SECTION 19
HOT MIXES USING ASPHALT EMULSIONS

19.1 Scope

This performance guide covers the preparation and use of hot mixed, hot laid asphalt emulsion mixtures for base, binder, and surface courses.

19.2 Applicable Documents

19.2.1 ASTM Documents:

- C127 Test for Specific Gravity and Absorption of Coarse Aggregate
- C128 Test for Specific Gravity and Absorption of fine Aggregate
- C131 Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine
- C136 Method for Sieve Analysis of fine and Coarse Aggregates
- D75 Practice for Sampling of Aggregates
- D140 Practice for Sampling Bituminous Materials
- D242 Specification for Mineral filler for Bituminous Paving Mixtures
- D244 Standard Methods of Testing Emulsified Asphalts
- D423 Test Method for Liquid Limit of Soils
- D424 Test Method for Plastic Limit and Plasticity Index of Soils
- D546 Test Method for Sieve Analysis of Mineral filler for Road and Paving Materials
- D692 Specification for Coarse Aggregate for Bituminous Paving Mixtures
- D977 Specification for Emulsified Asphalt
- D979 Practice for Sampling Bituminous Paving Mixtures
- D1073 Specification for fine Aggregate for Bituminous Paving Mixtures
- D2172 Test for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
- D2419 Test Method for Sand Equivalent Values of Soils and fine Aggregate
- D2489 Test Method for Degree of Particle Coating of Bituminous-Aggregate Mixtures
- D3203 Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
- D3515 Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
- D3628 Practice for Selection and Use of Asphalt Emulsion

19.2.2 AEMA Documents

- **A Basic Asphalt Emulstion Manual**

19.3 Descriptions

This guide describes base, binder, and surface mixture types mixed and placed hot using asphalt emulsion. It is intended to be descriptive only, and to present types of construction which have been in use for many years but which have not been promoted outside of limited areas.

Basic concepts supporting the use of asphalt emulsion in warm mixtures are twofold. Both are dependent upon the use of asphalt emulsions properly formulated to meet the objectives. First, by this means it is possible to coat readily large size and very open-graded coarse aggregate with thick films of asphalt. This is difficult to accomplish in the conventional hot mix process using asphalt cements. Second, by this means asphalt is incorporated with the aggregate, irrespective of whether the mix is an open or dense-graded one that has improved characteristics of greater toughness and less temperature susceptibility than would normally be the case.

There are additional benefits that accrue in the use of mixtures of this type. More thorough mixing is achieved because initial distribution of the asphalt occurs while the asphalt is emulsified and in a highly dispersed state. Any fines present are individually coated in this stage. The process significantly reduces asphalt hardening when compared to the conventional hot mix process because of the water vapor generated which effectively excludes air and allows lower mixing temperatures.

19.4 Asphalt Emulsions

Asphalt emulsion for warm mixes would conform to the following ASTM specifications:

- D977 HFMS-2h, MS-2h, HFMS-2, MS-2, HFMS-2 D2397 CMS-2h, CMS-2

When specifically approved by the purchaser, other types of asphalt emulsion may be used, if experience has proven that satisfactory performance will result.

19.5 Aggregate

The aggregates should conform to the quality requirements of ASTM, MSHTO, state and local highway specifications. Other mineral aggregates, such as uncrushed gravel and crushed shell may be specified provided that local experience or tests have demonstrated their ability to produce satisfactory warm asphalt emulsion paving mixtures.

Recommended grading requirements for coarse and fine aggregates are found in ASTM D448 and D1073, respectively. Other aggregate gradations may be used, provided that the combined coarse and fine aggregates, and filler, when used, produce a mixture that conforms to the requirements for grading of total aggregate.

NOTE

Other gradations may be specified, provided that local experience or tests have demonstrated their ability to produce satisfactory warm asphalt emulsion mixtures.

19.6 Mineral Filler

The mineral filler, if any, should conform to the quality requirements of ASTM D243 or to similar specifications of MSHTO, state or local highway departments.

19.7 Design Considerations

19.7.1 Subgrade

Whether it is new construction or a resurfacing operation, the performance of the pavement is affected by the characteristics of the subgrade. Desirable properties that the subgrade should possess include strength, drainage, ease of compaction, permanency of compaction, and permanency of strength. In a resurfacing operation, any existing surface irregularities which can be traced to a subgrade problem should be corrected.

19.7.2 Subbase

The subbase, along with the base, helps spread the load which is applied to the surface. This is to minimize subgrade deformation which can lead to pavement failure. Subbases should consist of select materials such as natural gravels that are stable and drainable, but have characteristics which make them not completely suitable as base courses.

19.7.3 Base

The base course may be placed on the subbase or upon the old asphalt or unpaved surface. It is suggested the base be made up of a suitably graded crushed stone, gravel, or slag. These aggregates can be mixed warm with asphalt emulsion to provide a suitable base.

19.7.4 Binder

The binder course, if used, is a transitional layer between the base course and the surface course. Warm asphalt emulsion mixtures may be used for this lift.

