Working Model 2D: Tutorial 6

Example 13-10

A 6-ft slender rod weighing 64.4 lb is initially at rest when the force of 10 lb is applied as shown in the figure below. Determine the reactions at *A* and the angular acceleration of the rod for this instant.
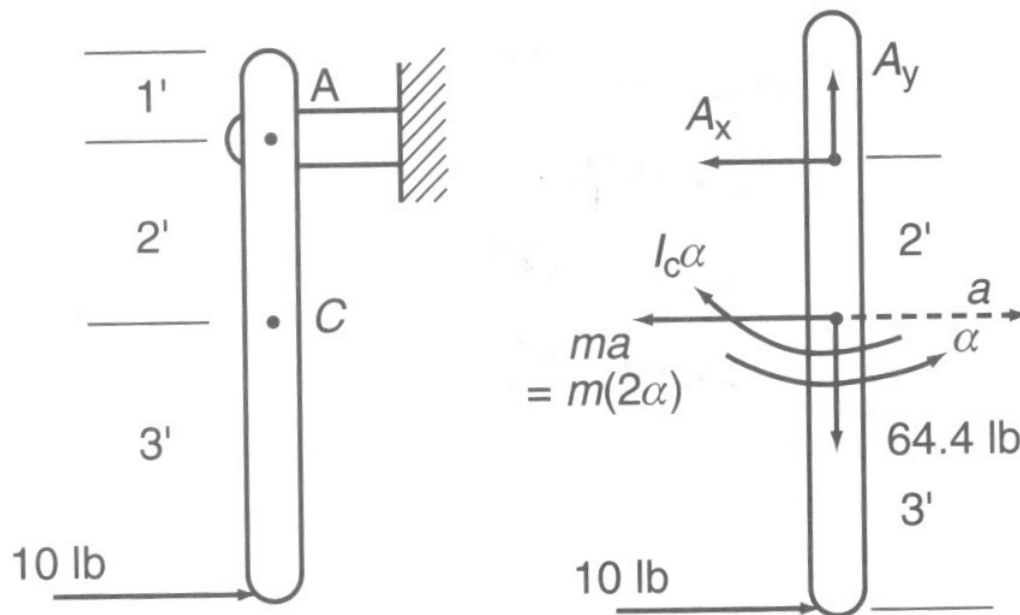

Figure 1

Initial Setup:

1. Set the Unites to English (Pounds) on Numbers and Unites… sub menu and click on the More Choices. Set the distance to Feet on the Distance pull-down menu, and the Rotation to Radians on Rotation pull-down menu.
2. Select the View Size menu from View and set the Window Width to 15 ft.
3. Change the accuracy to 0.0001
4. Set the Pause Control to pause when t > 0

Creating Geometry

1. Draw the vertical slender rod and set the height to 6 ft (change the width to about 0.4 ft in order to show a slender rod, but actual width is not important in this example).

2. Draw the cross-link close to the top end of the slender rod as shown in Figure 2. Send this object to the background by selecting the cross-link and using the "Send to Back" from Object menu.
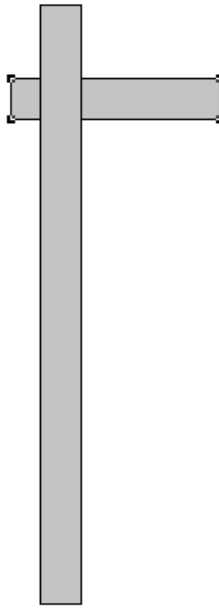
Figure 2

3. Select the Pin Joint from the drawing tool bar and bring the mouse pointer to the middle of the intersection of the two rods, and left-click to make a pin joint between the two rods.

