Steel Design

5.2-2 An unsymmetrical flexural member consists of a ½ × 12 top flange, a ½ × 7 bottom flange, and a ⅜ × 16 web.

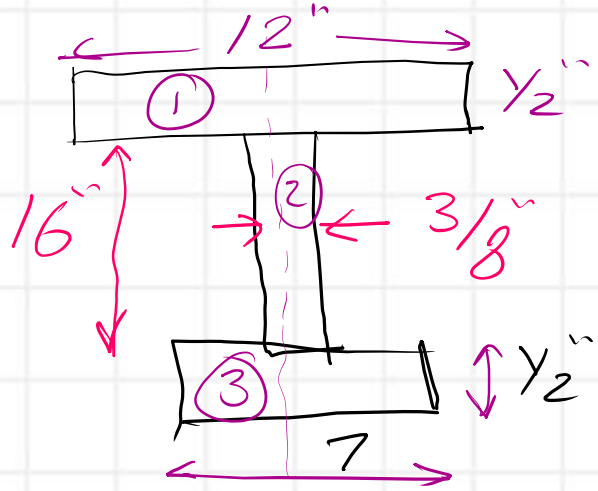
a. Determine the distance $\bar{y}$ from the top of the shape to the horizontal *plastic* neutral axis.

b. If A572 Grade 50 steel is used, what is the plastic moment M_p for the horizontal plastic neutral axis?

c. Compute the plastic section modulus Z with respect to the minor principal axis.

Prof. SEGui

Solutions



Notice due to No axis of symmetry, we need to Find $(A/2)$ axis or the axis that divides area into Two Equal parts

Total area $\Rightarrow A_T$

$$A_1 + A_2 + A_3 = 12\left(\frac{1}{2}\right) + 16\left(\frac{3}{8}\right) + 7\left(\frac{1}{2}\right)$$

$$= 6 + 6 + 3.5 = 15.50 \text{ inch}^2$$

$$\frac{A_T}{2} = \frac{15.5}{2} = 7.75 \text{ inch}^2$$

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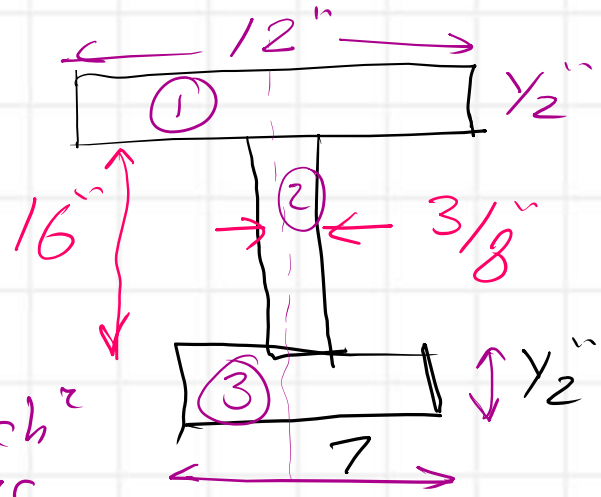

