5. Determine the elastic section modulus and the plastic section modulus for a W18×35 modeled as three rectangles forming the flanges and the web. Compare the calculated values to those given in the *Manual*.

Solution :

W18X35

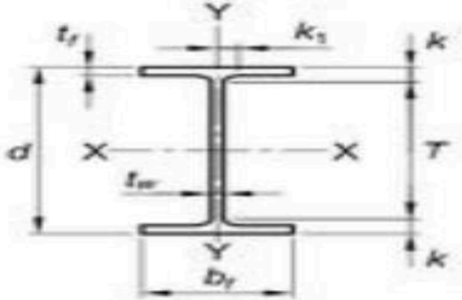


Table 1-1
W-Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		Web $\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	Distance k k_{det}	k_1	T	Workable Gage
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W18×46^c	13.5	18.1	18	0.360	3/8	3/16	6.06	6	0.605	5/8	1.01	1 1/4	13/16	15 1/2	3 1/2^g
×40^c	11.8	17.9	17 7/8	0.315	5/16	3/16	6.02	6	0.525	1/2	0.927	1 3/16	13/16	↓	↓
×35^c	10.3	17.7	17 3/4	0.300	5/16	3/16	6.00	6	0.425	7/16	0.827	1 1/8	3/4		

$B_F = 6.0''$ $\quad d = 17.70''$ $\quad t_w = 0.30''$

$t_F = 0.425''$ $\quad A = 10.30$ inch^2

Prepared by Eng.Maged Kamel.

Table 1-1 (continued)
W-Shapes
Properties

W18–W16

$W18 \times 35$

Nom-inal Wt.	Compact Section Criteria		Axis X-X				Axis Y-Y				r_{ts}	h_o	Torsional Properties	
	$\frac{b_f}{2t_f}$	$\frac{h}{t_w}$	I	S	r	Z	I	S	r	Z			J	C_w
lb/ft			in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.	in.^{4}	in.^{6}
46	5.01	44.6	712	78.8	7.25	90.7	22.5	7.43	1.29	11.7	1.58	17.5	1.22	1720
40	5.73	50.9	612	68.4	7.21	78.4	19.1	6.35	1.27	10.0	1.56	17.4	0.810	1440
35	7.06	53.5	510	57.6	7.04	66.5	15.3	5.12	1.22	8.06	1.51	17.3	0.506	1140

