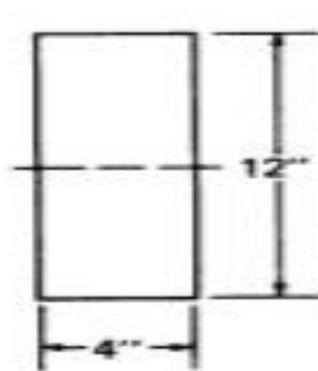
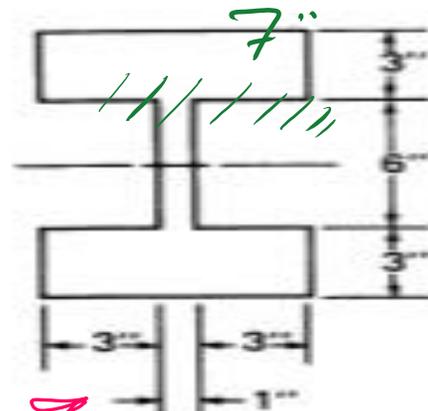


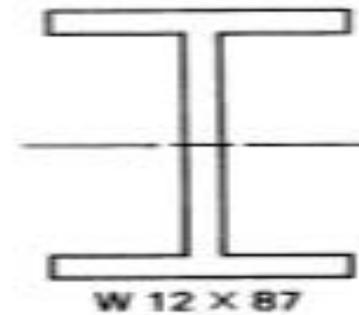
**Example 2.22.** Determine the maximum shearing stress for the following sections when the external shear force  $V = 75$  kips.



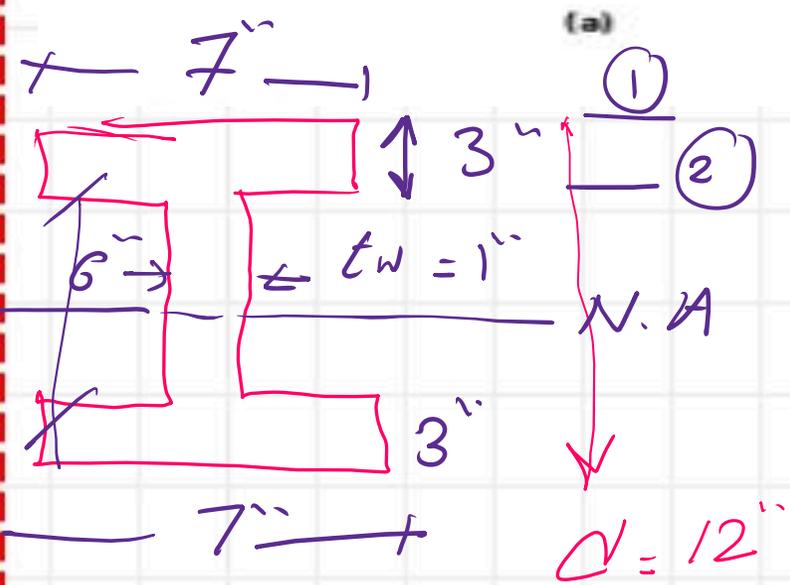
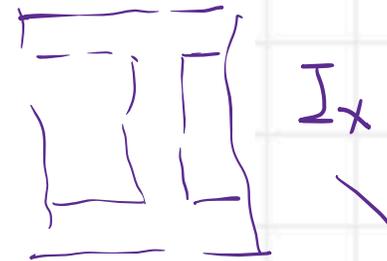
(a)



(b)



(c)



(b)