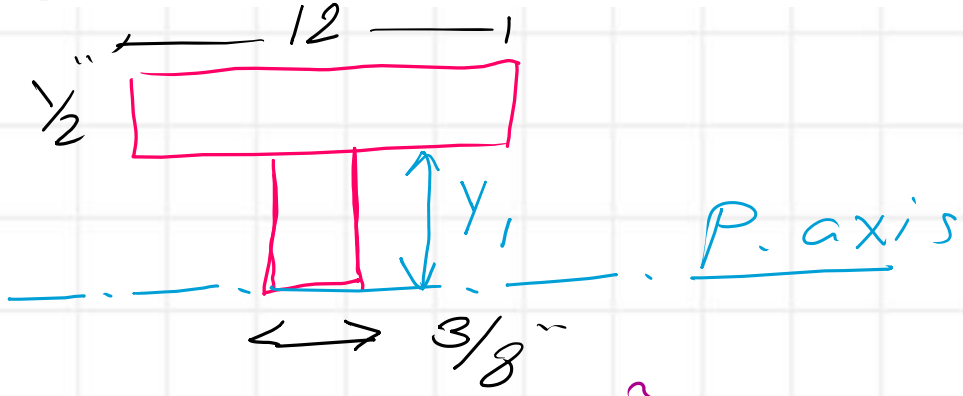

$A_T = 7.75 \text{ inch}^2$

$\frac{A_T}{2}$

T section ⇒ 7.75 inch²

$$y_1 = \frac{7.75 - (\frac{1}{2})(12)}{(\frac{3}{8})} = 4.667 \text{ inch}$$

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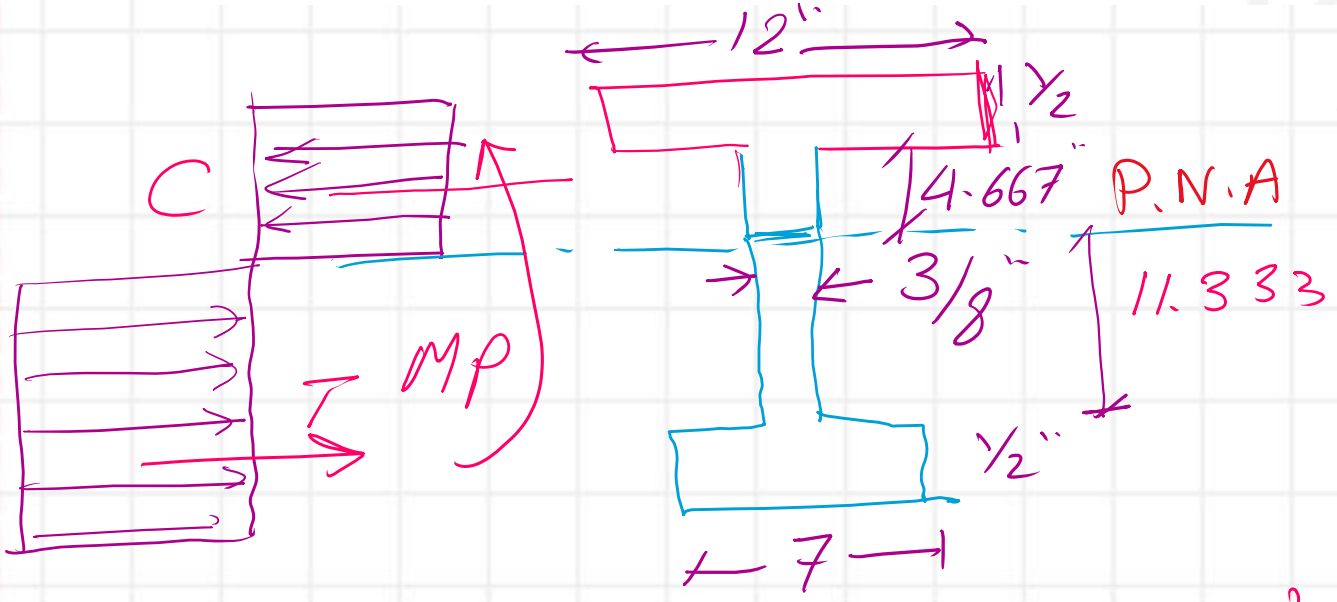