$S_x = 57.6\ \text{inch}^3$

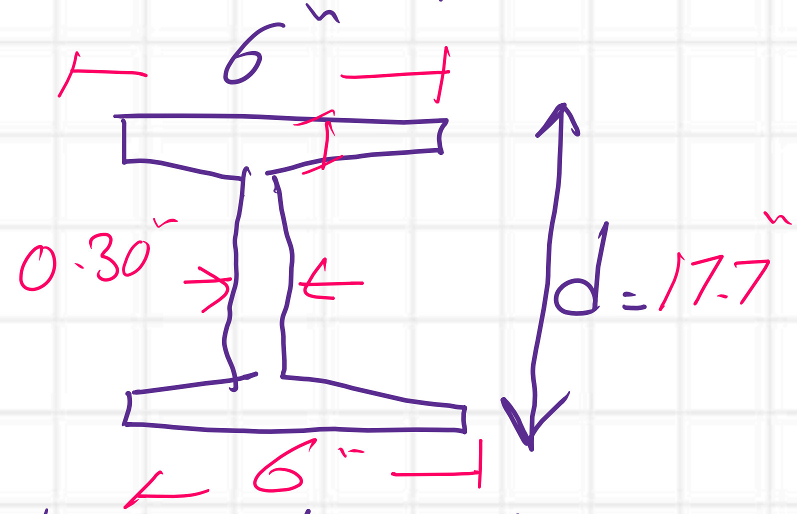
$Z_x = 66.50\ \text{inch}^3$

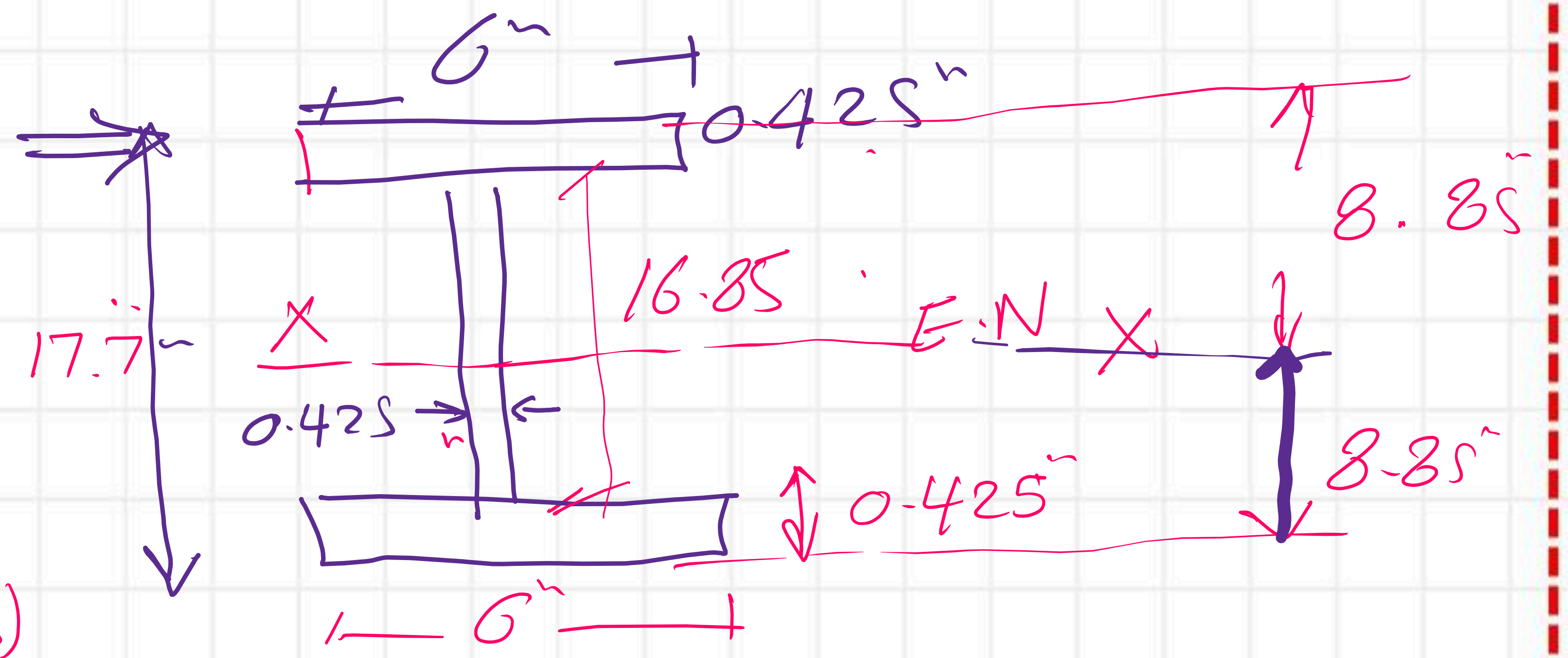
Prepared by Eng.Maged Kamel.

