Friction Mechanics

Friction:

In practice, no object is perfectly smooth. When two surfaces are in contact with each other, and one surface tends to move with respect to the 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:

There are some advantages as well as some disadvantages with frictional force. For example, it enables us to walk, ride a vehicle. If the frictional force on floor (or) road surface is absent, then it would not be possible to walk or ride a vehicle. To transmit power from a motor to a machine, belts are used. These belts are working with the frictional force at the contact surface. Disadvantage of frictional force is, it increases the wear and tear of the machine, which leads loss of energy and loss of power.

Types of Friction:

i) Dry Friction (or) Coulomb Friction &
ii) Fluid Friction

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

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

The dry friction is of two types.
a) Static friction and
b) Dynamic friction

Static Friction is the friction experienced by a body during rest and dynamic (or kinetic) friction is the friction experienced by a body during motion.

The dynamic friction is further classified into
i) Sliding friction and
ii) Rolling friction

Sliding friction is the friction experienced by a body when it slides over an another, and rolling friction is the friction experienced by a body when it rolls over a surface.

Co-efficient of friction and angle of friction.

The ratio of limiting friction to the normal reaction is known as "co-efficient of friction". It is denoted by the symbol 'μ'

$$\mu = \frac{Limiting\ friction}{Normal\ reaction} = \frac{F_m}{N_R}$$

Limiting friction = Co-efficient of friction x Normal reaction

Co-efficient of friction in static and dynamic states are called coefficient of static friction (μ_k) respectively.

$$\therefore (F_m)_s = \mu_s \times N_R \text{ and}$$
$$(F_m)_k = \mu_k \times N_R$$

Coulomb's laws of dry friction:

Professor Coulomb has presented some laws of friction based on his research, which are grouped into
i) Laws of static friction &
ii) Laws of dynamic (or kinetic) friction

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i) Laws of static friction:

1. The frictional force always act in the opposite direction to that the body tends to move.
2. The frictional force does not depend on the shape and are of contact of the bodies.
3. The frictional force depends on the degree of roughness of the contact area between two 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. $F_m \alpha N_R$

$F_m = \mu_s N_R$

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 about to move or slide is called Impending motion. When the maximum frictional force (i.e Limiting friction) is attained and if the applied force exceeds the limiting friction, the body starts sliding or rolling. This state is called Impending motion.

Angle of Repose:

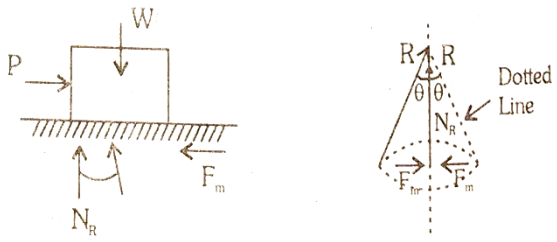
The angle of the inclined plane, at which the body tends to slide down in known as angle of repose.

$$\alpha_m = \emptyset$$

i.e. Angle of repose = Angle of static friction.

Cone of friction:

When a body lying on a rough surface is subjected to a horizontal force P as shown in fig. and when the motion is impending the frictional force developed at the contact surface is equal to the limiting friction 'F_m' and the angle made by the resultant with the normal reaction is equal to the angle of static friction.



(a) (b)Cone of friction

If the horizontal force P is changed gradually at an angle. From θ = 0 to 360°, then the line of action of resultant reaction R will also be changed. It generates a right circular cone with semi – central angle equal to the angle of static friction. This is known as cone of friction.

Simple contact Friction:

The Friction force is the resisting force developed at the contact surface of two bodies due to their roughness and when the surface of one body moves over the surface of an another body.

Some of the important engineering applications of simple contact friction are

i) Ladder friction

ii) Wedge friction
iii) Screw friction
iv) Belt friction

Rolling resistance:

When one body is made to roll freely over an another body, a resistance is developed in the opposite direction, known as Rolling Resistance the resistance helps to roll the body without any slipping (or) turning of the body. Rolling resistance is developed due to the deformation made by the rolling body over another body.

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