@ $\bar{y} = \frac{1}{2}" + 4.667$

$\bar{y} = 5.166" \approx 5.17"$

if we to check the Lower portion

$(7)(\frac{1}{2}) + (11.333)(\frac{3}{8}) \approx 7.75 \text{ inch}^2$

$= \frac{A_T}{2}$ ok

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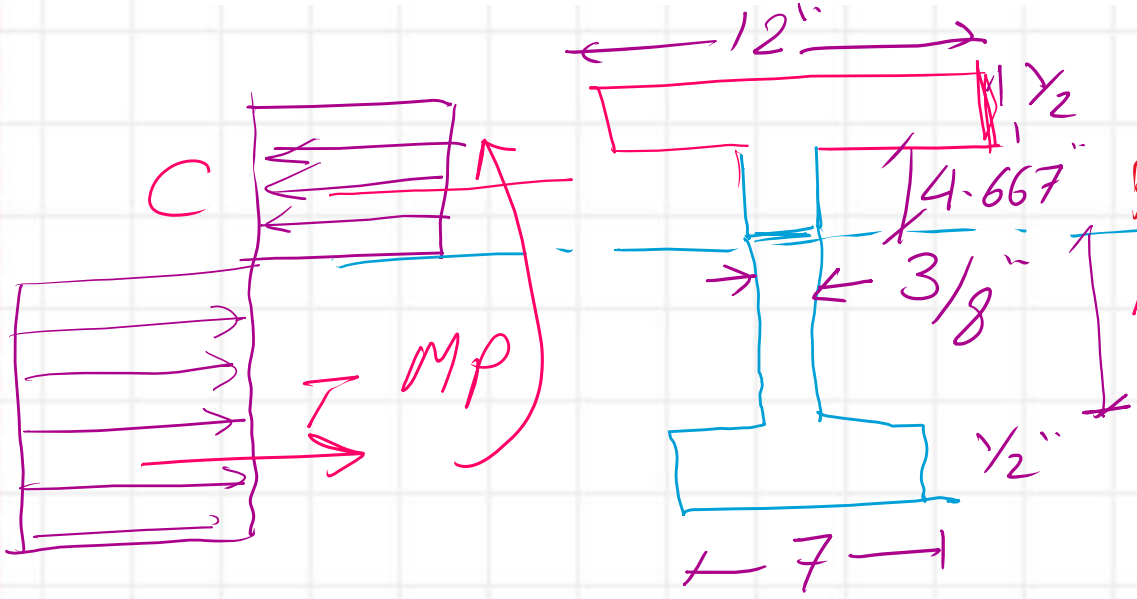

(b) A572 Grade 50

$F_y = 50$ ksi

To find M_p we need to find C, $y_{c.t}$

$$C = T = \frac{A_T}{2} F_y = 7.75(50) = 387.50 \text{ kips}$$

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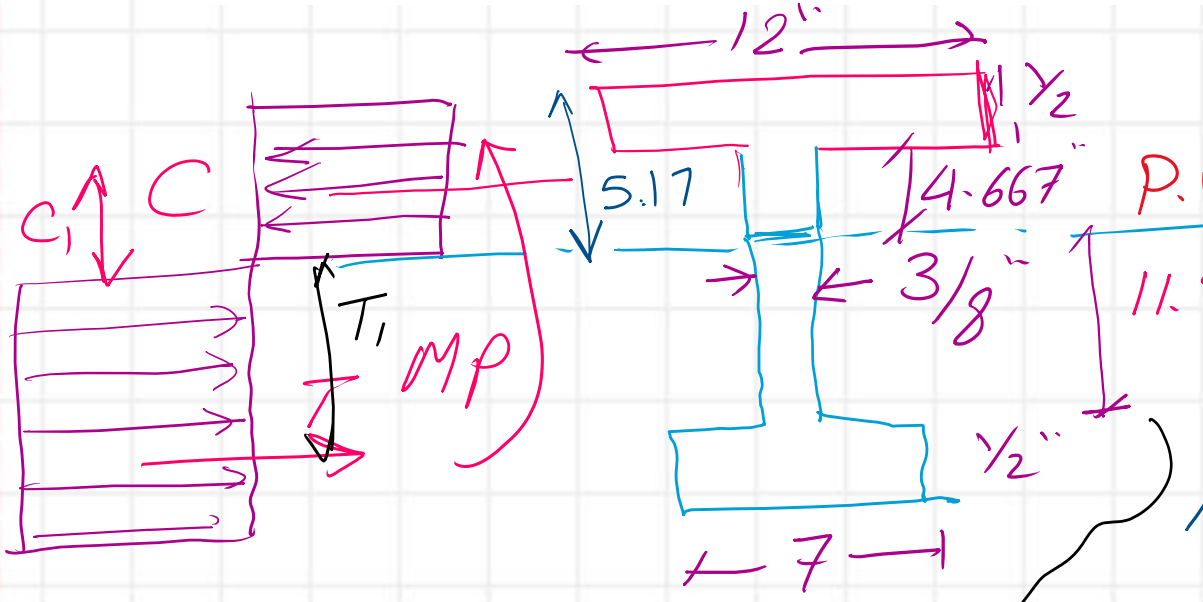

