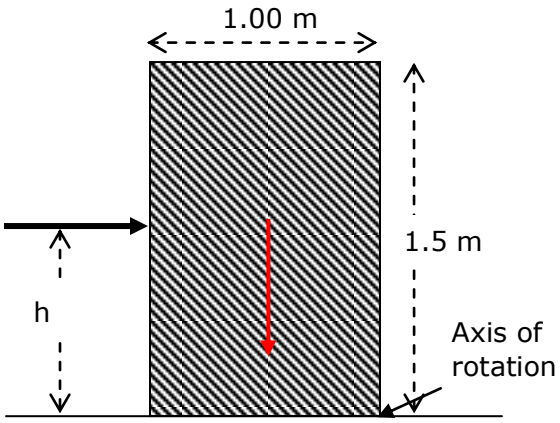
Q- Determine the horizontal force F necessary to slide the 100 kg crate of height 1.5 m and width 1.00 m. The crate has uniform mass distribution. The coefficient of static friction at the floor is μ_s = 0.4. What is the maximum height h for which with this force the crate will slide without tipping?

Answer:

The Forces acting on the crate are its weight, normal reaction of the floor, the external force F and the frictional force. The force required to move the crate is slightly greater than the limiting friction force and hence

$$F = \mu N = 0.4*100*9.8 = 392 \text{ N}$$



If the force F is acting above the center of gravity it will try to rotate the crate about right lower edge in clockwise direction. This moment of F will be opposed by the torque due to the weight. If the moment of F is slightly greater than that of the weight the crate starts tipping and with the tipping torque due to F will increase and the torque due to weight will decrease. Now in this case if the crate is just at the verge of tipping the two moments are balanced.

The torque of the weight will be given by the weight*perpendicular distance from axis of rotation. For uniform mass distribution, the center of mass will be midway and thus torque due to weight is mg*0.50 Nm. Thus for the crate is at the verge of tipping

$$\mu \, mg*h = mg*0.5$$

Or $h = 0.5/0.4 = 1.25$ m

Hence to slide the crate without tipping by the horizontal force, the force should be below 1.25 m.