W18X35

$t_f = 0.425''$

Modelled as 3ree rectangles





$h_w = d - 2t_f$
$= 17.7 - 2(0.425)$
$= 16.850''$

@ Elastic section Modulus S_x

Find I_x For upper and Lower Flanges I_{x1}

I_x For web $\Rightarrow I_{x2}$

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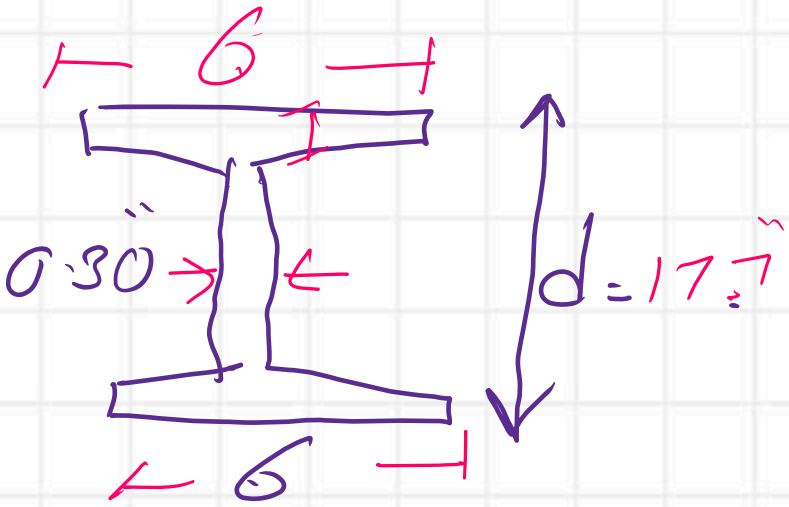
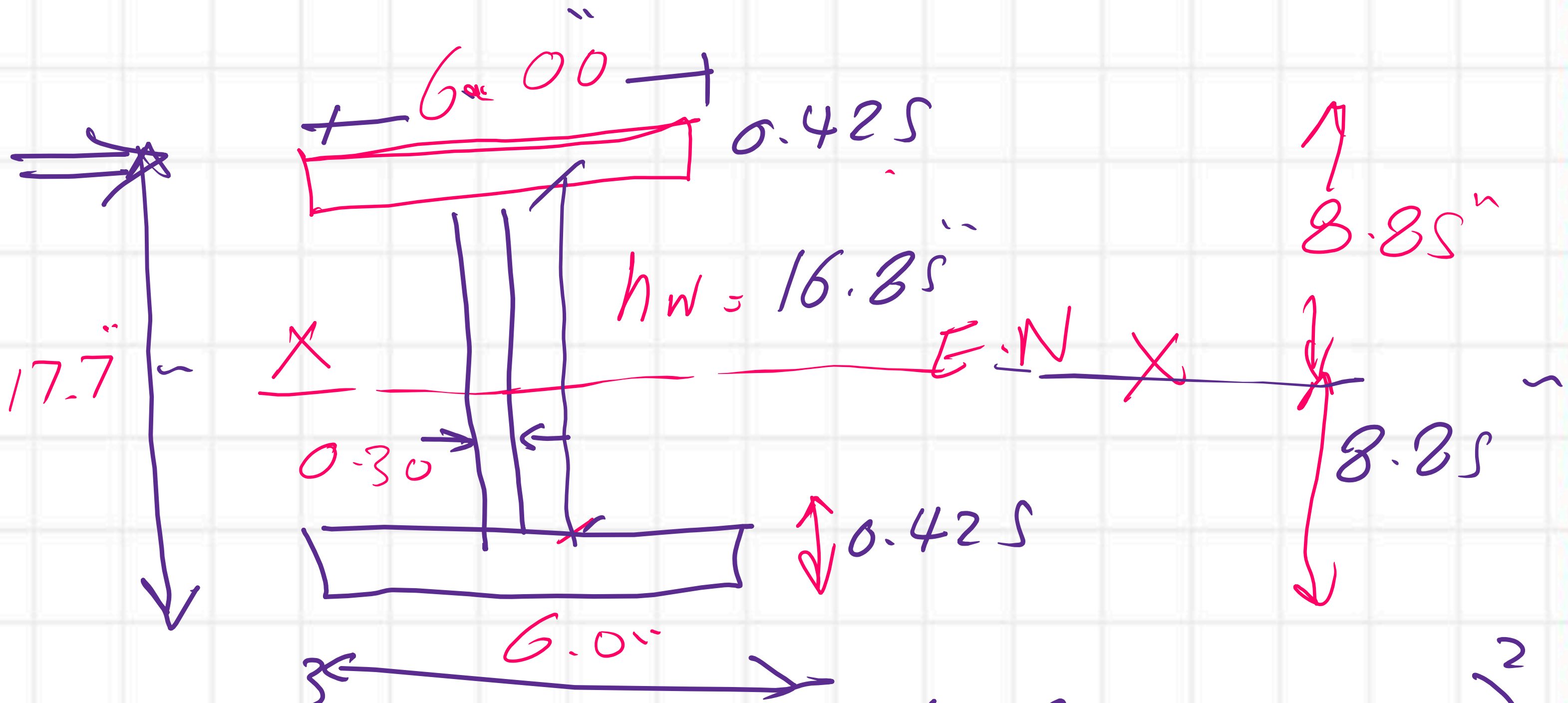
W18X35, $t_f = 0.425''$ Modelled as 3ree rectangles





