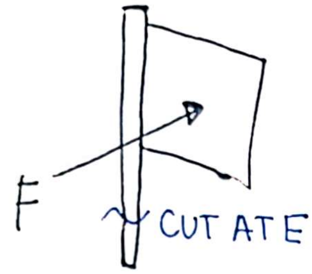
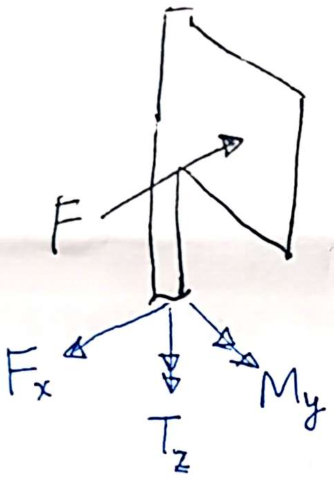
IN-CLASS QUIZ #1 SOLUTION

1) THE DISTRIBUTED WIND LOAD CAN BE REPRESENTED BY A POINT LOAD ACTING AT THE MIDDLE OF THE SIGN.



$$F = (0.5\ \text{psi})(1\ \text{ft})(4\ \text{ft})$$
$$= (0.5\ \text{psi})(12\ \text{in})(48\ \text{in})$$
$$= 288\ \text{lbf}$$



@ E:

$$\Sigma F_x = 0 \Rightarrow F_x = 288\ \text{lbf}$$ TRANSVERSE SHEAR

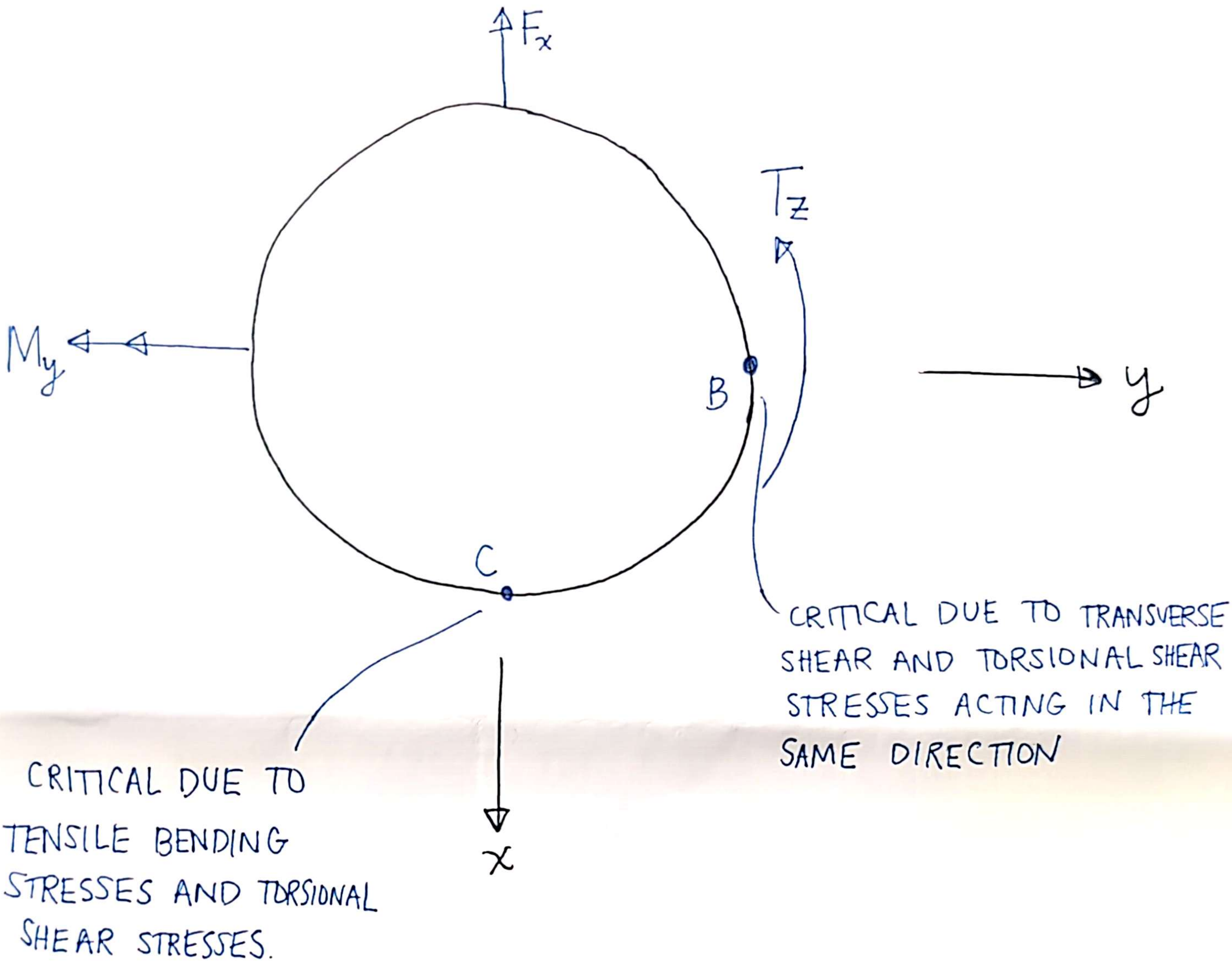
$$\Sigma M_y = 0 \Rightarrow M_y = F(1\ \text{ft} + 2\ \text{ft})$$
$$= (288\ \text{lbf})(3\ \text{ft})$$
$$M_y = 864\ \text{lbf-ft}$$
(OR 10,368 lbf-in) BENDING MOMENT

