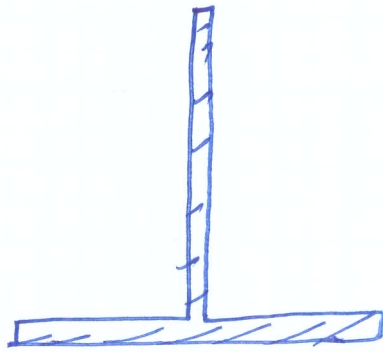


Elastic and Plastic section Properties of

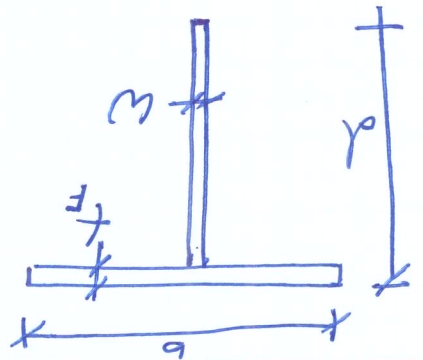
"T" shape



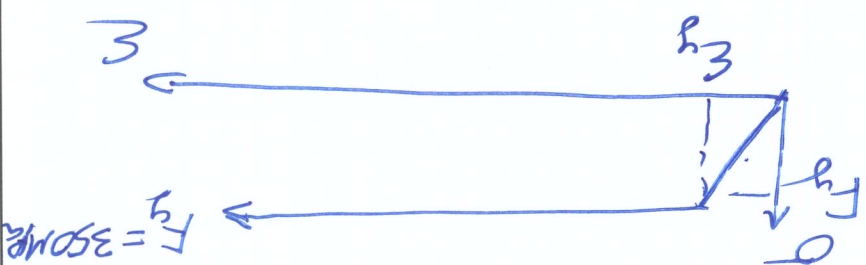
S_x, M_y
 Z_x, M_p
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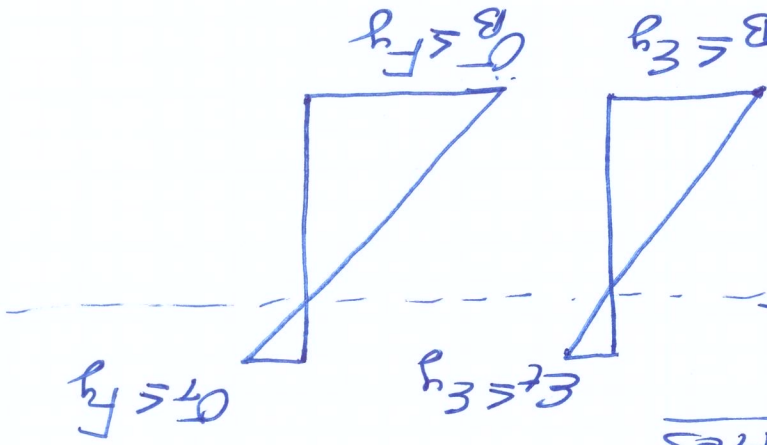
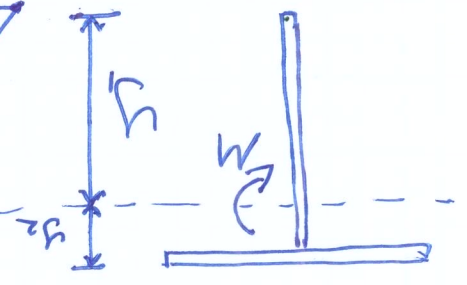
What if section is not symmetric



Find: M_y, S_x
 M_x, Z_x
 M_y, Z_y



Elastic properties

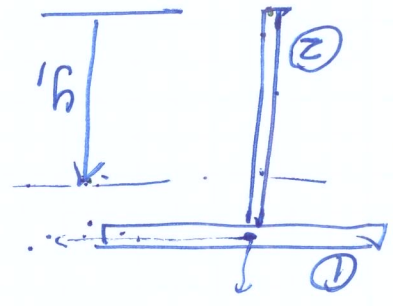


Find y_1 (Elastic Neutral axis location)

