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16. Abstract

Past experience and recent field performance data has shown that several of TxDOT's widely used asphalt mixtures are rut resistant but increasingly prone to cracking. Under Research Project 0-4467 the Overlay Tester (OT) was successfully demonstrated as a simple performance-related test to identify the crack resistance of asphalt mixtures. This implementation project focused on developing specifications for the OT, purchasing three units, and conducting shakedown tests on the new units. Within lab testing at the Texas Transportation Institute produced very consistent results. However, variability problems were encountered in the initial Round-Robin tests between labs. An investigation was conducted to identify the source of the differences. Several factors were identified and these are described in this report. Recommendations were made to modify the test protocol and it is highly recommended that a second Round-Robin test be conducted to evaluate the repeatability and reproducibility of the overlay tester.

Additionally, specifications for double-bladed saws were developed and three saws were purchased and delivered to Districts labs. The samples cut with these saws meet the required operational tolerances. However, it was recommended that calibration may be required on mixtures made with extremely hard rock, such as river gravels.

The results obtained with both the new overlay testers and double bladed saws are presented in this report. The specifications for each device are given in the Appendices.

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PILOT IMPLEMENTATION OF THE OVERLAY TESTER AND DOUBLE-BLADE SAW

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation. The engineer in charge was Dr. Fujie Zhou, P.E. (Texas, # 95969).

There is no invention or discovery conceived or first actually reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new useful improvement thereof, or any variety of plant, which is or may be patentable under the patent laws of the United States of America or any foreign country.

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Miles Garrison, P.E., Atlanta District;
Ron Hatcher, P.E., Childress District; and
Stanley Yin, P.E., Houston District.

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CHAPTER 1

OVERLAY TESTER

BACKGROUND

The first Overlay Tester (OT) was designed by Germann and Lytton at the Texas Transportation Institute (TTI) in the late 1970s (*1*). The key parts of the apparatus (shown in Figure 1), consist of two steel plates, one fixed and the other movable horizontally to simulate the opening and closing of joints or cracks in the old pavements beneath Hot-Mix Asphalt (HMA) overlays. The OT specimen is glued to the two steel plates, with half of its length resting on each plate. Since its development, the OT has been widely used to evaluate the effectiveness of different geosynthetic materials to retard reflective cracking (*2, 3, 4, 5, 6, 7*). Recently, Zhou and Scullion used this equipment to evaluate the crack resistance of HMA mixes (*8*). The two main drawbacks of the old OT system were: 1) a long-beam specimen was required, and 2) there was no clear/simple criterion to define the specimen failure. In the past, the most often used beam specimen (Figure 1) was 15 in (375 mm) long by 2 in (50 mm) thick by 3 in (75 mm) wide, a size that is relatively difficult to fabricate in the laboratory and more difficult to get from the field. Additionally, the specimen failure was defined by visual observation, which is very subjective and requires the technician to visually observe the crack propagation. To overcome these drawbacks a new OT machine was designed and tested in this implementation project. Detailed information about the new OT machines is presented in the following text.

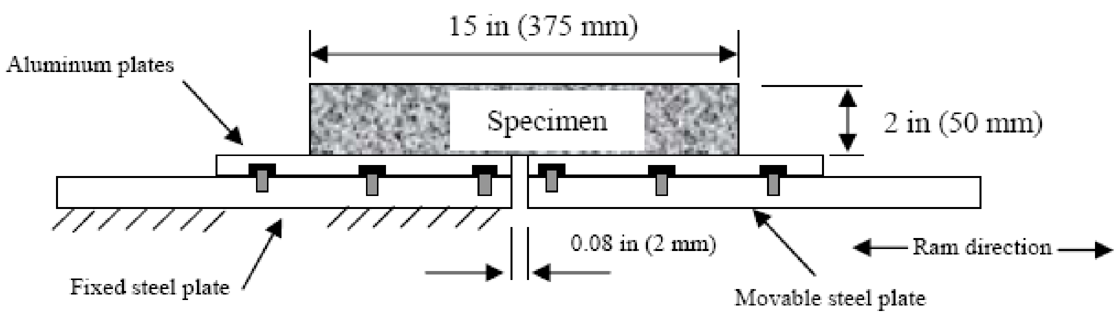

Figure 1. Concept of the Overlay Tester.

NEW OT MACHINES

Under this implementation project, based on their previous experience, the research team developed the OT performance specification shown in Appendix A. In this study three new OT machines were purchased using these specifications. As shown in Figure 2, each OT machine is a computer controlled system and all the data acquisition is automated.

2a). New OT Machine: External View

2b). New OT Machine: Internal View

Figure 2. New OT Machine.

