Texas Department of Transportation

PROJECT SUMMARY REPORT

0-6923: Develop Guidelines and Design Program for Hot Mix Asphalts Containing RAP, RAS and Other Additives through a Balanced Mix Design Process

Background

The inclusion of the Hamburg wheel-tracking (HWT) test in TxDOT mix design process in the last decade has reduced the problems with rutting significantly. Satisfying the HWT criteria requires stiffer and more brittle mixes that may experience premature cracking. The designers often fulfil the HWT requirements by increasing the recycled material content, decreasing asphalt content or using higher performance grade binder. The balanced mix design (BMD) concept can be implemented to improve simultaneously the performance of the mixes in both rutting and cracking. The incorporation of BMD to enhance current design, production and construction practices is paramount to avoid durability and stability performance problems with asphalt concrete mixtures and promote long-lasting flexible pavements.

The main goal of this project was to provide TxDOT with a mix design program, testing protocols and corresponding specifications to produce BMD mixtures without significantly compromising the constructability of the final product.

What the Researchers Did

A comprehensive literature review was carried out to identify current practices in terms of design, production and construction of Superpave mixtures as well as to document the early implementation of the BMD concept into current practices. A rigorous experiment design plan was formulated and was carried out to investigate the main steps of the design process including mix design approach, optimization of aggregate gradation, formulation of BMD mixtures, and influence of essential mix design variables.

Two mix design approaches, volumetric analysis with performance verification and performance-based analysis, were thoroughly investigated. The overlay tester (OT, as per test procedure Tex-248-F), Hamburg wheel-tracking (HWT, as per test procedure Tex-242-F), and indirect tension (IDT, as per test procedure Tex-226-F) tests were implemented to assess the cracking, rutting and strength of the asphalt mixtures, respectively.

Given the limited understanding of the influence of aggregate gradation selection on the performance of asphalt mixtures, the role of aggregate gradation in contributing or mitigating cracking and rutting was investigated. In addition, the influences of other variables such as asphalt content, binder performance grade (PG) and source, and the type and dosage of recycled materials on the performance of BMD mixtures were assessed.

At the end, the knowledge and experience gained in this study were used to convert four traditional mixtures to BMD mixtures using locally available pavement materials. Those BMD mixtures not only met the desired mechanical properties for durability, they also met the volumetric properties required for constructability.

What They Found

New TxDOT Special Specification (SS) 3074 "Superpave Mixtures – Balanced Mix Design" to produce BMD mixtures (https://ftp.txdot.gov/pub/txdot-info/cmd/cserve/specs/2014/spec/ss3074.pdf) was developed and proposed in this study. A performance space diagram representing the OT and HWT tests results (see Figure 1) was incorporated in the specification

Research Performed by:
University of Texas El Paso

Research Supervisor:
Dr. Soheil Nazarian, UTEP

Researchers:
Victor Garcia
Denis Vieira
Luiza Barros
Imad Abdallah

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to assess the durability and stability of the asphalt mixtures during the design process.

Even though the performance-based analysis mix design approach seems fundamentally correct, changing the asphalt content arbitrarily to meet the performance requirements may introduce other challenges in terms of the production and construction of asphalt mixtures. A volumetric analysis with performance verification mix design approach can be successfully used to produce BMD mixtures. The selection of aggregate gradation plays a key role in accommodating the optimal asphalt content necessary for producing a durable and stable asphalt mixture. The BMD mixtures produced with this approach were not impacted much by the minor changes in the essential mix design variables such as binder PG and source, and recycled materials like reclaimed asphalt pavement and recycled asphalt shingles. BMD mixtures satisfactorily met the volumetric and mechanical performance requirements proposed in this study. To ease the process of optimizing a mix design, a gradation tool was developed to work seamlessly with TxDOT mix designs (see Figure 2).

What This Means

The proposed SS 3074 "Superpave Mixtures – Balanced Mix Design" specifications and guidelines can be readily implemented to enhance current practices. By implementing the key findings and outcomes from this study, TxDOT will be able to produce BMD mixtures with locally available pavement materials while optimizing the use of asphalt content, recycled materials and additives from a mechanical performance perspective. This paradigm shift leads to more economical and better performing asphalt mixtures.

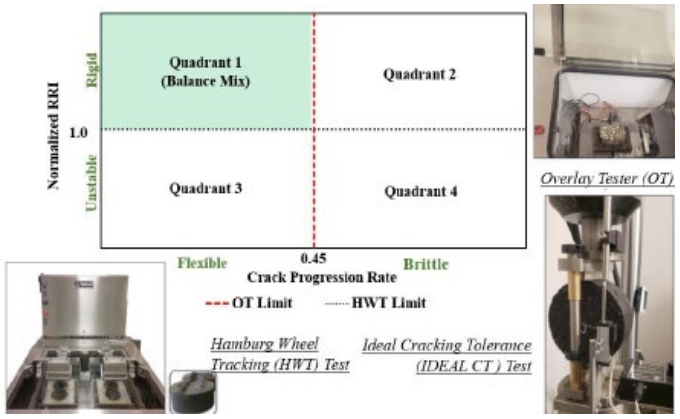

Figure 1 – Performance Space Diagram for Balanced Mix Designs

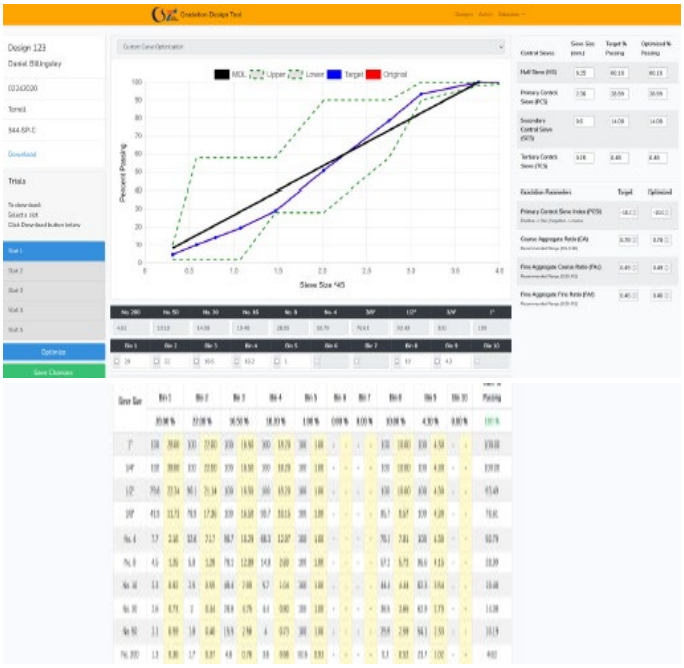

Figure 2 – Gradation Tool for Mix Designs

For More Information

Project Manager:
Tom Schwerdt, RTI Tom.Schwerdt@txdot.gov
Research Supervisor:
Imad Abdallah, UTEP emadn@utep.edu
Project Monitoring Committee Members:
Daniel Garcia, Enad Mahmoud, Gisel Carrasco, Marta Czarnecka Stephens, Miguel Arellano, Ryan Barborak, Stephen Kasberg, Travis Patton

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

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