Determination of the Coefficient of Friction

Introduction

Friction is the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other. A coefficient of friction (μ) is a value that shows the relationship between the force of friction between two objects and the normal reaction between the objects that are involved.

Friction can either be **static** or **kinetic**. Static friction is mobilised between two objects to prevent any relative moving whereas kinetic friction acts between two objects when one object is moving, or if two objects are moving against one another.

Purpose

To determine the coefficient of static friction and the coefficient of kinetic friction.

Principle

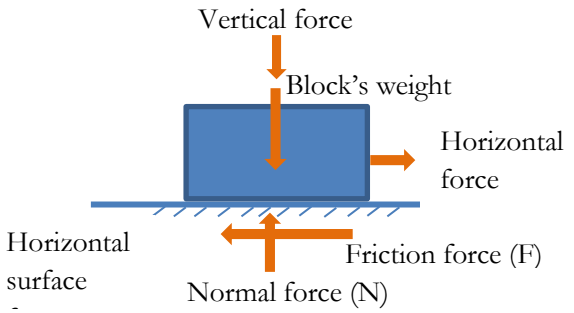

Fig.1a Free-body diagram for a block on a horizontal surface

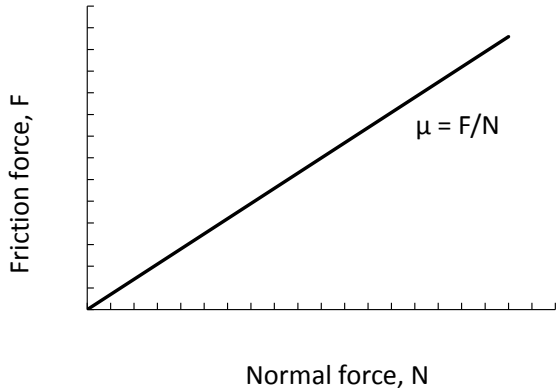

Fig.1b Typical variation of friction force with normal force

If the amount of the externally applied force (F) brings the body to the verges of slipping, then:

$F=F_s$

and

$\mu = \mu_s=F_s/N$

where

F_s is the force of static friction and μ_s is the coefficient of static friction.

If the externally applied force (F) is just enough to slip the object at constant speed, then:

$F=F_k$

and

$\mu = \mu_k = F_k/N$

where

F_k is the force of kinetic friction and μ_k is the coefficient of kinetic friction.

Which is greater μ_s or μ_k? why?

Experimental equipment & procedure

- This experiment will be conducted by using "direct shear equipment" available in the soil mechanics lab. The equipment has a box made up of two halves, where the top half moves laterally relative to the fixed bottom half.

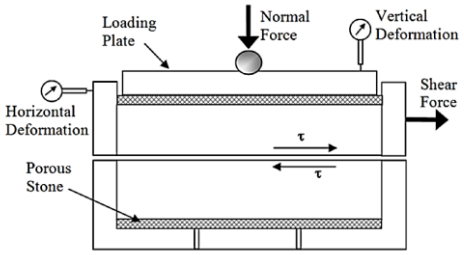

Fig.2 Typical shear Box
Image source: http://research.iitgn.ac.in/stl/directshear.php

- Fill up the box with some granular material, apply different magnitudes of normal force (N) (one at a time) from the top, push the top half of the box at a constant speed by using the gearbox and the electrical motor setup and measured the corresponding friction (shear) force.
- take F_s as the greatest measured force and take F_k as the measured force when it becomes nearly constant.
- Record the values of F_s, F_k and the corresponding N value in your experiment sheet.
- Repeat the work with different N value.
- Use the coordinate graph in you report to plot the pairs of F_s and N and the pairs of F_k and N, on the same graph.
- Obtain the μ_s and μ_k as the slope of the best-fit lines (see Fig.1b) of the above plots respectively.

Dear student, in your discussion:

- try to find out the significance and use of the coefficient of friction in engineering applications.
- the value of μ is usually between 0 and 1. What does that mean? Can it be greater than 1? Explore that aspect.
- μ is a scalar quantity, how do you understand that?