## C24 An Analysis of Test-Foot-Acclimation Issues in Walkway Safety Tribometry

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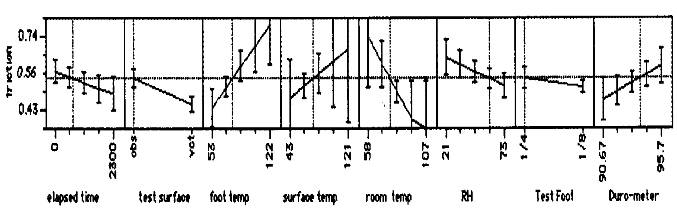
The goals of this presentation are to (1) to allow practitioners to assess potential problems from not acclimating test feet before starting testing, and (2) to provide information useful in the walkway-safety tribometry standards-development process.

**Background:** The evaluation of the friction inherent between a walkway and a shoe bottom (or shoe-bottom surrogate, called a test foot) is important because fall accidents represent the second largest generator of accidental-injury costs in the U.S. Because resilient-material friction does not necessarily follow the rather simple college-physics friction model (called the Amontons-Coulomb model where friction is independent of temperature, contact time, etc.), questions of the metrology of slip resistance become significant. This brief paper explores issues in the measurement of pedestrian-walkway friction, namely, the effect of having a test foot and test surface at different temperatures and, more generally, the temperature effects in friction testing.

**Experiment:** The testing was conducted in constanttemperature/humidity environments: a cold-room (kept at about 50°F, a room-temperature room (kept at about 70°F) and a hot-room (kept at about 105°F). Vinyl composition tile (commonly used in both walkways and as a reference surface in tribometric testing) and glass walkway tiles were utilized as test surfaces. Neolite® Test Liner, a commonly used tribometric test-foot reference material, was used as a test foot against these Surfaces. All tests were conducted under clean, dry conditions using a Slip Test Mark II Portable Inclineable Articulated Strut Tester (PIAST). The test surfaces and the tribometer were acclimated to the various room environments before testing; the test foot was brought into the testing environment at room temperature and testing was accomplished as the test foot came to the room's ambient temperature. During the testing, the friction between the test foot and test surface, the elapsed time, the test surface material, the test-foot thickness, the temperature and relative humidity of the room, and the temperatures of the test surfaces and the test foot were acquired and recorded. The latter two temperatures were acquired with a handheld remote-sensing infrared thermometer. For a subset of the tests, the durometer hardness of the test foot was acquired and recorded. Finally, the relationship between temperature and acclimation time was explored by taking the temperature of a test foot as it cooled from approximately 90°F to room temperature.

**Analysis:** A multivariate model was fit to the data, with friction (dimensionless) as the dependent variable and the test-surface material, test-foot thickness (inch), elapsed time (seconds), relative humidity (dimensionless), room temperature (°F), surface temperature (°F), and test-foot temperature (°F) as independent variables. The test-surface material (vinyl tile (vct) or glass (obs)) was highly significant ($p < 0.0001$). The test-foot temperature, relative humidity, and elapsed time were significant ($p = 0.0045$, 0.0156, and 0.0165, respectively). The room temperature was marginally significant ($p = 0.0626$). The test-foot thickness and surface temperature were not significant ($p > 0.15$ and 0.35

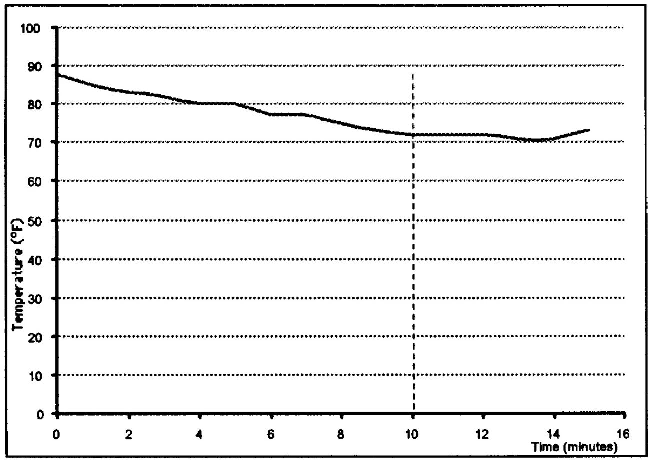
respectively). Durometer hardness was not utilized, as the data collection did not cover all the tests. Below are the prediction profiles, graphically displayed:




**Discussion:** While it is clear that there is a statistically significant effect due to test-foot temperature, that effect is slight: amounting to an increase in the friction coefficient by +0.005 per degree. Preliminary analysis of the relationship between temperature and the hardness of the test foot (not discussed in this paper) suggests that at least a part of the temperature/friction effect may be the effect of the change in test-foot hardness as a function of temperature. The elapsed-time effect, a stand in for acclimation effects, was significant.

The temperature vs. acclimation time graph is given below:

 ** Presenting Author*




**Recommendations:** Because tribometric results have at least a mild sensitivity to test-foot temperature, it is suggest that practitioners of walkway-safety tribometry acclimate the test feet used in testing for at least ten minutes so that the test feet and test surfaces are at least at approximately the same temperature before commencing testing. It would be expected that this would be true no matter which tribometer the practitioner chooses to use. As is recommended in many tribometric standards, the temperature and humidity of the environment should routinely be recorded.

**Future Research:** The temperature sensitivity of the various commonly used tribometric test materials needs to be further explored, as well as any interactions between temperature and humidity, and between temperature, test-foot hardness, and friction.

**Reference:** Marletta, William, *The Effects of Humidity and Wetness on Pedestrian Slip Resistance Evaluated with Slip Testing Devices on Selected Sole and Floor Materials:* Doctoral Thesis. New York University School of Education, 1994

**Forensic Sciences, Walkway-Safety Tribometry, Test-Foot Acclimation**