Project Summary

Texas Department of Transportation

0-5893: Laboratory Evaluation of Constructability Issues With Surface Treatment Binders

Background

TxDOT depends greatly on sprayed seals for new road construction (surface treatment) and on preventive maintenance (seal coat). It is very important for TxDOT to have emulsified asphalt (EA) as a key binder type at its disposal to reduce costs in this era of high energy prices and emphasis on sustainable design practices. However, EA brings its own set of unique challenges. Compared to other binder types, EAs are more complex in composition, have a much shorter shelf life, and their behavior under different construction scenarios is difficult to predict. TxDOT field personnel can effectively use EAs if tools are available to test binder quality as received at the site and to predict their behavior. It is useful for the designers to rank the most effective binder-aggregate combinations and to predict the rate at which EA will achieve stiffness and bond strength with aggregate to be able to open the road for traffic. This research project was launched by TxDOT to address these issues and find solutions that are of benefit to field personnel.

What the Researchers Did

A field evaluation of selected seal coat projects was conducted to help design laboratory experiments for this study. For each field project, extensive construction-related data was collected. The same aggregate-binder combinations used in these field projects were also included in the laboratory test programs at TechMRT and CTR. The CTR team conducted additional weather-rack related tests using a wider range of binders available from the TxDOT Cedar Park lab.

The focus of the testing program was to conduct laboratory tests at conditions similar to those in the field. The stiffness development of the binder when in contact with different aggregate surfaces was investigated using the DSR Strain Sweep Test. Additional tests were conducted using the ASTM D7000 Sweep Test on laboratory-prepared seal coat specimens. Tests were also conducted on curing and breaking of EA. An algorithm was developed based on this test data to predict the breaking time, curing rate, and stiffness development. A limited field evaluation of the developed algorithm and the field test protocols was conducted towards the end of the project. In addition, field tests were developed to assess the quality of the EA received at site using an evaporation test and a Shell cup viscosity test. The research products, along with other findings from the research were presented to the greater TxDOT community using four regional training workshops conducted in Bryan, Corpus Christi, Lubbock and Fort Worth Districts.

Research Performed by:

Center for Multidisciplinary Research in Transportation (TechMRT), Texas Tech University

Center for Transportation Research (CTR), The University of Texas at Austin

Research Supervisor:
Sanjaya Senadheera, TechMRT

Researchers:
Lei Niu, TechMRT
Andrew A. Tubb, TechMRT
Ambarish Bannerjee, CTR
Jorge Prozzi, CTR
Andre Smit, CTR

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What They Found

Laboratory test data clearly showed that some binder-aggregate combinations become ready for opening to traffic and/or brooming sooner than others. This time delay also depends significantly on the climatic conditions. The ASTM D7000 Sweep Test, used in other states to determine the effectiveness of binder-aggregate combinations for seal coats, was also conducted.

A statistics-based curing model that incorporates the amount of water lost to evaporation is proposed. The experimental data was used to develop a second statistical model to predict the rate of setting of binder when in contact with different aggregates under different climatic conditions.

Two field tests were developed to assess the quality of the emulsion received at the job site. The first is a simple field test that determines mass loss and calculates the dilution ratio in EA. This test showed commendable repeatability of results. The second field test used Shell cups to determine the Saybolt-Furol Viscosity (SFV) of the binder. The repeatability of the test improved drastically when a water bath was introduced to control specimen temperature.

Finally, a total of six project sites were visited to conduct a field evaluation program for the tests that were proposed and also to determine the thresholds for the statistical models that were developed.

What This Means

The following key observations can be made based on the findings of this study.

- The development of the algorithm to help decisions such as when to place the aggregate and when to open for traffic was constrained by the limited number of material combinations that could be included. In order to improve the reliability of this algorithm, it is important to calibrate it using a large number of additional data points (projects).
- The Shell cup test developed to measure field viscosity of EA was found to be repeatable. However, there appears to be a consistent shift between this result and laboratory measured SFV. Therefore, it is important to develop a relationship between lab and field measurements such that field results can be validated against the specification.
- The strain-sweep test, using the aggregate substrate and environmental conditioning, can be effectively used in the seal coat planning and design stage to identify the best emulsion-aggregate combinations for different climatic conditions. This data would also provide information on the rate of stiffness gain in the binder, under different geographic and environmental conditions. This type of performance-based test method can be used to rank material combinations for use in roadways with different traffic levels and functional classifications.
- Even though the ASTM D7000 Sweep Test has been used by other states to evaluate seal coat material effectiveness, it is not recommended for use by TxDOT in its current form due to several limitations.

For More Information:
Research Engineer - German Claros, TxDOT, 512-416-4730
Project Director - Darlene Goehl, TxDOT, 979-778-9650
Research Supervisor - Sanjaya Senadheera, TechMRT, 806-742-3037

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Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080
512-416-4730