The main features of the new OT machines are as follows:

- OT specimen: The standard OT specimen is 6 in (150 mm) long by 3 in (75 mm) wide by 1.5 in (38 mm) high. This size specimen can be easily prepared from either a Superpave Gyratory Compactor (SGC) or field cores.
- Failure criterion: The OT is a fixed displacement test. As used in the traditional bending beam fatigue test, the percentage drop in applied load was used to define specimen failure. Based on extensive OT testing, the researchers recommend that failure is defined as the cycle number where the load to open the sample is less or equal to 7 percent of the load measured in the first cycle (93 percent load reduction) . This is the point at which the researchers consider that the specimen is completely fractured.
- Testing temperature: With the built-in temperature controlling chamber, the OT testing can be conducted at a range of 23 ºF (-5 ºC) to 104 ºF (40 ºC).
- Test termination criteria: It should be noted that the old OT machine must be stopped manually when the user determines specimen failure based on visual observation of sample cracking. However with the new OT machines two criteria are available to automatically stop the test. First, the new OT machine will automatically stop running if it reaches the maximum number of cycles set by the user; second, when the applied load is measured to be equal to or less than 7 percent of the maximum load of the first cycle, the OT machine will automatically terminate the test. The maximum number of cycles and the load level reduction factors are entered by the user at the start of the test.

OT MACHINE SHAKEDOWN TESTING

A Type D plant mix was used for the OT machine shakedown testing. Table 1 presents the aggregate gradation of the Type D mix used. The optimum asphalt content was 4.8 percent with a PG76-22 binder from SemMaterials.

A total of 15 Hamburg size specimens 6 in (150 mm) diameter and 2.5 in (62 mm) high were molded by the SGC and then cut to form the standard OT specimens using the double-blade saw. The measured air voids of the specimens after cutting are presented in Table 2. Then, following TxDOT's test procedure Tex-248-F: Overlay Test, the specimens were glued and tested at 77 ºF (25 ºC) with a maximum opening displacement of 0.025 in (0.63 mm). The OT test results on these control samples are shown in Table 2 and Figure 3. Additionally, the average number of cycles to failure for each of the three OT machines is presented in Figure 3. It is clear that the results from these three OT machines are very similar and their average values are almost identical. It is worth mentioning here that the same operator molded, cut, glued the specimens, and operated the OT machines. Additionally, these specimens are dense-graded Type D mixes (Table 1) and the air void contents of the specimens after cutting were, as shown in Table 2, very similar. With these consistent results the three OT machines were delivered to TxDOT's Atlanta, Childress, and Houston District labs.

Table 1. Type D Mix: Aggregate Gradation.

Aggregate Source:	**Martin Marietta Ty D**		**Hanson Ty D**		**Hanson Man-Sand**		**HJG Field-Sand**		**Total Bin**
Individual Bin (%):	31.0	Percent	27.0	Percent	32.0	Percent	10.0	Percent	100 %
Sieve Size:	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	*Cum. % Passing*
3/4"	100.0	31.0	100.0	27.0	100.0	32.0	100.0	10.0	100
1/2"	99.8	30.9	100.0	27.0	100.0	32.0	100.0	10.0	99.9
3/8"	85.0	26.4	95.2	25.7	100.0	32.0	100.0	10.0	94.1
No. 4	33.1	10.3	27.7	7.5	98.0	31.4	99.8	10.0	59.1
No. 8	7.0	2.2	4.2	1.1	81.0	25.9	99.4	9.9	39.2
No. 30	1.9	0.6	1.1	0.3	18.0	5.8	96.4	9.6	16.3
No. 50	1.0	0.3	1.0	0.3	10.0	3.2	54.4	5.4	9.2
No. 200	0.7	0.2	0.8	0.2	3.5	1.1	5.7	0.6	2.1

Table 2. OT Specimens and Test Results.

OT Machines	**Specimen No.**	**Air Voids (%)**	**Max. Load @1st Cycles (lb)**	**No. of Cycles to Failure**	**Statistical Information**
#1	1	6.9	991	85	Average (No. of Cycles): 91 Standard Deviation: 18 Coefficient of Variance: 20 %
	2	6.7	950	77	
	3	6.6	1028	98	
	4	7.3	986	75	
	5	7.6	850	119	
#2	6	6.8	860	98	Average (No. of Cycles): 95 Standard Deviation: 19 Coefficient of Variance: 20 %
	7	6.8	929	83	
	8	6.8	854	115	
	9	6.7	923	112	
	10	7.0	788	69	
#3	11	6.5	763	82	Average (No. of Cycles): 97 Standard Deviation: 22 Coefficient of Variance: 23 %
	12	6.5	1067	99	
	13	6.5	996	107	
	14	7.3	956	71	
	15	7.1	738	128	

