Florida Department of Transportation
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EVALUATION OF SUPERPAVE MIX DESIGN FOR RICE DENSITY EFFECTS

PROBLEM STATEMENT

The SuperPave^{TM} mixture design procedure that evolved from the Strategic Highway Research Prograrn (SHRP) is completely dependent upon a mixture's volumetric properties (i.e., air void content and volume of mineral voids). Although the volumetric criteria for design is always the same (i.e., percent G_{mm} at N_{ini}, N_{des}, and N_{max}) the number of gyrations required to achieve N_{ini}, N_{des}, and N_{max} (gyration levels: initial, design, and maximum) are specified according to categories of Equivalent Single Axle Loads (ESALs) and average design high pavement temperature. Consequently, lower levels of compaction and/or the use of coarse-graded aggregate blends produce mixtures with greater permeability, making the determination of volumetric properties more difficult, particularly when compared to cores cut from the pavement. Conceptually, it would be better to use a high number of gyrations to achieve high density and to minimize bulk density/volumetric density differences at N_{max} , thereby improving the reliability of volumetric computations of N_{ini} and N_{des}.

The main difficulty achieving reliable volumetric parameters is related to the accuracy of individual test measurement of bulk specific gravity (G_{sb}) of the aggregate blend, maximum specific gravity (G_{mm}) of the mix and the amount of absorption and adsorption of asphalt into the aggregate, which is dependent upon asphalt viscosity, mix temperature, and storage/aging time prior to compaction and cooling. Also, moisture retained in the aggregate during hot mix production can alter the amount of asphalt absorption and, if excessive, produce flushing and fat spots in the pavement.

OBJECTIVES

The intent of this research was to evaluate current testing procedures and calculation methods used to determine density and volumetrics of asphalt mixtures to identify those factors that contribute to differences in air void (Va) and volume of mineral voids (VMA), and to develop/recommend procedural changes to improve the reliability of test results. Specific objectives included:

1. Evaluating the differences in asphalt absorption, maximum theoretical density (G_{mm}) using the Rice test, and volumetric properties of mixtures using the SuperPave^{TM} testing protocol.
2. Comparing the maximum theoretical density computed using the impregnated specific gravity (ISG) of the aggregate for comparison with G_{mm} and effective specific gravity (G_{se})from the Rice density tests.
3. Determining the influence of hot mix asphalt (HMA) storage time (short term aging) on asphalt absorption and G_{mm} values.
4. Identifying the effect of changes in test methods and/or computational procedures that will improve the reliablity of density, Va and VMA parameters.

FINDINGS AND CONCLUSIONS

The following are among the several conclusions that were drawn:

G_{mm} and G_{se} by Rice Test : The results of this research indicated that G_{mm} values obtained from the Rice test using 2000 ml flasks, 30 mm mercury vacuum, and shaking for 15 minutes at 270 cpm were influenced by sample size, asphalt content/absorption, degree of aging, amount and type of wetting agent, amount of water covering the sample, and tilting of the shaker. All problems in obtaining precise and/or accurate G_{mm} values had in common difficulty removing the air from the sample, resulting from insufficient container size to (1) properly distribute the loose asphalt mixture at minimal layer thickness, and (2) achieve good agitation. Mixtures tended to stick together in the lower portion of the flask, particularly at higher asphalt contents. This problem occurred even though great care was taken to continuously stir and break down the mix after oven aging, followed by further separation of coated particles by hand. Specific conclusions and observations relating to the effect of testing conditions and materials on G_{mm} and computed G_{se} values are as follows:

- Smaller sample sizes (600 and 750 grams) consistently gave the highest mean G_{mm} values, while 900 gram samples produced considerably lower G_{mm} values and better precision (lower std. dev.). Larger samples (e.g., 1200 and 1500 grams) gave poor precision and low G_{mm}.
- Asphalt absorption has a substantial affect on G_{mm} and G_{se} values when mixtures contain highly absorptive aggregate. Longer aging times increase asphalt absorption. Statistical analysis proved that G_{mm} values were significantly different according to asphalt content and aging times of 30 minutes and 4 hours. G_{se} values were not significantly different for different asphalt contents, which indicates that the amount of absorption was the same for the different asphalt contents used in this study. However, G_{se} was significantly different for the two aging times. Consequently, differences in Rice density could occur because of absorption/time effects associated with points of sampling, as in HMA production, hot-mix storage, transportation, and paving.
- G_{mm} values were greater as the depth of water/wetting agent covering the sample increased when using 30 mm Hg vacuum (atmospheric). A linear relationship between G_{mm} and the ratio of weight of water to weight of asphalt mix sample was established. Again, even though the test results were precise, there was no guarantee that an accurate value of G_{mm} had been obtained.

Specific Gravities of Aggregates

- The G_{se} values from Rice tests conducted on mixture samples oven aged for 2 hours and 4 hours using 30 mm Hg vacuum (both atmospheric and absolute) and the values obtained from the Corps of Engineers "Impregnated Specific Gravity" test gave essentially the same results.

Assessment of SuperPave^{TM} Gyratory and Volumetrics

- Analysis of Quality Assurance Data for seven (7) Florida paving projects indicated that the range between minimum and maximum V_a and VMA varied from 1.3 to 5.5 percent and from 0.9 to 4 1 percent, respectively. Further analysis showed this high variability was primarily due to G_{mb}. On all but two of the projects, the variability of G_{mb} resulted in V_a and VMA having a range of about 2.0 to 3.5 percent.

- The VMA of the mixtures evaluated in this investigation were almost always significantly less than FDOT mixtures even though the source and gradation of the aggregates were supposedly the same. One potential cause of this difference was that FDOT mixtures contained RAP that was simulated with limestone aggregate in the UF laboratory.
- Only mixtures NS619, G1219, and LS1319 met all of the SuperPave™ criteria for design.

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