4. Change the second set of X, Y coordinates on the coordinate bar (See Figure 3) to (0, 2) in order to place the pin joint at the exact mid point of the width of the rod and 2 ft along the Y axis from center C of the rod.

x -0.500 ft   y 0.000 ft   x 0.000 ft   y 2.000 ft

Figure 3

5. Anchor the horizontal link.

6. Double-click on the vertical link to get the properties window. Change the weight of the link to 64.4 lb as shown in Figure 4. Notice that you can specify the mass moment of the bar too.
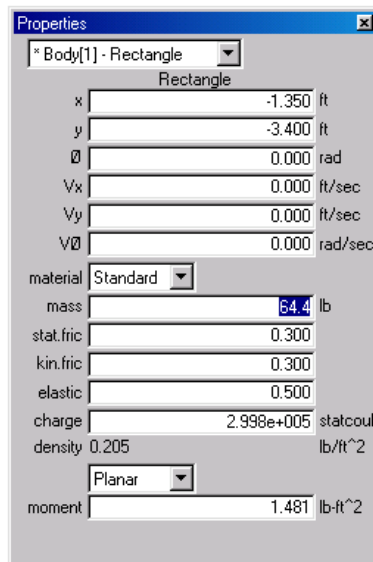

Properties	
* Body[1] - Rectangle ▼	
Rectangle	
x	-1.350 ft
y	-3.400 ft
Ø	0.000 rad
Vx	0.000 ft/sec
Vy	0.000 ft/sec
VØ	0.000 rad/sec
material	Standard ▼
mass	64.4 lb
stat.fric	0.300
kin.fric	0.300
elastic	0.500
charge	2.998e+005 statcoul
density	0.205 lb/ft^2
	Planar ▼
moment	1.481 lb-ft^2

Figure 4

7. Select the Force ⇨ constraint from the drawing tool bar and click on the bottom-left corner of the vertical bar and draw a horizontal force vector, and change the vector properties on the coordinate bar similar to Figure 5.
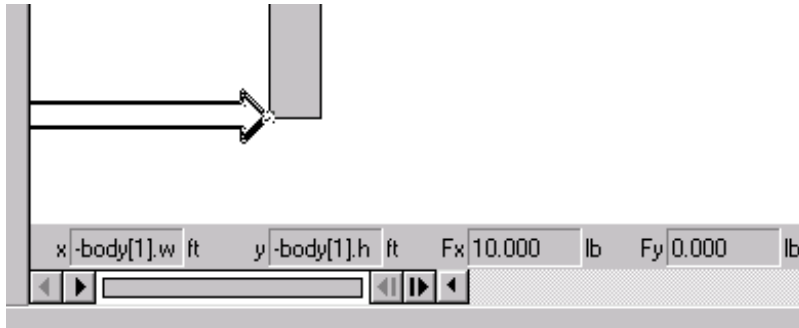
Figure 5

8. If you see a long force vector, you can change the size of the vector displayed on the screen by selecting Vector Lengths … from Define menu and changing the length of the Force Vector to a desired value (0.002 in this example) similar to Figure 6.
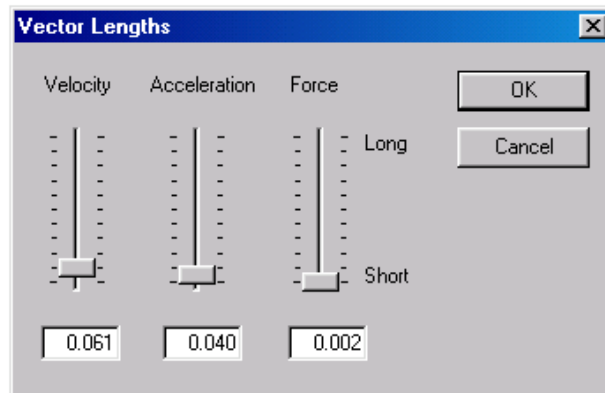

Figure 6

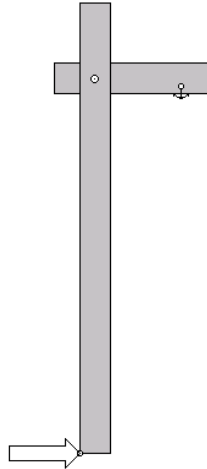9. Now, you should have a model similar to Figure 7.

