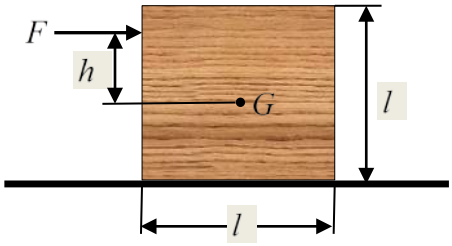
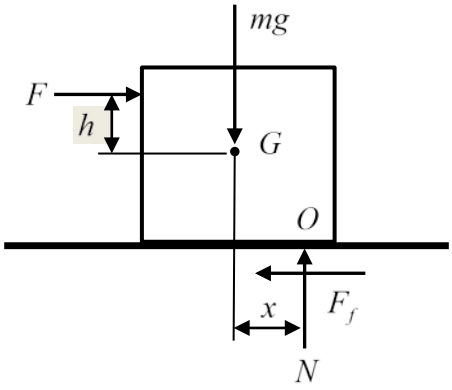
4-14. A 50-kg block rests on the floor, and a force $F = 400$ N is applied to it. The line of action of F is random, h is normally distributed with $h \sim N(0.3, 0.03^2)$ m. If $l = 1$ m, determine the probability that the block will tip over. The coefficient of kinetic friction between the block and the floor is $\mu_k = 0.5$.





$$(\rightarrow +)\ \Sigma F_x = m(a_G)_x$$

$$F - F_f = ma_G$$

$$(\uparrow +)\ \Sigma F_y = m(a_G)_y$$

$$N - mg = 0$$

$$\Sigma M_G = 0$$

$$-Fh + Nx - F_f l/2 = 0$$

$$x = \frac{Fh}{mg} + \frac{\mu_k l}{2}$$

$$\mu_x = \frac{F\mu_h}{mg} + \frac{\mu_k l}{2} = \frac{400(0.3)}{50(9.81)} + \frac{0.5(1)}{2} = 0.4947 \text{ m}$$

$$\sigma_x = \frac{F\sigma_h}{mg} = \frac{400(0.03)}{50(9.81)} = 0.0245 \text{ m}$$

The probability that the block tips over is

$$\Pr\{x > l/2\} = 1 - \Phi\left(\frac{l/2 - \mu_x}{\sigma_x}\right) = 1 - \Phi\left(\frac{0.5 - 0.4947}{0.0244}\right) = 0.41$$