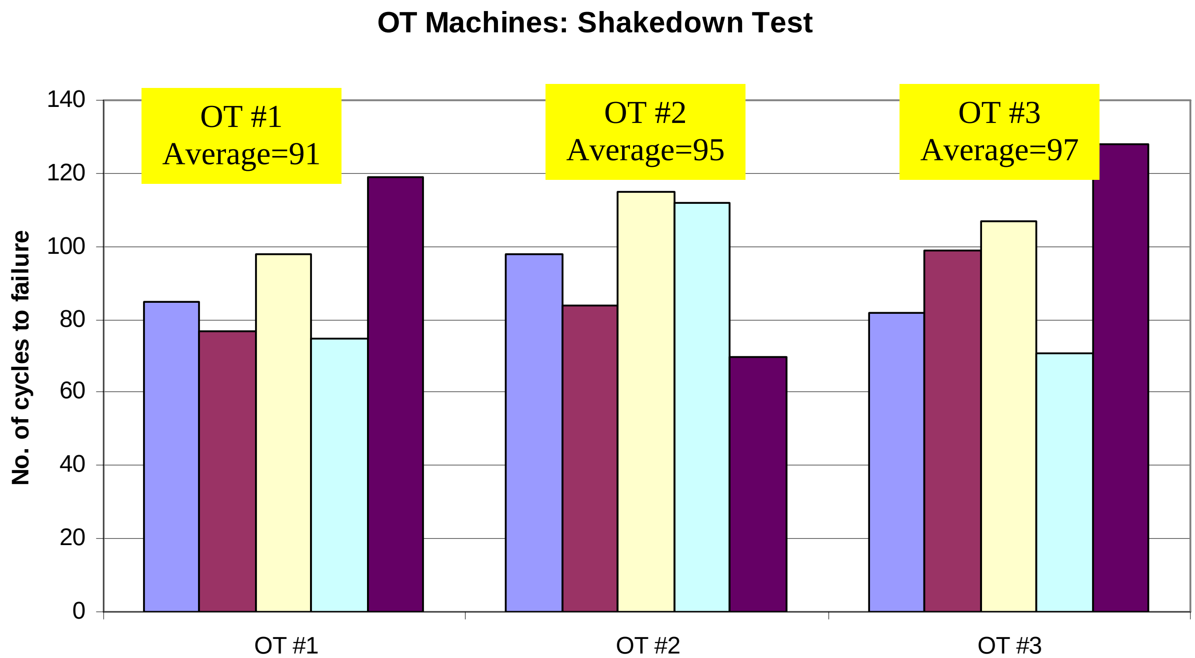

Figure 3. Shakedown Test Results of the OT Machines.

OT ROUND-ROBIN TEST

After delivering the OT machines to the three District labs, a Round-Robin test was conducted among six labs including the TTI, TxDOT-Cedar Park, Atlanta, Childress, Houston, and PaveTex Engineering and Testing Inc. labs. The purpose of the Round-Robin test was to evaluate the repeatability and reproducibility of the overlay tester. A modified Crack Attenuating Mix (CAM) with a PG76-22 binder was used to mold the OT specimens. The original optimum asphalt content was 7.8 percent, based achieving the CAM criteria of obtaining at least 750 cycles in the overlay tester and also less than 0.5 inch rutting in the Hamburg Wheel tracker. The initial OT results for this CAM mix showed that its number of cycles to failure was around 1800, and it took about 5 hours to test a specimen, which was thought too long for this Round-Robin test. Therefore, the asphalt binder content was reduced to 6.8 percent, which allowed the OT to be completed in approximately 1 hour. A total of 18 OT specimens were prepared at the TTI lab and 3 specimens were shipped to each participating lab for OT testing. The Tex-248-F: Overlay Test procedure was required to conduct the round-robin test. The test temperature was 77 ºF (25 ºC) and the maximum opening displacement was 0.025 in (0.63 mm). The first round-robin test results are listed in Table 3.

Table 3. First Round-Robin Overlay Test Results.

Labs	Specimen No.	Sitting Load (lb)	Max. Load @1st Cycle	No. of Cycles to Failure
TTI	I-5	-5	769	372
	I-8	-4	789	415
	II-4	-5	822	375
Cedar Park	F685-1	0	931	*
	F685-2	0	954	623
	F685-3	0	987	>2000
Atlanta	A-5	4	975	*
	A-6	11	1200	1006
	A-7	6	1011	1028
Childress	B-1	38	1136	110
	B-4	94	816	5
	B-7	30	560	10
Houston	II-5	-1	936	*
	II-6	4	944	416
	II-7	34	939	325
PaveTex Engineering and Testing, Inc.	II-1	0	918	305
	II-2	-5	831	383
	II-3	3	944	872

* Note: Test was automatically terminated before reaching failure.

