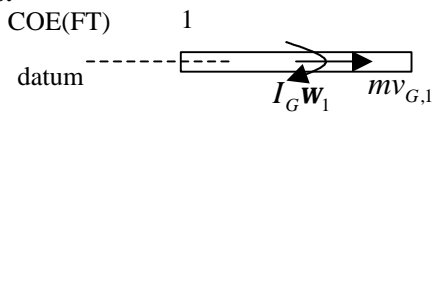# Example Problem - Le 14

6.121 AB is the cross section of a garage door which is a rectangular 2.5m by 5m panel of uniform thickness with a mass of 200 kg. The door is supported by the struts of negligible mass and hinged at O. Two spring-and-cable assemblies, one on each side of the door, control the movement. When the door is in the horizontal open position, each spring is unextended. If the door is given a slight push from the open position and allowed to fall, determine the spring constant *k* for each spring which will limit the angular velocity of the door to 1.5 rad/s when edge B strikes the floor. (*taken from Engineering Mechanics, 4th Edition by Meriam & Kraige*)
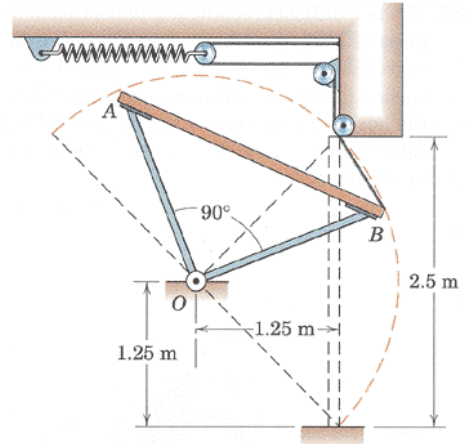
System: garage door, springs, and cable

Kinetics:

COE(FT)   1   2

datum

$I_G\mathbf{w}_1$ $mv_{G,1}$

$I_G\mathbf{w}_2$

$mv_{G,2}$

unk	eqs
k	1
E_{K1}	2
E_{G1}	3
E_{S1}	4
E_{K2}	5
E_{G2}	6
E_{S2}	7
$v_{G,2}$	8
x	9

$$\Delta E_{sys} = W = 0$$

$$E_{K1} + E_{G1} + E_{S1} = E_{K2} + E_{G2} + E_{S2} \tag{1}$$

$$E_{K1} = 0 \quad (2) \qquad E_{K2} = \frac{1}{2}mv_{G,2}^2 + \frac{1}{2}I_G\mathbf{w}_2^2 \quad (5)$$

$$E_{G1} = 0 \quad (3) \qquad E_{G2} = -mgh \qquad (6)$$

$$E_{S1} = 0 \quad (4) \qquad E_{S2} = 2\left(\frac{1}{2}kx^2\right) \qquad (7)$$

Kinematics:

relate velocities $$v_{G,2} = \mathbf{w}_2 r_{G/O} \tag{8}$$

dependant motion $$2x + y = L \quad \Rightarrow \quad x = \frac{y}{2} \tag{9}$$

Other:

$$\mathbf{w}_2 = 1.5\,rad/s \quad r_{G/O} = 1.25m \qquad y = 2.5m$$

$$m = 200kg \qquad h = 1.25m \qquad I_G = 1/12mL^2 \; kgm^2$$

Solving:

$$\boxed{k = 1270 \; N/m}$$