

BIOMECHANICS LABORATORY

Evaluating the coefficient of friction (COF) during walking

1. Object:

To find and compare the coefficient of friction during walking using different two methods

2. Introduction:

Slippage is one of the most common causes of falls and is a major concern to both industry and society owing to the associated financial costs. In the work environment, slippage is identified as the primary antecedent event to falls on both stairs and level surfaces. The financial costs associated with falling are expected to exceed \$85 billion during the year 2020, so it is important to compute COF and then investing it.

Reaction forces are the forces that the ground or other external surface exerts on the performer as a reaction to the force that the performer exerts on the ground or surface. This principle is known as Newton's third law of linear motion or the law of action–reaction.

The ground, or other, contact force acting on an subject can be resolved into three components, one normal and two tangential to the contact surface. The former component is the normal force and the latter are the friction force.

During walking, slip resulted from a loss of traction (i.e., friction) between the foot and the floor. Here, the COF is determined from the force plate recordings of ground reaction forces (GRF). The utilized COF is defined as the ratio between shear (resultant of the fore-aft and medial-lateral forces) and the vertical component of the GRF as shown in Figure (1).

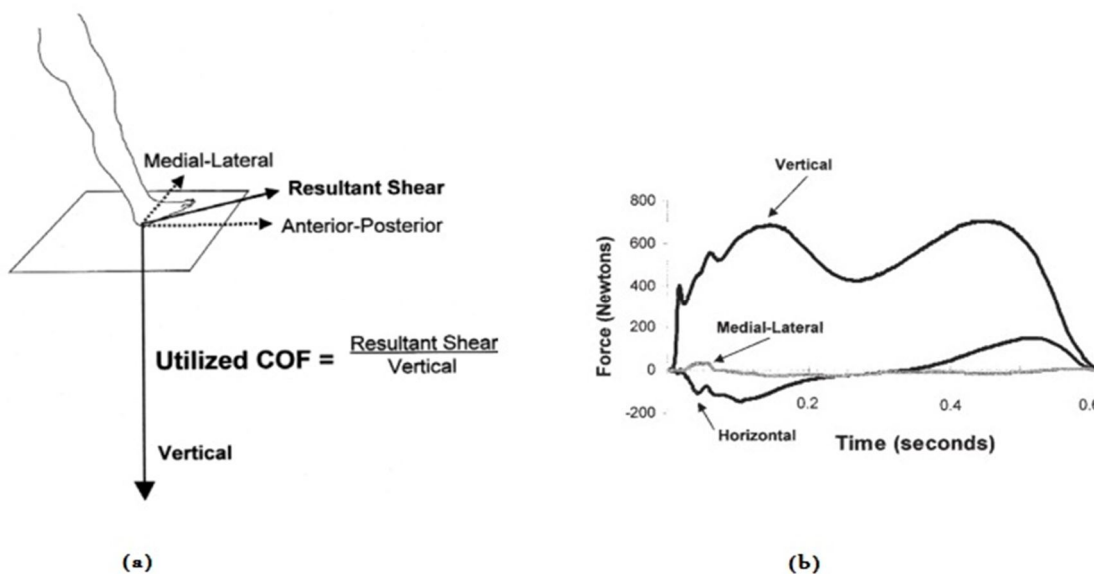


Figure 1: a: The method used to calculate the COF and b: Ground reaction forces generated during walking

A frequently cited theory related to the assessment of walkway slip resistance proposes that the utilized COF generated during walking can be estimated using anthropometric and stride characteristic data. This theory suggests that the tangent of the angle formed by the lower extremity (relative to the vertical) at foot impact is equal to the ratio of shear to normal GRFs at initial contact.

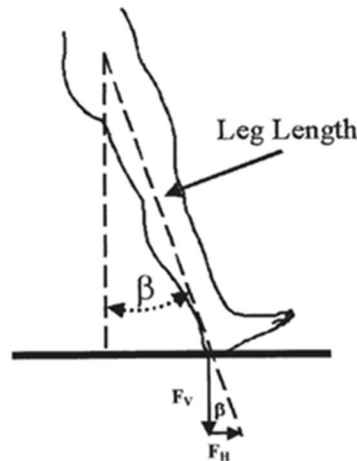


Figure 2: Trigonometric calculations used to determine the estimated impact angle (relative to the vertical) that is used to estimate the COF generated during walking.

3. Procedure:

1. Prepare the force plates (keeping in mind the warm up time for the amplifier "about 1 hr").
2. Fit a digital camera on a tripod and ensure that the camera is leveled.
3. Put the camera perpendicular to the line of walking.
4. Prepare normal subject to be walked normally and barefoot to cancel the effect of the shoes types.
5. Attach 2 reflective markers at the right fibular head and at the lateral malleolus for better determination of the impact angle β .
6. Record the GRFs.
7. Use any motion analysis software (such as kinovea, datrfish, tracker) to find the impact angle β with respect to the vertical.

4. Calculations:

1. Find the COF from the force plate data using the formula:

$$COF = \frac{\sqrt{F_x^2 + F_y^2}}{F_z}$$

2. Find the estimated COF from the measured impact angle β using the formula:

$$COF = \tan \beta$$

3. Calculate the error between the measured and estimated COF.
4. Plot the measured COF with respect to time.
5. Discussion:
 1. What are strategies to increase the friction between a subject's feet and the floor?
 2. When does the most injurious period during walking? And why?
 3. Does the velocity of walking affects the estimated COF? And why?