by the Contractor unless otherwise permitted by the Director of Research and Materials, or his representative.

The Department will use one of the following procedures to approve the RAP quality:

(1) RAP obtained from a pavement which was constructed with asphalt cement and aggregates that meet the current requirements of Subarticle M.04.01-1. Aggregates will be approved by the Director of Research and Materials. Recycle option shall be submitted with approval request indicating:

- a. Source and location of pavement to be recycled.
- b. Type of aggregate(s)
- c. Type of bitumen
- d. Planned removal technique
- e. Estimated metric tonnage of recyclable pavement
- f. Class mix(es) to be produced with RAP.

(2) If the source of the RAP or its quality is not known, the Contractor shall submit the following to the Department at least 30 calendar days prior to the start of paving:

- a. Designated use of the RAP and approximate proportions.
- b. A 2.5 kg (minimum) sample representing the RAP to be incorporated into the recycled mixture.
- c. A 2.5 kg (minimum) sample of the aggregate extracted from the RAP for examination.
- d. The penetration (25° C. 100g. 5s) and viscosity (60° C Pascal Seconds) test results of the bituminous material recovered from the RAP.
- e. Removal Technique for obtaining RAP
- f. Estimated metric tonnage of recyclable pavement
- g. Class Mix(es) to be produced with RAP.

The Department will determine the acceptability of the RAP for the designated use. Details for sampling and testing the RAP are available from the Materials Testing Section.

Basis of Acceptance: The RAP will be accepted on the basis of one of the following:

(1) Certification from the Contractor that the RAP is from a specific pavement which was constructed with aggregates that meet current specification requirements and asphalt cement.

(2) Analysis of RAP and its components by the Contractor.

2. Sources of Supply: Approval of all bituminous concrete mixtures at the sources of supply shall be obtained prior to delivery. Samples of each shall be submitted as directed by the Director of Research and Materials.

3. Job-Mix Formula and Production Percentage of Bitumen:

(a) Job-Mix Formula: The general limits prescribed in Article M.04.03 are master ranges of tolerances to govern mixtures made from raw materials meeting specifications, and they are maximum and minimum for all cases. A closer control appropriate to the materials is required in accordance with the mix formula. Such mix formula shall show the bitumen expressed as percentage of the total mixture with the individual fractions of the aggregate expressed as percentages of the total mass of the aggregate.

For surface courses Class 1, in addition to the job-mix formula submission requirements, a 0.45 power gradation chart* shall be submitted on which is plotted the specific job-mix formula percentages passing each testing sieve.

*The 0.45-power gradation chart is a plot of the amount of material passing each test sieve in percent versus the size of the sieve mesh openings raised to the 0.45 power.

The job-mix formula shall indicate in writing the single, definite percentage for each sieve fraction of aggregate and for the bitumen chosen as the fixed mean in each instance as well as the temperature of completed mixture taken as it is dumped from the mixer and tested in accordance with AASHTO T 164 (Modified) see Note 1. The source and location of all materials shall be included with the formula. Temperature of the mix when discharged from the mixer shall be $\pm 8^{\circ}$ C from the job-mix formula.

The submission of such job-mix formula shall, upon approval of the Director of Research and Materials, thereafter bind the Contractor to furnish a mixture in conformance to the job-mix formula.

Class 1, 2, 3 (and Class 12 only when directed by the Director of Research and Materials), mixtures shall meet the Marshall criteria for voids, stability and flow when tested in accordance with AASHTO T 245 (Modified). (See Note 1). Marshall criteria is not binding for Classes 4, 5, 5A, 5B, 8 and 14.

(b) Production Percentage of Bitumen: Due to an expected loss of fines in the extraction testing procedure, the actual percentage of bitumen shown (by mass) on the batch plant ticket or the drum plant print-out may be less than the job-mix formula percentage. Accordingly, the contractor shall submit a production percentage along with the job-mix formula, in writing, for each mix class, indicating the percentage of bitumen actually added to the mix. This shall be shown as a mass on the batch plant tickets or as a percentage on the drum plant print-out.

