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Project Summary Report 0-4523-S
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Project 0-4523: Controlling Mineralogical Segregation in Bituminous Mixes

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PROJECT SUMMARY REPORT

Identifying Poor-Quality Coarse Limestone Aggregates in Texas: Bituminous Mixes and Acceptable Limits

Due to large variations in acceptance criteria for coarse aggregate in bituminous mixes, the Texas Department of Transportation (TxDOT) has observed large variations in the quality of hot mix asphalt (HMA) pavements constructed with aggregate from certain sources. More specifically, a coarse aggregate from a quarry may have a soundness loss of 5 percent one day and a soundness loss of 30 percent the next day.

Obviously, the large variation in coarse aggregate quality from one day to the next will impact the quality of bituminous mixes. This project focused on identifying poor-quality aggregates at the quarry, steps to decrease the amount of poor-quality aggregate going into stockpiles, and how much poor-quality coarse aggregate can be used in bituminous mixes so that mixes maintain acceptable performance.

What We Did…

Texas Transportation Institute (TTI) researchers began this project by evaluating pavements that were failing due to poor-quality coarse aggregate as identified by TxDOT. By testing cores from field projects, the TTI team determined that coarse limestone aggregates were the most problematic. Detailed evaluations of the quarried rock and processing techniques were made at 13 quarries to identify ways to improve aggregate quality at the quarry.

In addition to the work in the rock quarries, the research team selected three coarse limestone aggregates for extensive laboratory testing. One good, one marginal, and one poor performing limestone coarse aggregate were selected to blend using a standard Type C gradation. Samples were molded with a Superpave gyratory compactor using a blend of aggregates ranging from 100 percent good, 90 percent good/10 percent bad, etc. Control samples were also manufactured with 100 percent bad aggregate and performance-related tests were run on these materials.

What We Found…

Based on the quarry evaluations, the researchers identified three grades of coarse limestone aggregate: good, marginal, and poor (Figure 1). To quantify the concentration of poor-quality aggregate, we found that the stockpiles were generally too large to obtain representative samples (Figure 2), so sampling from the conveyor belt is the preferred technique for acquiring samples. Table 1 details how much aggregate should be taken for analysis.

Figure 1. Coarse Limestone Aggregate Types Identified in This Project.

Figure 2. Large Stockpiles Are Difficult for Obtaining Representative Samples.

Table 1. Quantities of Aggregate Needed to Statistically Identify 10 Percent Poor-Quality Aggregate at an Accuracy of ±10 Percent.

Maximum Aggregate Size in mm (inches)	Minimum Mass Taken from the Quarry in kg (lb.)	Minimum Mass Needed for Lithologic Analysis in g (lb.)
20 (0.79)	50 (110)	11,000 (24.23)
10 (0.4)	25 (55)	1100 (2.42)
5 (0.2)	10 (22)	110 (0.24)

*This table is based upon British Standard 812: Part 104: Draft.

All of the quarries contained varying percentages of good aggregate; the units are often too thin-bedded (2-3 feet thick) to make selective quarrying economical. Therefore, use of log or barrel washers may separate the poor-quality rock from the good material.

One important aspect of this project was to determine the impact of different percentages of marginal-to-poor coarse limestone aggregate on the significant engineering properties of hot mix layers. The introduction of marginal coarse limestone aggregate into the mix had little clear impact on the rutting potential of the mix as measured by the Hamburg test or inferred from the dynamic modulus. The fatigue life inferred from the dynamic modulus was not clear; no consistent trends were observed in the data. Using the TTI overlay tester, consistent trends were observed in reflection cracking resistance. The higher the percentage of poor-quality coarse limestone aggregate, then the lower the reflection cracking life.

Using Micro-Deval and Magnesium Sulfate Soundness data supplied by TxDOT from quarries around the state, the researchers could not identify a good correlation between the two tests. However, testing of the good and bad aggregate blends showed that both techniques do a good job of identifying lower-quality coarse limestone aggregate in this investigation.