First moment of Area at (1) = 0  
 at (2) = 0

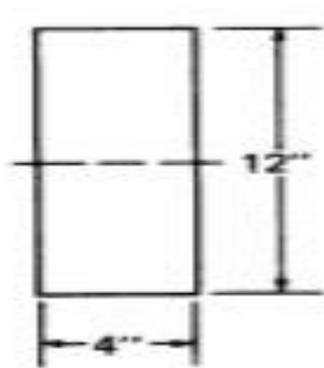
Do

$$= 7(3)(3+1.5) = 21(4.5) = 94.50 \text{ inch}^2$$

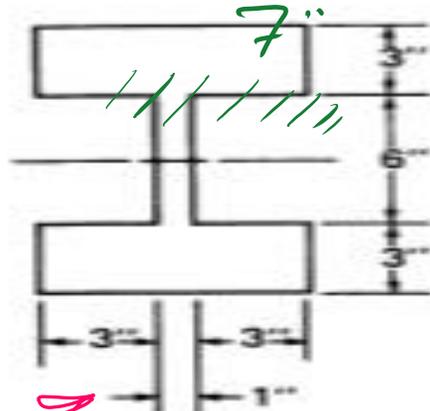
$$I_x = 7\left(\frac{12^3}{12}\right) - \frac{2(3)(6)^3}{12} = 1008 - 108 = 900 \text{ inch}^4$$

Prepared by Eng. Maged Kamel.

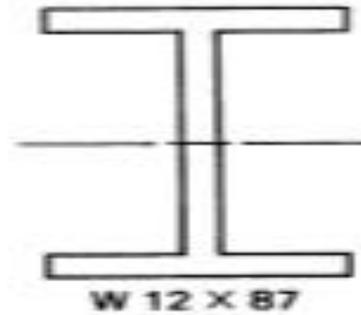
**Example 2.22.** Determine the maximum shearing stress for the following sections when the external shear force  $V = 75$  kips.



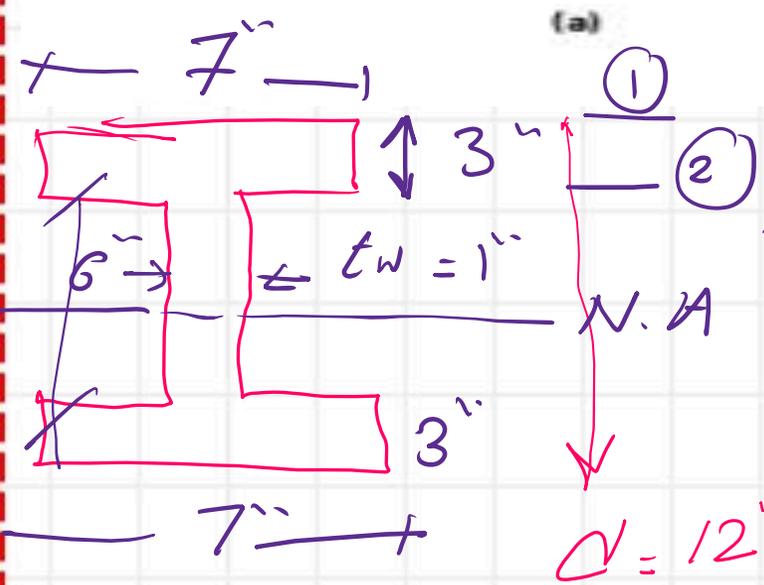
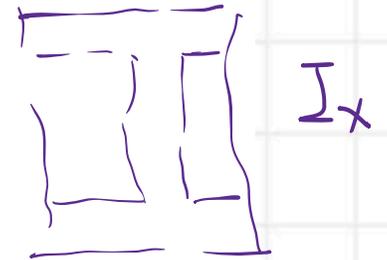
(a)



(b)



(c)



(b)