(b) Point of C application

$$\frac{\sum A_1 y_1}{\sum A} = \frac{A_T}{2}$$

Take moment about P.N.A

$$12\left(\frac{1}{2}\right)\left(5.17-\frac{1}{4}\right)+4.67\left(\frac{3}{8}\right)(2.333)$$

$$= 29.52 + 4.089 = 33.609 \text{ inch}^3$$

$$C_1 = \frac{33.609}{7.75} = 4.34"$$

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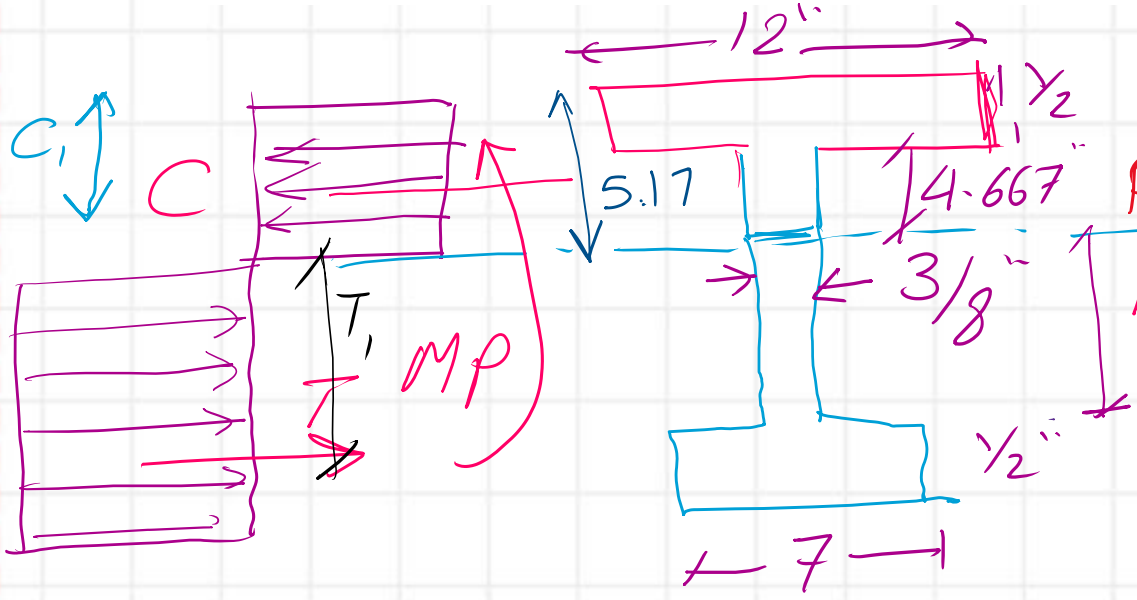
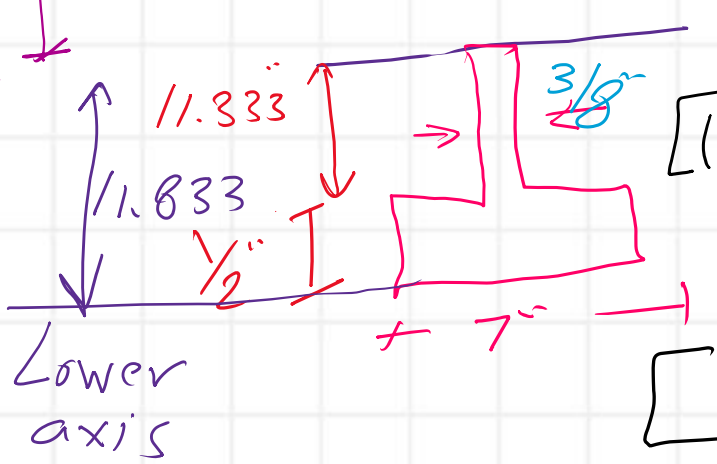


