Slip testing of floorings

Good slip resistance of floorcoverings is essential to prevent injuries caused by slips, trips and falls. Steve Ferry explains the different types of tests available.

One of the biggest issues for the floor coverings industry is the measurement of slip resistance. Slip related incidences in the UK are still the most common cause of work related injuries. In fact, in a typical year slips, trips and falls account for 33 per cent of all reported major workplace injuries, 20 per cent of (over 3 day) workplace injuries and 50 per cent of all reported accidents to members of the public. This pattern is similar all over the EU. So it is justified that this is a major concern for insurance companies, building specifiers and architects.

The key property of a walking surface in respect of its capacity to resist the potential for pedestrian slip is its dynamic coefficient of friction (CoF), (*see Box 1*), and this will be influenced by a range of factors including surface roughness (Rz).

However, there is no universally agreed method of test for CoF throughout the EU making it difficult for those selling product. There are a number of slip assessment tools available using very different methods and this article will review these.

Ramp test

This test measures slip through the use of a human subject, who walks backwards and forwards over contaminated flooring (water or oil is usually applied but any substance can be used) at ever increasing angles of inclination. The resulting angle at which slip occurs classifies the flooring via a rating using a designation such as R9 to R14.

The DIN (German national standard) version of the method utilises a specific viscosity grade oil with the subject wearing safety footwear or, in the case of bare foot testing, a soap solution as the contaminant. In our opinion this is not representative of typical slip conditions and the test footwear is not sufficiently controlled.

The use of human subjects to determine the slipperiness of floors can also lead to inconsistency of results.

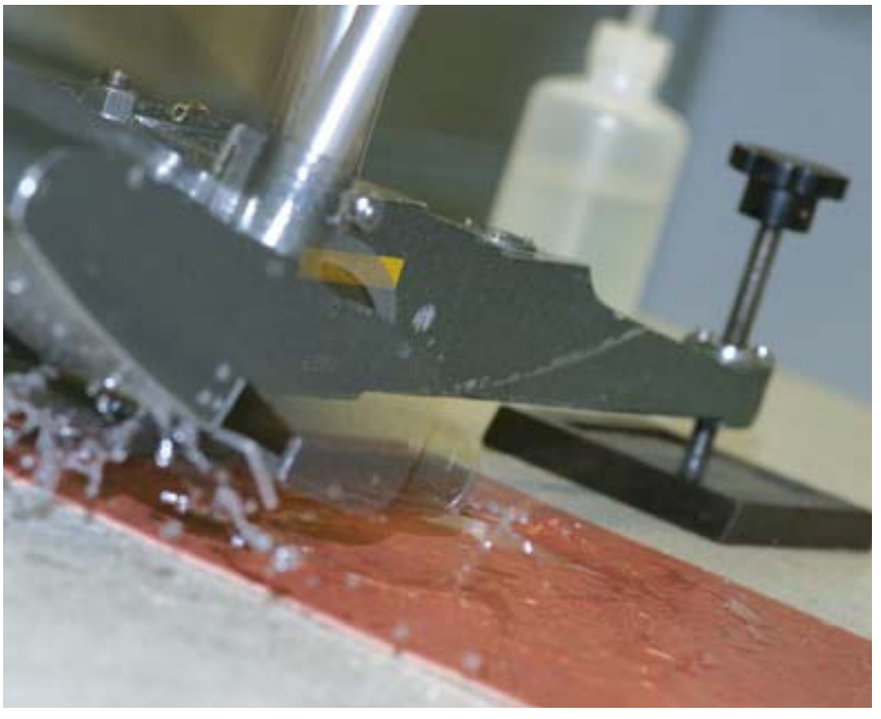
Draft methods (prENs) based on the ramp test are being discussed for wet (water) tests with both Slider 96 (formerly known as Four S rubber), soled footwear and bare foot modes as EN laboratory methods to determine the coefficient of friction of floorings. This will not be suitable for on-site testing. In such cases it is likely that a set of parameters will be established and portable machines found to fall within certain tolerances will then be accepted.

Pendulum test

The pendulum test was originally developed to simulate the action of a slipping foot. The method is based on a swinging dummy heel (pendulum), which sweeps over a specified area of flooring (just making contact with the surface) in a controlled manner. The slipperiness of the flooring has a direct influence on the pendulum value obtained (known as the Slip Resistance Value SRV), with high CoF values slowing down the pendulum and reducing the distance it travels after contact with the test floor.