The results were highly variable and an investigation was conducted to identify the source of the differences in results. Several factors were identified in this round-robin test which must be addressed before making conclusions on the repeatability and reproducibility of the overlay test. First, the OT machine at the Cedar Park lab was different from the other five OT machines. It was the first prototype machine from Research Project 0-4467 and had never been calibrated since it was delivered to Cedar Park in October 2004 (9). For future Round-Robin studies it is recommended that every OT machine used in this study should be calibrated with the same calibration unit.

The second factor identified is the initial sitting load, which is closely related to specimen mounting to the OT machine. It was found that the initial sitting load of each lab was different.

Specifically, the initial sitting load at the Childress lab was very questionable. It was found later that the glued specimen was forced into the OT machine, which may damage the specimen prior to the testing. The glued specimen should freely slip into the OT machine in the Load Control mode.

The third factor is the tape width, as shown in Figure 4. This tape is intended to stop the epoxy glue from entering the gap between plates and more importantly to provide a uniform "gauge length." The wider the tape width, the longer the gauge length, and, consequently, the larger the number of cycles to failure. In the first test protocol recommended in the Research Report of Project 0-4467-1 (*9*), the researchers clearly defined that the tape width after cutting should be around 0.2 in (5 mm), and the current Tex-248-F specifies a 0.25 in (6 mm) wide tape. In reviewing the results of this first test it was determined that many of the labs were using different tape widths which clearly had a big impact on the test results. To eliminate this variability, it is highly recommended that an uncut 0.25 in (6 mm) wide tape be used to cover the gap between the two plates. Tapes of this width will be supplied to all labs for future test.

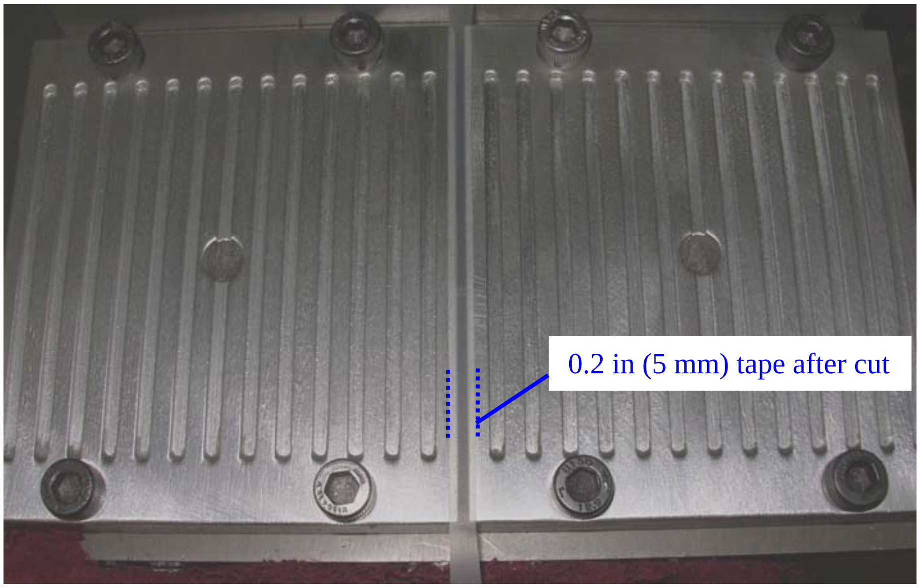

Figure 4. Demonstration of 0.2 in (5 mm) Tape Width after Cutting.

The fourth factor is the room temperature. It was initially thought that the room temperature in every lab was 77 ºF (25 ºC), but the researchers quickly realized that this is not the case. It is well known that HMA mixes are very temperature sensitive, thus different room temperatures may have significant influence on the OT results. A two-hour preconditioning time in the OT machine at 77 ºF (25 ºC) is highly recommended in order to reduce the influence of "room" temperature.

The fifth factor is the glue type. The glue used by the Cedar Park lab was different from the glue TTI recommended. A recent study in the Cedar Park lab showed that the glue type has an impact on the OT results. Therefore, it is recommended that the same glue type be used for all future overlay test.

All five of these factors have been addressed in the proposed updates to the OT testing protocol. Based on the variances in test protocols it is strongly recommended that a second round-robin test be conducted to evaluate the repeatability and reproducibility of the overlay test.

RECOMMENDATIONS

Based on the first round-robin test results, the following recommendations are offered:

- Calibration: Calibrate all OT machine using the same calibration unit.
- Tape width: Specify a 0.25 in wide tape.
- Glue type: Use a specified glue type for all OT testing.
- When mounting the glued specimen to the OT machine, use the Load Control mode and let the glued specimen freely slip into the OT machine.
- Preconditioning time: Allow a two-hour preconditioning time in the OT machine at 77 ºF (25 ºC).