$$T_1 = \frac{64.62}{7.75} = 8.34"$$

(b) Point of C application

$$\sum_1^2 A_1 y_1 = \sum A \frac{AT}{2}$$



$$\left[\left(\frac{3}{8}\right)\left(\frac{11.333}{2}\right)^2 + 5.5\,(11.583)\right]$$

$$[24.08 + 40.54]$$

$$= 64.62 \text{ inch}^3$$

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(b) $h = 17''$ $\quad y_{C.T} = 12.68''$

$C_1 = 4.34$
$T_1 = 8.34$ $\Rightarrow C_1 + T_1$

$M_p = C.y_{C.T} = T.y_{C.T} = 327.5\ (12.68)$

$M_p = 4913.5$ inch-kips

$M_p = \frac{1}{12}(4913.5) = 409.46$ FT-kips

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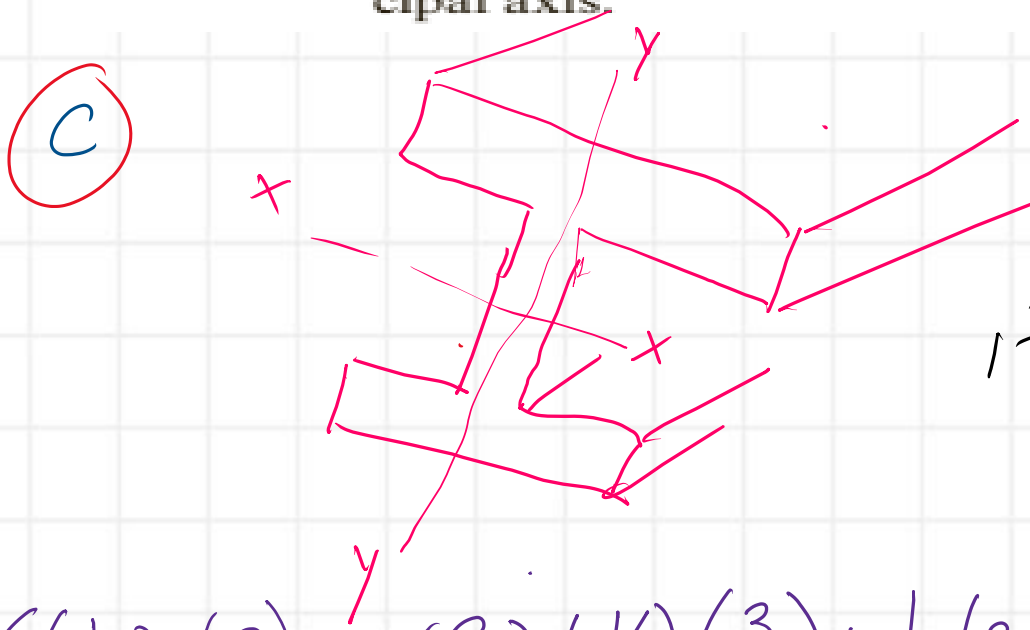