$$A_1 = b t_f = (200)(10) = 2000 \text{ mm}^2$$

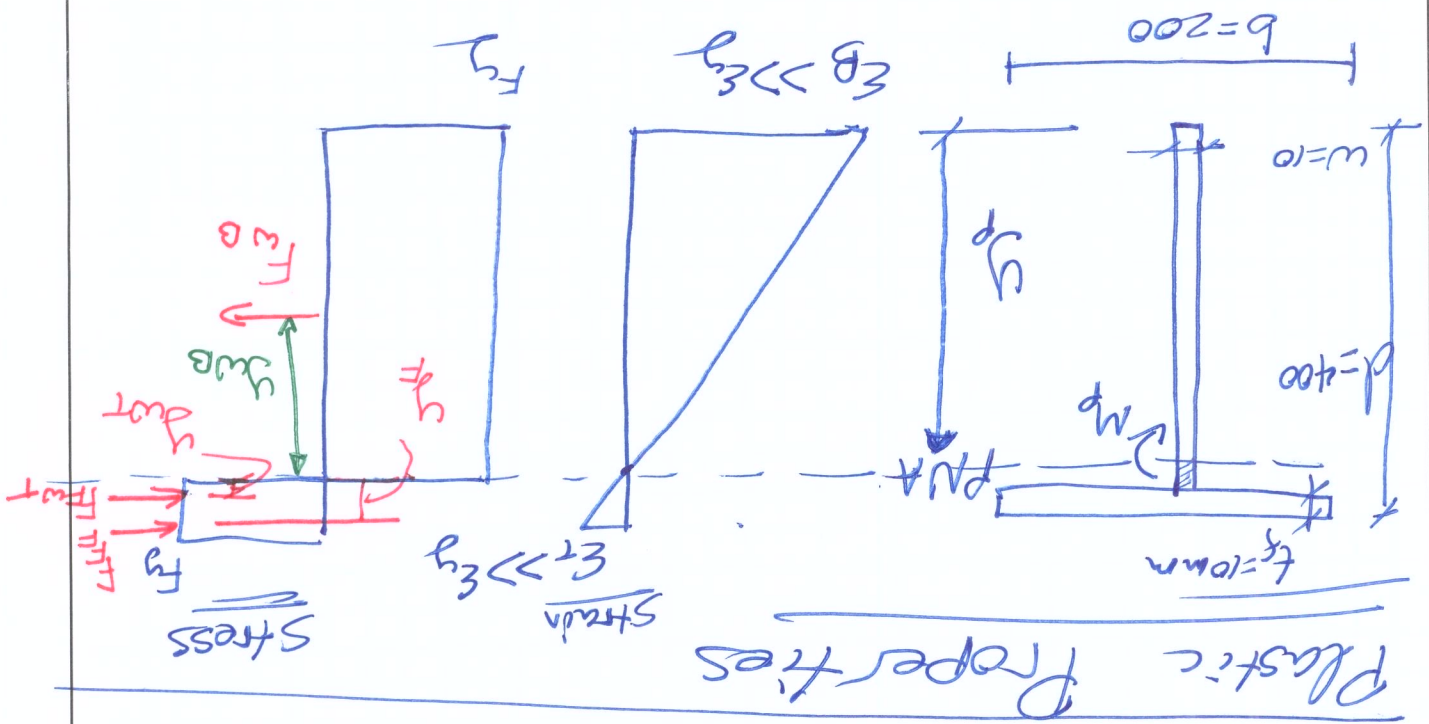
$$A_2 = (d - t_f) w = (400 - 10)(10) = 3900 \text{ mm}^2$$

$$A_T = A_1 + A_2 = 5900 \text{ mm}^2$$



$$(y_1 A_T) = A_1 (d - t_f/2) + A_2 (d - t_f)$$

$$y_1 = \frac{(2000)(400 - 10/2) + (3900)(400 - 10)/2}{5900} = 262.8 \text{ mm}$$



Plastic Properties

$$M_y = F_y S_x = (350 \text{ MPa}) (389.39 \times 10^3) = 136.286 \times 10^6 \text{ Nmm}$$

$$M_y = 136.286 \text{ kNm}$$

$$S_x = 389.39 \times 10^3 \text{ mm}^3$$

$$S_x = \frac{I_x}{y_1} = \frac{102.332 \times 10^6}{262.8} = 389.39 \times 10^3 \text{ mm}^3$$

$$I_x = 102.332 \times 10^6 \text{ mm}^4$$

$$I_x = 0.01667 \times 10^6 \text{ mm}^4 + 34.954 \times 10^6 \text{ mm}^4 + 49.432 \times 10^6 \text{ mm}^4 + 17.928 \times 10^6 \text{ mm}^4$$

$$I_x = \frac{1}{12} (10)(400-10)^3 + 3900 (262.8 - (400-10))^2 + \frac{1}{12} (200)(10)^3 + 2000 (400-262.8-10)^2$$

$$I_x = \frac{1}{12} b t^3 + A_1 (d-y_1 - t/2)^2 + \frac{1}{12} w (d t_f)^3 + A_2 (y - (d-t)/2)^2$$