A second Round-Robin test is highly recommended to evaluate the repeatability and reproducibility of the overlay test. The above five issues must be addressed before the second round-robin test. Additionally, it is important to have one lab to fully prepare the OT specimens. It is anticipated that this second round of test will be completed in the spring of 2008.

CHAPTER 2

DOUBLE-BLADE SAW

BACKGROUND

As mentioned in the previous chapter, the standard OT specimen is 6 in (150 mm) long by 3 in (75 mm) wide by 1.5 in (38 mm) high and this sample is cut from either a standard Hamburg specimen (6 in [150 mm] diameter and 2.5 in [62 mm] high) or field cores. It was quickly found that cutting the OT specimen was a big concern in the District laboratories. Using single bladed saws there were concerns about both safety and about the accuracy of cutting. This was not a problem at TTI, since TTI has a double-blade saw. To address the OT specimen cutting and safety issues, three double-blade saws were purchased for the three District labs that have the new OT machines. Detailed information about the double-blade saws is presented below.

DOUBLE-BLADE SAW

Based on TTI's current double-blade saw, performance specification (see Appendix B) was developed and three double-blade saws, shown in Figure 5, were purchased in this study. The clamping system use to cut the 1.5 in (38 mm) high sample is illustrated in Figure 6, and Figure 7 shows the arrangement to make the final 3 in (75 mm) cut. It should be noted that the cutting is completely automated after the operator has entered the target thickness into the control panel (Figure 5).

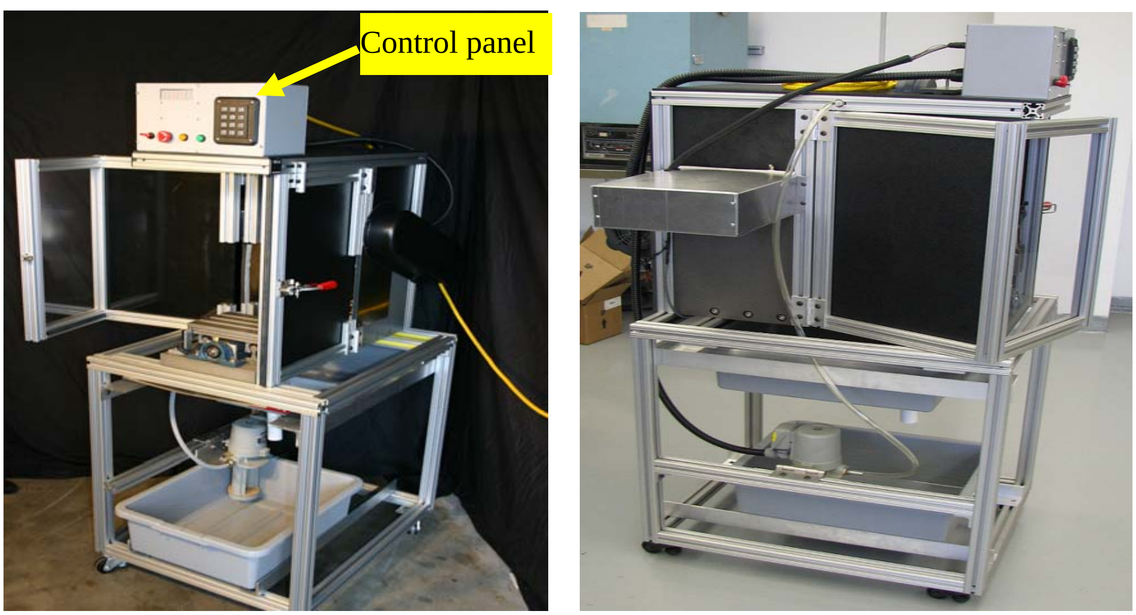

Figure 5. Double-Blade Saw.