If an additional source of supply for materials is approved, the mix formula and production percentage of bitumen shall be readjusted as necessary. Any job-mix formula or production percentage of bitumen submitted but found unacceptable shall be readjusted to the satisfaction of the Director of Research and Materials.

When required by the Director of Research and Materials, the Contractor shall make available to the Laboratory samples of the hot bins.

Mixtures which are found to have characteristics not in conformance with the limits prescribed in Article M.04.03 will be subject to rejection.

4. Approval of Job-Mix Formula and Production Percentage of Bitumen: After receiving the job-mix formula and production percentage of bitumen, in writing, the Division of Materials Testing will make a minimum of two Marshall mold specimens of bituminous concrete at the plant meeting the submitted job-mix formula and production percentage of bitumen. The Marshall molds shall meet the requirements of M.04.03.

All equipment, tests and computations shall conform to the Marshall method in accordance with AASHTO T 245 (Modified). (See Note 1). The theoretical density will be determined by AASHTO Method T 209 (Modified). (See Note 1)

If the Marshall molds meet requirements of M.04.03 the job-mix formula will be approved. If the Marshall molds do not meet all of the requirements, the job-mix formula shall be adjusted (within the ranges shown in M.04.03) until an approved mix is obtained. Contractors must demonstrate for all mixtures, the ability to meet their submitted job-mix formula and production percentage of bitumen values prior to approval.

5. Control of Mixture: Failure of the Contractor to consistently meet the job-mix formula or any other part of the specification shall be deemed sufficient cause for the Director of Research and Materials, to prohibit the use of any material from the plant. Use of material shall not be resumed until the producer has demonstrated the ability to supply an approved mix.

The Contractor may make a single job-mix formula change in writing, after the second test but prior to the third, during the production day on bituminous mixes not requiring Marshall molds. Repeated job-mix changes will result in nonapproval of the mixture. Job-mix changes may be made on mixes designed by Marshall criteria only as directed by the Director of Research and Materials. Any change in the job-mix formula greater than the following percentages shall be subject to approval by the Director of Research and Materials.

Job-Mix Formula Revision Limits

| | |
|--------------------|---------|
| 9.5 mm and larger | ± 4 % |
| 4.75 mm and 6.3 mm | ± 3 % |
| 2.36 mm | ± 3 % |
| 600 μm | ± 2 % |
| 300 μm | ± 2 % |
| 75 μm | ± 1 % |
| * Bitumen | ± 0.2 % |

*When a job-mix formula revision is made in bitumen content, the corresponding production percentage of bitumen shall be revised accordingly.

For mixtures sampled at the plant, from hauling vehicles (for all classes except 5, 5A, 5B, and 8), the viscosity of the recovered asphalt shall be no greater than 400 Pa·s at 60° C. If the value exceeds 400 Pa·s, a penetration of 50+ at 25° C will be used as an alternate acceptable value. A minimum ductility value of 75 cm at 25° C will be required.

Approved job-mix formulas from the previous operating season may be acceptable on a tentative basis at the discretion of the Director of Research and Materials, provided the following conditions have been met:

- a. There is no change in the sources of supply for the coarse or the fine aggregate.
- b. The plant operation had been consistently producing satisfactory mixes.

M.04.02--Joint Seal Material: Joint seal material shall be a rubber compound of the hot-poured type and shall conform to the requirements of AASHTO M 173.

Paper rope shall be 12.5 mm in diameter, and a type acceptable to the Engineer.

NOTE 1: Specification and Procedure Modification details are available from the Division of Materials Testing.

M.04.03—BITUMINOUS CONCRETE MIXTURES
PG XX^(k)

