SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution, Affiliated to Anna University)
Coimbatore – 641 035.

23AGT207 Engineering Properties of Agriculture Produce

Unit III Thermal Properties
3.2. Frictional Properties – Static and Kinetic Frictions

What is friction?

Friction is a force that resists motion between two objects that are in contact with each other. Smooth surface exhibit less friction, while more friction is exhibited by rough surfaces.

Frictional properties:

- Static friction
- Kinetic friction
- Angle of repose
- Internal friction
- Rolling resistance

Why frictional properties are important?

The frictional properties of granular materials are important in designing

- Storage bins, hoppers, chutes,
- Pneumatic conveying system, screw threshers andconveyors,
- Forage harvesters,
- Fruits and Vegetables grader

i) Static Friction: It is the force that prevents two surfaces from sliding relative to each other when they are at rest. Static friction arises between two objects that are not in motion with respect to each other. It is ameasured as the maximum force the body will sustain before motion occurs.

A force (like a shovel pushing the grain) must be greater than the static friction to initiate movement. Example in Agriculture:

The friction between a grain of rice and the wall of a silo, preventing the grain from moving, is an example of static friction.

Factors Affecting Static Friction

The type of materials in contact, the surface roughness, and the normal force (force pressing the surfaces together) all influence static friction.

ii) Kinetic Friction: It is the force that opposes the motion of two surfaces sliding against each other. Kinetic friction arises between bodies that are in motion with respect to each other. It is measured as the maximum force the bodies will require to keep them in motion.

Example in Agriculture: The friction between grains moving down a conveyor belt or through a chute is an example of kinetic friction.

Factors Affecting Kinetic Friction:
Similar to static friction, the type of materials, surface roughness, and the normal force influence kinetic friction.

Relationship to Static Friction:
In many cases, the force of kinetic friction is less than the maximum force of static friction required to initiate movement.

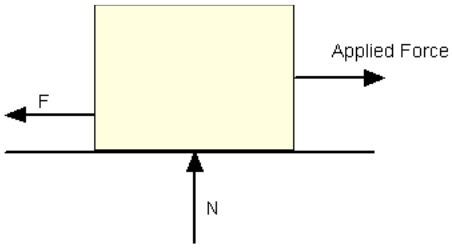
Frictional force can be expressed as

$F_f = \mu N$ (1)where

F_f = frictional force(N)

μ = static (μ_s) or kinetic (μ_k) frictional coefficient

N = normal force(N)

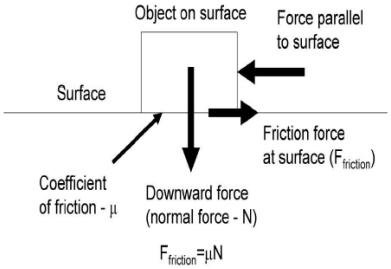


For an object pulled or pushed **horizontally**, the normal force 'N' is simply the weight:

$N = mg$ (2)

Where, m = mass of the object (kg)

g = acceleration of gravity ($9.81 m/s^2$)



$F=P*\sin\alpha$

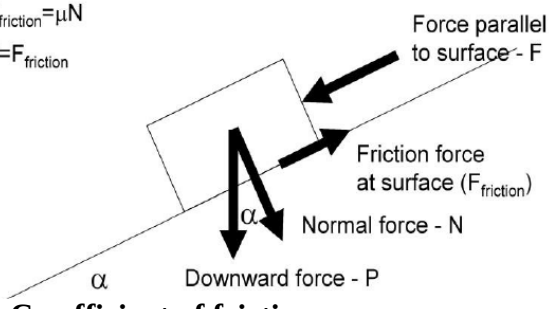
$N=P*\cos\alpha$

$F_{friction}=\mu N$

$F=F_{friction}$

$P*\sin\alpha=\mu N=\mu*P*\cos\alpha$

$\mu=\sin\alpha/\cos\alpha=\tan\alpha$



If the object is on a tilted surface like an inclined plane, the normal force is less because less of the force of gravity is perpendicular to the face of the plane. Therefore, frictional properties is measured by vector analysis.

Co-efficient of friction

The **ratio** of the frictional force, parallel to the surface of contact, that opposes the motion of a body which is sliding or rolling over another, to the force, normal to the surface of contact, with which the bodies press against each other.