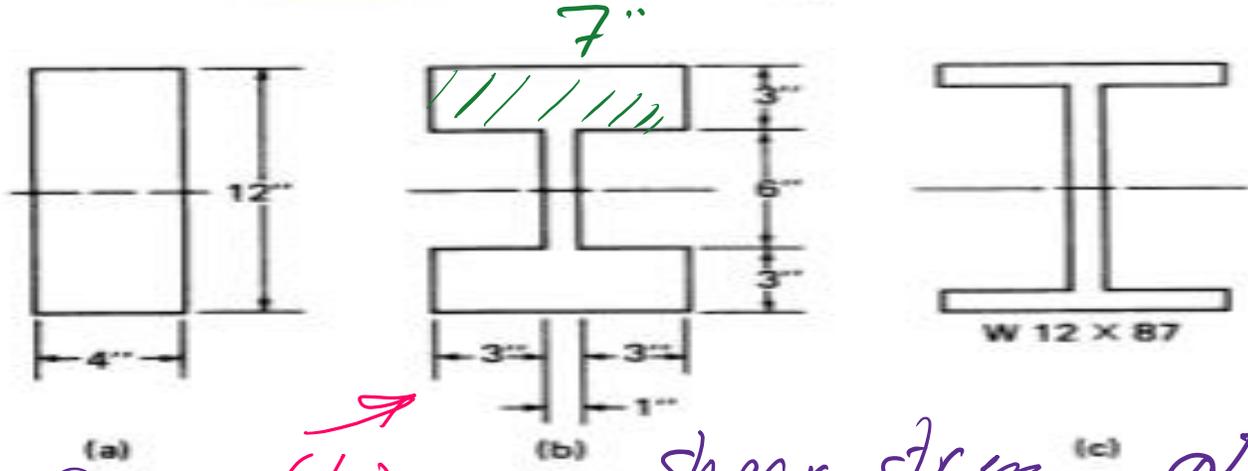
First moment of Area at N.A

$$= 7(3)(4.5) + (3)(1)(1.50)$$

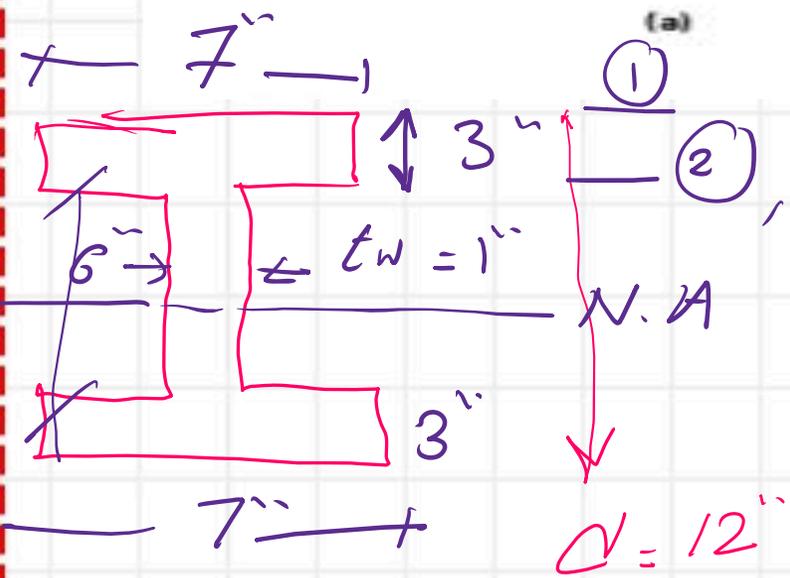
$$= 99 \text{ inch}^2$$

$$I_x = 900 \text{ inch}^4$$

**Example 2.22.** Determine the maximum shearing stress for the following sections when the external shear force  $V = 75$  kips.



