Friction:

When two surfaces are in contact with each other and one surface tends to move with respect to other, a tangential force will be developed at the contact surface in the opposite direction of motion. This tangential force is called “frictional force” or simply “friction”.

Role of frictional force :

Advantages

(i) Enables us to walk

(ii) Ride a vehicle

(iii) To transmit power

Disadvantages

Increases wear and tear of the machine which leads loss of energy and loss of power.

Types of Friction

(i) Dry friction (or coulomp friction)

(ii) Fluid friction

Dry friction refers to the friction which develops between two dry surfaces, slides or trends to slide relative to another.

Fluid friction exists when the contacting surfaces are separated by a film of fluid.

Dry friction of two types

(i) Static friction

(ii) Dynamic friction

Static friction is the friction experienced by a body during rest.

Dynamic friction is the friction experienced by a body during motion.

Dynamic friction is further classified into

(i) Sliding friction

(ii) Rolling friction

Sliding friction is the friction experienced by a body when it slides over an another.

Rolling friction is the friction experienced by a body when it rolls over a surface.

Limiting friction

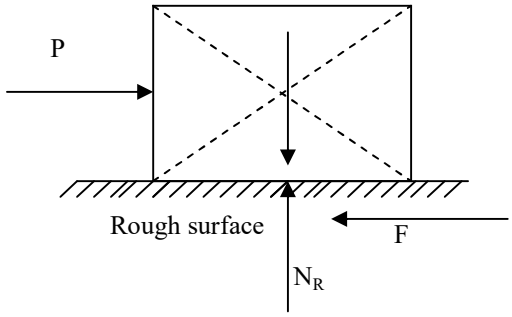
It is defined as the maximum force of friction that can be generated between two static surfaces. When the magnitude of force applied to body exceeds the limiting friction the body comes into the state of motion.

The value of limiting friction is always greater than that of static and dynamic friction.

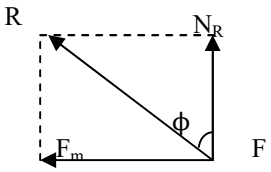
Coefficient of friction and angle of friction

The ratio of limiting friction to the normal reaction is known as "coefficient of friction". It is denoted by 'μ'

$$\mu = \frac{limiting\ friction}{normal\ friction} = \frac{F_m}{N_R}$$



When the body moves there are two reactions



There are two forces can be combined into a single resultant 'R'.

$$R = \sqrt{(F_m)^2 + (N_R)^2}$$

The angle between the resultant 'R' and the normal reaction is called 'angle of friction'. It is denoted by symbol 'Φ'.

From Figure, $\tan \Phi = \frac{F_m}{N_R}$

$$\mu = \tan \Phi$$

$$F_m = \mu \times N_R$$

i.e limiting friction = co-efficient of friction×normal reaction

Coulomb's laws of dry friction

(i) Laws of static friction

1. The frictional force always acts in the opposite direction to that the body tends to move.
2. The frictional force does not depend on the shape and area of contact of the bodies.
3. The frictional force depends on the degree of roughness of the contact area between the

bodies.

4. The frictional force is equal to the force applied to the body, so long as the body is at rest.
5. The limiting frictional force (F_m) bears a constant ratio to the normal reaction N_R between the surfaces of contact.

   i.e $F_m \propto N_R$

   (or) $F_m = \mu_s N_R$

(ii) Laws of dynamic friction

1. The frictional force always acts in the opposite direction to that the body moves.
2. The magnitude of dynamic friction bears a constant ratio to the normal reaction between the two surfaces.
3. Co-efficient of kinetic friction is less than the co-efficient of static friction

Impending motion

The state of motion of a body which is just to move or slide is called impending motion.

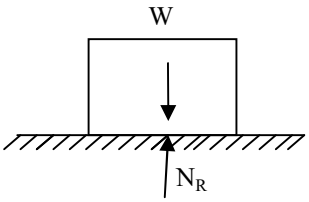
When the maximum frictional force is attained and if the applied force exceeds the limiting friction, the body starts sliding or rolling this state is called impending motion.

Basic concepts

(i) F=0

$\sum V = 0$

$W = N_R$



(ii) $F < F_m$

$\sum \mathbf{H = 0}$

$\sum V = 0$

$F = P\cos\theta$

$N_R = W + P\sin\theta$