Figure 7

Post Processing

Measuring Reaction Forces at Joints

You can measure the reaction forces at joints using meters similar to other quantities such as velocity and rotation. When you select a joint and create a meter to measure the reaction force, the meter measure the force exerted on the body located at the top layer when the joint was created. Since in this example we have to measure the force on the vertical link, it was necessary to move the vertical link to front (Step 2).

10. Click on the pin joint and select the Force from Measure menu. This will give you a meter to measure the X and Y components of the joint force.
11. Click on the vertical bar and select the rotation graph from Acceleration menu of Measure menu to plot the angular acceleration.
12. Now, the model is ready for simulation. Start the simulation to get the output similar to Figure 8.
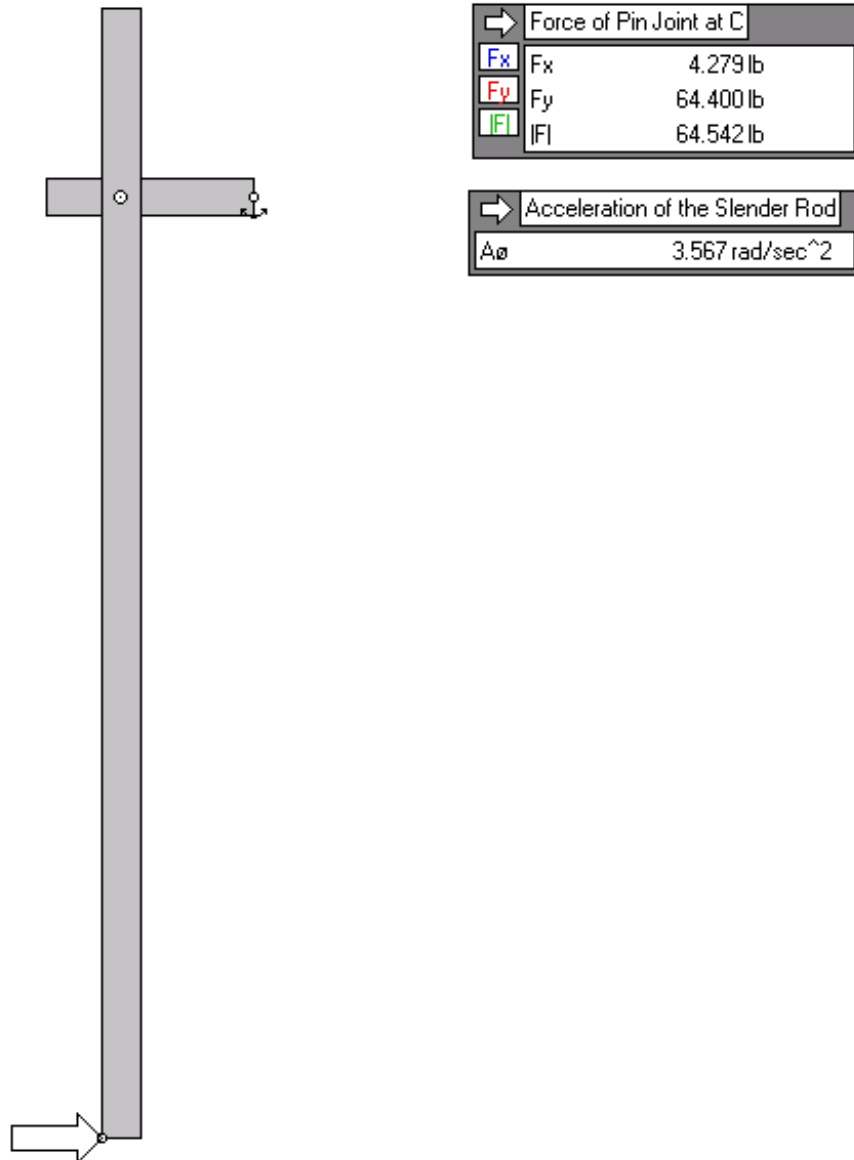
Force of Pin Joint at C	
Fx	4.279 lb
Fy	64.400 lb
|F|	64.542 lb

Acceleration of the Slender Rod	
Aø	3.567 rad/sec^2

Figure 8