$Q = 75$  kips  
 $I_x = 900$  inch<sup>4</sup>

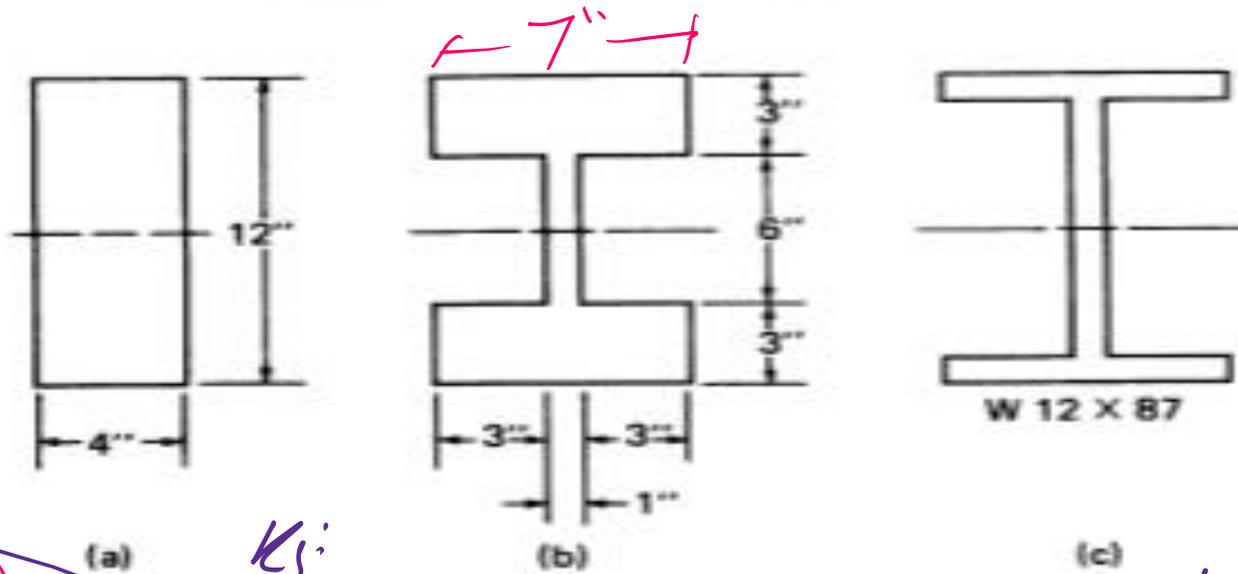


(b) Shear stress at (1) = 0  
 Shear stress at (2) =  $\frac{VQ}{I_x b}$

$$I_2 = \frac{94.5 (75)}{900 (7)} = 1.25 \text{ ksi}; T_2 = 7(1.25) = 7.875 \text{ ksi}$$

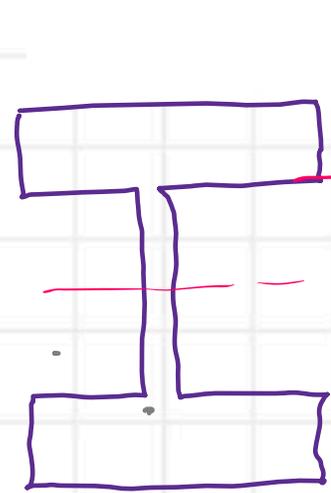
$$I_{N.A} = \frac{99 (75)}{900 (1)} = 8.25 \text{ ksi}$$

**Example 2.22.** Determine the maximum shearing stress for the following sections when the external shear force  $V = 75$  kips.



Part b

width = 7"



①  
②

1.25 ksi

7.875 ksi

width = 1"

8.25 ksi

Shear stress For I section

Prepared by Eng. Maged Kamel.