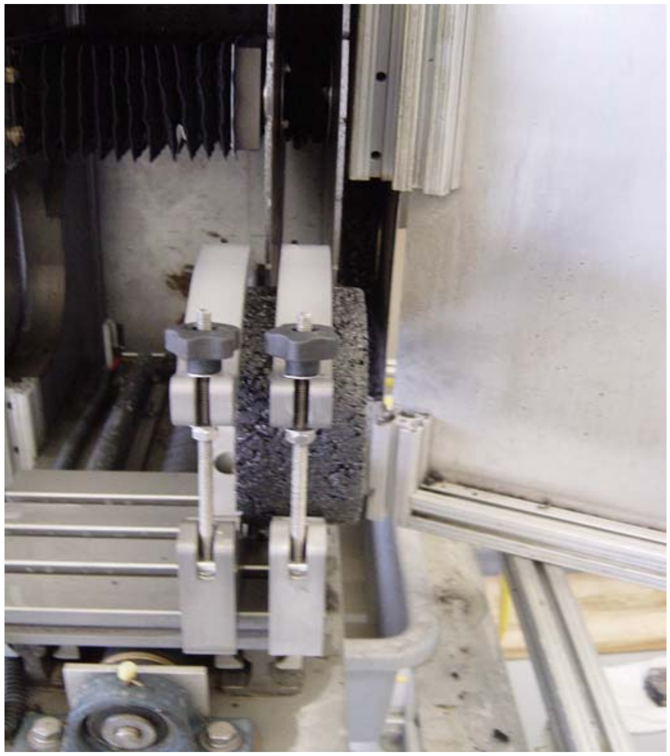

Figure 6. Specimen Core after Clamping Down for 1.5 in (38 mm) Cutting.

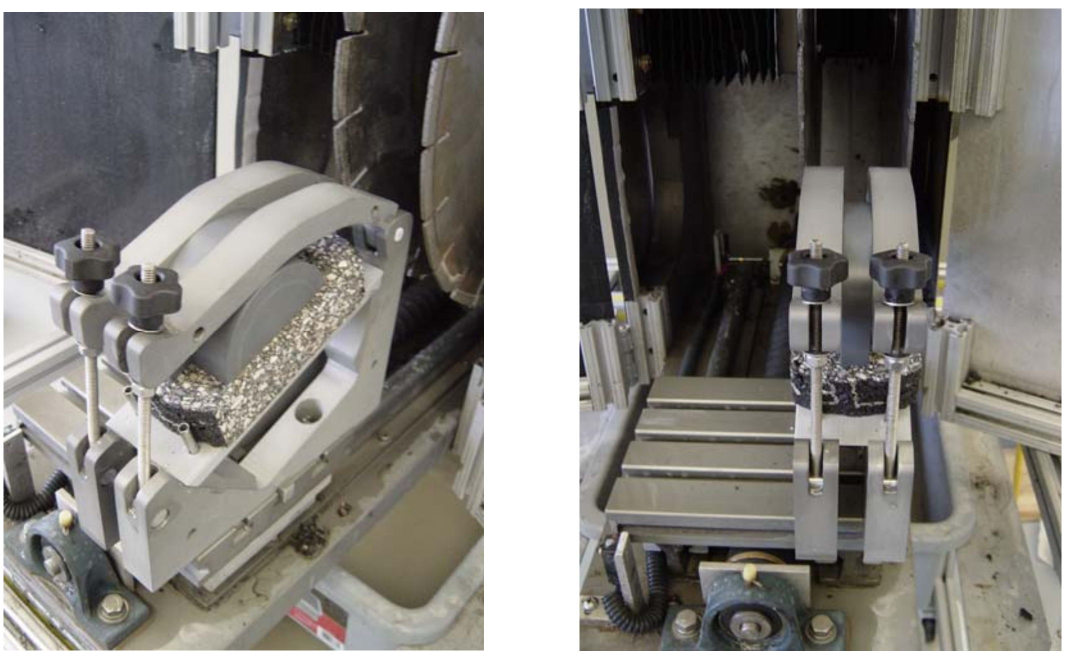

Figure 7. Finished 3 in (76 mm) Wide Specimen after Cutting.

DOUBLE-BLADE SAW TESTING

More than 50 OT specimens have been cut using the double-blade saws since these saws were delivered to TTI on October 31, 2007. Figure 8 shows some of the OT specimens cut from the double-blade saws, and most of the specimens meet the cutting tolerance of ± 0.01 in. The only concern TTI researchers have is the tiny bend of the cutting blade. Consequently, the specimen size is potentially different, depending on the aggregate type. For example, an HMA mix with hard crushed gravel potentially opens up the double blades a small amount; however, that is not the case for soft limestone. After communicating this concern to the manufacturer, two steps have been taken to address this issue. The first step was to reduce the blade traveling speed, which can minimize the influence of the aggregate type; and the second step was to change the calibration factor for each specific aggregate type. Since making these adjustments all of the specimens cut from these saws meet the required tolerances.

Figure 8. OT Specimens Cut from Double-Blade Saw.

RECOMMENDATION

In general, these double-blade saws are very accurate, safe, and ready for each District to use. Most of the OT specimens cut from these saws meet the tolerance requirement. The only reminder is that re-calibration may be necessary for different types of aggregates.

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APPENDIX A

SPECIFICATIONS FOR THE OVERLAY TESTER

OVERLAY TESTER SYSTEM

The Overlay Tester System shall include 1) loading machine, 2) environmental chamber, 3) load and deflection measuring system, 4) specimen mounting system, 5) computer control and data acquisition system, and 6) calibration kit (optional). The Overlay Tester System shall be capable of performing cyclic testing on specimens cut into a rectangular cross section from cores and molded specimens.

