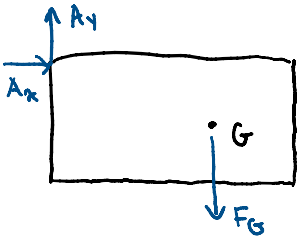
20-R-KIN-DK-22

July 22, 2020 9:43 AM

20-R-KIN-DK-22 Intermediate Rotation (RBK)

Inspiration: 7.4.1 Example, 17-58

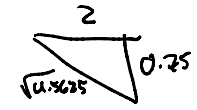
An advertisement can be modelled as a thin plate with density distribution ***rho = 50x***. If the supporting wire at B suddenly snaps, what is the angular acceleration of the advertisement and the reaction forces at A at that instant? The sign has a width of ***w = 3 m*** and a height ***h = 1.5 m***.



Find Center of gravity: $\rho = 50x$ By symmetry $\bar{y} = \frac{1.5}{2} = 0.75$

$\bar{x} = \frac{\int x\,dm}{\int dm}$ $dm = \rho\,dA = \rho_y\,dx = 50xy\,dx$ $\bar{x} = \frac{\int x\,50x\,y\,dx}{\int 50xy\,dx}$

$\bar{x} = \frac{\int_0^3 x^2\,dx}{\int_0^3 x\,dx} = \frac{\frac{x^3}{3}\Big|_0^3}{\frac{x^2}{2}\Big|_0^3} = \frac{2}{3}x\Big|_0^3 = 2$



$m = \int \rho\,dV = 50\frac{x^2}{2}y = \frac{1}{2}50(3^2)(1.5) = \frac{675}{2}$ kg

$\sum M_A = F_G(2) = I_A\alpha$ $\frac{675}{2}(9.81)(2) = \left[\frac{1}{12}\left(\frac{675}{2}\right)(3^2+1.5^2) + \frac{675}{2}(4.5625)\right]\alpha$

$13243.5 = 3712.5\,\alpha$ $\alpha = -3.56727$

$\sum F_x = \frac{675}{2}a_{Gx} = A_x$ $\sum F_y = A_y - \frac{675}{2}(9.81) = \frac{675}{2}a_{Gy}$

$a_G = a_A + \vec{\alpha}\times\vec{r}_{G/A} - \omega^2\vec{r}_{G/A}$ $\omega^2 = 0 \Rightarrow$ Started from rest $a_A = 0$ Pinned

$a_G = \alpha\hat{k}\times(2\hat{i} - 0.75\hat{j}) = 2\alpha\hat{j} + 0.75\alpha\hat{i}$

$a_{Gx} = 0.75\alpha = 2.67545$

$a_{Gy} = 2\alpha = 7.1345$

$A_x = -\frac{1805.973618}{2}$

$A_y = \frac{1805.973618}{2}$