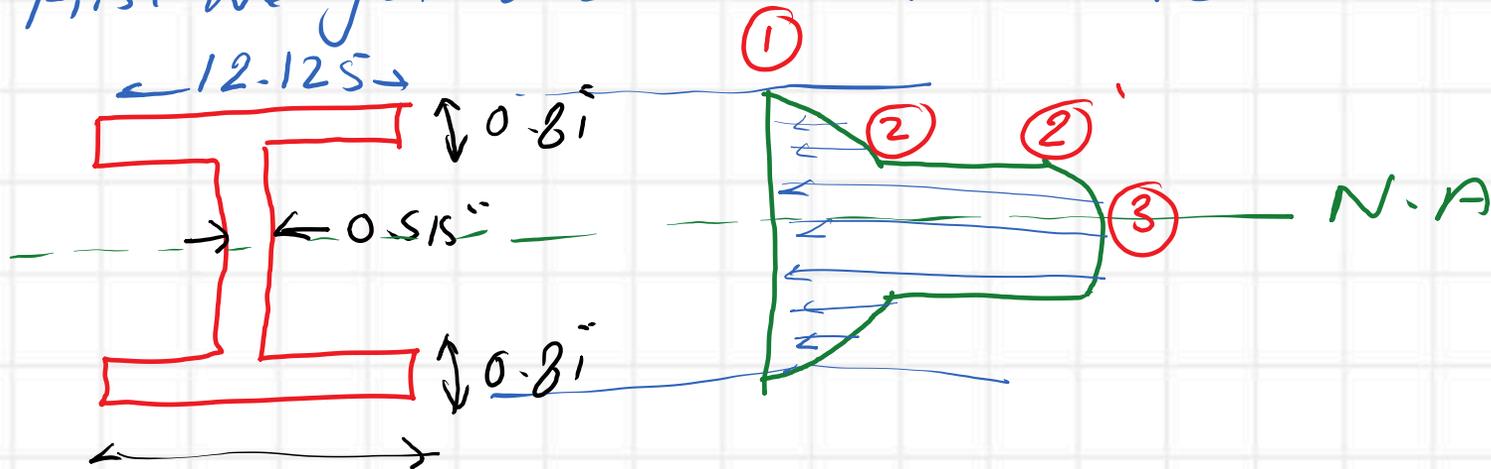
Part C W12 x 87 steel beam

✓ : stands for First moment of area

$Q = 75$  kips  
Shear Force

Designation Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness $t_w$ (in)	Flange Thickness $t_f$ (in)	Sectional Area (in <sup>2</sup> )	Weight (lb/ft)	Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
							$I_x$ (in <sup>4</sup> )	$I_y$ (in <sup>4</sup> )	$S_x$ (in <sup>3</sup> )	$S_y$ (in <sup>3</sup> )
W12x87	12.53	12.125	0.515	0.810	256	87	740	241	118	39.7

First we get the data for W12 x 87



$$I = \frac{VQ}{I_x b}$$

at point - 1

$$V = 0$$

Prepared by Eng. Maged Kamel.

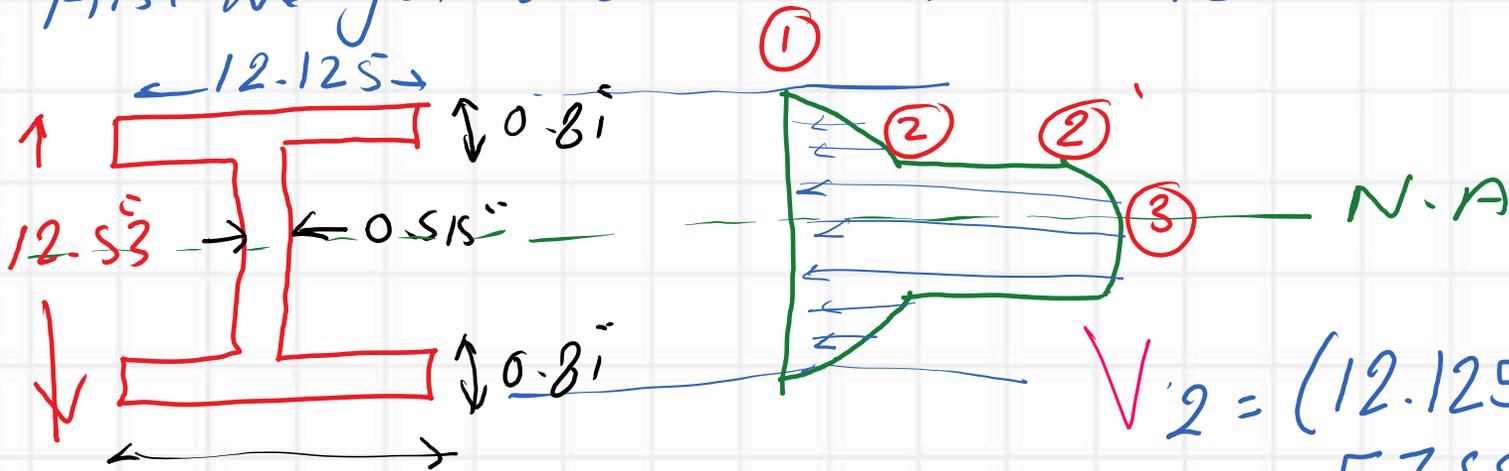
$Q = 75$  kips

Part (c)

$\checkmark$  : stands for First moment of area

Designation Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness $t_w$ (in)	Flange Thickness $t_f$ (in)	Sectional Area (in <sup>2</sup> )	Weight (lb/ft)	Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
							$I_x$ (in <sup>4</sup> )	$I_y$ (in <sup>4</sup> )	$S_x$ (in <sup>3</sup> )	$S_y$ (in <sup>3</sup> )
W 12x87	12.53	12.125	0.515	0.810	25.6	87	740	241	118	39.7

First we get the data for W 12x87



$$\checkmark_2 = \frac{VQ}{I t_f}$$

$$\checkmark_2 = A_F (\bar{y})$$

$$\checkmark_2 = (12.125)(0.81) \left[ \frac{12.53 - 0.81}{2} \right] = 57.55 \text{ inch}^3$$

Prepared by Eng. Maged Kamel.