$I_{x_1} = I_{x3}$

Upper Flange Lower Flange

$$= \frac{6.00(0.425)^3}{12} + 6(0.425)(8.85 - 0.2125)^2 \to 0.0384 + 190.246 = 190.284 \text{ inch}^4$$

$$I_{x2} = 0.3(16.85)^3/12 = 119.602 \text{ inch}^3$$

$$I_x = 2 I_{x_1} + I_{x2} = 500.171 \text{ inch}^4$$

Prepared by Eng.Maged Kamel.

$I_x = 500.171$ inch^4

$y = 8.85''$

$S_x = I_x/y = \frac{500.171}{8.85} = 56.52$ inch^3 by Calculation

S_x From Table $= 57.60$ inch^3

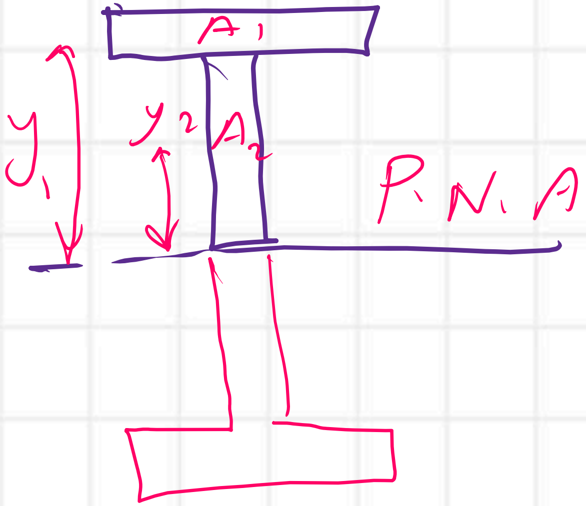
Table

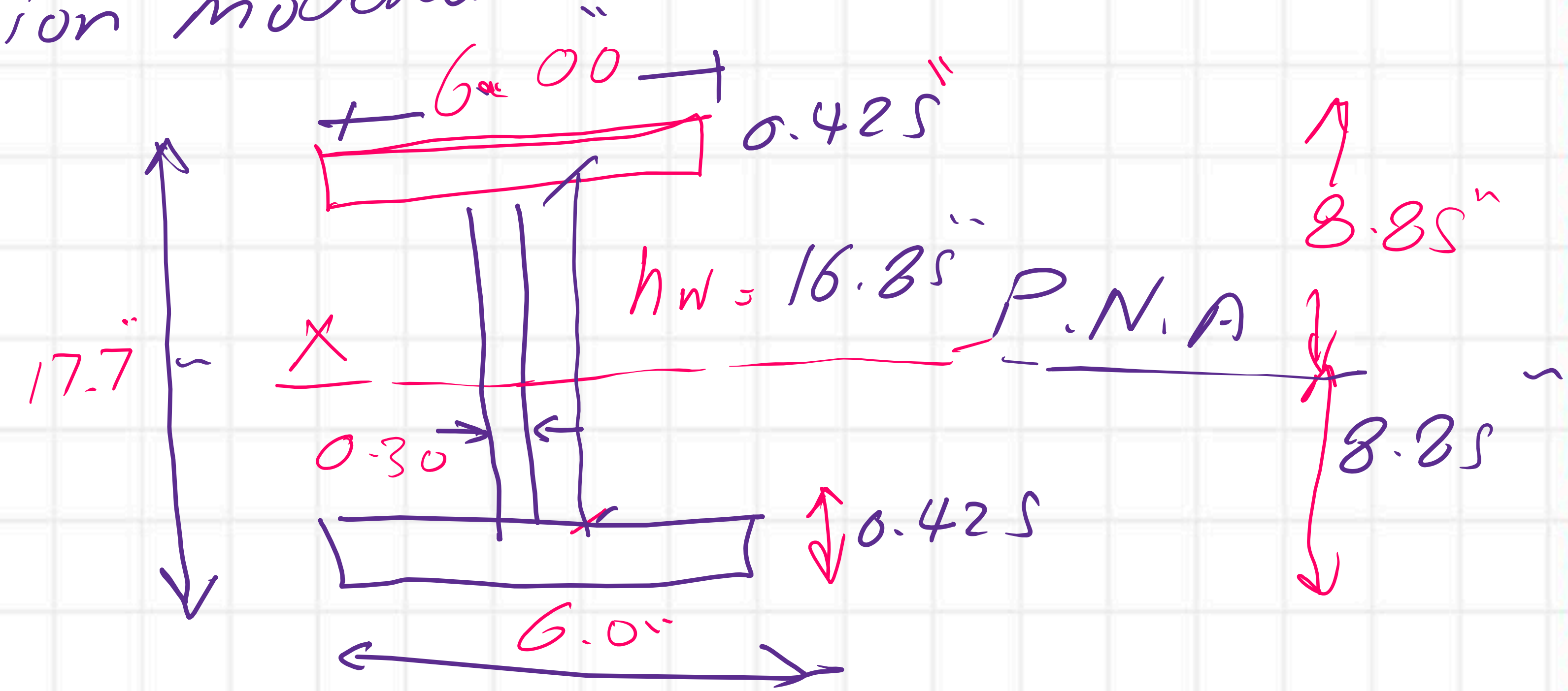
Prepared by Eng.Maged Kamel.

