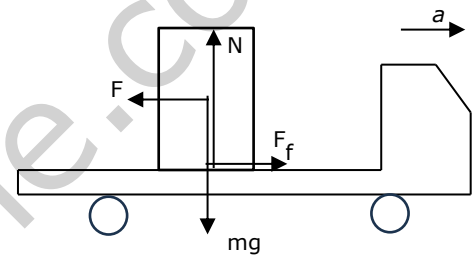


Q- A box of base area as a square of side 0.50 m, height of 1 m and mass 200 kg rests on horizontal floor of a truck with one edge of the base is perpendicular to direction of motion of the truck. If the acceleration of the truck is gradually increased, what is the minimum value of friction coefficient for which the box tips before it slides?

Here it is easy to use concept of pseudo force.

If we consider the accelerating truck as the frame of reference i.e. we consider motion of box relative to accelerating truck, with all real forces we have to consider an additional virtual force equal to the mass of the box and the acceleration of the truck in the direction opposite to the direction of acceleration of the truck. Thus, when the acceleration of the truck is a , the forces acting on the box which is at rest relative to the truck are

1. Weight of the box $W = mg$ (downward)
2. Normal reaction of the truck floor $N = mg$ (upward)
3. Pseudo force at the center of mass of the box $F = ma$ (backward)
4. Friction force which try to accelerate the box with the truck F_f in the direction of acceleration.



If the box is just not slipping, the box is in limiting equilibrium and the limiting friction will be

$$F_f = \mu N = \mu mg \quad \text{----- (1)}$$

Now if the box is just not tipping the Normal reaction is passing through the rear edge and torque due to it about the center of mass of the box is just equal to the torque due the weight of the box about the center of mass of the box and on the opposite direction. Gives

$$\mu mg \cdot (h/2) = mg \cdot (l/2) \quad [l \text{ is the length of the edge of the base}]$$

$$\text{Or } \mu = l/h = 0.5/1 = 0.5$$

If μ is less than 0.5, the box will start sliding forward before it tips due to torque due to pseudo force.

If μ is greater than 0.5, the box will start tipping backwards before it start sliding due to friction force.

Hence for tipping before sliding If μ is less than 0.5, the box will start sliding forward before it tips due to torque due to pseudo force. μ should be greater than 0.5.

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