From Prof. William Segui's book

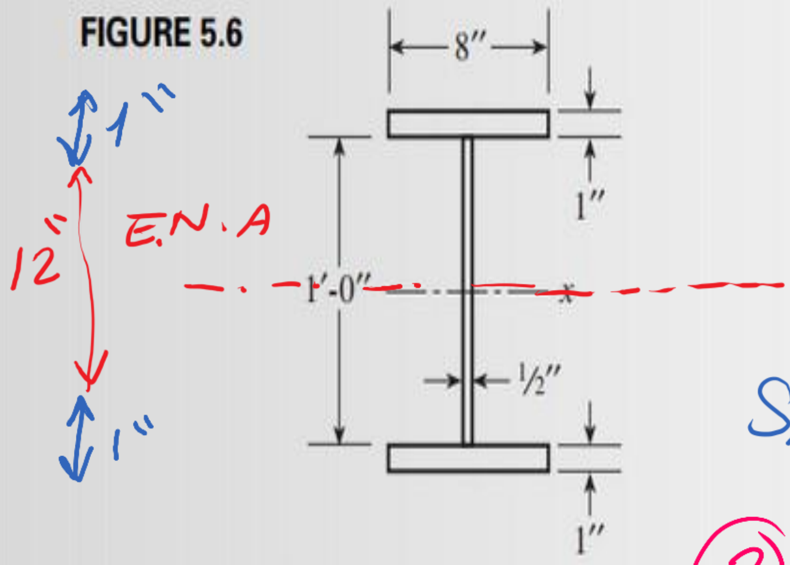
EXAMPLE 5.1

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.

(a) Part a

Elastic section modulus

FIGURE 5.6



(1) Due to symmetry E.N.A will be in middle of the Built-up section

$S_x = \frac{I}{y_{max}}$ our $y_{max} = (12+1+1)\,0.50 = 7''$

(2) I_x can be Estimated for half of the Built up section and then multiply by 2.

(3) We can Estimate I_x as for a big Rectangle and deduct void rectangle I_x value.

Prepared by Eng.Maged Kamel.

EXAMPLE 5.1

P - 2

From Prof. William Segui's book

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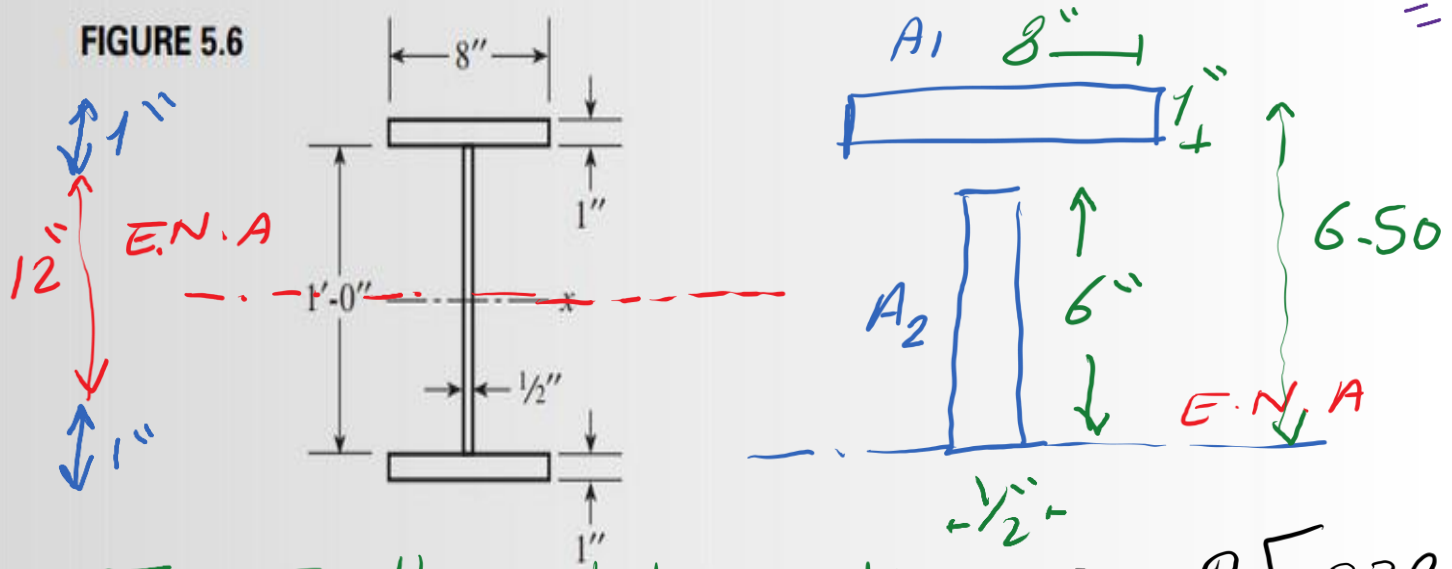
FIGURE 5.6



