National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

Bulk Specific Gravity Round Robin Using the Corelok Vacuum-Sealing Device

RESEARCH SYNOPSIS–NCAT REPORT 02-11

Problem Statement

Proper measurement of the bulk specific gravity (G_{mb}) of compacted hot-mix asphalt (HMA) samples is essential to mix design and quality assurance. For decades, G_{mb} has been measured by the water-displacement approach outlined in AASHTO T166 or ASTM D2726. However, for specimens with water-permeable interconnected air voids, this approach yields inaccurate results. This issue has become a greater problem with increased use of coarse Superpave gradations and stone matrix asphalt (SMA). These mixes have a higher volume of interconnected air voids than fine gradations. Past research indicated that the Corelok vacuum-sealing device may provide a better measure of internal air void contents of coarse-graded mixes. However, before the Corelok device could be specified, the repeatability and reproducibility of the procedure needed to be evaluated.

Objective

The primary objectives of this study were to 1) evaluate the repeatability and reproducibility of test results from both the Corelok and water-displacement methods and 2) further evaluate the ability of the Corelok device to accurately determine the G_{mb} of compacted HMA.

Description of Study

Eighteen laboratories participated in this round -robin study to determine G_{mb} of compacted HMA mixes using the Corelok vacuum-sealing device and the SSD method, AASHTO T 166. All samples were prepared (including compaction) by NCAT and were provided to each participating laboratory for testing. Test results were returned to NCAT for statistical analysis and determination of the repeatability and reproducibility of both methods.

Each laboratory received 27 samples, which included three mix types: coarse- and fine-graded Superpave and SMA. To provide a range of air void contents, three compaction levels were included for each mix type: low (15 gyrations), medium (50 gyrations), and high (100 gyrations). A low water absorption (0.6 percent) granite aggregate was used to fabricate the mixes. A total of 567 samples were tested in this study. This equated to 1,134 tests since both the Corelok and AASHTO T166 methods were performed on each sample.

Key Findings

Analysis of the round-robin data indicates that the Corelok procedure is slightly more variable than AASHTO T166. However, the participating laboratories had less experience with the Corelok procedure. An outlier analysis confirmed that some laboratories produced more erroneous results (outliers) with the Corelok procedure. When the outliers were removed from the dataset and the data was corrected for sample production variability, there was not a significant difference between the variability of the Corelok method and AASHTO T166 in six of nine cases. In the other three cases, AASHTO T166 was less variable. Further, the variability of the Corelok method appears to be less sensitive to changes in air void contents than AASHTO T166.

Figure 1 Sealed HMA sample following the Corelok procedure.

Based on this study, the recommended precision statement for the Corelok method is as follows: "The single-operator standard deviation has been found to be 0.0124. Therefore, results of two properly conducted tests by the same operator on the same material should not differ by more than 0.035. The multilaboratory standard deviation has been found to be 0.0135. Therefore, results from two properly conducted tests from two different laboratories on samples of the same material should not differ by more than 0.038."

It was suggested that the Corelok procedure is a better measure of sample density, particularly for specimens with higher air void contents. The AASHTO T166 and Corelok results were significantly different for mixes that had gradations passing below the restricted zone. The difference between the AASHTO T166 and Corelok results was not constant and varied with both changes in mix type (gradation) and air void content (gyrations). Comparisons with uncorrected gyratory densities suggest that the Corelok procedure does not overestimate G_{mb} at high air void levels in the same manner that AASHTO T166 does. Analysis of results from the AASHTO T166 and Corelok methods

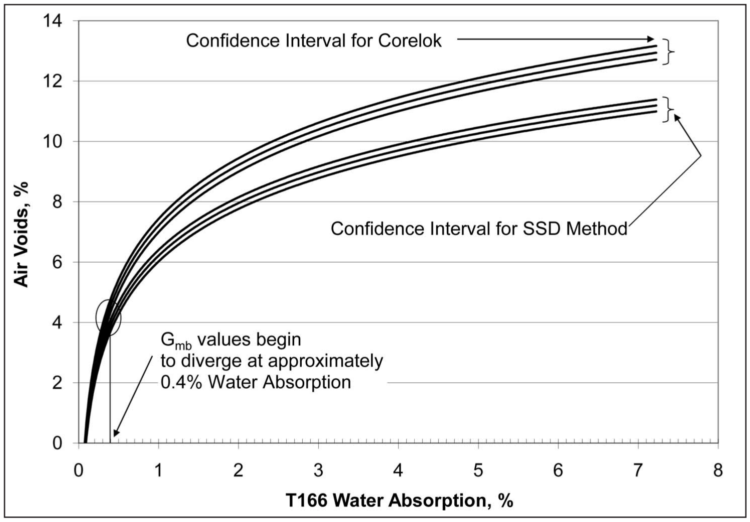

Figure 2 Divergence in air voids for the two methods: Corelok and water displacement.

indicates that G_{mb} measurements diverge when the water absorption exceeds 0.4 percent. Since it is expected that a significant portion of coarse gradations and SMA samples would exceed 0.4 percent water absorption, the Corelok method should be used to determine G_{mb} for design and quality control gyratory samples with gradations below the restricted zone. However, this conclusion is for laboratory-compacted samples only. No inferences were made in the report with regard to roadway core samples.

Recommendations for Implementation

The study found that the Corelok procedure is a viable method for determining the bulk specific gravity of compacted hot-mix asphalt. For mixes below the restricted zone, it is recommended that the Corelok method be used when water absorption values exceed 0.4 percent by volume. This suggests that the Corelok method will be the method of choice for determining the bulk specific gravity of mixtures below the restricted zone. For fine-graded mixtures, AASHTO T166 may be used when water absorption is less than 2.0 percent. This matches current criteria within AASHTO T166.

Suggested Further Research

Several aspects of the Corelok test method were identified as possible ways to reduce the variability of the method. The following factors should be evaluated through a ruggedness study:

- Corelok bag thickness
- Volume of water infiltrating the bag
- Sample temperature
- Time samples are left sealed prior to testing

In addition, research could be conducted to define coarse- and fine-graded mixtures based upon the interconnectivity of air void structures within HMA mixes, which directly related to the amount of absorbed water within a sample when testing with AASHTO T166 or ASTM D2726.

Acknowledgements and Disclaimer

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