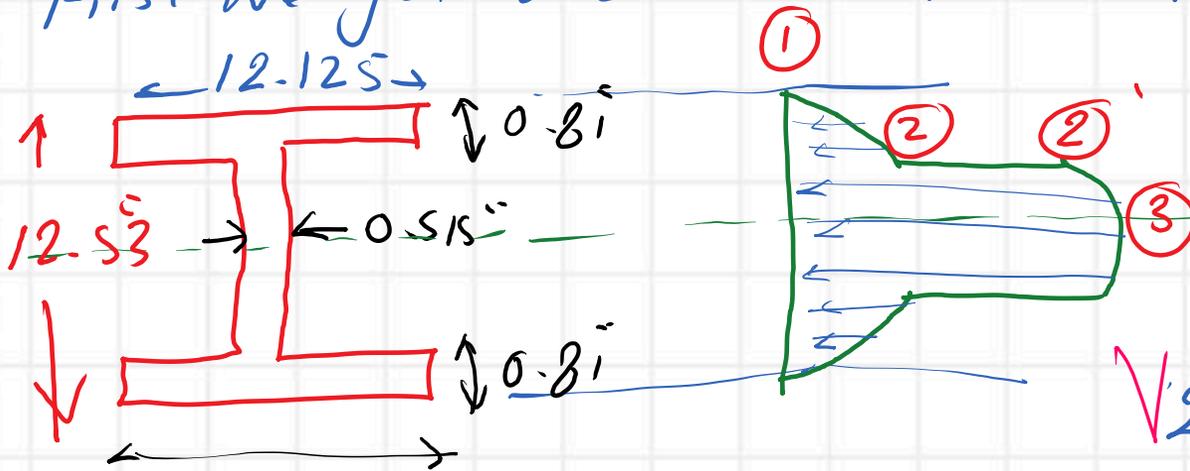
$Q = 75$  kips

Part (c)

$\checkmark$  : stands for First moment of area

Designation Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness $t_w$ (in)	Flange Thickness $t_f$ (in)	Sectional Area (in <sup>2</sup> )	Weight (lb/ft)	Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
							$I_x$ (in <sup>4</sup> )	$I_y$ (in <sup>4</sup> )	$S_x$ (in <sup>3</sup> )	$S_y$ (in <sup>3</sup> )
W 12 x 87	12.53	12.125	0.515	0.810	25.6	87	740	241	118	39.7