W18X35

(b) Plastic Section modulus

Z_x





$$Z_x = \Sigma A y = (A_1 y_1 + A_2 y_2)\, 2$$

$A_1 = 6(0.425) = 2.55 \text{ inch}^2$

$y_1 = 8.85 - \frac{0.425}{2} = 8.6375$

$A_2 = \frac{16.85}{2}(0.30) = 2.528 \text{ inch}^2$

$y_2 = 16.85/4 = 4.2125"$

Prepared by Eng.Maged Kamel.

$$Z_x = 2\left[(2.55)(8.6375) + 2.528(4.2125)\right]$$

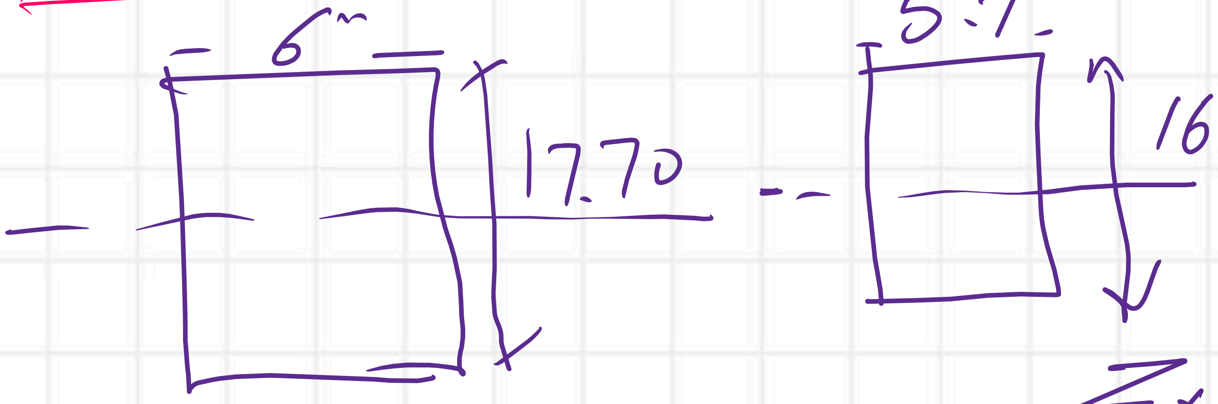
manual Estimate inch^3

$$Z_x = 2(22.026 + 16.649] = 65.35$$

Z_x From Table = $\boxed{66.50 \text{ inch}^3}$

Table

Quick check



$$\frac{b_1 d_1^2}{4} - \frac{b_2 d_2^2}{4}$$

$$Z_x = \frac{1}{4}\left(6(17.7)^2 - 5.7(16.85)^2\right)$$

$$Z_x = 65.345 \text{ inch}^3$$

Prepared by Eng.Maged Kamel.