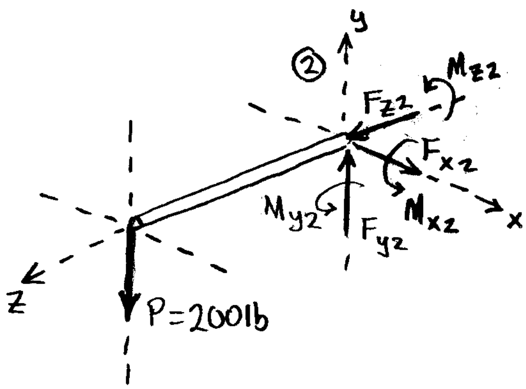
LAB # 1

FBD: END OF BAR TO SECTION ②



STATICS:

$\Sigma F_x = 0; \quad F_{x2} + 0 = 0 \rightarrow F_{x2} = 0$

$\Sigma F_y = 0; \quad F_{y2} - P = 0 \rightarrow F_{y2} = P$

$\Sigma F_z = 0; \quad F_{z2} + 0 = 0 \rightarrow F_{z2} = 0$

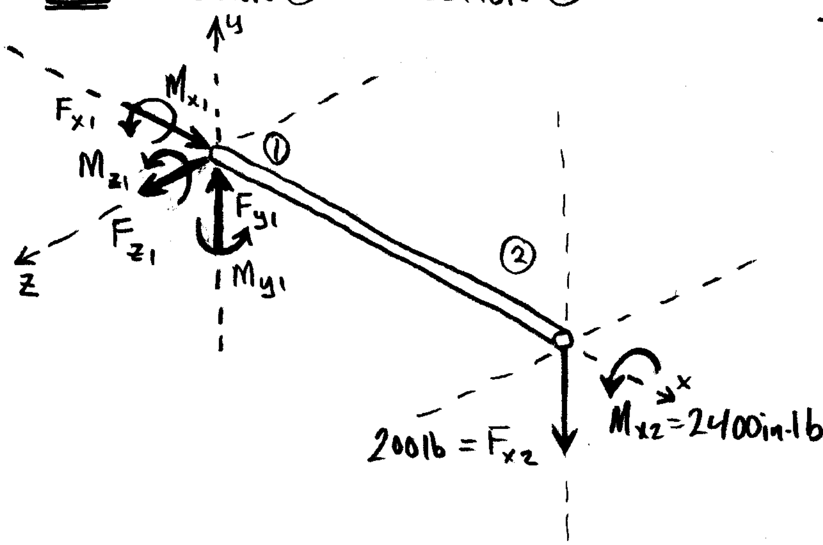
$\Sigma M_x = 0; \quad M_{x2} + P(12in) = 0$

$M_{x2} = -200lb(12in)$

$\Sigma M_y = 0; \quad M_{y2} + 0 = 0 \rightarrow M_{y2} = 0$

$\Sigma M_z = 0; \quad M_{z2} + 0 = 0 \rightarrow M_{z2} = 0$

FBD SECTION ② TO SECTION ①



STATICS:

$\Sigma F_x = 0; \quad F_{x1} + 0 = 0 \rightarrow F_{x1} = 0$

$\Sigma F_y = 0; \quad F_{y1} - F_{x2} = 0 \rightarrow F_{x1} = 200lb$

$\Sigma F_z = 0; \quad F_{z1} + 0 = 0 \rightarrow F_{z1} = 0$

$\Sigma M_x = 0; \quad M_{x1} + M_{x2} = 0$

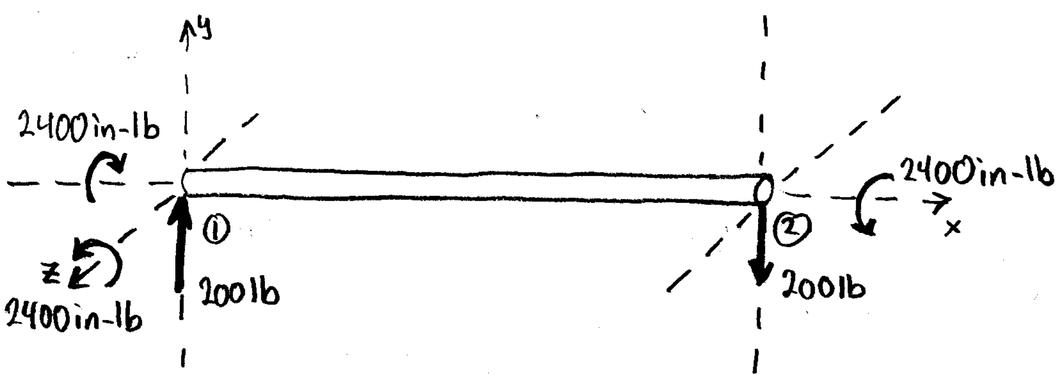
$M_{x1} = -2400 in\text{-}lb$

$\Sigma M_y = 0; \quad M_{y1} + 0 = 0 \rightarrow M_{y1} = 0$

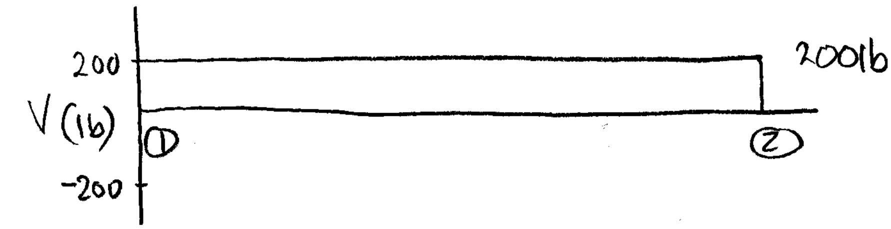
$\Sigma M_z = 0; \quad M_{z1} - F_{x2}(12 in)$

