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TEST REQUESTED BY: Regan Scientific Instruments

TEST METHOD: ASTM F2508-16 “Standard Practice for Validation, Calibration, and Certification of Walkway Tribometers Using Reference Surfaces”, Section 16.2.2 Interlaboratory Study (ILS) according to ASTM E691

Informal Test Method Description: This practice provides a walkway tribometer supplier with a procedure and suite of reference surfaces to validate his walkway tribometer by properly ranking and differentiating the surfaces. This section specifically describes the interlaboratory study procedure for walkway tribometers using the suite of reference surfaces.

This summary is provided for the reader’s convenience and is not a complete description of the method. See ASTM F2508 and ASTM E691 for all method details and information.

TRIBOMETER TESTED: Model Name: “**BOT 3000E**”

TEST DATE: 3/12/2018 – 5/17/2018

TEST PROCEDURE NOTES:

- Six (6) different BOT 3000E devices were used in the study. Each device was operated by a different operator.
- Each device/operator tested the four reference surfaces according to the method, 3 times.
- The reference surfaces RS A, RS B, RS C, and RS D were obtained from ASTM in February 2011. The surfaces have been maintained in a temperature and humidity controlled environment.
- The tiles were cleaned according to section 8.2.1 of ASTM F2508 prior to testing in between each set of 24 measurements.
- The SBR sensor was resurfaced according to the sensor resurfacing procedure found in ANSI A326.3. Throughout testing, the sensor was resurfaced every four measurements as specified in ANSI A326.3.
- Testing was conducted in a temperature and humidity controlled laboratory maintained at 70°F - 77°F and 50% ± 5% relative humidity.
- Each reference surface was tested according to the procedure in ASTM F2508.
 - RS A was tested in the wet condition with 0.04% by volume solution of Triton X-100, and the other three reference surfaces were tested in the wet condition with de-ionized water.
 - 24 measurements were made on each surface, 6 measurements in each of 4 orthogonal directions.
- After the data was collected, it was analyzed according to ASTM E691 “Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method”.



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PRECISION STATEMENT:

The following table was created based on the ASTM E691 suggested format for presentation of the precision of a test method.

MATERIAL	\bar{x}	$s_{\bar{x}}$	s_r	s_R	r	R
RS-A	0.30	0.01	0.02	0.02	0.06	0.06
RS-B	0.29	0.02	0.01	0.02	0.04	0.06
RS-C	0.58	0.02	0.02	0.02	0.05	0.07
RS-D	0.86	0.03	0.03	0.04	0.08	0.10

\bar{x}	Overall average
$s_{\bar{x}}$	Standard deviation
s_r	Repeatability standard deviation
s_R	Reproducibility standard deviation
r	Repeatability
R	Reproducibility

DEFINITIONS:

Repeatability: Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the “r” value for that material; “r” is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day. “Sr” represents the repeatability standard deviation.

Reproducibility: Two test results shall be judged not equivalent if they differ by more than the “R” value for that material; “R” is the interval representing the difference between two test results for the same material, obtained by different operators using different equipment. “SR” represents the reproducibility standard deviation.

OBSERVATIONS:

The testing was performed by six (6) different operators with varying levels of experience with the BOT 3000E. Some had very little experience and others had extensive experience, working with the equipment on a daily basis. Even with varying levels of experience, there were no outliers identified in the ASTM E691 calculations. The “h” and “k” consistency statistics can be found in the appendix of this report. The “h” value being the between-laboratory consistency statistic and the “k” value being the within-laboratory consistency statistic.

The repeatability and reproducibility reported above were similar to that of the data collected during a previous interlaboratory study performed during the development of the ANSI A137.1 DCOF test method. That study, completed in 2011, showed repeatability and reproducibility results comparable to those above, when comparing surfaces in similar DCOF ranges. The previous ILS was performed using the BOT 3000, the predecessor to the BOT 3000E device. The 2011 ILS data was first published in ANSI A137.1, and subsequently in ANSI A326.3.



