South Carolina
Department of Transportation

CLEMSON UNIVERSITY

U.S. Department of Transportation
Federal Highway Administration

SUMMARY REPORT

Report Number **FHWA-SC-05-01**
January 2005

South Carolina
Department of Transportation
955 Park Street
P.O. Box 191
Columbia, SC 29202

Evaluation of South Carolina Aggregate Durability Properties

EXECUTIVE SUMMARY

Introduction

The performance of hot-mix asphalt (HMA) and Portland cement concrete (PCC) pavements depends, to a large extent, on the quality of aggregates used in the matrix. Traditionally, South Carolina Department of Transportation (SCDOT) has used Los Angeles (LA) abrasion and impact test to determine the abrasion resistance /toughness of aggregates. The long-term durability/soundness of aggregate has been evaluated using the sodium sulfate soundness test.

Recent studies have indicated that LA abrasion test may not be accurately characterizing the relevant properties of aggregates to assess their performance in field conditions. The primary concerns in this regard are (i) LA test is essentially an impact test rather than an abrasion test, and (ii) LA test measures the resistance of aggregates in dry-condition rather than wet-condition. Similarly, there has been very little correlation observed between the long-term durability performance of aggregates and the percent loss values in the sodium sulfate soundness test.

NCHRP 4-19 study and other recent studies have indicated that micro-Deval test method is a better test in characterizing aggregate's field performance. This test method is unique in that the aggregates are tested in saturated conditions rather than dry-condition. NCHRP 4-19 study along with other recent studies, found magnesium sulfate soundness test to be a better test in characterizing the durability/soundness of aggregate compared to the sodium sulfate soundness test.

The objective of this study was to characterize the abrasion resistance/toughness and durability/soundness of aggregates, from 23 different sources in South Carolina using the micro-Deval abrasion resistance test and magnesium sulfate soundness test. These results were compared with the results of traditional LA impact and abrasion test and sodium sulfate soundness test. Based on the comparisons, correlations between the results of

micro-Deval test with other tests were explored. The effect of aggregate gradation on the losses obtained in micro-Deval and LA abrasion tests were also studied. In addition, results from all the tests were correlated with field performance of aggregates.

Results

Based upon the results of this study, no strong correlation between the results of micro-Deval test and LA abrasion and impact test were observed. For any given source of aggregate, finer gradation consistently yielded higher losses compared to coarser gradations, in micro-Deval test. However, no such correlation was found with LA impact and abrasion test.

No significant correlation was observed between results of micro-Deval test and either of the two sulfate soundness tests. However, good correlation was observed between sodium sulfate and magnesium sulfate soundness test results, with exception of one aggregate source.

A micro-Deval loss limit of 17 percent appears to identify nearly all of the aggregates that were rated as being "fair" or "poor" in field performance. In contrast, using an LA abrasion and impact loss limit of 55 percent resulted in identification of less than half the aggregates that were rated as being "fair" or "poor" in field performance.

With a maximum allowable loss criterion of 15%, sodium sulfate soundness test was not able to identify any aggregates that were rated as being "fair" or "poor" in field performance. Likewise, in magnesium sulfate soundness test only two marginal aggregates were identified using a maximum allowable loss criterion of 12%.

Conclusions and Recommendations

Based on the findings from this study, the following general conclusions can be drawn:

1. LA abrasion and impact test (at 55% loss limit) does not appear to clearly distinguish "good" performing aggregates from "fair" or "poor" performing aggregates, based on the field performance rating of aggregates provided by SCDOT.
2. Micro-Deval test appears to provide a better characterization of aggregate behavior compared to LA abrasion and impact test from a field performance standpoint.
3. A micro-Deval loss limit of 17% appears to identify all of the marginal aggregates (rated "fair" and "poor" in field performance) studied in this research.
4. No significant correlation could be observed between the losses in micro-Deval test and LA abrasion and impact tests.
5. No significant correlation could be observed between the losses in micro-Deval test and either of the two sulfate soundness tests.
6. Aggregate gradation appears to have an influence on the loss observed in the micro-Deval test, with finer gradations generally yielding larger loss values, compared to coarser gradations.
7. A good correlation was found between the loss observed in the sodium sulfate soundness test and magnesium sulfate soundness test.

Based on the results of this study, it is recommended that a specification based on loss in micro-Deval test (according to AASHTO TP 58-02) be adopted as a measure to assess the quality of aggregates, in combination with other exiting SCDOT specifications. A micro-Deval loss limit of 17% appears to be adequate in identifying "poor" or "fair" aggregates.

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