Updates to an American Method for Measuring Coefficient of Friction

By Eric Astrachan

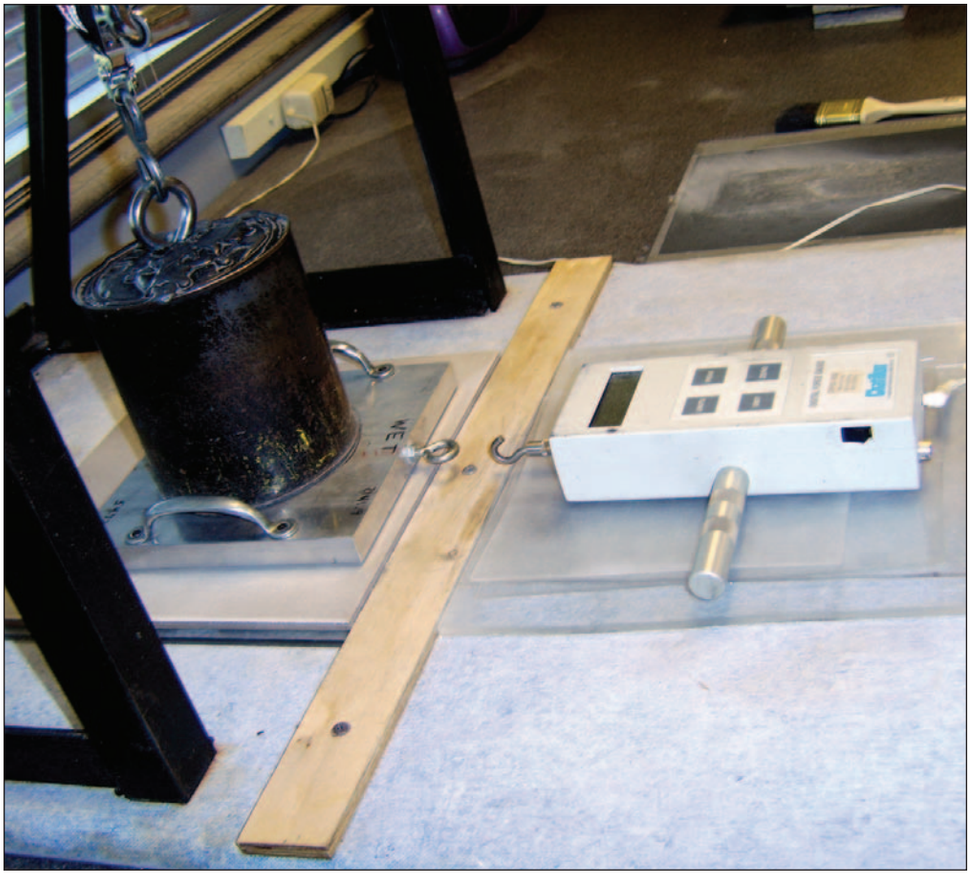
Did you know that the cost of injuries related to slips and falls exceeds 20 billion dollars a year in the United States? In addition to the medical costs and human suffering associated with slips and falls, there are also legal costs, which reportedly are second only to the costs of asbestos claims in the total value of awards made.

As good citizens, we are all concerned with how to reduce the number of such injuries that occur each year. As manufacturers, distributors, retailers, installers, or owners of floor tile, you could be involved in this issue.

This year, the method generally used in the tile industry for measuring the coefficient of friction of floor tile (ASTM C1028) was revised and updated. This article explains the most important revisions and provides some insight.

First, let's review some basic background information about ASTM C1028. "ASTM" stands for American Society for Testing and Materials. This is an international organization in which TCNA staff and many others in the tile industry belong, and whose members develop standards according to established international consensus rules. These standards can be "standard" test methods or criteria for the manufacture or use of various products. To be accepted as a standard requires a minimum of 90% consensus and the discussion of all negative opinions—a very high requirement indeed! "C1028" is the number assigned by ASTM, International to our tile industry standard method for measuring coefficient of friction.

To measure the friction between a surface and an object, you must first determine how much force is required to move an object horizontally across the surface. The heavier the object is, the more force required moving it—so we must also know the weight of an object to evaluate the frictional resistance (or resistance to movement between the object and the surface). The ratio of the horizontal force divided by the weight of an object (also called the vertical force or normal force), is the coefficient of friction (COF). The higher the coefficient of friction is, the more resistance there will be to movement. There are two more important terms: static COF and dynamic COF. Static COF refers to the coefficient of friction when an object is stationary; dynamic COF refers to the coefficient of friction when the object is already moving—i.e. the force required to keep an object already in motion—in motion. Dynamic COF is lower than static COF.



This is a horizontal dynamometer pull-meter testing assembly and weight, sitting atop a tile being tested at the TCNA laboratory.

This year when the ASTM C1028 method was revised and approved, there were three important changes:

- A new calibration tile was approved
- A table explaining the precision of the method was added
- The procedure for running the test was clarified

TESTING WITH A REFERENCE TILE

When measuring COF, many things can affect the measurement. This is especially important to remember if making measurements in the field (i.e. outside of a laboratory). It is well-established that temperature and humidity both affect the measurement of COF. For the same reason a basketball player dampens the soles of his shoes for better traction, humidity can increase the COF measured between a surface and the neolite sensor used to make the measurement. You can also understand how the preparation of the sensor can affect the measurement, so it is important to relate all measurements back to standard conditions. By checking a reference tile (or calibration tile) whose values are well-established, it is easy to insure correct COF measurements are being made. Compensation can also be made for small discrepancies through an arithmetic correction factor by comparing values measured in the field on the calibration tile to the values seen under standard conditions.

