Measuring Slip Resistance

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Introduction

When investigating a slip and fall incident, forensic experts are often asked to comment on how slippery a surface would have been under certain conditions and whether a typical person would have slipped in that situation. In order to answer these two questions, experts conduct slip testing to determine the frictional properties between the floor and the surface of an object contacting the floor (i.e. the sole of a shoe). There are two major challenges to conducting scientifically accurate slip testing: accurately replicating the floor condition and accurately simulating the human gait, especially the heel strike.

How Do We Measure Slip Resistance?

Most surfaces are not slippery when dry, and most slips occur on a wet or contaminated surface. It is important to know whether, for example, the pedestrian slipped on a wet floor, a freshly waxed floor, or a spill on the floor. This information allows us to replicate the condition under which the slip occurred as closely as possible to determine whether the flooring played a role in the incident.

Slip Index

When testing a wet or contaminated surface, we are measuring the slip index, which is similar to dynamic friction: the ratio of force required to keep a sliding object in motion once slipping has begun divided by the downward and forward force exerted. This specific type of measurement of friction is called tribometry. Measuring the "slip index" or "slip resistance" of a surface can be somewhat tricky using simple tools or other instrumentation where the test foot drags on the floor because the human heel strike is a complex dynamic motion with variable force application and therefore a complex motion to emulate.

Dynamics of Taking a Step

The human gait begins the moment the foot makes contact with the ground. This is commonly referred to as the heel strike. After the heel strike, the body weight is normally rapidly applied to the heel with increasing force as the body begins to rock over the foot, propelling the body forward until the weight is unloaded from the heel to the toe. Slips occur quickly, in less than a fraction of a second, and typically occur just as the heel strikes the ground and when the body weight is beginning to load downward and forward onto the foot. In general, only a small fraction of the shoe bottom is in contact with the surface when the slip occurs.

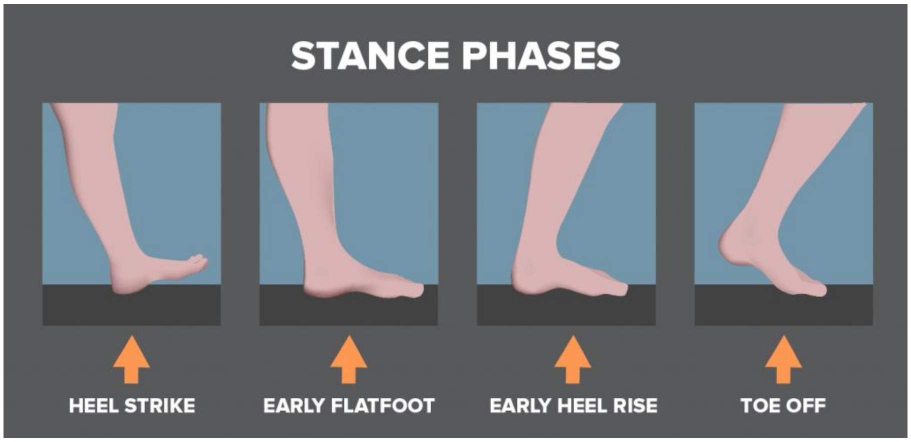

Figure 1 - Phases of the stance during human ambulation.

What Is a Tribometer, and How Is It Used to Measure Slip Resistance?

To replicate most accurately the angled downward motion of the heel during human walking (as seen in Figure 1), we use a mechanical test tool which uses regulated compressed air to activate a piston and emulate the motion and force of the human heel strike.

An English XL VIT tribometer tool, for instance, can be used by a qualified expert to directly measure the slip resistance of a given surface under dry and wet conditions and has been tested and independently evaluated.[1, 2, 3] This tribometer, which has undergone various advancements over the years, has proven to be accurate (Flynn 1998, Underwood and Vidal 2000), reliable, and repeatable as a measurement tool for replicating the dynamic action of a human heel strike while walking. Essentially, the test foot mimics human heel articulation and movement while walking; the test foot moves at the speed of an average individual and slips in a similar manner to the human heel.

