Washington State Department of Transportation

Materials Laboratory
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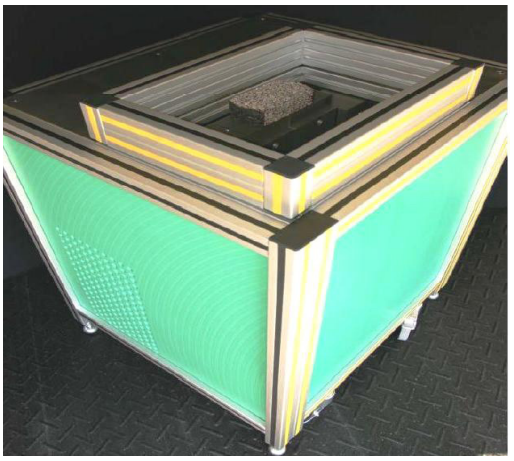
tech notes

"tech notes" is an effort by the Headquarters Materials Laboratory to share design and construction technology gained from projects done through WSDOT. This issue is from the Bituminous Materials Section discussing the Texas Overlay Tester project.

Texas Overlay Tester Project

Introduction:

Since the Washington State Department of Transportation (WSDOT) implemented Superpave for design and acceptance of Hot Mix Asphalt (HMA), the Bituminous Materials Section at the State Materials Laboratory has been evaluating various devices for possible use as HMA performance prediction tools. In February of 2007, contact was made with the Texas Department of Transportation (TxDOT) regarding an Overlay Tester machine they were using for reflective crack prediction. A study was set up in partnership with TxDOT to utilize their Texas Overlay Tester on WSDOT HMA mix design samples from projects in Washington State.



The Texas Departement of Transportation (TxDOT) Overlay Tester. Photo courtesy of TxDOT.

Objective:

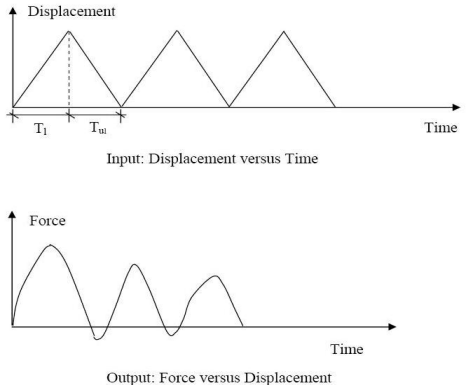
This study was set up to determine the susceptibility of WSDOT HMA volumetric mix designs to fatigue or reflective cracking using the TxDOT Overlay Tester. The correlation to field performance and the overlay test results will aid in determining if this device is something WSDOT would like to investigate further.

Background:

The Texas Transportation Institute (Texas A&M) overlay tester was designed by F.P. Germann and R.L. Lytton in the late 1970's to simulate the opening and closing of joints or cracks. The device is a computer-controlled electro-hydraulic system that applies repeated direct tension loads to HMA specimens. The machine features two steel blocks, one is fixed and the other slides horizontally. The sliding block applies tension in a cyclic triangular waveform to a constant maximum displacement of 0.025 inches. The sliding block reaches the maximum displacement and then returns to its initial position in 10 seconds. Testing is performed at a constant temperature of 77 ±3°F. This test method measures the number of cycles to failure. The device automatically measures and records load, displacement, and temperature every 0.1 seconds.

Typical display during testing. Image courtesy of TxDOT.

The overlay tester can be run on standard size samples, typically 6 in (150 mm) long by 3 in (75 mm) wide by 1.5 in (38 mm) high. These specimens can be prepared from either field cores or from Superpave Gyratory Compactor (SGC) molded specimens. According to TxDOT Report 0-4467-2 (Zhou, F. and Scullion, T. et al, Oct 2004), "The test is rapid and repeatable, and poor samples fail in minutes. It characterizes both crack initiation and crack propagation properties of asphalt mixtures. Based on repeatability study results, three replicates are recommended for the overlay tester." "The effectiveness of the overlay tester was validated by five case studies in Texas. The overlay tester results all correlated well with the field performance."



