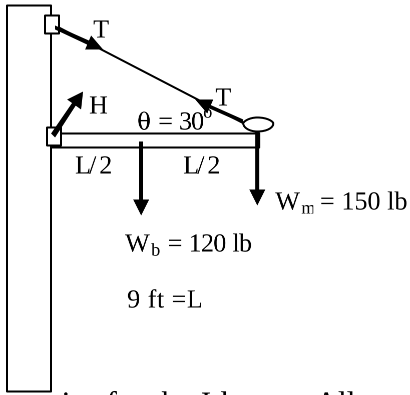
1. Group Problem



What is the force on each attachment to the wall? Compare to 500 lbs.

Use dynamics for the I-beam. All accelerations are zero.

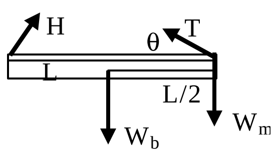
Sum of forces on beam = 0

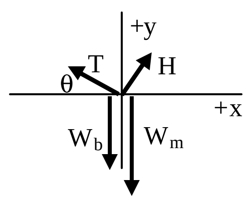
Sum of torques on beam = 0

Choose axis of rotation at end of beam.

Neglect the size of the mechanic.

Free body diagram of bar:





Take axis at end of beam.

+ is out.

$$\sum \tau = \frac{L}{2} W_b - H_y L = 0$$

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$$H = \sqrt{H_x^2 + H_y^2}$$

$$\sum F_x = H_x - T_x = 0$$

$$\sum F_y = H_y + T_y - W_b - W_m = 0$$

$$T_x = T\cos\theta$$

$$T_y = T\sin\theta$$

Target: H, T

Plan		unknowns
Find T		T
$T_y = T\sin\theta$	[1]	T_y
Find T_y		
$H_y + T_y - W_b - W_m = 0$	[2]	H_y
Find H_y		
$\frac{L}{2} W_b - H_y L = 0$	[3]	

3 unknowns, 3 equations – ok

Solve [3] for H_y

$$\frac{L}{2}W_b - H_y L = 0$$

$$H_y L = \frac{L}{2}W_b$$

$$H_y = \frac{\frac{L}{2}W_b}{L} = \frac{W_b}{2}$$ put into [2] and solve for T_y

$$\frac{W_b}{2} + T_y - W_b - W_m = 0$$

$$\frac{W_b}{2} + W_m = T_y$$ put into [1] and solve for T

$$\frac{W_b}{2} + W_m = T\sin\theta$$

$$\frac{\frac{W_b}{2} + W_m}{\sin\theta} = T$$

Check units: weight is a force so this is the correct units for T

$$\frac{\frac{120\text{lb}}{2} + 150\text{lb}}{\sin 30^o} = 420\text{lb} = T$$ The force on the bolts holding the cable is ok.

Now solve for H

Plan		unknowns
Find H		H
$H = \sqrt{H_x^2 + H_y^2}$	[1]	H_y, H_x
Find H_y		
$\frac{L}{2}W_b - H_y L = 0$	[2]	
Find H_x		
$H_x - T_x = 0$	[3]	T_x
Find T_x		
$T_x = T\cos\theta$	[4]	

4 unknowns, 4 equations

Solve [4] for T_x and put into [3]

$$T_x = T\cos\theta$$

$$H_x - T\cos\theta = 0$$ solve for H_x and put into [1]

$$H_x = T\cos\theta$$

$$H = \sqrt{(T\cos\theta)^2 + H_y^2}$$

Solve [2] for H_y and put into [1]

$$\frac{L}{2}W_b - H_y L = 0$$

$$\frac{W_b}{2} = H_y$$

$$\boxed{H = \sqrt{(T\cos\theta)^2 + \left(\frac{W_b}{2}\right)^2}}$$

Check units: Weight and T are forces so the units of H are force which is correct.

$$H = \sqrt{(420\text{lb})^2 + (60\text{lb})^2}$$

H = 424 lb The force on the hinge is ok

Evaluate:

$$\frac{\frac{W_b}{2} + W_m}{\sin\theta} = T$$ The tension in the cable increases if the weight of the bar or the weight of the mechanics increases. This is reasonable.

$$H = \sqrt{(T\cos\theta)^2 + \left(\frac{W_b}{2}\right)^2}$$

The force on the hinge increases if the weight of the bar increases. This is reasonable.

The force on the hinge increases if the force on the cable increases. This is reasonable because the cable pushes the bar into the wall.