$M_{z1} = 2400 in\text{-}lb$

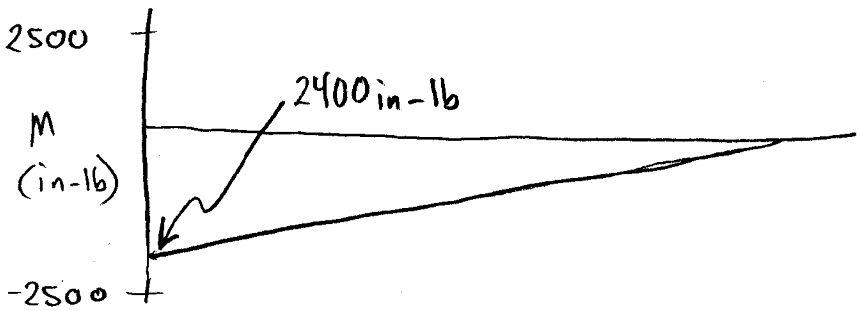
FBD SECTION ② TO SECTION ① REDRAWN FOR CLARITY:



SHEAR AND MOMENT DIAGRAMS: (SECTION ① TO SECTION ②)



SIGN CONVENTION:



REMEMBER: $\frac{dM}{dx} = V$

MAX BENDING MOMENT:

2400 in-lb AS SHOWN ON MOMENT DIAGRAM ABOVE.
THIS MAX MOMENT OCCURS AT "THE WALL" (SECTION ①)

NOTE: A 2400 in-lb BENDING MOMENT IS ALSO ACTING AT SECTION ③

MAX SHEAR STRESS:

BENDING: $\tau = \frac{4}{3}\frac{V}{A} = \frac{4}{3}\frac{200\,lb}{\frac{\pi}{4}(1\,in)^2} = 340$ psi

TORSIONAL: $\tau = \frac{Tr}{J} = \frac{16T}{\pi D^3} = \frac{16(2400\,in\text{-}lb)}{\pi\,(1\,in)^3} = 12,223$ psi

$\tau_{max} = 12.5$ kpsi , LOCATED AT MIDLINE OF SECTION ①-② ON POSITIVE Z SIDE.

NOTE: THE BENDING SHEAR IS NEGLIGIBLE, BUT MUST BE SHOWN TO BE SMALL BEFORE YOU CAN NEGLECT IT.

LAB # 1 (CONT'D)

DRAW STATE OF STRESS FOR TOP AT SECTION ①:

FIND STRESSES AT SECTION ①

BENDING STRESS:

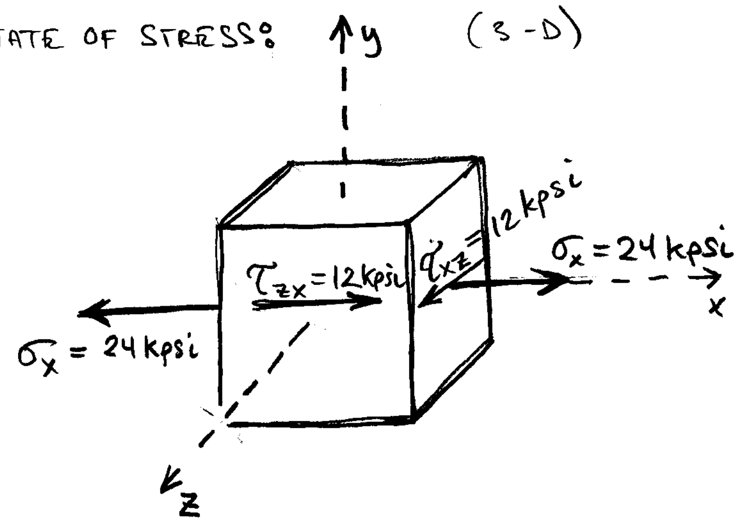
$$\sigma_x = \frac{Mc}{I} = \frac{M\frac{D}{2}}{\frac{\pi D^4}{64}} = \frac{32M}{\pi D^3} = \frac{32(2400 \text{ in-lb})}{\pi (1 \text{ in})^3} = 24 \text{ kpsi}$$

TORSIONAL STRESS:

$$\tau_{xz} = \frac{Tr}{J} = \frac{T\frac{D}{2}}{\frac{\pi D^4}{32}} = \frac{16T}{\pi D^3} = \frac{16(2400 \text{in-lb})}{\pi (1 \text{in})^3} = 12 \text{ kpsi}$$

NOTE: NO BENDING SHEAR ON TOP SURFACE

STATE OF STRESS: (3-D)



TOP VIEW: (2-D)