Input and output of Overlay Tester. Figure courtesy of TxDOT.

Project Selection:

Five construction projects were selected for this project that represented a range of traffic loading and environmental conditions experienced on Washington State highways. The parameters used in the project selection included the class of mix (nominal maximum aggregate size), Performance Grade of asphalt binder, Equivalent Single Axle Load (ESAL) level as it applied to N_{design} compaction level, and that volumetric properties would be used as part of statistical acceptance of the HMA.

Sample Preparation:

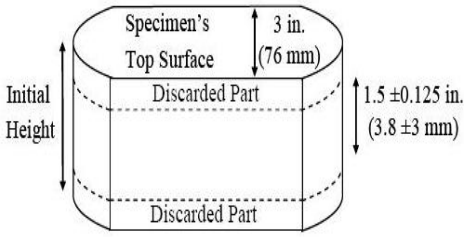
Five specimens were prepared in accordance with AASHTO T-312, "Preparing and Determining the Density of Hot-Mix Asphalt Specimens by Means of the Superpave Gyratory Compactor (SGC)," from each mix design used on the five projects selected. Specimens used for overlay testing must meet a relative density specification of 93±1% (7±1% Va) in accordance with AASHTO T-209, "Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures" and AASHTO T-166, "Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens," after being trimmed to test sample size. To achieve the specified density, per TxDOT Overlay Test TEX-248-F, three trial HMA samples containing 2400, 2500 and 2600g of aggregate and a fixed asphalt content are compacted to a constant height of 62±0.2mm. Since WSDOT did not have the proper equipment to trim the SGC specimens TxDOT agreed to trim the specimens prior to testing.

Summary of Procedure:

Using TxDOT Test Designation TEX-248-F, the method for the Overlay Test, the procedure is summarized as follows:

Trimming of Cylindrical Specimen—Using a cutting template, trim the specimen ends by cutting the specimen perpendicular to the top surface. Trim off the top and bottom of the specimen to produce a sample to a specified height. Measure the relative density of the trimmed specimen. Density for trimmed laboratory molded specimen must be 93 ±1%. Dry the trimmed specimen to constant weight.

Note *—Constant weight is defined as the weight at which further oven drying does not alter the weight by more than 0.05% in a 2-hr. interval.*



Trimming specimen to required height. Figure courtesy of TxDOT.

Mounting Trimmed Specimen to Base Plates—Mount and secure the base plates to the mounting jig. Center and place a piece of tape over the gap between the base plates. Glue the trimmed specimen to the base plates using a prepared epoxy. Place a 10-lb. (4.5 kg) weight on top of the glued specimen to ensure full contact of the trimmed specimen to the base plates. Remove the weight off the specimen after the epoxy has cured. Use a hacksaw to cut through the tape and dry epoxy located at the gap opening between the base plates. Slightly score the test specimen to propagate a crack at the gap opening.

Starting Testing Device—Turn on the 'Master' switch and start the overlay test software. Turn on the hydraulic pump using the software. Turn the machine to load mode.

Mounting Trimmed Test Specimen to Testing Device—Enter the required test information into the overlay test software for the specimen mounted. Mount the specimen assembly onto the machine according to the manufacturer's instructions.

Assembly of Texas overlay specimen. Image courtesy of TxDOT.

Testing Specimen—Turn the machine to stroke mode. Perform testing at a constant temperature of 77 ±3°F (25 ±2°C).
Note *— Ensure temperature of trimmed test specimen is 77 ±3°F (25 ±2°C). Start the test by enabling the start button in the program. Perform testing until failure, defined as a 93% reduction or more of the maximum load measured from the first opening cycle. If 93% is not reached, run the test to 1,200 cycles. Turn the machine to load mode. Remove specimen assembly.*

Data Collection:

For each specimen the trimmed specimen density, starting load, final load, percent decline in load, number of cycles to failure, and test temperature are reported. TxDOT recorded and compiled the results from WSDOT test specimens into an Excel spreadsheet for review. Of the 25 samples sent to Texas for testing, three samples were destroyed prior to testing and 12 samples did not meet the relative density requirement of 93±1% (7±1% Va). Excluding the samples that were destroyed TxDOT tested all the samples sent and reported the results. In addition to the TxDOT spreadsheet a second spreadsheet is included with only the specimens that met the relative density requirement (***See Appendix A***).