The Overlay Tester System must include the following items:

A) Overlay Tester Machine (1 each): A complete, fully integrated testing system. It includes the load frame, environmental chamber, and computer control system.

B) Setup Plate (1 each).

C) Specimen mounting plates (9 pairs). Price is per pair (i.e. quantity 1 each is two pieces).

D) Calibration kit (1 each).

SPECIFICATIONS

Loading Machine

A) Applies repeated direct tension loads to trimmed laboratory prepared specimens or field cores in the horizontal plane.

B) Features a fixed platform and a moving platform to which the specimen plate is mounted.

C) Includes a wide, low profile linear rail bearing system to move the platform.

D) With a displacement measurement and control sensor to measure the displacement between the platforms parallel to the loading direction.

E) Includes a plus or minus 0.1 in LVDT for measurement and control.

F) Shall have a closed-loop control capable of applying triangular loading waveforms in displacement control for testing, and load control for specimen setup with a closure rate for feedback of 1 kHz or faster.

G) Must be of servo-hydraulic system; however, other systems may be used if they are shown to be equal to, or surpass, hydraulic system performance.

H) Shall operate on single phase 115-120 VAC/60 Hz electrical power.

I) Shall include caster wheel for moving and leveling feet for placement and operation.

Environmental Chamber

A) Environmental chamber capable of controlling the test temperature in the test space over the range from -5 to +40 ºC (23 to +104 ºF), when room temperature is between 65 and 80 ºF.

B) Capable of accommodating the test specimen.

C) Allows the operator to view the specimen and the dial indicator during the test.

D) Designed for rapid installation of the test specimen and subsequent equilibration of the chamber temperature to the target temperature.

E) A temperature sensor shall be mounted in the chamber to control the temperature and provide continuous temperature readings during the test.

Deflection and Load Measuring System

A) Electronic displacement measuring system with a range of at least plus or minus 0.1 in with a throughput resolution of 0.0001 in or better.

B) Additional mechanical dial indicator shall be installed for visual indication of movement.

C) Electronic load measuring system with a full-scale range of plus or minus 5 kip and accuracy of 0.25 percent of full-scale or better.

Specimen Mounting System

Specimen Mounting Plates

Mounting plates are required to glue the testing specimen on them.

1. Aluminum or steel plates must have grooves cut in the top perpendicular to the loading direction with dimensions approximately 1/8 in wide, 1/16 in deep, spaced 1/4 in apart or other suitable design to ensure no movement occurs between sample and glue joint on mounting plate.
2. Plates must be capable of handling a maximum specimen length of 8 in. and a specimen width of 3 in.
3. Plates shall be approximately 3/4 in thick and shall be manufactured in matched pairs to minimize height differences, with each pair uniquely marked for identification.
4. Each plate shall have screws or suitable rigid mounting system to attach the plate to the platform.
5. Shear pins or keys shall be incorporated into the system to ensure alignment and minimize slippage of the plates.

Setup Plate

1. Setup plate allows precision alignment and simultaneous glue-up of up to three specimens at a time.
2. The spacing between the two halves of the mounting plates when positioned on the setup plate shall be 0.08 in (2 mm).

Computer Control and Data Acquisition System

Main Control and Data Acquisition Program

1. System shall be controlled from a personal computer user interface specifically designed to conduct the test.
2. The period and amplitude of the triangular waveform shall be selected by the user.

3. The software shall cycle the loading in displacement feedback control during the testing phase.
4. The data acquisition rate shall be 10Hz or faster. All data to include, as a minimum, time step, load, and displacement shall be stored in an Excel compatible file format.
5. Temperature readings may be stored at the same acquisition rate or slower.
6. The file will contain header information that is entered by the user.
7. The software must stop the test when either the machine reaches the maximum number of cycles or the target load drop.
8. The load drop is calculated as a drop from the initial peak load.
9. A visual display of load and displacement versus time or cycle number should be presented during the test.
10. The software should incorporate limit controls in order to avoid hardware damage during testing.

Calibration Control System

1. A calibration control program shall be provided.
2. The program should allow “jogging” to various load levels for calibration purposes.
3. Either load or displacement control may be selected.

Data Reduction and Reporting Feature

1. A program shall be provided to reduce the test data.
2. The software should read the data and plot the load peaks versus the cycle number or time.
3. One-page summary report shall be available.

Calibration Kit

Equipment for verification process shall be provided as part of an optional calibration kit. The kit shall contain 1) mounting system for installing the verification instrument in the machine for testing, 2) load verification device, 3) gauge blocks or thickness gauges, and 4) a polymer specimen that yields approximately 1200 lb load (plus or minus 150 lb) at 0.025 in displacement at room temperature.

