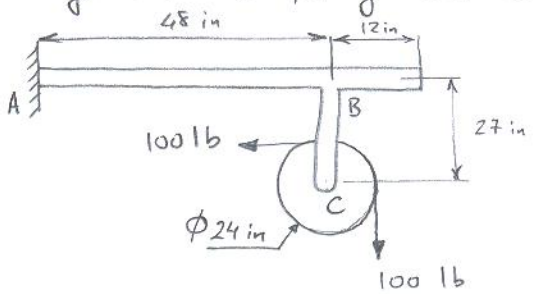
AE361 Applied Elasticity
HOMEWORK # 1

Name: Serzhan AKHMETOV
ID: 1527860

① Given: geometry of a pulley and support structure, the forces acting on the pulley via wires.



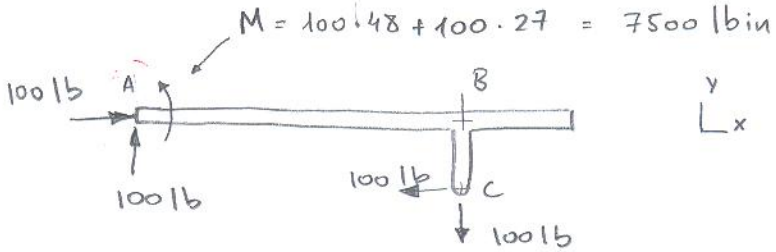
Find: a) Draw the free-body diagram of the pulley support structure;
b) Draw shear and bending moment diagrams for the vertical and horizontal portions of structure.

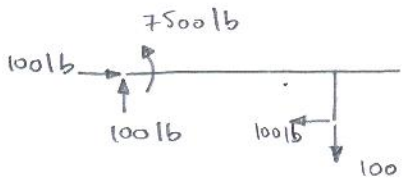
Solution:

Assumption(s): • We assume the whole structure + pulley to have negligible weight (no distributed forces)

Analysis:

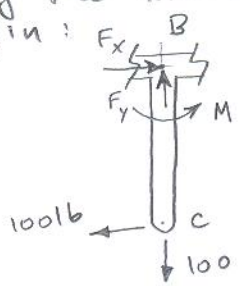
a) The FBD:





b) Vertical Structure supporting pulley:

Taking the intersection of the vertical and horizontal parts as origin:

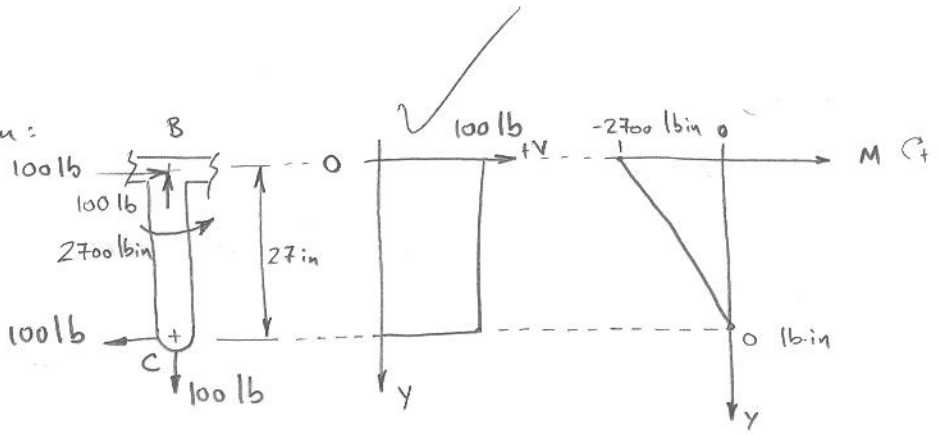


$\rightarrow \Sigma F$: x-direction: $F_x = 100$ lb
y-direction: $F_y = 100$ lb

$\circlearrowleft \Sigma M$: $M = 100 \cdot 27 = 2700$ lb.in

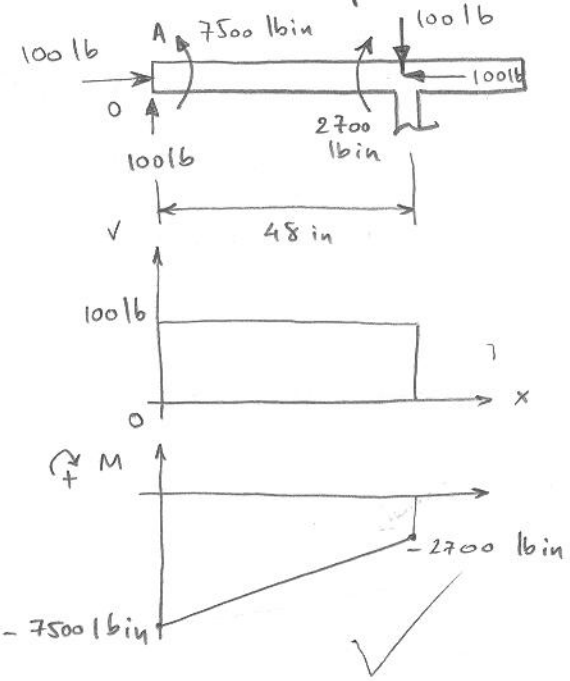
① (cont...)

Then:



b) Horizontal Part:

Moments and forces at point B are opposite of those found in the vertical part, thus:



Due to constant gradient of the moment and the known start and end moments at A, B, the moment diagram is a simple line

$$M = -7500 + 100\,x$$

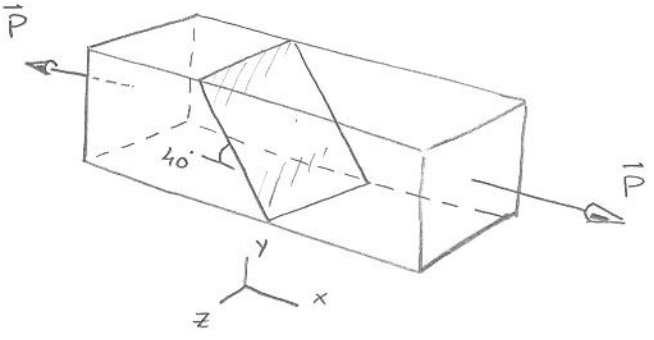
② Given: Geometry of a two part glued prizm with maximum allowable stresses and shears is under axial load P.

$$A = 50 \cdot 10^{-3}\ m \cdot 75 \cdot 10^{-3}\ m$$

$$\sigma'_{max} = 700\ kPa$$

$$\tau'_{max} = 560\ kPa$$

Find: axial maximum load P

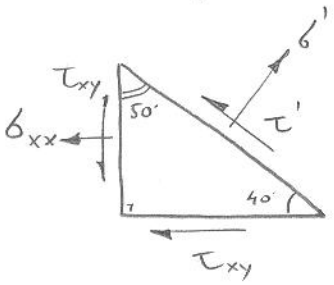


② (cont...)

Solution:

Assumptions: Load P is such that $\tau_{xz} = \tau_{yx} = 0$

Analysis: $A = 3{,}75 \cdot 10^{-3}\ m^2$



From σ': $\sigma'_{max} = \frac{\sigma_{xx}}{2} + \frac{\sigma_{xx}}{2}\cos 2\phi$

$$P^{(\sigma')} = A \cdot \sigma_{xx} = A \cdot \frac{2\sigma'_{max}}{(1+\cos 2\phi)}$$

where $\phi = 50°$

$$P = 3{,}75 \cdot 10^{-3}\ \frac{2 \cdot 700 \cdot 10^{3}}{1+\cos(100°)} = 6{,}353\ kN$$

From τ':

$$\tau'_{max} = -\frac{\sigma_{xx}}{2}\sin 2\phi \quad \rightarrow \quad \sigma_{xx} = -\frac{2\tau'_{max}}{\sin 2\phi}$$

$$P = A \cdot \frac{-2\tau'_{max}}{\sin 2\phi} = 3{,}75 \cdot 10^{-3} \cdot \frac{2 \cdot 560 \cdot 10^{3}}{\sin(100°)} = 4{,}265\ kN$$

Any force larger than 4,265 kN will cause shear greater than allowable, therefore the answer is:

$$P_{max} = 4{,}265\ kN \quad \blacktriangleleft$$