Summary Report ICAR-201-1S

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EVALUATION OF SUPERPAVE AGGREGATE SPECIFICATIONS

This comprehensive research program was conducted in three concurrent phases which examined the Superpave fine aggregate angularity (FAA) test, the restricted zone requirement, and the voids in the mineral (VMA) specification.

FINE AGGREGATE ANGULARITY

Both owner agencies and the paving and aggregate industries have questioned the validity of the Superpave FAA requirement. The FAA test is based on the assumption that more fractured faces will result in higher void content in the loosely compacted sample; however, this assumption is not always true. Some agencies have found that some fine aggregates having cubical particles,100% fractured faces, do not meet the FAA requirement for high-volume traffic. State agencies are concerned that local materials, previously considered acceptable and that have historically provided good field performance, cannot meet the Superpave requirements.

Researchers evaluated angularity of 23 fine aggregates representing most types of paving aggregates used in the USA using seven different procedures: FAA test, direct shear test, compacted aggregate resistance (CAR) test, three different image analyses, and visual inspection. The image analysis techniques included Hough Transform at University of Arkansas at Little Rock, unified image analysis at Washington State University, and VDG-40 Videograder at the Virginia Transportation Research Council. Relative rutting resistance of HMA containing fines with different particle shape parameters was evaluated in the laboratory using the Asphalt Pavement Analyzer (APA).

The FAA test method did not consistently identify angular, cubical aggregates as high-quality materials. There was a fair correlation between the CAR stability value and angle of internal friction (AIF) from the direct shear test. No correlation was found between FAA and CAR stability or between FAA and AIF. Fairly good correlations were found between FAA and all three image analysis methods, except cubical crushed calcareous aggregates with FAA values less than 45. These aggregates gave very high values of CAR stability, AIF, and 'angularity' from imaging techniques, but low FAA values. Moreover, the three image-analysis methods exhibited good correlation among themselves. The APA study revealed that rut resistance of HMA mixtures is not sensitive to FAA (Figure 1).

Until a suitable replacement method(s) for FAA can be identified, the researchers recommend that the FAA criteria be lowered from 45 to 43 for 100 percent crushed aggregate.

RESTRICTED ZONE

The purpose of this study was to evaluate the restricted zone effect using four different aggregates: crushed granite, crushed limestone, crushed river gravel, and a mixture of crushed river gravel as coarse aggregate with natural-sand fines. Each type of aggregate was used for mixture design of three hot-mix asphalt (HMA)

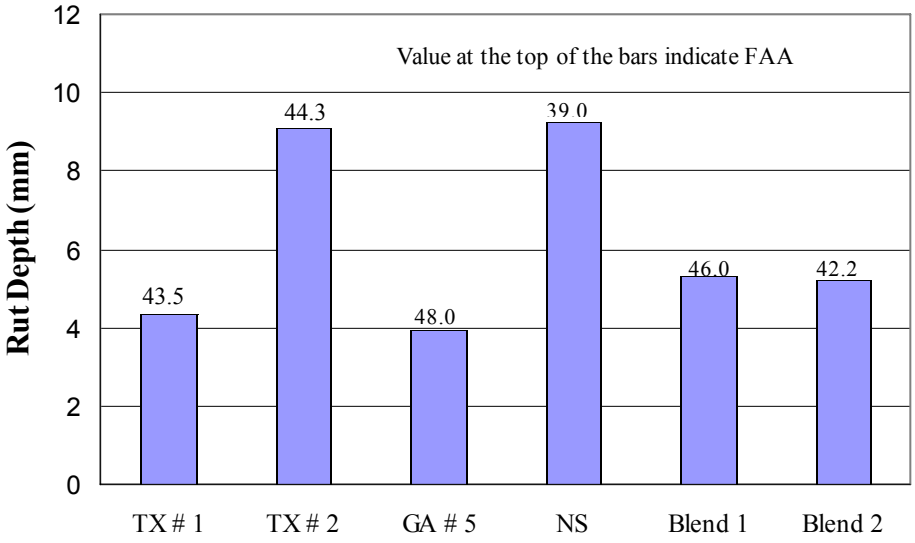

Figure 1. Rut Depth Measured by APA for HMA Containing Limestone Coarse Aggregate with Different Fine Aggregates

gradings: above, through, and below the restricted zone. The HMA mixtures prepared met most of the Superpave criteria, except the restricted zone in selected mixtures and fine aggregate angularity in three mixtures. The twelve mixtures designed were tested in the laboratory to evaluate their relative resistance to permanent deformation. Four types of tests were performed using Superpave equipment: simple shear at constant height, frequency sweep at constant height, repeated shear at constant stress ratio, and repeated shear at constant height. Rutting resistance was measured using the APA.

Researchers found that there is no relationship between the restricted zone and permanent deformation when crushed aggregates are used in the mixture design. Superpave mixtures with gradings below the restricted zone were generally most susceptible to permanent deformation while mixtures above the restricted zone were least susceptible to permanent deformation. Recommendations include elimination of the restricted zone from HMA design specifications.

VOIDS IN THE MINERAL AGGREGATE

The Superpave volumetric mixture design process contains a required minimum value for FAA as a function of traffic level and position of the layer within the pavement structure. This parameter is reported as the percentage of uncompacted air voids, with larger values generally indicating increased aggregate angularity and, thus, higher VMA and better resistance to permanent deformation.

The purpose of this study was to evaluate the effects of FAA and grading on the resulting VMA of certain HMA mixtures. The effect of FAA was evaluated using permanent deformation results from mixtures containing limestone coarse aggregate combined with six different fine aggregates. Mixtures with three gradings that pass through, above, and below the restricted zone; three different mineral filler contents; and four different values of FAA were analyzed to evaluate the effects of these parameters on VMA of Superpave HMA mixtures.

Based on analyses of these tests, HMA mixtures containing fine granite or limestone showed less permanent deformation than mixtures containing fine crushed river gravel or natural rounded sand. FAA values and permanent deformation of HMA did not correlate well. Proximity of gradings to the restricted zone did not significantly affect HMA mixture VMA. As mineral filler contents increased, VMA decreased, and higher FAA values yielded higher VMA.

The information in this summary is detailed in ICAR Reports 201-1, Evaluation of Superpave Fine Aggregate Angularity Specification, *by Arif Chowdhury, Joe Button, Vipin Kohale, and David Jahn.; ICAR 201-2,* Effects of Superpave Restricted Zone on Permanent Deformation, *by Arif Chowdhury, Joe Button, and Jose Grau; and ICAR 201-3F,* Effects of Aggregate Gradation and Angularity on VMA and Rutting Resistance, *by Dae-Wook Park, Arif Chowdhury, and Joe Button. The contents of this summary do not necessarily reflect the official views of AFTRE or ICAR.*