This is one preferred method of test in the UK. It is simple to operate and is said to demonstrate good correlation to real life conditions. The method of test is recognised in the UK by the Health and Safety Executive and detailed in the UK Slip Resistance Group Guidelines. The added benefit of full portability is most helpful in the evaluation of on-site slip potential.

Testing is usually completed with calibrated Slider 96 rubber, which represents standard simulated footwear soling materials – although in reality, this type of rubber is rarely used for footwear today. However, it is also possible to use Slider 55, formally known as the Transport and Road Research Laboratory (TRRL) slider, a softer more malleable rubber material similar to that used on soft soled footwear such as trainers.



The BS 7976 Pendulum test is based on a swinging dummy heel. It sweeps over a specified area of flooring, just making contact with the surface.

SATRA Friction tester STM 603

SATRA TM144:2004 utilising the SATRA STM 603 slip rig measures the slip resistance of flooring in the laboratory and, although developed for footwear, is based on biomechanical studies of slips. The test defines a dynamic coefficient of friction measurement at a constant speed under a vertical load representative of human body weight. The test slider generally employs Slider 96 rubber mounted at a contact angle of 7°.

The method has the added benefit of adaptation to utilise footwear mounted on a foot form as the slider, allowing end-users the option to specify footwear, sole tread, pattern, surface contaminants and other parameters to give realistic performance values under normal service conditions.

This method provides SATRA's customers with informed knowledge of slip resistance of floorings under a variety of conditions. In fact, SATRA TM144 can give reliable indication of slip resistance on profiled floor coverings.

Surface roughness

Also to be included in any assessment of slip potential is measurement of surface roughness. Roughness is a principle factor in determining the friction properties of floorings. The benefit of a rough surface is that in wet or oily conditions, any peaks will project through the thin fluid film trapped between the shoe sole and flooring, biting into the soling and reducing the risk of hydroplaning. Roughness is measured using a fine stylus that traverses the surface mapping the microscopic profile. The most commonly quoted parameter for roughness is Rz or Rtm – the average of all peak and valley heights in a measured length. A glazed tile will have an Rtm of say 6 microns compared with a safety resilient floor of 40 microns. The UK Health & Safety Executive (HSE) recommend that floors have a minimum Rtm of 10 microns, representing a moderate risk under wet conditions.

When measuring surface roughness the hardness of the flooring material under test should be considered as softer floors will demonstrate better coefficient of friction with lower Rtm measurements.

Sled test

Another method that was once very popular in the ceramics industry is the sled type test, one example being the so-called Tortus test. These types of test employ Slider 96 mounted onto a circular, sometimes freely rotating, stud, which is placed in contact with the floor. The sled is then set to run a prescribed distance to measure the friction applied to the slider. Although highly portable, these methods are now very much disregarded in industry as inappropriate as the constant contact of the slider to the floor prior to testing leads to 'sticktion'. 'Sticktion' is a term that has been applied due to the slider dispersing any contaminant and creating adherence to the surface under test, resulting in misleadingly high coefficient of friction values under wet conditions.

The SATRA STM603 slip rig provides customers with a knowledge of the slip resistance of floorings under a variety of conditions, usually to SATRA TM144:2004.

Floorcoverings

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Coefficient of Friction is the ratio of horizontal (shear) to vertical (normal) forces which need to be applied to cause sliding movement between two surfaces in contact. It has no units.

Static coefficient of friction relates to the ratio of the forces at the point when sliding begins from a static contact between the two surfaces.

Dynamic coefficient of friction relates to the ratio of the forces required to keep the surfaces sliding over each other at a known rate.

It is inherent in both of these definitions that the two surfaces must be in direct contact with each other. If there is anything on the interface, you are not measuring static coefficient of friction. Therefore, static meters must be used only under clean, dry conditions you cannot take a static coefficient of friction reading on a wet floor.

Roller Coaster Slip test

Modified Sled-type tests are becoming available on the market, such as the Slip Alert. These 'Roller Coaster' type tests are based on the same principle as the sled tests but they overcome the 'sticktion' problem by utilising a gravity operated trolley that is already in motion as it comes into contact with the test floor. Current correlation work has shown that the test can differentiate between wet and dry test conditions but fails to correctly measure high coefficient of friction values.

The test area required is large and the trolley can fail to follow a straight line when released. Contamination of the trolley wheels adversely affects the test and bouncing can occur on softer floor materials such as rubber or vinyl.

In conclusion

End users such as local authorities, health and educational institutions, shopping malls, airports and factories can all benefit from knowledge gained through correct testing of slip. Please contact the author for more information.