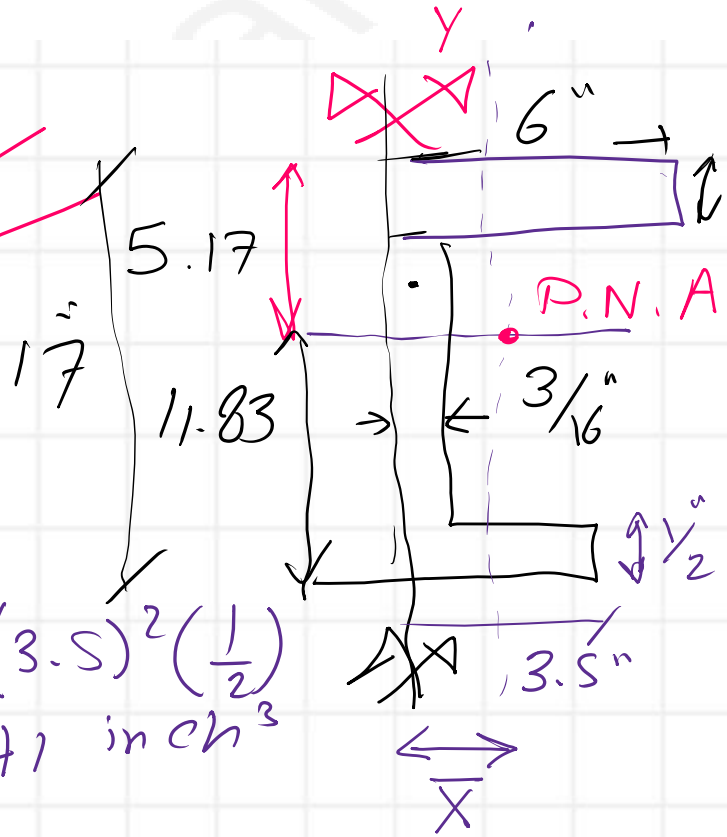

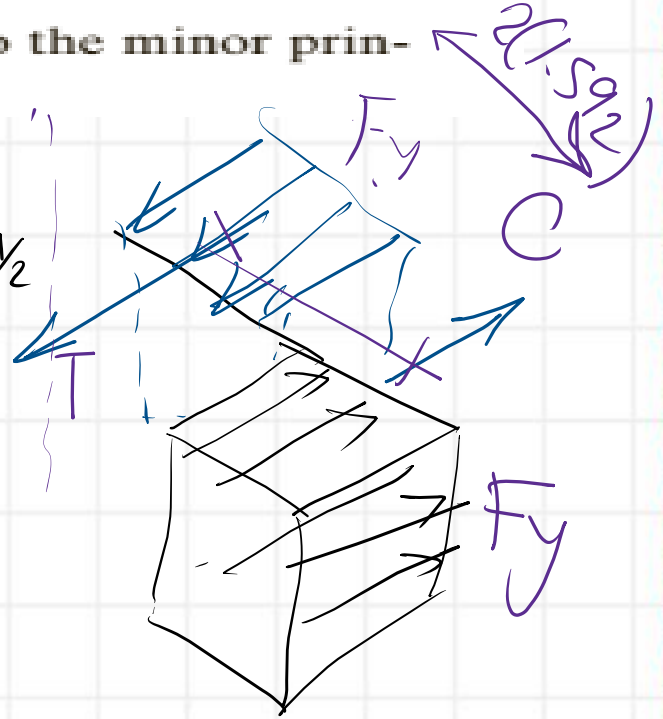

$$6\left(\frac{1}{2}\right)(3) + \left(\frac{3}{16}\right)(16)\left(\frac{3}{32}\right) + \frac{1}{2}(3.5)^2\left(\frac{1}{2}\right)$$

