Chapter 2B

Design and Control of Stone Matrix Asphalt (SMA) Mixtures

1. General Scope

The Department has established procedures for the design and control of Stone Matrix Asphalt (SMA). SMA is a hot-mix asphalt consisting of two parts, a coarse aggregate skeleton and a rich asphalt binder mortar. The mortar is a mixture of asphalt binder, mineral filler and a stabilizing additive. SMA mixtures must have an aggregate skeleton with coarse aggregate-on-coarse aggregate contact, generally referred to as stone-on-stone contact. Much of the design and control of SMA is consistent with the procedures for Superpave outlined in Chapter 2A, but there are some differences as well. The purpose of these procedures discussed in Chapter 2B is to provide guidance for the design and use of Stone Matrix Asphalt for Department work.

The Department will follow the Stone Matrix Asphalt mix design procedure and specifications contained in the AASHTO R 46, Standard Practice for Designing Stone Matrix Asphalt (SMA) and the AASHTO M 325 Standard Specification for Stone Matrix Asphalt (SMA) except as revised herein. All AASHTO standard practices, specifications and test procedures are implied to reference the most current approved and published version available at the time of bid letting.

2. Department Revisions to AASHTO R 46 – Standard Practice for Designing Stone Matrix Asphalt (SMA)

AASHTO R 46, Section 3. Terminology

Revise Section 3 by adding a new Subsection as follows:

3.8 Design Number of Gyrations (N_{des}) – The number of gyrations which, when applied to the design mixture specimens, results in 3.5 – 4.0 percent air voids and determines the asphalt content.

AASHTO R 46, Section 4. Summary of the Practice

Revise Subsection 4.2 as follows:

Replace the fourth sentence with “Where no previous history is available, it is recommended that an initial trial asphalt binder content be selected according to Table C of Publication 408, Section 419.”

Revise Subsection 4.3 as follows:

Delete Note 2. Mixes must meet the minimum asphalt content requirements of Table C in Publication 408, Section 419.
Revise Section 4 by adding a new Subsection as follows:

4.6 Review of Job-Mix Formula (JMF) – The contractor will be solely responsible to design a mix that meets all Department requirements. The contractor shall submit the required test results, the composition of the mixture and the combined aggregate gradation curves proposed for use in the production of the mixture to the District Materials Manager/Materials Engineer (DMM/DME) for review at least three weeks prior to the scheduled start of work. Submit mix designs to the DME/DMM for review following the procedures outlined in Appendix J. The acceptability of the bituminous concrete produced from any mix design is determined as specified in Publication 408, Section 419 in addition to the criteria specified herein.

Whenever the Contractor’s gradations and calculations do not check, the DMM/DME will request the Contractor to do additional testing and/or recalculate and submit the correct mathematical solutions. The DMM/DME may request, at his option, to observe testing of the trial mix. He may also request that materials be submitted to the Materials and Testing Division (MTD) for the evaluation of the mix. The Department reserves the right to review any design through plant production, prior to using for Department work, at no additional cost to the Department. See Bulletin 27, Chapter 2A and the revisions for AASHTO M 323, Section 7 for the procedure on the statistical evaluation of a JMF through plant production and replace the references to Publication 408, Section 419 with equivalent values from Section 419.

AASHTO R 46, Section 6. Selection of Trial Gradations

Revise Subsection 6.1 as follows:

Replace both references to M 325 for gradation with the gradation ranges as specified in Table B of Publication 408, Section 419.

AASHTO R 46, Section 7. Selection of Trial Binder Content

Revise Subsection 7.1 completely as follows:

A binder content should be selected according to Table C of Publication 408, Section 419.

AASHTO R 46, Section 9. Selection of Desired Gradation

Revise Subsection 9.1 as follows:

Replace reference to AASHTO T 166 with PTM No. 715, typical throughout
AASHTO R 46, Section 10. Selection of Optimum Binder Content

Revise Subsections 10.1 and 10.2 as follows:

Replace AASHTO M 325 criteria with that outlined in Tables B and C of Publication 408, Section 419.