| | MC-250(e) | | MC-250(e) | | MC-250(e) | | MC-3000 | | | |
|--------------------------|---------------------|--------------------|--------------------|--------------------|-------------------------|-----------------|------------------------------|-------------------------------|-------------------------------|----------------------|
| | <u>Class 1</u> | <u>Class 2</u> | <u>Class 3</u> | <u>Class 4</u> | <u>Class 12</u> | <u>Class 14</u> | <u>Class 5^(f)</u> | <u>Class 5A^(f)</u> | <u>Class 5B^(f)</u> | <u>Class 8</u> |
| Pass 75 µm | 3-8 ^(b) | 3-8 ^(b) | 3-8 ^(b) | 0-5 ^(b) | 3-10 ^(b) | 1-5 | 0-2.5 | 0-2.5 | 0-2.5 | 3-10 ^(b) |
| 300 µm | 6-26 | 8-26 | 10-30 | 5-18 | 10-40 | — | — | — | — | 15-40 |
| 600 µm | 10-32 | 16-36 | 20-40 | — | 20-60 | — | 2-15 | 2-15 | 2-15 | 20-60 |
| 2.36 mm | 28-50 | 40-64 | 40-70 | 20-40 | 60-95 | 5-19 | 10-45 | 10-45 | 10-45 | 65-95 |
| 4.75 mm | 40-65 | 55-80 | 65-87 | 30-55 | 80-95 | 20-45 | 40-100 | 40-100 | 40-100 | — |
| 6.3 mm | — | — | — | — | — | — | — | — | — | 95-100 |
| 9.5 mm | 60-82 | 90-100 | 95-100 | 42-66 | 98-100 | 80-100 | 100 | 100 | 100 | 100 |
| 12.5 mm | 70-100 | 100 | 100 | — | 100 | 95-100 | — | — | — | — |
| 19.0 mm | 90-100 | — | — | 60-80 | — | 100 | — | — | — | — |
| 25.0 mm | 100 | — | — | — | — | — | — | — | — | — |
| 50 mm | — | — | — | 100 | — | — | — | — | — | — |
| Bitumen % ^(g) | 5-6.5 | 5-8 | 6.5-9 | 4-6 | 7.5-10 | 5.5-7.5 | 6.0-7.5 | 6.0-7.5 ⁽ⁱ⁾ | 6.0-7.5 ⁽ⁱ⁾ | 7-10 |
| " Temp/°C | 163 Max. | 163 Max. | 163 Max. | 163 Max. | 163 Max. | 163 Max. | 60-85 | 60-85 | 60-85 | 66-93 |
| Temp of Mix/°C | 129-163 | 129-163 | 129-163 | 129-163 | 135-163 ^{(a)*} | 107-121 | 49-79 | 49-79 | 49-79 | 135-163 [†] |
| Aggregate Temp/°C | 138-177 | 138-177 | 138-177 | 138-177 | 138-177 | — | 38-79 | 38-79 | 38-79 | 138-177 |
| Voids | 3-6 ^(b) | 2-5 ^(c) | 0-4 | — | 0-5 ^(b) | — | — | — | — | — |
| Stab. N. Min. | 5300 ^(d) | 4500 | 4500 | — | 4500 | — | — | — | — | — |
| Flow (mm) | 2-4 | 2-4 | 2-5 | — | 2-4 | — | — | — | — | — |
| VMA % Min. | 15(1) 16(2) | | | | | | | | | |

* 149 °C minimum after October 1

(1) Mixture with 5% or more aggregate retained on 19 mm sieve

(2) Mixtures finer than condition (1) above

(a) Or recommended by membrane manufacturer

(b) 75 blows (Marshall criteria)

(c) 3-6% when used for a roadway wearing surface

(d) For 4 or more lane divided roadways, a stability of 6600 N is required.

(e) Contains an approved non-stripping compound

(f) To help prevent stripping, the mixed material will be stockpiled on a paved surface and at a height not greater than 1.5 m during the first 48 hours.

(g) All producers will add at least the minimum allowable percentage of bitumen to the mixes.

(h) The percentage of 75 µm mesh material shall not exceed the percent of bitumen as determined by extraction tests (AASHTOT-164 (Modified)), See Note 1.

(i) Polypropylene Fibers 9.5 -12.5 mm polypropylene fibers added at the minimum rate of 3 kg of fiber per metric ton mix. Fibers will be approved by the Director of Research and Materials..

(j) Polyester Fibers — 6.3 mm polyester fibers added at the rate of 1.25 kg of fiber per metric ton mix. Fibers will be approved by the Director of Research and Materials.

(k) As required by JMF for project.