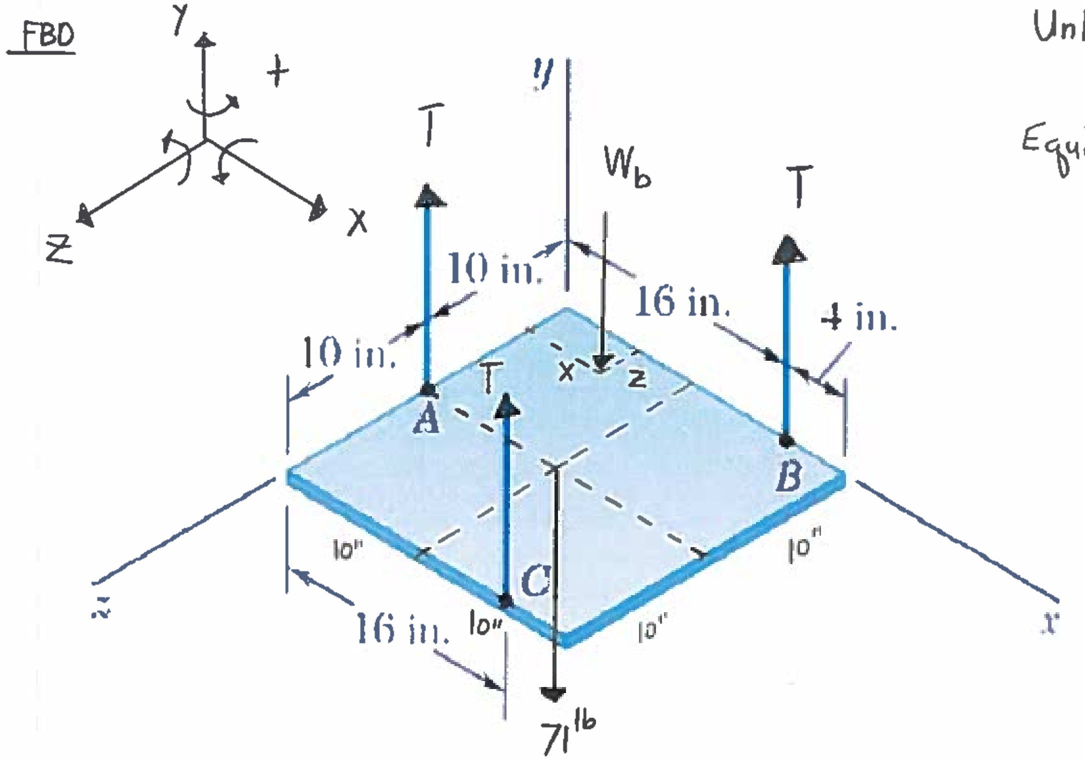
A (20 ×20)-in. square plate, as shown in the figure, weighs 71 lb and is supported by three vertical wires. Determine the weight and the location of the lightest block that should be placed on the plate if the tensions in the three wires are to be equal. (Round the final answer to two decimal places.)

FBD



Unknowns: W_b, T, x, z

Equilibrium: $\sum M_z = 2T(16") - 71^{lb}(10") - W_b(x) = 0$

$32T - 710 - W_b x = 0$

$\sum M_x = -T(20") - T(10") + 71^{lb}(10") + W_b(z) = 0$

$= -30T + 710 + W_b z = 0$

$\sum F_y = 3T - W_b - 71^{lb} = 0$

The weight of the lightest block is ______ lb, at x = ______ in. and z = ______ in.

Equations:

(1) $32T - 710 - W_b x = 0$

(2) $-30T + 710 + W_b z = 0$

(3) $3T - W_b - 71 = 0$

We have 4 unknowns, but only 3 <u>independent</u> equations. Therefore, we need an equation of condition to solve this.

The equation of condition comes from symmetry.

Determine z: By symmetry z must be 10" -or-

$$3T - W_b - 71 = 0 \Rightarrow T = (71 + W_b)\tfrac{1}{3} \quad \text{"sub into eqn. (2)"}$$

$$-30(71 + W_b)\tfrac{1}{3} + 710 + W_b z = 0$$

$$\Rightarrow (z - 10)\, W_b = 0$$

$$\therefore \underline{\underline{z = 10"}}$$

Determine X to minimize W_b:

$$32(71 + W_b)\tfrac{1}{3} + 710 - W_b X = 0$$

$$757.33 + 10.67 W_b - 710 - W_b X = 0$$

$$\Rightarrow \quad W_b = \frac{-47.33}{(10.67 - X)}$$

* We know W_b must be positive to satisfy equilibrium, therefore $X > 10.67''$ and to minimize W_b we need to maximize the denominator.

$$\therefore \quad \underline{\underline{X = 20''}}$$