Sx:

$A_1 - I_x$

$I_{x\,cg} + A_1 \bar{y}_1^2$

$= \frac{8(1)^3}{12} + (8)(6.5)^2$

$\Rightarrow 338.666$ inch^4

$A_2 - I_x$

$= \frac{(\frac{1}{2})(6)^3}{12} + (3)(3)^2 = 36$ inch^4

I_x For the whole section $\Rightarrow 2[338.666 + 36] = 749.333$ inch^4

$S_x = \frac{I_x}{y} = \frac{I_x}{h/2} = \frac{2(749.333)}{14} = 107.05$ inch^3

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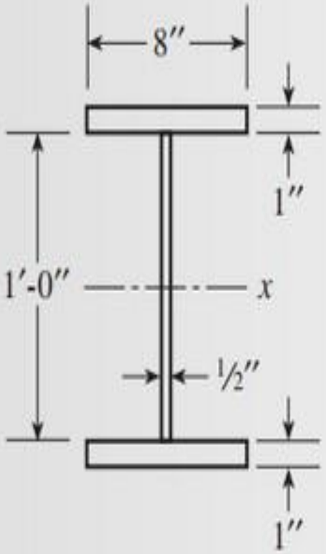
Page 3

$F_y = 50$ ksi

My can be estimated directely From Sx value

Yielding Moment

FIGURE 5.6



$S_x = \frac{I_x}{y}$, but $f = \frac{M_y}{I_x} \cdot y = \frac{M_y}{S_x}$

$F = F_y = 50$ ksi $\quad M_y = S_x \cdot f_y = 107.05(50)$ $\text{inch}^3 \left(\frac{k\,Lb}{\text{inch}^2}\right)$

$M_y = 5352.6$ k. inch. Lb $\left(\frac{Ft}{12\,inch}\right)$

$= 446.05$ Ft.kips

$M_y = 446$ FT. Kips

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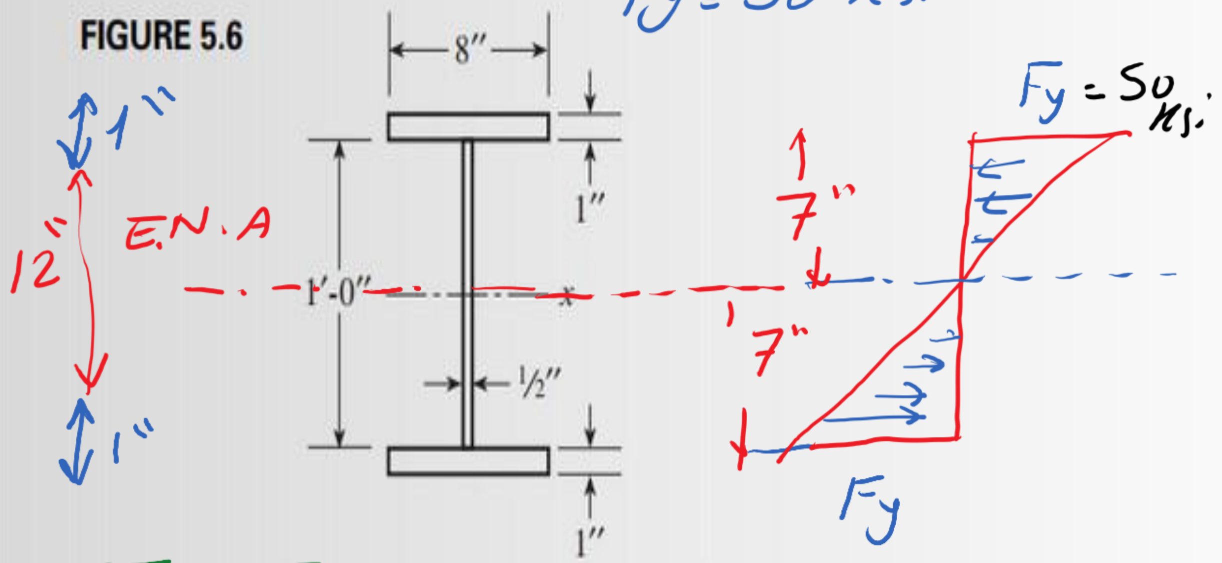
S_x : elastic section Modulus

