CENTER FOR TRANSPORTATION INFRASTRUCTURE SYSTEMS
THE UNIVERSITY OF TEXAS AT EL PASO

Project Summary Report 0-4821-S
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Project 0-4821: Mix Design and Performance Testing of Crumb Rubber Modified Hot Mix Asphaltic Concrete (CRM-HMAC)
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PROJECT SUMMARY REPORT

Mix Design and Performance Evaluation of CRM-HMAC

Although asphalt concrete mixes consisting of crumb rubber modifier (CRM) have been successfully placed and have performed well over the years, the laboratory design and preparation of specimens are cumbersome and often problematic.

In addition, the Hamburg Wheel Tracking Device (HWTD) or static creep tests, typically specified by TxDOT, have not been able to predict consistently the performance of these mixes.

Another issue related to the performance evaluation is the specimen preparation procedure. The specimens for the mix design are prepared with the Texas Gyratory Compactor (TGC). However, the new mixture performance tests including the HWTD are carried out on specimens prepared with the Superpave Gyratory Compactor (SGC).

The main objectives of this research were to: streamline the existing mix design procedure (Tex-232-F), develop a mix design procedure using the SGC, and propose a reliable laboratory performance test method that is easy to perform.

What We Did ...

We reviewed the available information to identify mix design and performance issues.

Based on the information gathered, the following mix design components were improved: the gradation optimization process, the CRM and asphalt cement blending procedure, the appropriate mixing and compaction temperatures, the handling of specimens after compaction, and the inclusion of the SGC in the process of

proportioning the aggregates and CRM.

To identify performance of CRM-HMAC, the following performance tests were evaluated: the Hamburg Wheel tracking Device (HWTD, Tex-242-F), static creep (Tex-231-F), indirect tensile strength, dynamic modulus, flow time, and flow number.

To evaluate the mix design issues, two different mixes from Odessa District were studied. Both mixes contained the same AC-10 neat asphalt, CRM and coarse aggregates. The main difference was the screener type. One mix was developed from the Rankin screener and the other from the Balmorhea screener.

Three plant-produced mixes and one laboratory-produced mix were selected for performance evaluation.

What We Found

The current Tex-232-F procedure suggests that a minimum of eighteen specimens be prepared to obtain optimized gradation and to meet ITEM 346 gradation requirements. This process can be minimized using Solver Tool of Excel which takes less than two minutes to meet gradation requirements.

Various blending temperatures (asphalt with CRM) have been proposed. In addition, how to mix CRM into asphalt has been proposed. To identify the influence of these variables, the mixing was performed at three temperatures, and the blends were produced by mixing them manually as well as by using a low shear mixer.

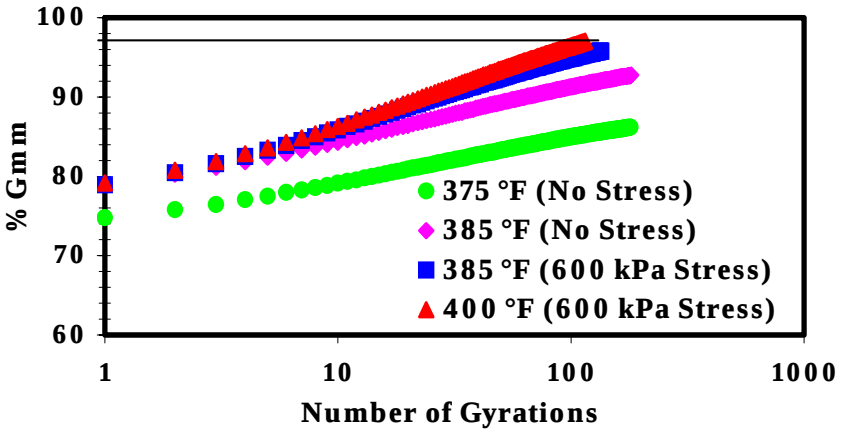
The penetration and dynamic shear rheometer test results suggested that the blend produced manually at 350 °F exhibited higher stiffness.

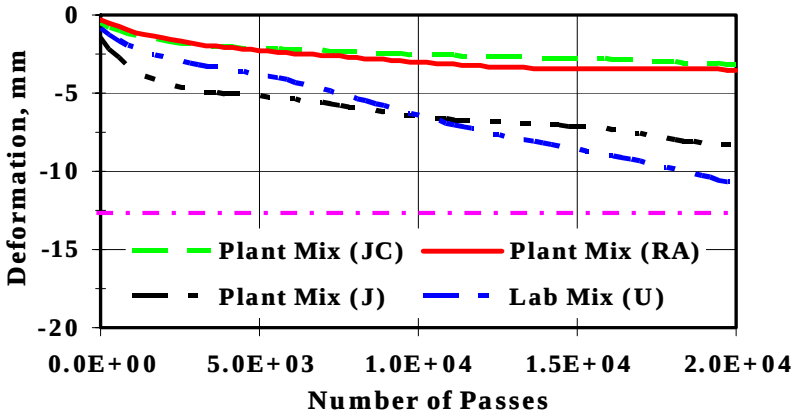
In terms of compaction, the test results identified that the mixes lose temperature quickly during compaction in comparison to conventional mixes and expand after compaction, especially specimens prepared with SGC.

The number of gyrations and $\%G_{mm}$ plot shown in the Figure (next page on top) suggests that the specimens can be prepared using SGC by increasing temperature and maintaining pressure after compaction. The

suggested N_{des} for CRM-HMAC is 106.

The performance of mixes was evaluated using a modified method of compaction. The HWTD test results (bottom right) indicate that all of the mixes meet the Tex-242-F requirements, thus indicating that the modified method of handling and compaction improved the reliability of HWTD.





The Researchers Recommend

Based on the mix design evaluation, the following design steps are recommended:

1. The asphalt binder should be heated to 375 °F before mixing of the CRM; however, the blend of CRM and asphalt should be maintained at 350 °F.
2. After mixing and before compaction, the loose mix should be heated to 400 °F for 2 hours.
3. After the desired number of gyrations, the SGC should be stopped and a stress of 600 kPa should be maintained for 45 minutes.
4. After the removal of the specimen from the mold, the specimen should be enclosed in a PVC mold overnight.
5. A modified method is proposed in Report 0-4821-1.

Based on performance evaluation, researchers make the following statements:

1. The Plant Mix (RA) provided the best performance in comparison to the other mixes.
2. The HWTD can reliably predict the performance of CRM-HMAC when the modified mixing and compaction method is utilized.

For More Details

The research is documented in the following reports:

- *0-4821-1: "Crumb Rubber Modified Hot Mix Asphalt"*
- *0-4821-2: "Performance Testing of Crumb Rubber Modified Hot Mix Asphaltic Concrete"*

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