$$\Sigma M_z = 0 \Rightarrow T_z = F(0.5\ \text{ft})$$
$$= (288\ \text{lbf})(0.5\ \text{ft})$$
$$T_z = 144\ \text{lbf-ft}$$
(OR 1728 lbf-in) TORSION

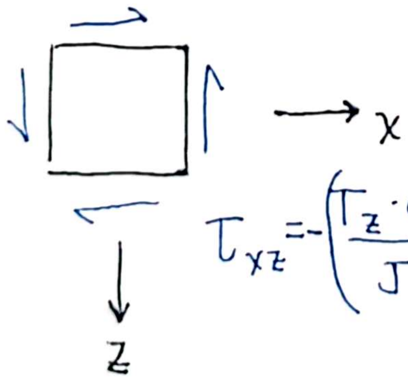
$\Sigma F_z = 0$ (NO AXIAL)

2) THE CRITICAL CROSS-SECTION WILL BE AT THE BASE OF THE POLE BECAUSE THE BENDING MOMENT WILL BE HIGHEST. (TRANSVERSE SHEAR AND TORSION WILL BE CONSTANT ALONG THE LENGTH OF THE POLE.)

3) CROSS-SECTION AT E



4) @ LOCATION B

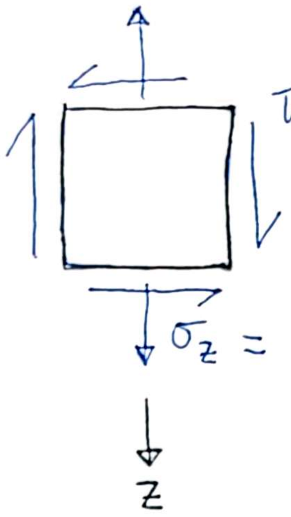


$$\tau_{xz} = -\left(\frac{T_z \cdot c}{J} + \frac{4V}{3A}\right) = -\left(\frac{(1728\ \text{lbf-in})(2\ \text{in})}{\frac{\pi}{32}(4\ \text{in})^4} + \frac{4}{3}\,\frac{288\ \text{lbf}}{\pi(2\ \text{in})^2}\right)$$

$$= -(137.5 + 30.6)$$

$$\boxed{\tau_{xz} = -168.1\ \text{psi}}$$

@ LOCATION C



$$\tau_{zy} = \frac{T_z c}{J} = \frac{(1728 \text{ lbf-in})(2 \text{ in})}{\frac{\pi}{32}(4 \text{ in})^4} = \underline{137.5 \text{ psi}}$$

