EXAMPLE 5.1

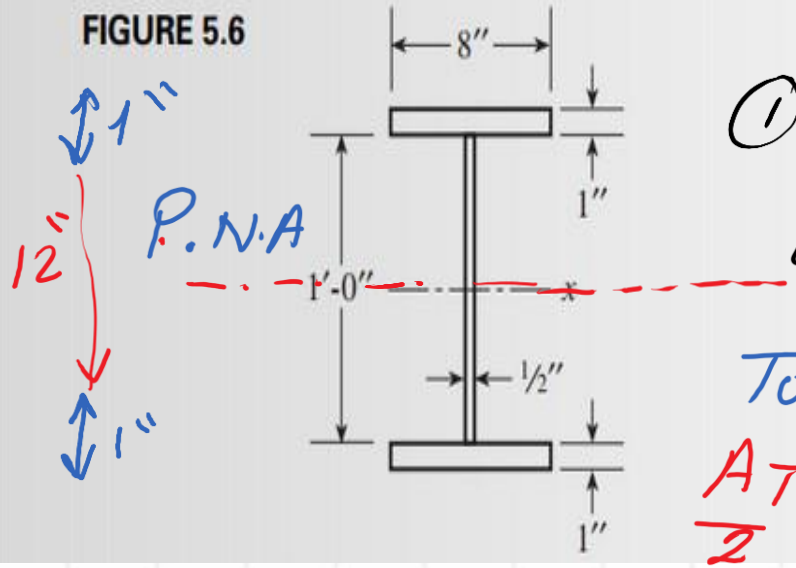
From Prof. William Segui's book

Part B _ For Plastic section modulus + Plastic moment Mp

For the built-up shape shown in Figure 5.6, determine (a) the elastic section modulus S and the yield moment M_y and (b) the plastic section modulus Z and the plastic moment M_p. Bending is about the x-axis, and the steel is A572 Grade 50.

P-1

FIGURE 5.6



① due to symmetry P.N.A will be in the mid height of built up section

Total Area = $2[8(1)] + 12(\frac{1}{2}) = 16 + 6 = 22$ inch^2

$\frac{A_T}{2} = \frac{22}{2} = 11$ inch^2

Let us Call y_1 is the distance between P.N.A and C.g of Top Flange

y_2 as the distance between P.N.A and C.g of half of the web

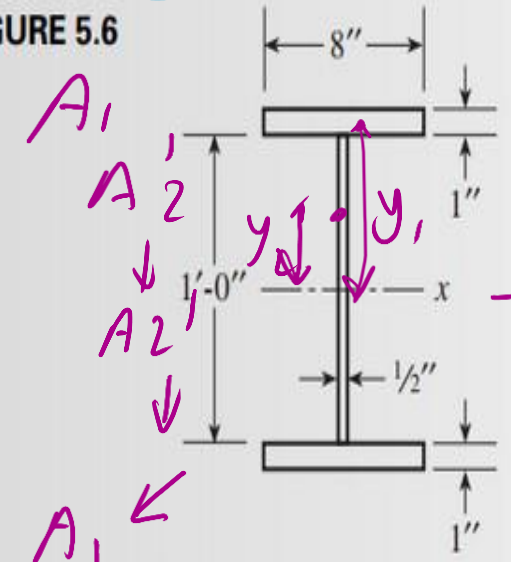
EXAMPLE 5.1

Detailed Area Estimate (Not in video)

For the built-up shape shown in Figure 5.6, determine (a) the elastic section modulus S and the yield moment M_y and (b) the plastic section modulus Z and the plastic moment M_p. Bending is about the x-axis, and the steel is A572 Grade 50.

Part (b)

FIGURE 5.6



Due to symmetry P.N.A will coincide with X-axis

Estimate the total Area

$A_T = 2A_1 + 2A_2$

$= 2(8)(1) + 2(6)(\frac{1}{2})$

$A_T = 16 + 6 = 22$ inch^2

Estimate $A_T/2$

$A_T/2 = 11.0$ inch^2 / P.N.A

y_1 C.g distance From mid of Top area

y_2 C.g distance From Cg of A_2

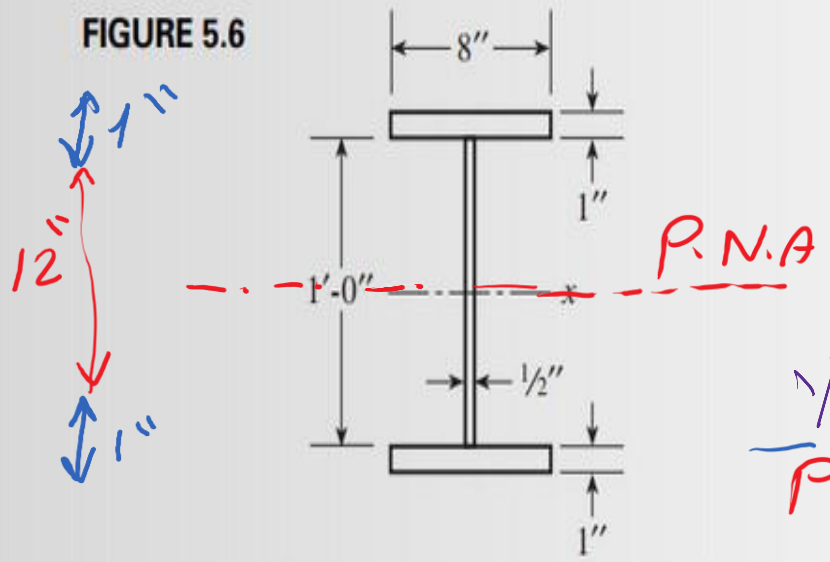
$y_1 = 6 + \frac{1}{2} = 6\frac{1}{2}$", $y_2 = 6/2 = 3$"