The Researchers Recommend…

Based on the quarry evaluations, samples should be taken from the conveyor belt to gauge aggregate quality. If one has to sample from a stockpile, then smaller stockpiles (≤ 2000 tons) are recommended. Visually inspect aggregate angularity, absorption, hardness, fines coating the aggregate, and porosity. To reduce the poor-quality rock at the quarry, selective quarrying, density separation, and washing the aggregate can be performed.

Based on the results of the overlay tester (Figure 3), asphalt mixtures using a coarse limestone aggregate with different percentages of poor-quality rock (a maximum of 10 percent poor-quality coarse limestone aggregate) are recommended. Micro-Deval percent loss should not exceed 20, and Magnesium Sulfate Soundness percent loss should not exceed 15 in order to achieve less than 10 percent poor-quality Texas coarse limestone aggregate.

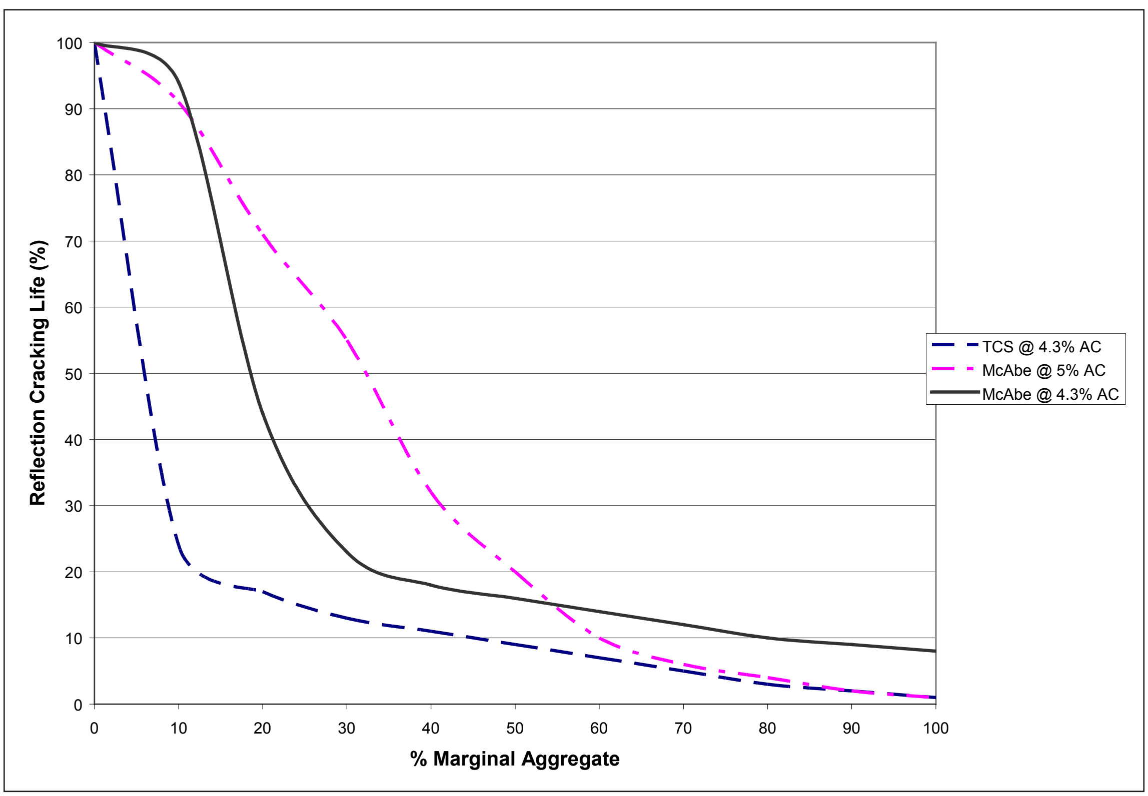

Figure 3. Graphical Summary of Overlay Tester Results.

For More Details...

This information is documented in the following reports:

Report 0-4523-1: *Recommendations for Minimizing Poor-Quality Coarse Aggregate in Asphalt Pavements*

Report 0-4523-2: *Tests to Identify Poor-Quality Coarse Limestone Aggregates and Acceptable Limits for Such Aggregates in Bituminous Mixes*

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