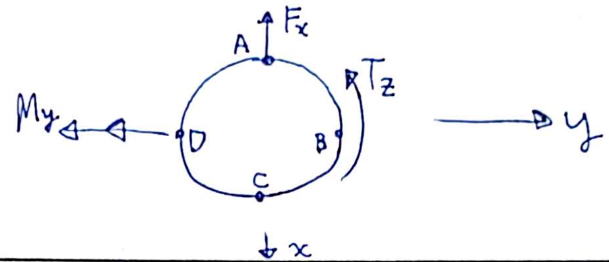
$$\sigma_z = \frac{M_y \cdot c}{I} = \frac{(10{,}368 \text{ lbf-in})(2 \text{ in})}{\frac{\pi}{64}(4 \text{ in})^4} = \underline{1650 \text{ psi}}$$

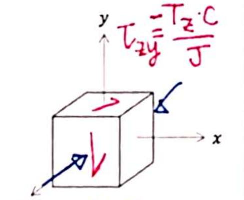
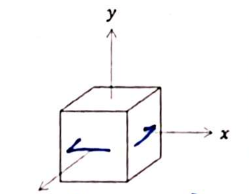
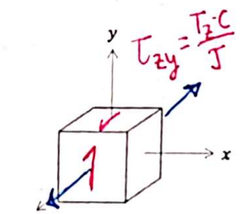
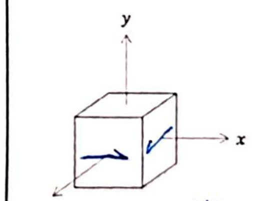
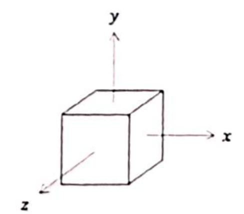
BONUS: IF WE DID NOT NEGLECT THE WEIGHT, THEN AN AXIAL (COMPRESSIVE) INTERNAL LOAD WOULD ACT AT CROSS-SECTION E, AS WELL AS A BENDING MOMENT ABOUT THE X-AXIS. THE CRITICAL CROSS-SECTION WOULD NOT CHANGE, BUT THE CRITICAL ELEMENT WOULD NOW REFLECT THE MAGNITUDE & ANGLE OF THE COMBINED BENDING MOMENTS.

MAG. $\Rightarrow \sqrt{M_x^2 + M_y^2}$

ANGLE $\Rightarrow \tan^{-1}\left(M_y / M_x\right)$

In this box,
- Draw the critical cross-section
- Identify and label the potential locations for the critical element(s) (e.g. top, bottom, left, right, and center)



Potential location of critical element		A	B	C	D	
Internal load	Axial: none	→	→	→	→	
	Torsion	(SHEAR STRESS ON Z FACE POINTS IN NEG Y DIR) $\tau_{zy} = -\frac{T_z \cdot c}{J}$	(SHEAR STRESS ON Z FACE POINTS IN NEG X) $\tau_{zx} = -\frac{T_z \cdot c}{J}$	(SHEAR STRESS ON Z FACE POINTS IN POS Y) $\tau_{zy} = \frac{T_z \cdot c}{J}$	(SHEAR STRESS ON Z FACE POINTS IN POS X) $\tau_{zx} = +\frac{T_z \cdot c}{J}$	
	Transverse shear	0	(SHEAR STRESS ON Z FACE POINTS IN NEG X) $\tau_{zx} = -\frac{4V}{3A}$	0	(SHEAR STRESS ON Z FACE POINTS IN NEG X) $\tau_{zx} = -\frac{4V}{3A}$	
	Bending	$\sigma_z = -\frac{M_y \cdot c}{I}$	0	$\sigma_z = +\frac{M_y c}{I}$	0	
Stress element		 $\tau_{zy} = \frac{-T_z \cdot c}{J}$; $\sigma_z = \frac{-M_y \cdot c}{I}$	 $\tau_{zx} = -\left(\frac{T_z c}{J} + \frac{4V}{3A}\right)$	 $\tau_{zy} = \frac{T_z \cdot c}{J}$; $\sigma_z = \frac{M_y \cdot c}{I}$	 $\tau_{zx} = \frac{T_z \cdot c}{J} - \frac{4V}{3A}$	

SAME AS C BUT σ_z IS COMPRESSIVE

CRITICAL LOCATIONS ARE AT B & C

D IS NEVER WORSE THAN B