Find I_x

$$I_x = I_1 + A_1 d_1^2 + I_2 + A_2 d_2^2$$

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of

Part

$$F_f = (F_y) (b \ t_f)$$

$$F_{wt} = (F_y) w (d - t_f - y_p)$$

$$F_{wb} = (F_y) w y_p$$

This assumes the P.N.A. is in the web.

$$\sum F = 0$$

$$F_f + F_{wt} = F_{wb}$$

$$(F_y) (b \ t_f) + F_y w (d - t_f - y_p) = F_y w y_p$$

$$(200 \times 10) + 10 (400 - 10 - y_p) = 10 y_p$$

$$2000 + 4000 - 100 - 10 y_p = 10 y_p$$

$$20 y_p = 5900$$

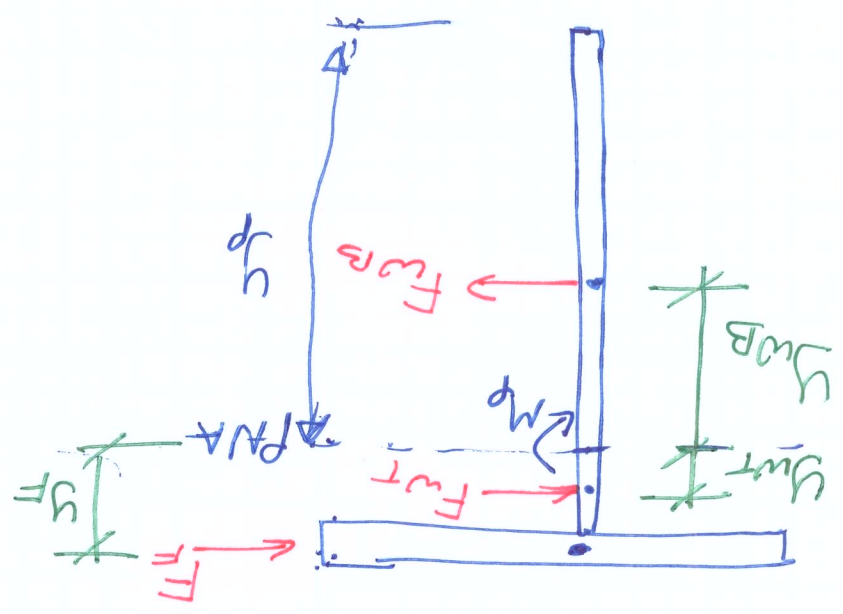
$$y_p = 295 \text{ mm}$$

in web

(Recall: $y_1 = 262.8 \text{ mm}$)

$$\sum M_{PNA} = 0$$

$$M_p = F_f y_f + F_{wt} y_{wt} + F_{wb} y_{wb}$$



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$$y^F = (d - t_f/2) - y_p = (400 - 10) - 295 = 100 \text{ mm}$$

$$y_{wt}^F = (d - t_f - y_p)/2 = (400 - 10 - 295)/2 = 47.5 \text{ mm}$$

$$y_{wb} = y_p/2 = 295/2 = 147.5 \text{ mm}$$

$$F = F_y b t_f = (350)(200)(10) = 700 \times 10^3 \text{ N}$$

$$F_{wt} = (F_y) w (d - t_f - y_p) = (350)(10)(400 - 10 - 295)$$

$$F_{wt} = 332.5 \times 10^3 \text{ N}$$

$$F_{wb} = F_y w y_p = (350)(10)(295) = 1032.5 \times 10^3 \text{ N}$$

$$\Sigma F = 0 \rightarrow F + F_{wt} = F_{wb}$$

$$(700 \times 10^3) + (332.5 \times 10^3) = 1032.5 \times 10^3$$

$$\Sigma M = 0$$

$$M_p = (700 \times 10^3)(160 \text{ mm}) + (332.5 \times 10^3)(47.5 \text{ mm}) + (1032.5 \times 10^3)(147.5 \text{ mm})$$

$$M_p = F_y y_F + F_{wt} y_{wt} + F_{wb} y_{wb}$$

$$M_p = 238.1 \times 10^6 \text{ N}\cdot\text{mm}$$

$$M_p = 238.1 \text{ kN}\cdot\text{m}$$

$$z_x = M_p / F_y = 238.1 \times 10^6 / 350 = 680.25 \times 10^3 \text{ mm}$$

$$z_x = 680.25 \times 10^3 \text{ mm}$$

$$k = \frac{z}{S} = \frac{680.25}{389.39} = 1.747$$

$$k = 1.747$$