P. 4

$F_y = 50$ ksi

FIGURE 5.6



if we wish to calculate M_y from first principles it might takes addition calculations as follows

f_1 at the junction

$= \left(\frac{6}{7}\right)(50) = 42.857$ ksi

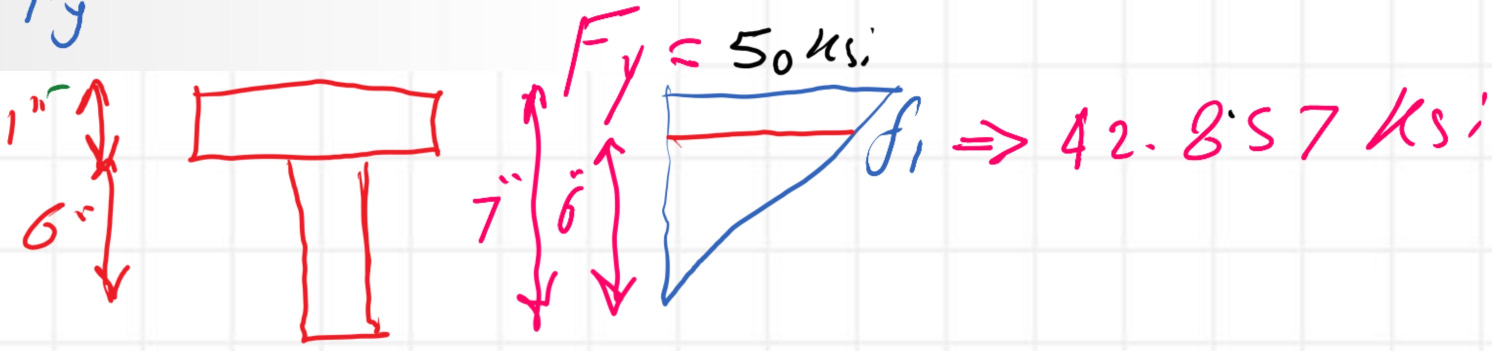


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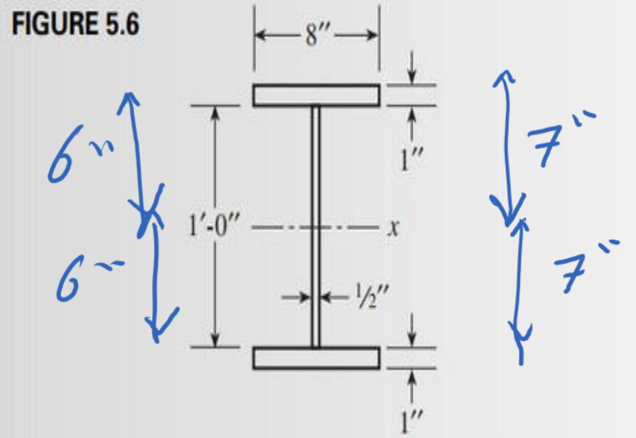
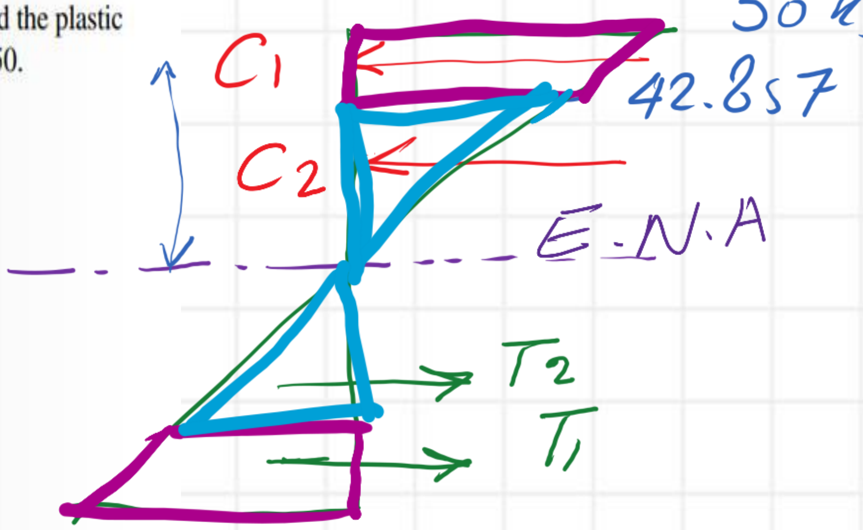
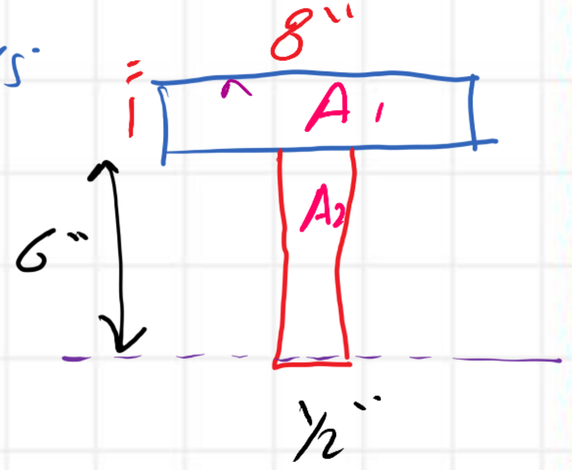
FIGURE 5.6



P-5





Compression Force $C_1 = \frac{1}{2}(42.857 + 50)[8)(1) = 371.428$ kips (Area)

Arm of C_1 → E.N.A $= 7 - \frac{1}{2}(1) = 6\frac{1}{2}$″