The English XL tribometer is recognized by the American Society for Testing and Materials (ASTM) as a valid method for testing slip resistance. In order to ensure the accuracy and repeatability of the measurements, the expert or user is required to obtain certified training and use a calibrated tile in order to operate the tribometer and interpret the results appropriately.

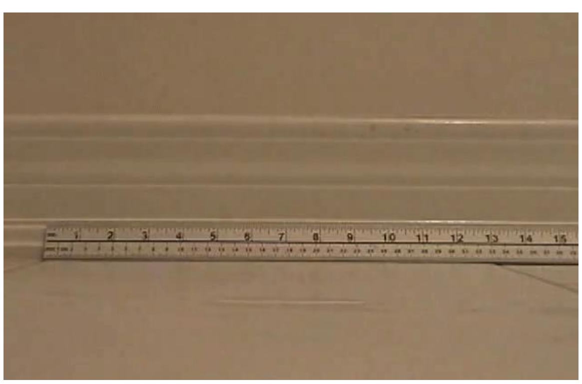

Figure 2 - The dynamic motion of a slip during the heel strike phase of walking (left) compared to the dynamic action of the English XL tribometer (right). Note the initial contact of the test foot and subsequent rotation of the test foot which simulates that of a human foot rocking from heel to toe.

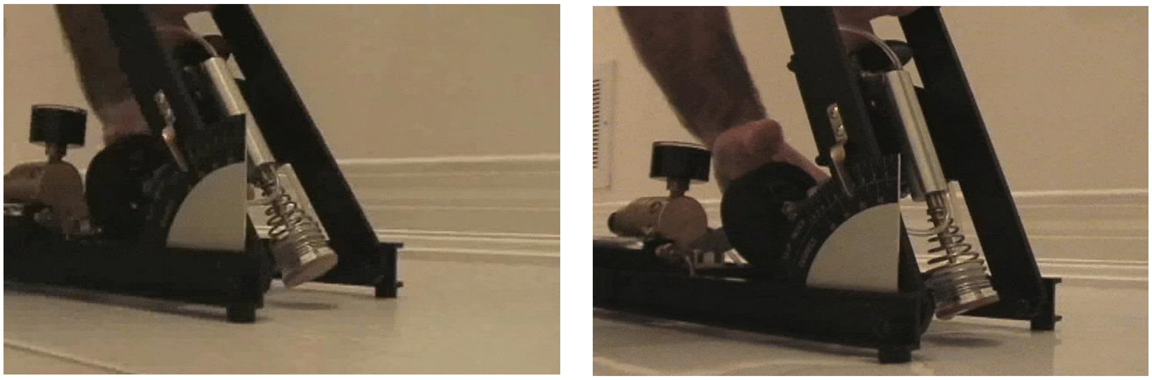

Figure 3 - The dynamic action of the English XL tribometer in dry testing conditions (left) versus wet testing conditions (right).

Conclusion

Slip testing is often a crucial component of a slip and fall investigation. To be reliable, testing and evaluation of the slip resistance of a surface needs to be conducted under similar conditions to the incident slip and with a tool that can accurately mimic the human slip conditions during the heel strike phase of walking. Of course, the expert must also consider the general environment, lighting, and other parameters, including the context of the incident.

Key Contact

Sam Kodsi is a Consulting Forensic Engineer in J.S. Held’s Accident Reconstruction Practice. Mr. Kodsi has been active in automotive engineering safety since 1995 and has specialized in Accident Reconstruction since 1997. He has been involved in more than 5,000 technical investigations and has been the lead engineer in more than 4,000 reconstructions involving motor vehicle collisions and other personal injury incidents. Mr. Kodsi has been involved in peer-reviewed research and testing and has qualified to provide expert evidence in the Ontario Court of Justice, Superior Court of Justice and in Arbitrations in the following areas: accident reconstruction (dynamics & speeds), biomechanics, mechanical failures, collision consistency, and driver perception and response.

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