C38 The Effect of Polyethylene Shoe Covers on the Available Friction of Reference Surfaces

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The goals of this presentation are to demonstrate the effect of an intermediate layer of textured polyethylene material on available friction and also show the value of the protocol described in ASTM F2508 Standard Practice for Validation and Calibration of Walkway Tribometers using reference surfaces.

This presentation will impact the forensic science community by demonstrating the importance of using reference surfaces to evaluate available friction.

Method: ASTM F2508 was used as a reference to measure the effect of polyethylene shoe covers on test results using the prescribed reference surfaces with a validated and calibrated Mark II portable inclinable articulated strut tribometer. The reference surfaces were those included in the ASTM Adjunct to F2508 consisting of ADJF2508-T1 (Vinyl), ADJF2508-T2 (Ceramic), ADJF2508-T3 (Porcelain), and ADJF2508-T4 (Granite). An additional reference surface of 2”x10” pine was incorporated as an exemplar surface encountered on a basement stairway.

Service companies, such as plumbing, heating, H&V, moving, furniture, and flooring, routinely require their employees to wear shoe covers in an attempt to protect their customers’ flooring and walkway surfaces from tracked-in soil and moisture. The shoe covers vary in type and some are advertised as waterproof and slip resistant on household walkway surfaces. In particular, certain waterproof, slip-resistant, textured polyethylene shoe covers were used during a routine plumbing repair that resulted in an individual slipping and falling down a flight of 2”x10” pine basement stairs.

To determine the effect of the shoe covers on the available friction of the reference surfaces, adjunct tiles from ASTM were obtained along with the ASTM F2508-11 Standard Practice for Validation and Calibration of Walkway Tribometers using Reference Surfaces. A piece of 10-year-old 2”x10” pine board was also used as an exemplar of the incident stairway. Two materials were evaluated as shoe soling, a standard Neolite® sensor material, and the same material covered with the incident-textured, plastic waterproof shoe cover.

Forty tests for each surface/sensor condition were conducted: 10 in each of 4 orthogonal directions, that is, at 0°, 90°, 180°, and 270° relative to an arbitrarily defined direction on the reference surface. A total of 400 tests were conducted (10 replications x 4 directions x five surfaces [sample] x two sensors [columns]). The tests were analyzed using ANOVA: Two Factor with Replication. Direction was not included as it had been previously found to be insignificant. Surface [Sample] and Sensor [Columns] were both highly significant (*p*-values of 1.9E-142 and 0.00 respectively).

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample [Surface]	2.86855	4	0.717138	435.8955	1.9E-142	2.394824
Columns [Sensor]	26.91534	1	26.91534	16359.87	0	3.865413
Interaction	0.080276	4	0.020069	12.19848	2.36E-09	2.394824
Within	0.64163	390	0.001645			
Total	30.5058	399				

For the 40 tests on each reference surface, the mean, Standard Deviation (SD), Standard Error (SE) of the mean, and 95th percentile Confidence Interval (CI) for the walkway tribometer test results were calculated. Using the mean and standard deviation, paired *t*-tests determined statistically significantly different results (t >1.694) for both sensors on all reference surfaces. (Neolite® — shoe-covered Neolite®).

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Granite using standard Neolite®			Granite using shoe covered Neolite®			Paired t-test difference	
Mean	1.00		Mean	0.47		Mean Diff	0.529
Std Dev	0.000		Std Dev	0.045		Std Dev	0.045
Std Error	0.000		Std Error	0.007		T	74.403
95% CI	1.000	1.000	95% CI	0.48542	0.45758	t-test	>1.694
Porcelain using standard Neolite®			Porcelain using shoe covered Neolite®			Paired t-test difference	
Mean	0.833		Mean	0.333		Mean Diff	0.500
Std Dev	0.053		Std Dev	0.038		Std Dev	0.048
Std Error	0.0084		Std Error	0.0060		T	65.607
95% CI	0.84976	0.81674	95% CI	0.34477	0.32123	t-test	>1.694
VC tile using standard Neolite®			VC tile using shoe covered Neolite®			Paired t-test difference	
Mean	0.798		Mean	0.283		Mean Diff	0.515
Std Dev	0.091		Std Dev	0.012		Std Dev	0.094
Std Error	0.0143		Std Error	0.0020		T	34.830
95% CI	0.82612	0.76988	95% CI	0.28659	0.27891	t-test	>1.694
Ceramic using standard Neolite®			Ceramic using shoe covered Neolite®			Paired t-test difference	
Mean	0.996		Mean	0.513		Mean Diff	0.483
Std Dev	0.014		Std Dev	0.015		Std Dev	0.018
Std Error	0.0021		Std Error	0.0023		T	173.678
95% CI	1.00044	0.99206	95% CI	0.51756	0.50844	t-test	>1.694
2 x 10 Pine using standard Neolite®			2 x 10 Pine using shoe covered Neolite®			Paired t-test difference	
Mean	0.900		Mean	0.333		Mean Diff	0.567
Std Dev	0.033		Std Dev	0.016		Std Dev	0.041
Std Error	0.0052		Std Error	0.0026		T	86.950
95% CI	0.90979	0.88921	95% CI	0.33781	0.32769	t-test	>1.694

It was clear the presence of the textured polyethylene plastic, waterproof shoe covers lowered the available friction of the reference surfaces and presented a slip hazard to the individual wearing them.

An additional paired t-test was done using the inside surface of the shoe cover as the walkway surface and standard Neolite® as the sensor under wet and dry conditions to determine the effect of moisture on the inside of the shoe cover.

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Shoecover using std Neolite® dry			Shoecover using std Neolite® wet			Paired t-test difference	
Mean	0.616		Mean	0.089		Mean Diff	0.527
Std Dev	0.025		Std Dev	0.018		Std Dev	0.027
Std Error	0.0039		Std Error	0.0028		T	123.577
95% CI	0.62343	0.60807	95% CI	0.09401	0.08299	t-test	>1.694

The shoe cover also presented a hazard to the wearer if used over wetted shoe soles.
Shoe Covers, Slip Resistance, Reference Surfaces

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