C24 The Role of Lateral Shear Force in the Required Coefficient of Friction for Level Walking

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The goal of this presentation is to help better identify the most critical instants that a slip and fall incident could potentially occur during level walking.

Traditionally, only the longitudinal component of the shear force at the shoe and floor interface has been used in calculating the required coefficient of friction and the lateral component of the shear force at the same interface has been often ignored by most researchers for simplicity. This presentation will impact the forensic science community by showing how the lateral shear component at the shoe and floor interface could play a critical role in determining the instant that a slip and fall incident might occur.

Slips, trips, and falls are a serious problem. Occupational injuries due to slip, trip, and fall incidents remain a leading source of losses in workers' compensation (*Leamon and Murphy, 1995*). The annual direct cost of occupational injuries due to slips, trips, and falls in the United States is estimated to exceed six billion U.S. dollars (*Courtney et al., 2001*). Falls on the same level accounted for 65% of claim cases, and, consequently, 55% of claim costs in the total direct workers' compensation for the occupational injuries due to slips, trips, and falls (*Leamon and Murphy, 1995*).

Required friction is the minimum friction needed at the shoe and floor interface to support different types of human activities. When the required friction for an activity exceeds the available friction at the shoe and floor interface, a slip may occur (*Redfern et al., 2001*). The available friction represents the maximum frictional force that can be supported without a slip at the shoe and floor interface. The required coefficient of friction (RCOF) is typically measured on dry surfaces with a force plate and is one of the maximum values in the friction coefficient obtained by dividing the component of the measured ground reaction force (GRF) tangent to the floor surface by the normal component during a step (*Redfern et al., 2001*). A mechanical device, known as a slipmeter, is typically used to measure the available coefficient of friction (ACOF) at the contact interfaces (*Chang et al., 2001a; 2001b*). Various models to estimate slip probability based on the comparison of the RCOF and ACOF have been published in the literature.

Traditionally, only the longitudinal component of the shear force at the shoe and floor interface has been used in calculating the RCOF in which the longitudinal component was divided by the normal component at the same instant. The lateral component of the shear force at the same interface has been often ignored by most researchers for simplicity. The argument for this neglect was that the longitudinal component of the shear force is usually much larger than the lateral component. Therefore, the contribution of the lateral component to the total magnitude of the actual shear force which is the vector sum of both the longitudinal and lateral components was negligible.

This general assumption might be true in many of the cases. However, the results from this experiment on level walking show that some walks exhibited very different results with a large lateral component shear force compared with its longitudinal component in the early part of a heel contact. Under these circumstances, the lateral component should not be ignored, and the instantaneous coefficient of friction reached its maximum near the instant when the lateral shear component also reached its maximum. Therefore, it triggered the mechanism for determining the RCOF. In comparison with the cases that the RCOF was triggered by the longitudinal component, those triggered by the lateral component usually happened earlier in a gait cycle than those triggered by the longitudinal component. Perkins (1978) reported that the shoe started slipping forward approximately 0.1 second after a normal landing in a typical severe slip on slippery surfaces in their experiment. Slip at the instant of heel contact was not very common, according to his results, but it usually led to an irrecoverable slip. The lateral shear component might help explain why some slips occurred early in a gait cycle, but some did not.

Lateral Component of Shear Force, Slips and Falls, Required Coefficient of Friction

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