From Prof. William Segui's book

EXAMPLE 5.1

For the built-up shape shown in Figure 5.6, determine (a) the elastic section modulus S and the yield moment M_y and (b) the plastic section modulus Z and the plastic moment M_p. Bending is about the x-axis, and the steel is A572 Grade 50.

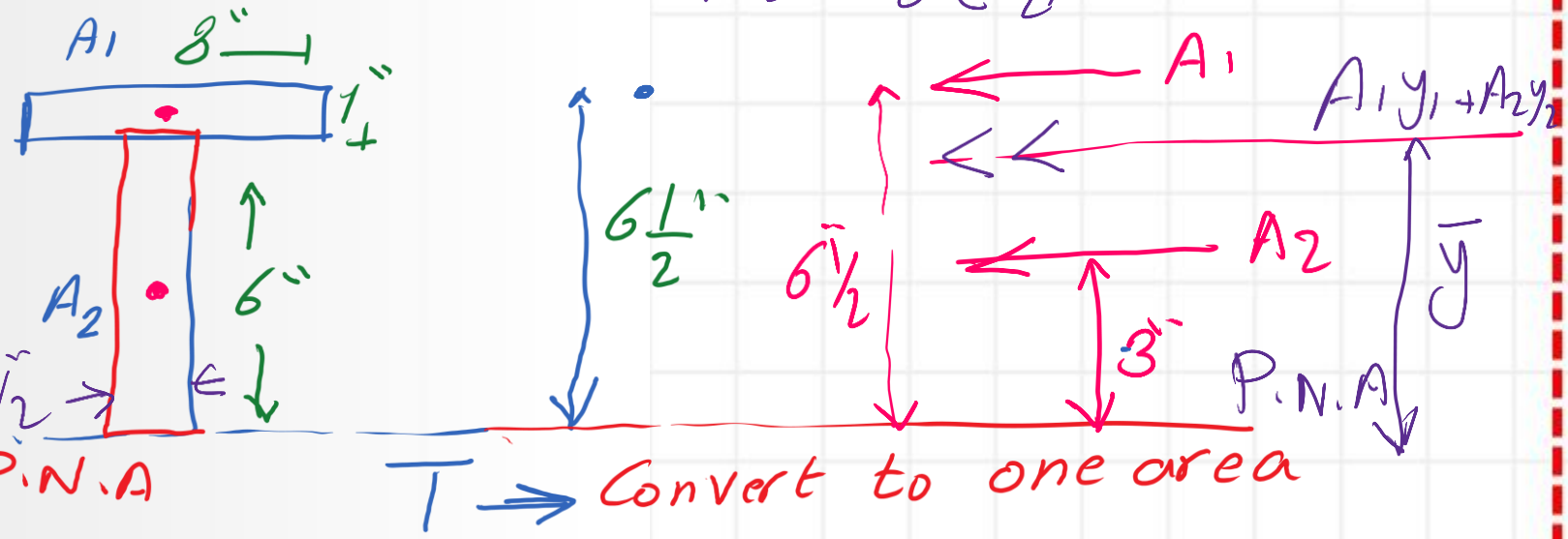
FIGURE 5.6



P-2

$A_1 = 8(1) = 8\ inch^2$

$A_2 = 6(\frac{1}{2}) = 3\ inch^2$



$$\bar{y} = \frac{A_1 y_1 + A_2 y_2}{A_1 + A_2} = \frac{8(1)(6.5) + 6(\frac{1}{2})(3)}{} = 5.545''$$