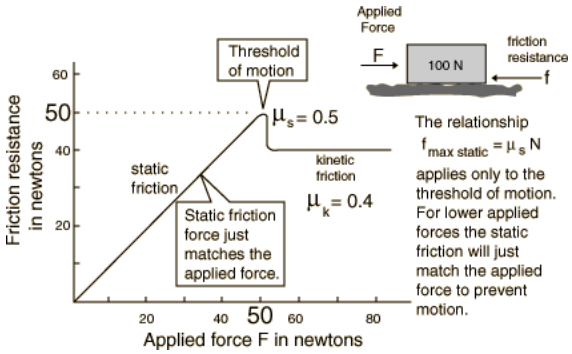
Kinetic (or dynamic) friction occurs when two objects are moving relative to each other and rub together. The coefficient of kinetic friction is usually less than the coefficient of static friction for the same materials meaning that more force is required to set the objects in motion than to keep them in motion.

Factors affecting frictional force

1.Load
2.Actual contact area
3.Sliding velocity
4.Nature of material in contact
5.Moisture content

Static vs Dynamic (kinetic) Friction

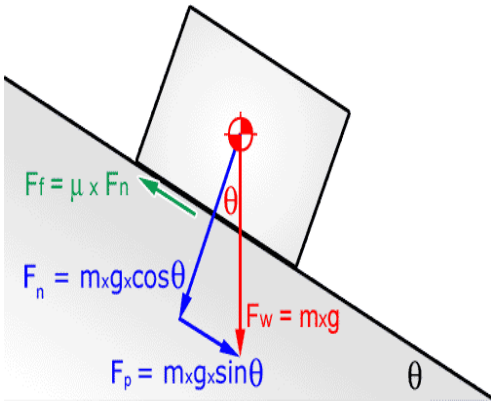
The coefficient of friction for a pair of materials is often quoted as STATIC and DYNAMIC values. From the typical diagram below, dynamic friction is usually lower than static (although this is nothing compared to the effect of a liitle moisture).

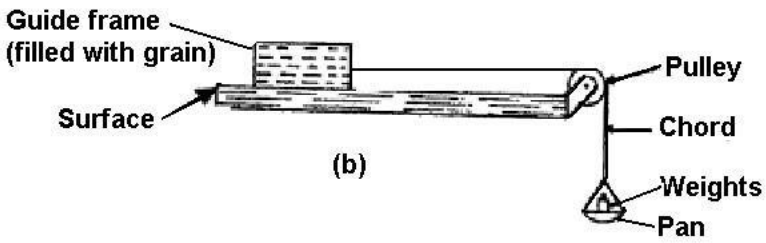


Any force larger than the force of static friction causes sliding to occur. The instant the sliding occurs, static friction is no longer applicable—the friction between the two surfaces is then called kinetic friction.

Experimental set up to determine coefficient of friction

- A tilting table is used to secure the surface to be evaluated, and the seeds are then put into a diameter-measured cardboard paper ring of dia 10 cm by 2 cm until the ring is completely filled.
- The ring is carefully raised so that it does not come into contact with the surface.
- A delicate screwing device is used to tilt the table until the seeds travel below and are mounted against the tilting table's edge.
- The coefficient of friction is the tangent of the angle of friction.





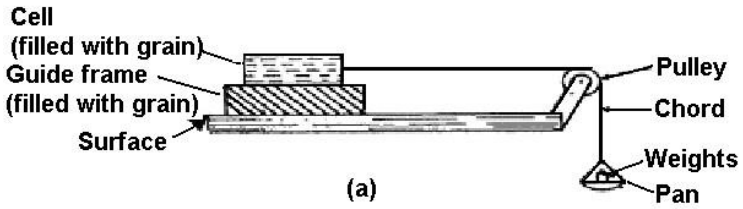
Co-efficient of friction on material surface

Co-efficient of internal friction

Static friction is the friction between the grain mass and the contact surface, whereas internal friction is the friction of the kernels or grains against one another. When designing silos and hoppers for gravity flow or forecasting the lateral pressure on a retaining wall in silos, the coefficient of internal friction of the grains is necessary.

Internal frictional force-influencing factors

1. Moisture content
2. Material size and shape
3. Amount of settling or consolidation
4. The load
5. Velocity of sliding



Experimental set up for coefficients of internal friction

(Tri-axial compression test apparatus or Shear test apparatus)

A regulated loading mechanism, a recorder, and a shear cell make up the direct shear test apparatus. The weights acting vertically apply the typical load. An electrical or mechanical drive provides the shearing action, and a load cell or dynamometer is connected

for force measurement. The plane of contact between the base and the ring is where the shearing force operates. Shear of the solid in the plane between the ring and base and a consistent stress distribution across the specimen sample are guaranteed by the shear cell.