while $C_2 = \frac{1}{2}(42.857)\left(\frac{6}{2}\right) = 64.285$ kips

C_2 arm to E.N.A $= \frac{2}{3}(6) = 4$″

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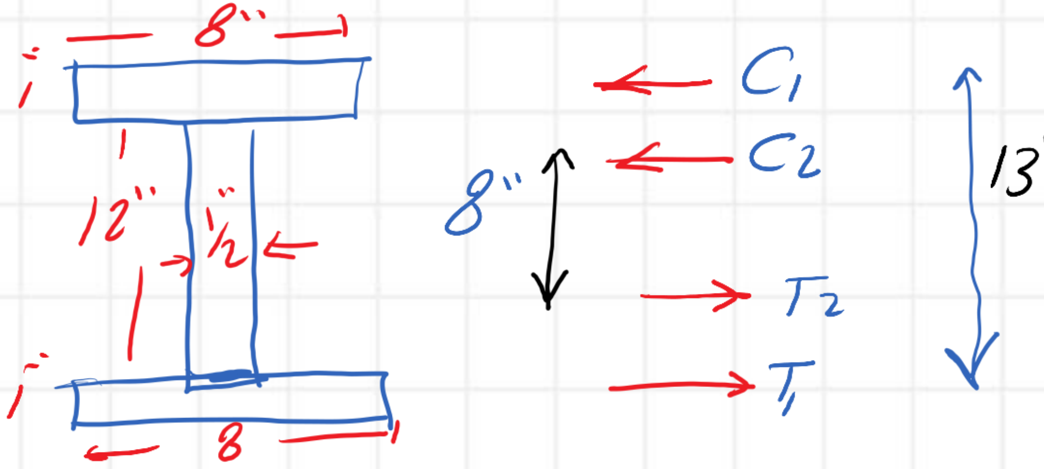
P-6

Part (a)

S_x, M_y



13" ⇒ $y_{c.t}$

List Each Force and the Relative arm y_{c-T} From Compression to Tension.

Forces	Value	$y_{c.t}$	M_y
C_1	371.428	13"	4828.56
C_2	64.285	8"	514.28
			5342.84 inch kips

M_y = 5342.84 inch.kips $\left(\frac{Ft}{12\ inch}\right)$ = 445.23 Ft.kips

close to the previous M_y value by S_x

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