19.7.5 Surface

The surface course must possess skid resistance, resist load and non-load associated fracture and resist permanent deformation. A warm asphalt emulsion mixture of a gradation listed in ASTM D3515, Table 3 may be used as a surface mixture.

NOTE

The aforementioned pavement layers should, prior to constructing, be designed to meet the standards as specified by ASTM, MSHTO, state, or local highway authorities.

19.8 Composition of Paving Mixtures

ASTM D3515, Table 3 lists the mix compositions required for warm asphalt emulsion mixtures. Warm asphalt emulsion mixtures should also conform to these composition limits. In addition, laboratory testing should be performed prior to construction. This

testing should include optimum asphalt determinations and mix stability studies, as well as aggregate coating and water resistance tests.

NOTE

The nominal top size aggregate (mix designation) selected should be determined by the intended use, thickness of paving courses, and desired texture. The required mix should be specified.

These aggregate compositions are based on the use of fine and coarse aggregates having approximately the same bulk specific gravities; grading of the total aggregate, therefore, would be the same on either a weight or bulk volume basis. If the bulk specific gravities of coarse and fine aggregates differ greatly, it may be desirable to change the grading limitations to compensate for these differences.

A job mixture shall be selected so that it comes within the specification limits and is suitable for the traffic, climate conditions, and specific gravities of the aggregates used.

Any variation, from the job mix formula, in the grading of the aggregate, as shown by the sieve analyses of materials in the plant or, any variation from the job mix formula in the asphalt content, as indicated by extraction tests of the finished mixture, greater than the percentage shown in ASTM D3515, Table 3, shall be investigated, and the conditions causing such variation shall be corrected.

19.9 Mixing Plant

The mixing plant may be any approved type of equipment of the batch or continuous type which provides for a drum type dryer and pugmill mixer.

- A combination dryer and mixer (drum mixer) in which the asphalt emulsion and aggregate are heated together by the direct application of heated gases from a burner may also be used. On batch plants the pug mill mixer chamber shall be vented to allow the escape of steam.
- The discharge end of the asphalt emulsion circulating pipe should be kept below the surface of the asphalt emulsion in the storage tank to prevent foaming and air entrainment.
- Provisions should be made in the asphalt transfer system that will enable the operator to turn off or reduce the heat media from all lines, pumps, and jacketed asphalt material buckets as soon as the system is open and circulating properly.
- Care should be taken to avoid overheating the emulsion in the lines, pumps, and tank.
- Approved storage silos for the hot asphalt emulsion mixture may be employed.

19.10 Mixing Plant Operation

19.10.1 Aggregate Storage

Aggregates furnished in different sizes or from different sources shall be kept separate, and adequate provision shall be made to keep them from becoming mixed or otherwise contaminated.

Stockpiles shall be built and the materials removed there from in such a manner as to minimize size segregation.

19.10.2 Storage & Handling of Asphalt Emulsion

The asphalt emulsion shall be maintained at a temperature at which it can be properly handled through the pumping system and uniformly distributed through the mixture. At no time during the processing, from storage to mixing, will the temperature of the asphalt emulsion be allowed to exceed 85° C (185° F).

19.10.3 Preparation and Handling of Mineral Aggregates

Each size aggregate shall be separately fed by feeders to the cold elevator or elevators in proper proportion and at a rate to permit correct and uniform temperature control of the heating and drying operation.

19.11 Mix and Temperature

- The aggregate shall be dried and delivered to the mixer at a temperature such that the asphalt emulsion mixture will be produced at a temperature within the range of 66 to 127° C (220 to 260° F).
- Minimum mixing time may be established on the percentage of coated particles as determined by ASTM D2489 Test for Degree of Particle Coating of Bituminous-Aggregate Mixtures.
- The minimum values for percentage of coated particles used to establish the minimum mixing time should be set by the engineer. These values will vary with aggregate gradation, particle shape and surface texture, and with the asphalt content and use for which the mixture is intended.

19.12 Construction

19.12.1 Spreading

The asphalt emulsion hot mix should be spread by the use of a self propelled spreading and finishing machine that will finish the surface to the line, grade, and cross-section shown on the plans. No mechanical spreader should be permitted that fails to provide an even surface of uniform texture; nor should it be operated at a speed that fails to allow proper screed action. All patches and areas of fine or under sized aggregate appearing in this course should be removed and replaced with properly combined mix. Each succeeding course should be varied in thickness to take up any unevenness of the previous layer and be compacted.

19.12.2 Compaction

As soon as the asphalt emulsion warm mix has become sufficiently hard to bear the weight of the roller, without shoving, it should be rolled with a self propelled pneumatic, three-wheeled, or vibratory roller; followed by a tandem roller. These rollers should compact the pavement sufficiently to provide not less than 95% of laboratory density as determined by the Engineer.

19.13 Methods of Sampling and Testing

Sample all material and determine the properties enumerated in this guide in accordance with ASTM methods.