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Coefficient of Friction Test

Testing Location:

Sample Concrete Tile

Hartstone Tile, Inc.
Glenview, Kentucky, 40025

Prepared by:

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The Science of Slip Fall Measurement

1. Testing the slip resistance of a walkway surface is a scientific method of gauging how safe the surface is for the average human to navigate. Various factors can contribute to a slippery condition of the floor, the actual floor surface, i.e. the floor finish, the extent of honing to the surface, the products used to maintain the surface, the polish or floor wax being applied and the extent that foreign substances may have contaminated the floor surface. The likelihood that a floor surface has a slippery condition when walked on is greatly increased when a contaminant, something as simple as rainwater or soda, is present. This greatly increases the chances that the 'hydroplaning effect' will accelerate underfoot and change the dynamics of the floor surface making the floor much more slippery when wet and much more difficult to navigate.

1.1 The primary function of performing slip resistance measurements is to determine what extent a surface can contribute to a slip and fall event. Various standards have been written and published that are specifically designed to address many of the guidelines for slip resistant surfaces. ASTM A 1264.2, ASTM C-1028, ANSI-B101.1, and DIN 51130, all embrace attributes that will help quantify what could be considered a slippery floor surface.

2. Slip Resistant Measurement Definitions/Standards

2.1 The coefficient of friction is a term which assigns a value of resistance to movement between two surfaces. When the coefficient of friction (COF) is measured from a resting position, it is called the "static coefficient of friction" (SCOF). When the coefficient of friction is measured with two surfaces in relative motion, it is called the "dynamic coefficient of friction" (DCOF). Industry consensus has demonstrated that the dynamic COF value is a more realistic evaluation of the slippery condition of the floor surface, since the majority of all slip and fall events happen when the individual is in motion.

The testing device utilized by Nu-Safe (BOT 3000) has passed the independent Precision and Bias testing protocol and is currently recognized throughout Europe, the US and numerous other countries as a consistently reliable means of measuring both dynamic coefficient of friction and static coefficient of friction testing for wet and dry conditions. It is now recognized as a state of the art instrument for measuring both SCOF and DCOF by The Tile Council of North America, ANSI, ASSE, and ASTM.

Hard tile and concrete surfaces that do not require a topical coating be applied, such as a floor finish, utilize an industry standard referenced as the **ASTM C-1028**, or, **ANSI B101.1** for measuring the COF value of the floor when wet. Vinyl Composition Tile, or tile requiring a floor finish, uses the industry standard for testing dry COF values as performed by the **James Machine** referencing the **ASTM F-489** Standard. Although this standard has been withdrawn, it is still commonly referenced by the apparatus

used to conduct the tests and is still used as the standard for the industry for floor finishes.

Another recognized standard for measuring coefficient of friction uses a rubber sensor for wet conditions on hard tile and concrete surfaces. This standard is based on the University of Wuppertal in Germany's findings as defined in a test commonly called the **German Ramp Test** or the **DIN 51130 Standard.** This test has gained International recognition as one of the most realistic methodologies for testing wet dynamic coefficient of friction for hard tile and concrete surfaces. This test method is mimicked using the BOT-3000 with an SBR rubber sensor for wet testing of surfaces.

Since the dynamic coefficient of friction is more recognized as a realistic means to define slip resistance values representative of real world experience, the BOT 3000's highly sensitive and consistent readings are providing documentation for several insurance companies, architects, and floor finish companies in the U.S. to quantify what constitutes a safe floor surface. (www.reganssci.com). The COF values presented in this report are representative of DCOF values, unless otherwise noted.

Scientific Equipment For COF Report

3.1 The BOT 3000 Slip Tester was designed by a German Company in accordance with the German Ceramic Research Association after undertaking detailed research into the action of people's feet on floors while walking. The main conclusion of this work was that the most critical time occurs as the edge of the heel of the shoe contacts the floor. At this point, the heel moves across the floor surface, albeit a very small movement during normal, safe walking. The amount of movement will increase on floors with poor slip resistance properties; possibly to a point when there will not be enough resistance to stop the heel from accelerating. At this point, the walker will lose control and slip in a manner in which it will be extremely difficult to recover and will, therefore, fall. The BOT 3000 is a precision instrument, which reproduces the action of the heel moving across the floor surface. It measures the slip resistance by sliding a leather, rubber or neolite pad across a floor and provides a direct reading of the static, dynamic and even replicates the James Machine coefficient of friction between the pad and the floor.

The BOT 3000 has been accepted by ANSI, ASSE, ASTM and numerous other standard writing agencies as a valid measuring device. OSHA has acknowledged that COF testing is a valuable safety approach as long as the test device can validate an acceptable degree of repeatability and re-productibility. The BOT 3000 completed the **ASTM E-691-99** "Inter-laboratory Study to determine the Precision of a Test Method" with results consistent with the level established by ASTM. It is the only scientific instrument for measuring the COF values that has published the Precision and Bias studies to date.

Instructions Received:

A Nu-Safe Floor Solutions Technician, Ken Fisher, performed several coefficient of friction tests on a sample of concrete received from Hartstone Tile Inc. As directed by Mr. Ron McLeod with Hartstone Tile, several COF tests were conducted on the sample surface. The coefficient of friction (COF) tests were performed in multiple directions to determine an average COF value of the floor surface when wet. The wet SCOF and DCOF tests were conducted using distilled water and a rubber and neolite sensor that had been properly maintained to prevent buildup of contaminants, which could affect the COF test results. Dry SCOF tests were conducted using a leather sensor. Static wet COF tests were conducted and DCOF tests were performed. The results are to be recorded and documented using the BOT 3000 slip meter.

Summary of Results

The COF values for the sample concrete tested in an 'as is' state revealed an excellent slip resistance level in accordance to the generally accepted regulatory standards of .50 wet and dry walkway surfaces. All COF tests below exceeded the regulatory standards as outlined below:

SCOF ANSI B101.1-wet	DCOF-German Ramp DIN 51130 Standard-wet	SCOF-James Machine ASTM F-489 Standard-Dry
1.00	.82	.83
0.99	.92	.89
0.98	.77	.95
0.99	.91	.89
Avg 0.99	.86	.89

Traction Ranges Defined in the ANSI B101.1-2009 Standard

WET SCOF Value (μ)	Available Traction	Remediation
$\mu \geq 0.60$	High: lower probability of slipping	Monitor SCOF regularly and maintain cleanliness
$0.40 \leq \mu < 0.59$	Moderate: increased probability of slipping	Monitor SCOF regularly and maintain cleanliness; consider traction-enhancing products and technologies
$\mu < 0.40$	Minimal available: higher probability of slipping	Seek professional intervention; consider replacing flooring and/or coating with high-traction products