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APPENDIX: Interlaboratory Study Data

\bar{x}	Average
s	Standard deviation
d	Deviation from material average
h	Between-laboratory consistency statistic (outlier if ± 1.92 based on 0.5% Significance level)
k	Within-laboratory consistency statistic (outlier if ± 1.98 based on 0.5% Significance level)
$s_{\bar{x}}$	Overall Standard deviation
s_r	Repeatability standard deviation
s_L	Between-laboratory standard deviation
s_R	Reproducibility standard deviation

RS-A

Lab	1	2	3	\bar{x}	s	d	H	k
1	0.29	0.28	0.28	0.28	0.01	-0.02	-1.64	0.28
2	0.29	0.28	0.33	0.30	0.03	0.00	0.18	1.27
3	0.32	0.31	0.25	0.29	0.04	-0.01	-0.55	1.82
4	0.31	0.31	0.28	0.30	0.02	0.00	0.18	0.83
5	0.32	0.31	0.30	0.31	0.01	0.01	1.28	0.48
6	0.31	0.30	0.30	0.30	0.01	0.00	0.55	0.28
			\bar{x}	0.30				
			$s_{\bar{x}}$	0.01				
			s_r	0.02				
			s_L	0.00				
			s_R	0.02				

RS-B

Lab	1	2	3	\bar{x}	s	d	h	k
1	0.30	0.29	0.33	0.31	0.02	0.02	0.85	1.43
2	0.32	0.31	0.28	0.30	0.02	0.01	0.66	1.43
3	0.27	0.26	0.27	0.27	0.01	-0.03	-1.41	0.40
4	0.28	0.29	0.26	0.28	0.02	-0.02	-0.85	1.05
5	0.30	0.32	0.31	0.31	0.01	0.02	1.03	0.69
6	0.29	0.29	0.28	0.29	0.01	-0.01	-0.28	0.40
			\bar{x}	0.29				
			$s_{\bar{x}}$	0.02				
			s_r	0.01				
			s_L	0.02				
			s_R	0.02				



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RS-C

Lab	1	2	3	\bar{x}	s	d	h	k
1	0.58	0.57	0.61	0.59	0.02	0.01	0.37	1.14
2	0.58	0.57	0.57	0.57	0.01	-0.01	-0.31	0.32
3	0.56	0.58	0.55	0.56	0.02	-0.02	-0.83	0.84
4	0.57	0.54	0.55	0.55	0.02	-0.03	-1.34	0.84
5	0.59	0.64	0.58	0.60	0.03	0.02	1.23	1.76
6	0.59	0.60	0.60	0.60	0.01	0.02	0.88	0.32
			\bar{x}	0.58				
			$s_{\bar{x}}$	0.02				
			s_r	0.02				
			s_L	0.02				
			s_R	0.02				

RS-D

Lab	1	2	3	\bar{x}	s	d	h	k
1	0.86	0.87	0.94	0.89	0.04	0.03	0.94	1.47
2	0.90	0.90	0.88	0.89	0.01	0.03	1.06	0.39
3	0.84	0.81	0.82	0.82	0.02	-0.04	-1.51	0.52
4	0.87	0.80	0.86	0.84	0.04	-0.02	-0.78	1.28
5	0.87	0.90	0.85	0.87	0.03	0.01	0.33	0.85
6	0.87	0.89	0.83	0.86	0.03	0.00	-0.04	1.03
			\bar{x}	0.86				
			$s_{\bar{x}}$	0.03				
			s_r	0.03				
			s_L	0.02				
			s_R	0.04				

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6/4/2018

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TEST REQUESTED BY: Regan Scientific Instruments

ASTM F2508-16 “Standard Practice for Validation, Calibration, and Certification of Walkway Tribometers Using Reference Surfaces” – Walkway Tribometer Validation

Informal Test Method Description: This practice provides a procedure and suite of reference surfaces to validate a walkway tribometer by properly ranking and differentiating the surfaces. This summary is provided for the reader’s convenience and is not a complete description of the method. See ASTM F2508 for all method details and information.