We have seen where unscrupulous litigants obscure this issue by manipulating the results they measure in the field and failing to correlate their measurements back to standard conditions. Because the existing supply of reference tiles was nearly exhausted, two new pallets were manufactured under controlled conditions for this purpose and generously donated by Dal Tile. The tile was tested extensively in our TCNA laboratory and in an official ASTM, International inter-laboratory study. The 2007 version of the C1028 method is based on this new reference tile. It includes an equation to correct results for reasonable variation in humidity, temperature, or sensor preparation. Methods that do not include a reference tile should be considered rather suspect, subject to manipulation, and not capable of comparison back to standard conditions.

For example, it is common for the architectural community to ask for tile with a static COF of 0.6 or better for public projects, with such values measured under standard conditions. Without a reference tile to check in-situ installations, there would be no reasonable way to determine if the completed project was being maintained according to the criteria set by the architect for floor traction.[1]

In addition to evaluating and establishing a new reference tile, the official inter-laboratory study evaluated the precision of the method on five differing surfaces, representing a cross-section of surfaces commonly found in tile installations. Understandably, the precision of the method will vary according to the variation in the surfaces being measured. This is because the values reported by the C1028 method are an average of four measurements (each in a different direction) taken on each of three tiles, for a total of twelve measurements. In this fashion, the C1028 test provides an average reading across a three-tile sample, and the more variation there is in the tiles being measured, the more variation there will be in the precision of the method.

After traveling to laboratories around the country as part of the effort to revise and improve this method, we were able to define tighter controls for how the method should be run to avoid errors being made in the field. These criteria, having to do with how to prepare the sensor to make a COF reading and how quickly to pull the weight, resulted in improvements in the preci-

[1]It is worth noting here that this common request for tile with a static COF of 0.6 or better stems from a now outdated ADA Access Board document in which a 0.6 static COF recommendation was made. Commonly misunderstood, this document never set a requirement and has now been withdrawn. The United States Access Board subsequently published a document called "Bulletin #4: Ground and Floor Surfaces" that clears up much of the confusion about this issue and which has no COF recommendation or requirement.

sion of the method, as seen when comparing the new precision section with the precision section before revision. The exact criteria for running the method are contained in the body of the test method itself.

USING THE TEST DATA

One thing the C1028 test method does not provide is how to interpret the results of the test. That is left to those using the data, and unfortunately the data is often misunderstood. The C1028 method provides a measurement of COF, which is but one of many criteria that should be considered when evaluating the slip potential of a surface.

When using C1028 data, one cannot assume a linear scale. For example, a tile that measures 0.6 when wet may have a low slip potential (i.e. be slip resistant), but a value of 0.4 is not 4/6ths (or 2/3rds) as slip resistant. That would assume a linear relationship, while in fact a tile with a value of 0.4 when wet can be quite slippery. Similarly, a tile with a value of 0.7 when wet often is much more slip resistant than a surface with a COF of 0.6.

It is also useful to evaluate the dynamic coefficient of friction when determining slip potential, as both static and dynamic COF are important when people walk on a surface. While the C1028 measurement does not provide a measurement of dynamic COF, the methods commonly used overseas (British Pendulum, TORTUS, and German ramp) do assess dynamic COF. We have seen that surfaces that have a high static and high dynamic COF (note—the dynamic value will be lower than the static value) generally have a low potential for slip. Similarly, surfaces with a low dynamic and static COF have a high slip potential, but surfaces with one value high and the other low may indicate an anomaly in how the coefficient of friction was determined. For example, it is well known that the German ramp tends to incorrectly report metal plates with a traction surface. Also, the British Pendulum can misread surfaces with an extensive amount of texture. The C1028 method can overreport highly polished surfaces that tend to "stick" (the way two glass plates will stick to each other when there is water between them). By comparing both dynamic and static values, a better assessment of the slip potential of a surface can be made.

Often plaintiffs in slip/fall litigation will try to substitute a dynamic measurement of COF for a static measurement. When comparing against a specified value (for example a static COF of 0.6), one cannot substitute one measurement for the other. Also, as noted previously, any measurement must be correlated back to what it would be under standard measurement conditions to avoid misleading data.

The Tile Council is now evaluating a device, the BOT-3000, that allows both static and dynamic measurements to be made in separate passes. The data is encouraging and over time standards for the BOT-3000 test method may be established much as the ASTM C1028 standard test method has been established. You can be sure that a calibration reference and a careful inter-laboratory study would be included in such a method to receive industry support. As with ASTM C1028, the input and involvement of manufacturers, distributors, retailers, installers, and users, in addition to slip/fall researchers and consultants would also be sought. On behalf of TCNA, we thank all those that contributed this year to the improvements to C1028. ◆

Eric Astrachan is the executive director of the Tile Council of North America (TCNA). Established in 1945 as the Tile Council of America (TCA), TCNA has a leadership role in promoting the use of ceramic tile and in developing North American and international industry standards. To learn more about TCA, please go to www.tileusa.com.