$$= 9 + 0.281 + 3.06 = 12.341 \text{ inch}^3$$

$$\bar{X} = \frac{12.341}{7.75} = 1.592"$$

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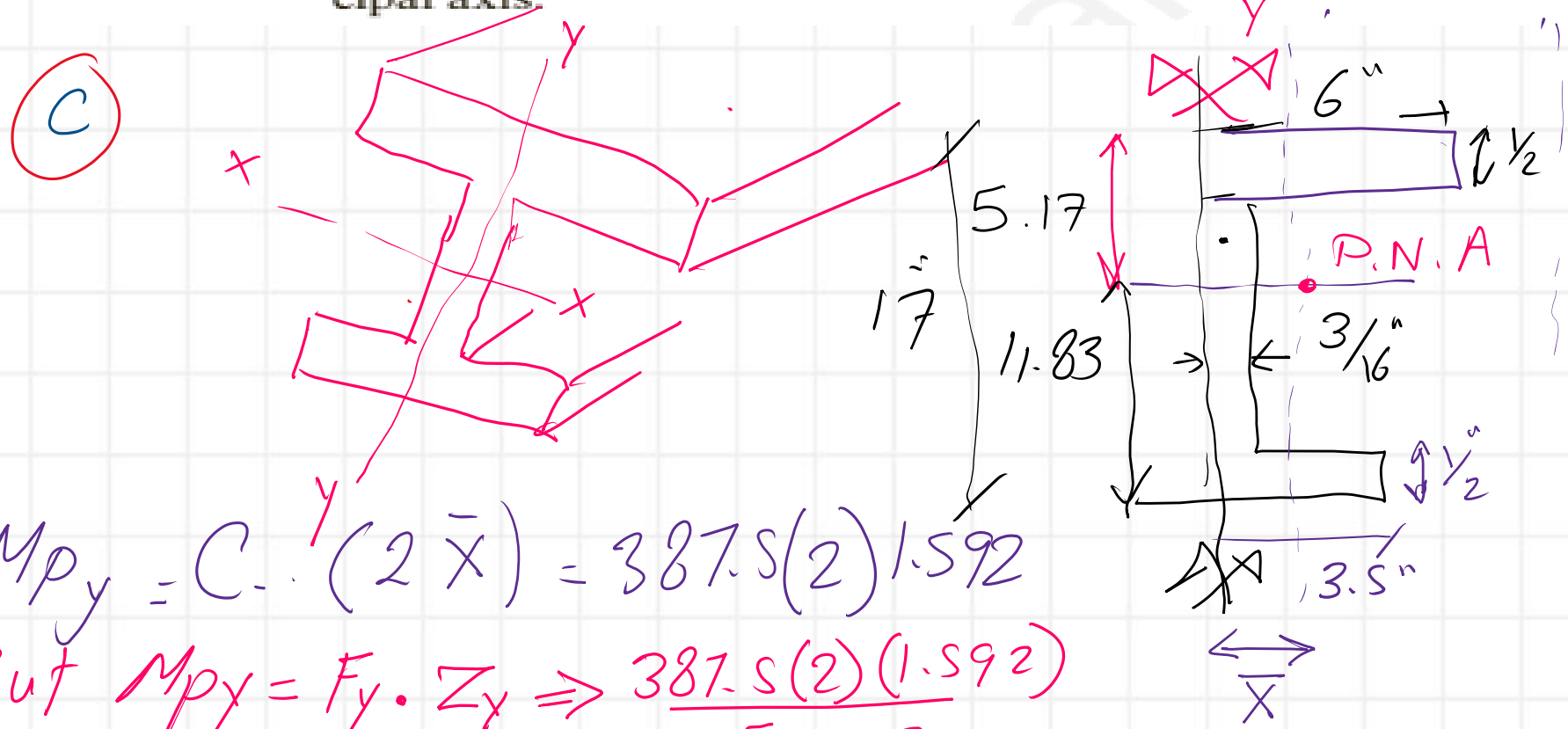

$$M_{py} = C \cdot (2\bar{x}) = 387.5(2)1.592$$

But $M_{py} = F_y \cdot Z_y \Rightarrow \dfrac{387.5(2)(1.592)}{50} = Z_y$

$$Z_y = 24.676\ inch^3$$

Prepared by Eng.Maged Kamel.