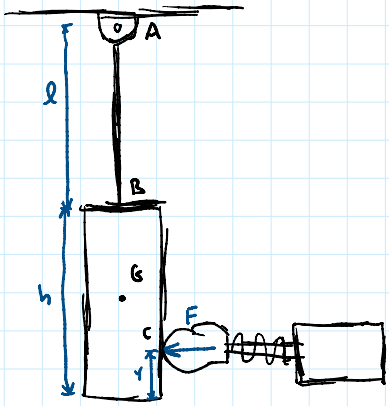
20-R-KIN-DK-30

July 22, 2020 9:38 AM

20-R-KIN-DK-30 Intermediate General Plane Motion

Inspiration: 17-41 Hibbeler



An engineering student is testing out the maximum settings on her punching machine. If the punching bag has a mass of ***m = 45 kg*** and an angular acceleration with magnitude ***omega = 4rad/s^2*** when the machine makes contact, determine the force applied by the machine in this moment. What is the tension and the angular acceleration of the supporting cable AB. The length of cable AB is ***l = 1 m***. Assume the punching bag can be modelled as a cylinder of uniform density with a radius of ***r = 21 cm.***

The punching bag has a height ***h = 1.5 m*** and the machine makes contact a distance ***y = 0.3 m*** from the bottom of the bag.

$\sum F_x = -F = m a_{Gx} \rightarrow -F = 45 a_{Gx}$

$\sum F_y = T_{AB} - F_G = m a_{Gy} \rightarrow T_{AB} - 45(9.81) = 45 a_{Gy}$

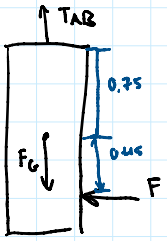
$\sum M_G = -F(0.45) = I_G \alpha$ $\quad I_G = \frac{1}{12} m (3r^2 + h^2) = \frac{1}{12}(45)(3(0.21)^2 + 1.5^2)$

$-0.45F = 8.433625(-4)$ $\quad = 8.433625$

$F = 79.41$

$-79.41 = 45 a_{Gx}$ $\quad a_{Gx} = -1.764666$

$\hat{i}$, $\hat{k}$ $\hat{j}$



$a_B = \vec{a}_G + \vec{\alpha} \times \vec{r}_{B/G} - \omega^2 \vec{r}_{B/G} = -1.764666\hat{i} + a_{Gy}\hat{j} + (-4\hat{k}) \times (0.75\hat{j}) - 0$

$= 1.233\hat{i} + a_{Gy}\hat{j}$

$a_B = \vec{a}_A + \vec{\alpha}_{AB} \times \vec{r}_{B/A} - \omega^2 \vec{r}_{B/A} = 0 + \alpha_{AB}\hat{k} \times (-1\hat{j}) - 0$

$= \alpha_{AB}\hat{i}$

$\alpha_{AB}\hat{i} = 1.233\hat{i} + a_{Gy}\hat{j} \Rightarrow a_{Gy} = 0$ $\quad \alpha_{AB} = 1.233\ \hat{k}\ rad/s^2$

$T_{AB} = (45)(9.81) = 441.45\ N$