Mounted specimen prior to testing. Image courtesy of TxDOT.

Summary:

In review of the test data provided in the appendix, few conclusions can be drawn as numerous samples did not meet the density requirement and the cycles to failure showed significant variation. Even with the non-compliant density samples removed, the sample sets showed significant variability. The variation in sample densities may be attributed to the inability to trim the test specimens and confirm the densities prior to shipment.

The HMA mix designs developed with the lower 7 day average high temperature PG asphalt binders (PG 64-22 and 64-28) show a higher average cycles to failure when compared to the higher temperature PG asphalt binder grades tested (Appendix A, Tables 1 and 2). However, no significant conclusions can be drawn since each mix design was developed from different aggregate sources and different gradations. Additional testing with samples of specified density would be required in order to definitively validate the potential of the Overlay Tester to accurately measure the susceptibility of WSDOT HMA mixtures to fatigue or reflective cracking.

Texas Overlay sample at failure. Image courtesy of TxDOT.

APPENDIX A

Table 1: Results for Texas Overlay Project

Lab#	District Lab #	PG Binder	AC (%)	Sample #	Density (%)	Starting Load	Final Load	% Decline in Load	#Cycles to Failure	Average
F1017	G71867 1 TO 5	70-22	5.6	1	93.9	1243.0	79.0	93.6	4	3
				2	95.0	1468.0	81.0	94.5	3	
				4	94.8	1113.0	78.0	93.0	3	
F1018	G71985 1 TO 5	70-28	5.9	1	93.9	1114.0	74.7	93.3	7	47
				2	93.5	941.8	65.2	93.1	172	
				3	94.2	879.0	57.6	93.4	35	
				4	94.5	876.0	61.1	93.0	12	
				5	93.4	965.7	60.5	93.7	7	
F1019	G71836 1 TO 5	70-28	5.3	1	94.3	927.0	63.0	93.2	125	61
				2	94.5	1057.0	78.0	92.6	80	
				3	94.8	970.2	60.7	93.7	35	
				5	93.2	1065.0	67.0	93.7	5	
F1020	G71827 1 TO 5	64-28	5.1	1	94.0	834.0	56.0	93.3	235	152
				2	94.3	736.0	53.5	92.7	155	
				3	93.5	799.0	71.0	91.1	15	
				4	94.6	800.5	54.7	93.2	235	
				5	93.8	755.5	52.6	93.0	122	
F1021	G71941 1 TO 5	64-22	5.8	1	93.8	635.0	42.8	93.3	251	134
				2	94.2	724.3	48.9	93.2	151	
				3	93.5	823.0	56.0	93.2	32	
				4	94.3	775.0	52.5	93.2	159	
				5	94.2	886.0	56.8	93.6	77	

Table 2: Results for Texas Overlay Project for Samples within Density Standards

Summary of samples that were within the 93±1% Density standard required for the Overlay Test										
Lab#	District Lab #	PG Binder	AC (%)	Sample #	Density (%)	Starting Load	Final Load	% Decline in Load	#Cycles to Failure	Average
F1017	G71867 1 TO 5	70-22	5.6	1	93.9	1243.0	79.0	93.6	4	4
F1018	G71985 1 TO 5	70-28	5.9	1	93.9	1114.0	74.7	93.3	7	62
				2	93.5	941.8	65.2	93.1	172	
				5	93.4	965.7	60.5	93.7	7	
F1019	G71836 1 TO 5	70-28	5.3	1	93.2	1065.0	67.0	93.7	5	5
F1020	G71827 1 TO 5	64-28	5.1	1	94.0	834.0	56.0	93.3	235	124
				3	93.5	799.0	71.0	91.1	15	
				5	93.8	755.5	52.6	93.0	122	
F1021	G71941 1 TO 5	64-22	5.8	1	93.8	635.0	42.8	93.3	251	142
				3	93.5	823.0	56.0	93.2	32	

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