First we get the data for W 12 x 87



$$I = \frac{VQ}{2' I_x b_{web}}$$

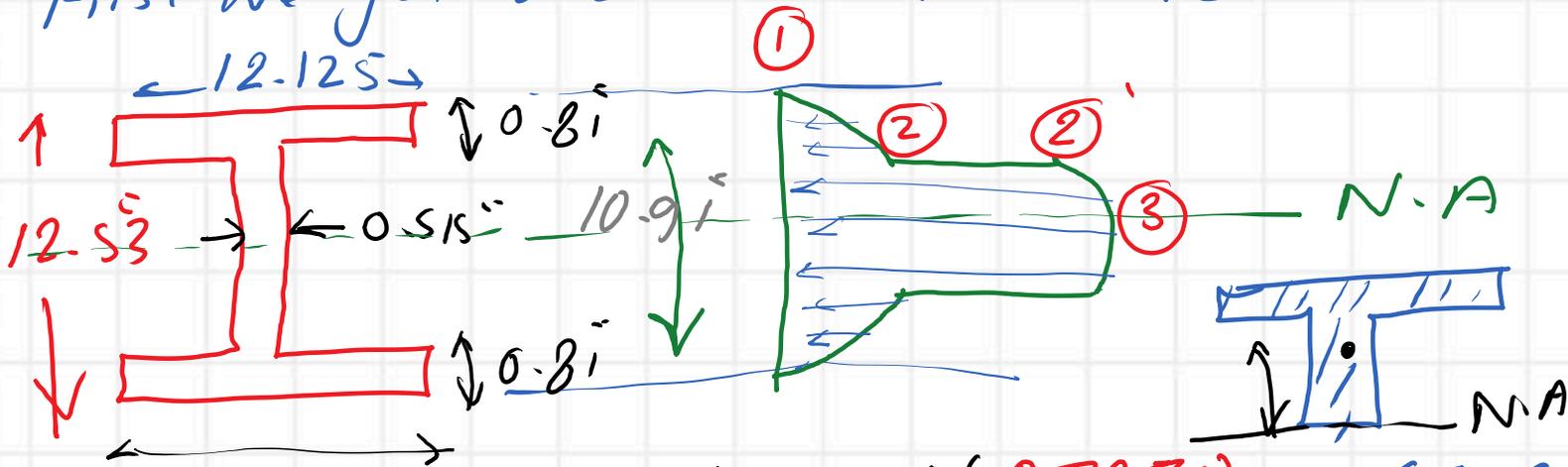
$$V_{2'} = A_F (\bar{y})$$

$$V_{2'} = (12.125)(0.81) \left[ \frac{12.53 - 0.81}{2} \right] = 57.55 \text{ inch}^3$$

Prepared by Eng. Maged Kamel.

Designation Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness t <sub>w</sub> (in)	Flange Thickness t <sub>f</sub> (in)	Sectional Area (in <sup>2</sup> )	Weight (lb <sub>f</sub> /ft)	Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
							I <sub>x</sub> (in <sup>4</sup> )	I <sub>y</sub> (in <sup>4</sup> )	S <sub>x</sub> (in <sup>3</sup> )	S <sub>y</sub> (in <sup>3</sup> )
W 12x87	12.53	12.125	0.515	0.810	25.6	87	740	241	118	39.7

