National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Effects of Re-heating and Compaction Temperature on Hot-Mix Asphalt Volumetrics

RESEARCH SYNOPSIS–NCAT REPORT 01-04

Problem Statement

In the hot-mix asphalt (HMA) construction industry, the air void content (Va), voids in mineral aggregate (VMA) and voids filled with asphalt (VFA) of compacted asphalt specimens, collectively known as volumetric properties, are used in mix design and acceptance testing for specification compliance and pay-factor determination.

Discrepancies in volumetric properties between two labs may be partially related to re-heating of mixture samples that have cooled below laboratory compaction temperatures. Differences in the compaction temperature labs use could also cause variation in results.

Objective

The objectives of this study were to evaluate the effects of both re-heating and compaction temperature on volumetric properties of HMA mixtures.

Description of Study

The laboratory study included eight different mixtures. The mixtures included two aggregate sources, two gradations and two grades of asphalt binder. The aggregate sources differed in moisture absorption percentages—one high (sandstone) and one low (granite). The two gradations were a coarse-graded and fine-graded Superpave. The two grades of asphalt binder were a PG 64-22 and a PG 76-22.

For the primary experiment, three storage times (zero, three and 20 hours) were used. Storage time refers to the additional time a mixture was allowed to sit at room temperature (about 25°C) after an initial four-hour aging. Zero storage time means that no cooling time was allowed between aging and heating-to-compaction temperature. These samples represent samples that are typically quartered and tested immediately after sampling. The three-hour samples represent samples that are transported to another laboratory before quartering and testing. The 20-hour samples might represent referee or verification samples that may be tested after several days of storage. The effect of storage time was studied by compacting three replicate samples for G_{mb} and splitting two replicate samples for G_{mm} at three different storage times.

Figure 1 An NCAT lab technician prepares to compact a sample using a Superpave gyratory compactor (SGC).

For the secondary experiment, the effect of compaction temperature was studied by compacting three replicate samples for G_{mb} and splitting two replicate samples for G_{mm} at three different compaction temperatures. The temperatures used in this phase of the study were the standard compaction temperature for the specific asphalt grade being tested and the standard compaction temperature ±14°C. These temperatures were 135, 149 and 163°C for the PG 64-22 binder, and 149, 163 and 177°C for the PG 76-22 binder. This range in temperatures was selected to simulate compaction temperatures that were too high and too low.

Key Findings

Within the limits imposed in this study (three- and 20-hour storage times plus re-heating), storage time plus re-heating did not significantly affect the volumetric properties of samples compacted with 100 gyrations of the Superpave gyratory compactor.

The results also showed that increasing or decreasing the compaction temperature by 14°C also had no effect on volumetric properties. Other studies have shown similar results.

Mixes at lower temperatures are compacted with a higher compaction effort since the strain is the same and the force is higher.

It is believed that re-heating and modifying the compaction temperature had no significant effect because the Superpave gyratory compactor is a constant strain compactor. The gyration angle is set at 1.25° and maintains this angle during the compaction process regardless of mix

stiffness. As the mix gets stiffer, the force required to achieve the 1.25° angle is simply increased. In effect, mixes at lower temperatures are compacted with a higher compaction effort since the strain is the same and the force is higher.

Recommendations for Implementation

Tests of volumetric properties for acceptance of field-produced HMA may occur at the project or plant site, or at remote laboratories after being transported. Mix samples that have cooled should be re-heated to the compaction temperature. Based on the results of this study, re-heating should not have an effect on the volumetric properties.

A standard procedure for re-heating samples should be developed. If samples are not controlled carefully during re-heating, they could either be overheated or held at an elevated temperature longer than necessary. Either of these situations could affect the final mixture properties. If no standard procedure is followed for re-heating or for selecting compaction temperature, there is a higher chance that discrepancies will occur between contractor and agency test results.

Acknowledgements and Disclaimer

The research reported herein was performed by the National Center for Asphalt Technology, Auburn University. This research synopsis provides a brief summary of the study's final publication. This document is for general guidance and reference purposes only. NCAT, Auburn University and the listed sponsoring agencies assume no liability for the contents or their use.