TRIBOMETER TESTED: Model Name: BOT 3000E
Tribometer Serial #: VS901265800358
Calibration Due Date: 11/03/2017
Test Foot: Sensor #03298, SBR rubber, approximately 1"x1", manufactured: 12/21/2015

TEST DATE: 1/24/2017

TEST PROCEDURE NOTES:

- The reference surfaces RS A, RS B, RS C, and RS D were obtained from ASTM in February 2011. The surfaces have been maintained in a temperature and humidity controlled environment and are in acceptable condition for testing.
- The tiles were cleaned according to section 8.2.1 of ASTM F2508 prior to testing.
- The SBR sensor was resurfaced according to the sensor resurfacing procedure found in ANSI A137.1, section 9.6.1.3. Throughout testing, the sensor was resurfaced every four measurements as specified in ANSI A137.1.
- Testing was conducted in a temperature and humidity controlled laboratory maintained at 70°F - 77°F and 50% ± 5% relative humidity.
- Each reference surface was tested according to the procedure in ASTM F2508.
 - RS A was tested in the wet condition with 0.04% by volume solution of Triton X-100, and the other three reference surfaces were tested in the wet condition with de-ionized water.
 - 24 measurements were made on each surface, 6 measurements in each of 4 orthogonal directions.

TEST RESULTS:

Reference Surface Results (based on 24 measurements)				
	RS A	RS B	RS C	RS D
Mean	0.22	0.26	0.40	0.79
SD	0.03	0.02	0.02	0.01
SE	0.007	0.005	0.004	0.002
CI -	0.20	0.25	0.39	0.79
CI +	0.23	0.27	0.40	0.80

Differences Between Adjacent Ranked Surfaces (based on 24 pairs)			
	RS A - RS B	RS B - RS C	RS C - RS D
Mean Difference	-0.04	-0.14	-0.40
SD	0.025	0.034	0.021
t	7.727	20.143	91.890

Note: All descriptions of calculations can be found in ASTM F2508. SD: Standard Deviation, SE: Standard Error of the Mean, CI+/-: 95th percentile confidence intervals, t: paired t-test value

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CONCLUSIONS:

Rank Order: ASTM F2508, section 9.2.1 states that the rank order of the mean walkway tribometer results shall be RS A < RS B < RS C < RS D.

The BOT 3000E (Serial #: VS901265800358) ranked the reference surfaces in the following order, RS A (0.22) < RS B (0.26) < RS C (0.40) < RS D (0.79)

Differentiation: ASTM F2508, section 9.2.2 states that using the mean and standard deviation, paired *t*-tests shall produce significantly different results for all adjacently ranked reference surfaces, that is between RS A and RS B, RS B and RS C, and RS C and RS D. As stated in Annex A2 of ASTM F2508, the *t* critical value is 1.714 which assumes one-tailed *t* test (used when there is an expectation of a significant difference between groups), 23 degrees of freedom (number of pairs -1), and 0.05 level of significance. A calculated *t* value greater than or equal to 1.714 indicates a statistically significant difference exists between reference surfaces.

The calculated paired *t*-test results for the measurements with the BOT 3000E (Serial #: VS901265800358) were as follows:

RS A – RS B, *t*=7.727

RS B – RS C, *t*=20.143

RS C – RS D, *t*=91.890

Based on the results above, the BOT 3000E (Serial #: VS901265800358) met the requirements established in ASTM F2508 for walkway tribometer validation.

IMAGES:



Image 1: BOT 3000E (Serial #: VS901265800358)

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Image 2: Reference Surface A



Image 3: Reference Surface B



Image 4: Reference Surface C



Image 5: Reference Surface D



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RAW DATA:

	RSA	RSB	RSC	RSD
1	0.28	0.28	0.41	0.77
2	0.26	0.24	0.43	0.81
3	0.21	0.25	0.38	0.77
4	0.21	0.24	0.41	0.80
5	0.26	0.24	0.39	0.80
6	0.21	0.26	0.44	0.81
7	0.18	0.23	0.39	0.80
8	0.19	0.23	0.40	0.80
9	0.25	0.29	0.42	0.79
10	0.23	0.26	0.42	0.80
11	0.18	0.25	0.38	0.78
12	0.19	0.25	0.41	0.80
13	0.25	0.29	0.36	0.78
14	0.25	0.29	0.41	0.79
15	0.20	0.23	0.37	0.79
16	0.20	0.23	0.39	0.78
17	0.24	0.28	0.37	0.78
18	0.20	0.24	0.40	0.79
19	0.19	0.26	0.39	0.80
20	0.18	0.25	0.42	0.77
21	0.27	0.31	0.36	0.80
22	0.20	0.28	0.39	0.79
23	0.18	0.22	0.38	0.80
24	0.18	0.23	0.39	0.79

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6/8/2017

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