Prior to shipment, the complete Overlay Tester shall be assembled at the manufacturer’s facility and calibrated. The results of these calibrations shall be provided with the system documentation.

The equipment furnished under this specification must be the latest improved model in current production, as offered to commercial trade, and be of quality workmanship and material. All equipment offered under this specification shall be new. Used, shopworn, demonstrator, prototype or discontinued model is not acceptable.

The instrument will be delivered with a current manual containing illustrated parts list, operating, calibration, and service instructions.

All equipment ordered will be subject to acceptance inspection and performance testing upon receipt. The vendor will be notified of any unit not delivered in full compliance with the purchase order specifications.

Documentation

An operator’s manual shall be provided. The manual may be provided as a PDF computer file.

Warranty

The Overlay Tester System shall carry a one-year parts and labor warranty.

APPENDIX B

SPECIFICATIONS FOR THE DOUBLE-BLADE SAW CUTTING SYSTEM

This specification describes the requirements for a laboratory cutting system to cut test specimens from cores and molded specimens. The device is required to cut two types of specimens, a cylindrical specimen with parallel end surfaces, and a rectangular cross section beam specimen. The specimens are usually hot-mix asphalt materials.

TEST SPECIMENS

Test specimens for the Overlay Tester System will be cut from cylindrical samples using this device. This is the primary application for the saw. A 6 in (150 mm) diameter sample from a field core or compacted with a gyratory compactor is the standard configuration and this sample is then cut to produce a specimen that is 1.5 in tall by 3.0 in wide by 6 in long. The 1.5 in and 3.0 in cross section dimensions have a tolerance of better than plus or minus 0.01 in. Opposite faces shall be parallel within 1 degree. The ends of the specimen are not cut, so the ends have a 3.0 in (75 mm) radius of curvature, and the 6 in length tolerance is not specified since it can come from either a molded sample or a coring rig. The length will normally be between 5.906 in (approximately 150 mm) and 6.125 in.

Secondary applications for the saw include:

1. Sawing the ends of a tall cylindrical sample (either 6 in [150 mm] or 4 in diameter) to achieve a height of 5.906 in plus or minus 0.098 in, with ends parallel within 1 degree and flat within 0.012 in (e.g., for use in simple performance/hot-mix asphalt testing machines), and

2. Sawing a cylindrical sample to provide various height cylinders (e.g., "pucks") for testing in indirect tension, Hveem stabilometer, or Hamburg type wheel loading machines.

SAW CUTTING SYSTEM SPECIFICATIONS

The saw shall be a complete, fully integrated system meeting the requirements of these specifications. The Saw Cutting System shall include the following components:

1. User interface/control panel.
2. Two diamond cutting blades.
3. Power and power transmission system.
4. Automated cut dimension positioning system.
5. Automatic feed.
6. Coolant system (e.g. closed fluid recirculation system).
7. An enclosure around the moving parts of the machine (e.g., blades and autofeed system) shall be provided. The enclosure is not required to be watertight, but shall provide protection for the operator from particles of asphalt/aggregate when the enclosure door(s) are shut. A simple visual mechanical or electronic indication that the door(s) are securely closed is required. An over-center latch and/or spring loaded latch pin is sufficient to meet this requirement.

8. Clamp(s) shall be provided to securely clamp the original sample for sawing the test specimens described in the previous section.

The saw cutting system shall occupy a footprint no greater than 5 ft (1.5 m) by 5 ft (1.5 m) with a maximum height of 6 ft (1.8 m). The system shall operate on single-phase 115 or 230 VAC 60 Hz electrical power.

When disassembled for shipping or moving, at least one dimension of any single component shall not exceed 30 in (76 cm). The machine shall have both caster wheels for moving and leveling feet for placement and operation. The minimum cut spacing required is 1.5 in or less, and the maximum cut spacing required is 6.0 in or more. The clamping system shall accommodate 6 in nominal diameter specimens (standard) and have provision for 4 in nominal diameter specimens. The automated cut dimension positioning system shall be calibrated by the manufacturer prior to delivery.

SOFTWARE/FIRMWARE CONTROL SYSTEM

The user interface shall provide the operator with the capability to enter dimensions for the cut spacing. During positioning for the desired cut spacing, the blade drive motor and feed motor shall be locked out from operation. When the machine run button is pushed, the blade drive motor and feed system are enabled, and the saw shall automatically feed to cut the specimen, then return to the starting position and turn off the feed and drive systems.

DOCUMENTATION

An operator’s manual shall be provided. The manual may be provided as a PDF computer file.

WARRANTY

The double-blade saw system shall carry a one-year parts and labor warranty.