

Module III: FRICTION

Session 12

Friction: When a body moves or tends to move over another body, a force opposing the motion develops at the contact surfaces. The force which opposes the movement or the tendency of movement is called the **frictional force** or simply **friction**. There are minutely projecting particles which develop frictional force to oppose the tendency to movement of one surface over the other surface.

Friction is a Necessary Evil: Friction is quite undesirable and needs to be mitigated in most cases such as power screws, bearings and gears, flow of fluids in pipes, etc. Its presence causes loss of power, wearing of parts and huge economic losses.

However, the working of many devices such as friction brakes, belt and rope drives, holding and fastening devices etc. depends on friction. Here the presence of friction is advantageous. Obviously friction is both a liability and a necessity and is often referred as necessary evil.

Types of Friction

Static Friction: It is the friction experienced by a body when it is at rest. Or in other words, it is the friction when the body tends to move.

Dynamic or kinetic Friction: It is the friction experienced by a body when it is in motion. It is also called kinetic friction.

Sliding Friction: It is the friction experienced by a body when it slides over another body.

Rolling Friction: It is the friction experienced by a body when it rolls over another body.

Dry or unlubricated Friction: It is the friction between two dry contact surfaces and there is tendency for relative motion. It is also called *Coulomb friction*.

Wet or Fluid or Lubricated Friction: It is the friction between two contact surfaces when a lubricating fluid is introduced between them.

Limiting Friction

Friction is a self-adjusting and self-increasing force. However, there is a limit beyond which the magnitude of the frictional force will not develop. If the applied tangential force is more than this maximum frictional force, there will be movement of one body over the other body. This maximum value of frictional force, which comes into play when the motion is just about to start is known as *Limiting Friction*. It may be noted that when the applied tangential force is less than the limiting friction, the body remains at rest and such friction is called *Static Friction*. If the value of applied tangential force exceeds the limiting friction, the body starts moving over another body and the frictional force is known as *Dynamic Friction*. The magnitude of dynamic friction is found to be less than limiting friction.

Coulomb's laws of dry friction

- a) The frictional force always acts in a direction opposite to that in which the body tends to move.
- b) Till the limiting value is reached, the magnitude of frictional force is exactly equal to the tangential force which tends to move the body.

- c) The magnitude of the limiting friction bears a constant ratio to the normal reaction between the two contacting surfaces.
- d) The force of friction depends upon the roughness/smoothness of the surfaces.
- e) The force of friction is independent of the area of contact between the two surfaces.
- f) After the body starts moving, the friction slightly decreases.

Coefficient of Friction (μ)

We know from laws of friction that the limiting friction bears a constant ratio to the normal reaction between the two contacting surfaces. This ratio is known as coefficient of friction and is generally denoted by μ . Mathematically, coefficient of friction, $= \frac{F}{R}$. It means $F = \mu R$.

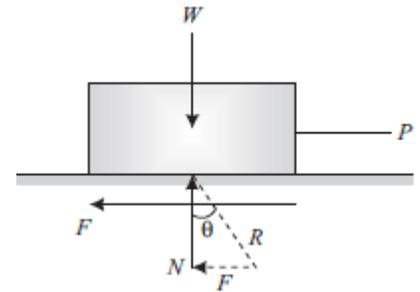
It is unit less and its value generally lies between 0 and 1. For smooth surface, its value is zero.

Angle of Friction (ϕ)

It is the angle between the resultant reaction and the normal to the plane on which the motion of the body is impending. It is denoted by ϕ .

Mathematically, coefficient of friction,

$$\mu = \frac{F}{R} = \tan \phi$$



Angle of Repose (α)

It is the angle of the inclined plane at which a block resting on it is about to slide down the plane under the action of its own weight only is known as angle of repose. It is denoted by α . It can be proved that the angle of repose is equal to the angle of friction, $\alpha = \phi$.