AASHTO R 46, Section 11. Moisture Susceptibility

Revise Section 11 by adding a Note as follows:

Note 7 - It has been shown that the chemical composition of asphalt binders, aggregates and any mixture additives can have a strong influence on the results obtained from these testing procedures. Therefore, it is recommended that the sources of materials (binder and additives) used in the design process be the same as the materials that will be incorporated in the mixture during production. If either of these components change at the time of production, the actual production mixture must be verified by retesting, initially with ASTM D 3625 (Boiling Water Test) as a screening test. Otherwise, the design testing may not be representative.

Revise Subsection 11.1 completely as follows:

11.1 Prepare at least six mixture specimens (half to be tested dry and the other half to be tested after partial saturation and freeze-thaw conditioning) composed of the design aggregate structure at the design binder content. Condition the mixtures in accordance with the revised mixture conditioning for volumetric mixture design and production quality control testing time (Appendix I herein) plus an additional 2 hours. After conditioning, compact the specimens to 6 ± 1.0 percent air voids in accordance with T 312 to the number of gyrations specified in Pub. 408, Section 419, Table B.

11.2 Test the specimens within 24 hours of completion of T 312 in accordance with T 283, starting with Section 9.6 of the procedure with the following exceptions:

(a) Revise T 283, Section 10.3.1 vacuum application time to apply a vacuum of 254 mm (10 in.) mercury partial pressure for 30 minutes to the conditioned specimens, regardless of air voids and percent final saturation. (See Note 8)

(b) Delete T 283, Sections 10.3.5 and 10.3.6

Note 8 – The following table explains the proper vacuum settings and readings.

<table>
<thead>
<tr>
<th>Vacuum Gauge Type</th>
<th>Measurement Scale</th>
<th>Vacuum Reading with No Vacuum Applied</th>
<th>Vacuum Reading with Proper Vacuum Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial</td>
<td>Inches of Mercury</td>
<td>0 (Zero)</td>
<td>10</td>
</tr>
<tr>
<td>Partial</td>
<td>mm of Mercury</td>
<td>0 (Zero)</td>
<td>254</td>
</tr>
<tr>
<td>Absolute</td>
<td>Inches of Mercury</td>
<td>Approximately 29.9</td>
<td>19.9</td>
</tr>
<tr>
<td>Absolute</td>
<td>mm of Mercury</td>
<td>Approximately 760</td>
<td>506</td>
</tr>
</tbody>
</table>
Calculate the average ($\bar{x}$) and standard deviation (s) of tensile strengths for both the dry group of specimens and the freeze-thaw group. Calculate the Coefficient of Variation (C.V.) for each group by dividing the standard deviation by the average:

$$\text{C.V.} = \frac{s}{\bar{x}} \, (\%)$$

If the C.V. is greater than 12% for the dry group, or 24% for the freeze-thaw group, the test results should be viewed as suspect and a new subset of specimens prepared and tested.

If only one of the results is suspect and analysis according to PTM No. 4 identifies that result as an outlier, a replacement is initially only required for that specimen. If the C.V. considering the replacement specimen in place of the outlier is still greater than the acceptable limit, prepare and test an entire subset of new specimens. Each group of specimens, dry or freeze-thaw, is defined as a subset.

11.3 If the average dry strength is less than 80 psi (552 kPa) or the average wet/freeze strength is less than 50 psi (345 kPa), the mix is unacceptable.

11.4 The design shall meet the tensile strength ratio (TSR) requirement listed in AASHTO M 325, Section 9.3

11.5 If visual stripping of the asphalt film is observed from the T 283 specimens and estimated to be 5% or greater of the specimen face area, further evaluate moisture susceptibility by performing test procedure ASTM D 3625 (Boiling Water Test). (Uncoated areas due to fractured aggregate should not be recorded as stripped). When asphalt binder coating is less than 95%, as determined by ASTM D 3625, retest the mixture according to AASHTO T 283 as outlined above. All collected specimens and test data should be carefully reviewed prior to determining acceptability. If there is any doubt concerning the mixture’s susceptibility, the recommended approach is to consider the mix moisture susceptible.