For the areas above P.N.A, a similar $\bar{y}$ For the area below P.N.A

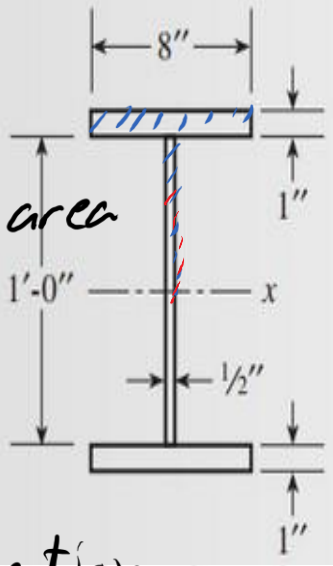
EXAMPLE 5.1

$A_T = 2(8) + 2(6)(\frac{1}{2}) = 22 \ inch^2$

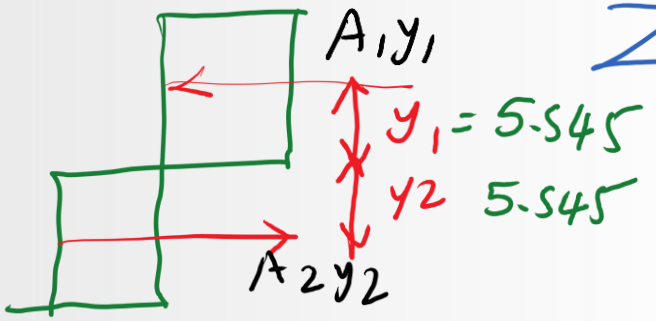
For the built-up shape shown in Figure 5.6, determine (a) the elastic section modulus S and the yield moment M_y and (b) the plastic section modulus Z and the plastic moment M_p. Bending is about the x-axis, and the steel is A572 Grade 50.

$F_y = 50 \ k$

FIGURE 5.6



We convert into one area



Part B

Z_x

P_3

$A_1y_1 + A_2y_2$

$A_1 = A_2 = \frac{A_T}{2} = \frac{A_T}{2}(y_1 + y_2)$

$Z_x = \frac{A_T}{2}(y_1 + y_2)$

$= (\frac{22}{2})(5.545 + 5.545)$

$= 121.957 \approx 122 \ inch^3$

The equation of Z_x comes from

$Z_x = A_1y_1 + A_2y_2$

since $A_1 = A_2 = \frac{A_T}{2}$

$Z_x = \frac{A_T}{2}(y_1 + y_2)$

Sum of First moment of areas

EXAMPLE 5.1

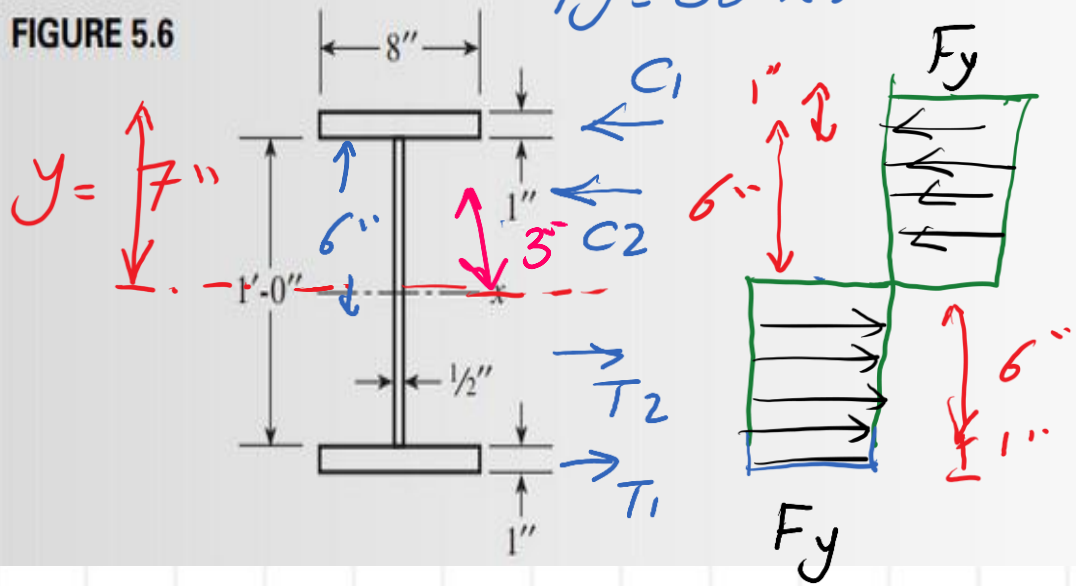
From Prof. William SeGui's book

Zx, Mp P-4

For the built-up shape shown in Figure 5.6, determine (a) the elastic section modulus S and the yield moment M_y and (b) the plastic section modulus Z and the plastic moment M_p. Bending is about the x-axis, and the steel is A572 Grade 50.

$F_y = 50$ ksi

FIGURE 5.6



$$F_y = \frac{M_p}{Z_x}$$

$$M_p = Z_x (F_y)$$

$$M_p = 122(50)\left(\text{inch}^3 \frac{\text{K Lb}}{\text{inch}^3}\right)\left(\frac{\text{Ft}}{12\ \text{inch}}\right)$$

$M_p = 508.33$

$\simeq 508$ Ft-kips

$$M_p = F_y A_1 (y_{c.t}) + F_y (A_2)(\ .t/2$$

$$= [50(8)(13) + 50(3)(6)]\left[\frac{1}{12}\right] = \frac{[5200 + 900]}{12} = 508.33 \text{ Ft-kips}$$

Prepared by Eng.Maged Kamel.