First we get the data For W<sub>12</sub>x87



$$I = \frac{VQ}{2} = \frac{I_x b_{web}}{2}$$

$$= A_f (\bar{y}_1) + A_w \frac{\bar{y}_{web}}{2}$$

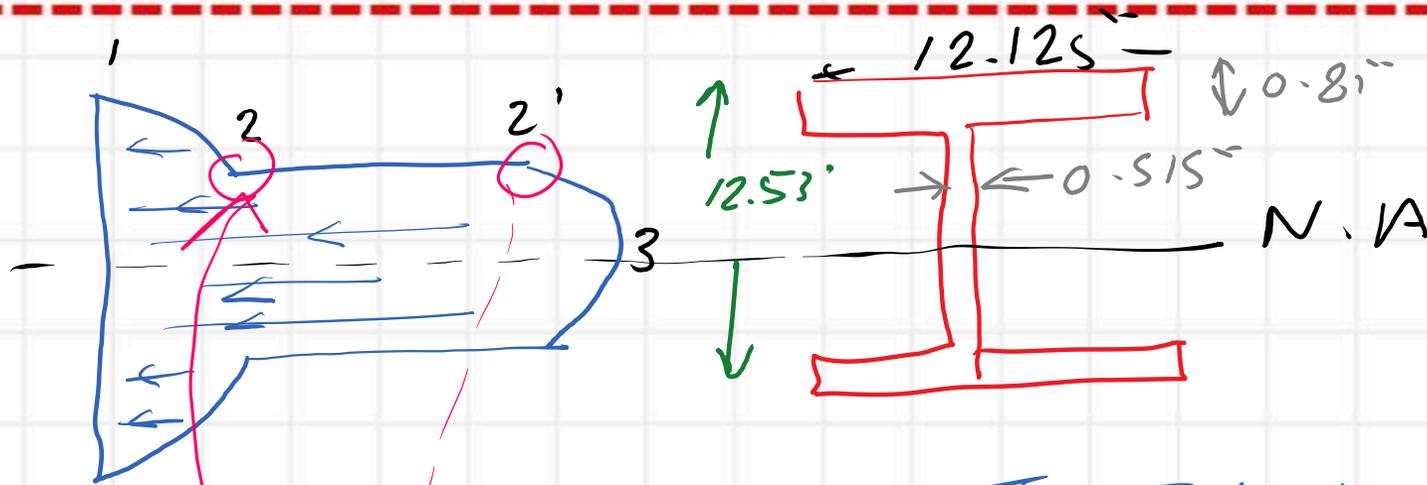
Calculated earlier

$$65.21 \text{ inch}^3$$

$$(57.55 + (\frac{10.91}{2})(0.515)(2.7275)) = 65.21$$

First moment of Area ↗

Prepared by Eng. Maged Kamel.



width at 2 = 12.125"  
 width at 2' = 0.515"  
 width at 3 = 0.515"

$I_x = 740 \text{ inch}^4$

From table

$\tau_1 = 0$

$\tau_2 = \frac{V Q_2}{I_x b_F} = \frac{(57.55)(75)}{740 (12.125)} = 0.481 \text{ ksi}$

$\tau_{2'} = \frac{V Q_{2'}}{I_x b_w} = \frac{(57.55)(75)}{740 (0.515)} = 11.33 \text{ ksi}$

$\tau_{3_{max}} = \frac{V Q_3}{I_x b_w} = \frac{65.21(75)}{740 (0.515)} = 12.83 \text{ ksi}$

if consider web carry shear as

$\tau_{av} = \frac{Q}{A_w} = \frac{75}{12.53(0.515)} = 11.62 \text{ ksi}$

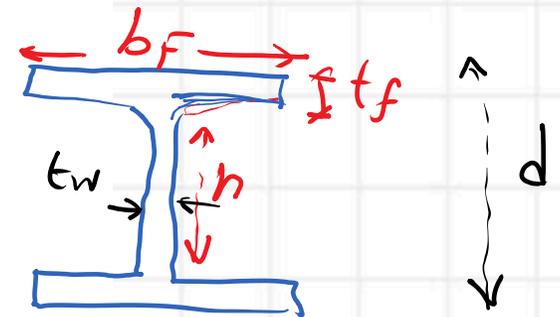
## Shear

The *design shear strength*  $\phi_v V_n$  is determined with  $\phi_v = 1.00$  for webs of rolled I-shaped members and is determined as follows:

$$V_n = 0.6 F_y A_w C_v \quad A_w = d \cdot t_w$$

$$C_v = 1.0$$

$A_w$  = area of web, the overall depth times the web thickness,  
 $d t_w$ , in<sup>2</sup> (mm<sup>2</sup>)



For webs of rolled I-shaped sections that meet the criterion  $h/t_w \leq 2.24 \sqrt{E/F_y}$ , the resistance factor for shear,  $\phi_v$ , is 1.00 (LRFD); the safety factor for shear,  $\Omega_v$ , is 1.50 (ASD); and the web shear coefficient,  $C_v$ , is 1.0.

**Prepared by Eng.Maged Kamel.**

Relation between  $F_y$ ,  $\frac{h}{t_w}$  for Zone I  $E = 29 \times 10^6$  ksi

$$E = 29 \times 10^6 \text{ psi} \quad \frac{h}{t_w} = 2.24 \sqrt{\frac{E}{F_y}}$$

Different Grades of steel

$$F_y = 36 \text{ ksi} \Rightarrow \frac{h}{t_w} = 2.24 \sqrt{\frac{29000}{36}} = 63.576 \Rightarrow 63.58$$

$$F_y = 42 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \sqrt{\frac{29000}{42}} = 58.86 \Rightarrow 58.90$$

$$F_y = 45 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \sqrt{\frac{29000}{45}} = 56.86 \Rightarrow 56.90$$

$$F_y = 50 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{50} \right)^{1/2} = 53.90$$

$$F_y = 60 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{60} \right)^{1/2} = 49.25$$

$$F_y = 65 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{65} \right)^{1/2} \approx 47.30$$

$$F_y = 100 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{100} \right)^{1/2} = 38.15$$

Prepared by Eng. Maged Kamel.

**Prepared by Eng.Maged Kamel.**