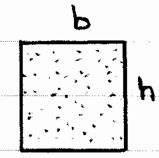
#18

Examples (Shearing stresses and shear flow)

Example 1 :



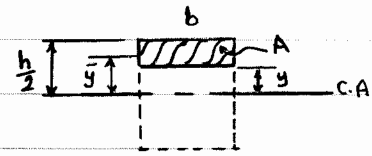
Given:

The cross section of a beam shown

Reqd.:

The shear flow and shearing stress formulas; sketch their distributions

Soln. :

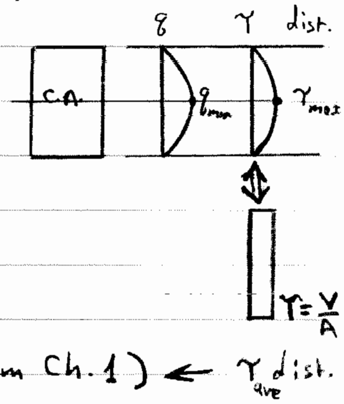


$q = VQ/I$

$I = bh^3/12$; $Q = A\bar{y} = [(\frac{h}{2}-y)b][\frac{\frac{h}{2}+y}{2}] = \frac{b}{2}(\frac{h^2}{4}-y^2)$

$q = V(\frac{b}{2})(\frac{h^2}{4}-y^2)/bh^3/12 \Rightarrow \underline{q = (1.5h^2 - 6y^2)V/h^3}$

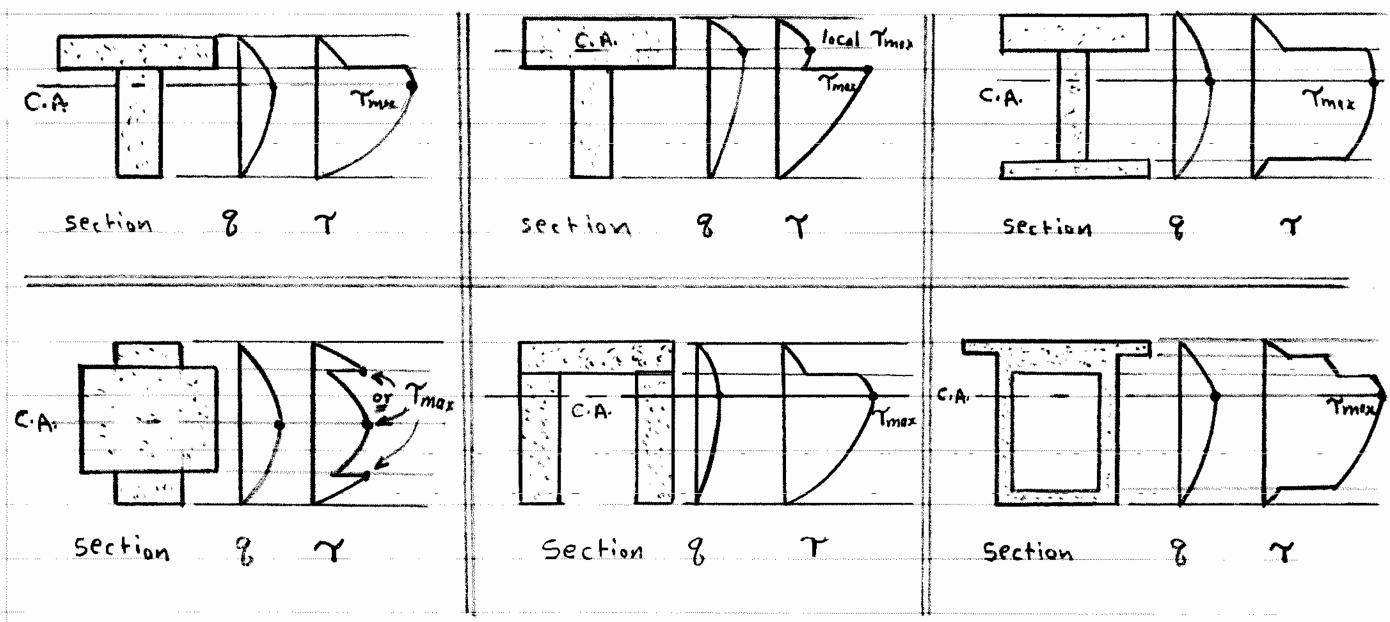
$\tau = q/b \Rightarrow \underline{\tau = (1.5h^2 - 6y^2)V/bh^3}$



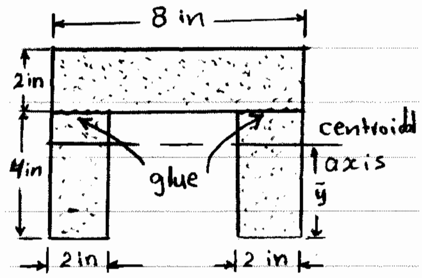
Note that q and τ have parabolic shapes with $q_{max} = 1.5V/h$ and $\tau_{max} = 1.5V/bh = 1.5V/A$ at the centroid. Compare this with $\tau_{av} = V/A$ which is constant across the depth of the beam as discussed in Chapter 1.

Example 2 :

Sketch the shear flow and shearing stress distributions for the sections shown.



Example 3 :



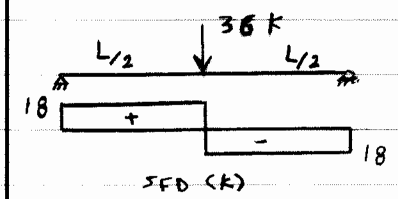
Given :

The section shown composed of 3 parts glued together

$\tau_{max}^{Glue} = 1.5$ ksi ; the load show on the beam

Req'd. :

Is the glue adequate ? Value & Location of τ_{max}



Soln. :

From the SFD, $V_{max} = 18$ k (The sign is unimportant for now)

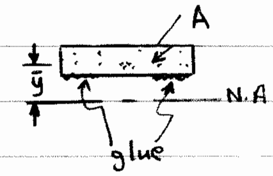
$\bar{y} = \Sigma A_i \bar{y}_i / \Sigma A_i$

$= [2(8)5 + 2\{2(4)(2)\}] / (2\times8 + 2\times2\times4) = 3.5$ in

$I = \Sigma(\bar{I}_i + A_i d_i^2) = \frac{1}{12}8(2)^3 + 16(1.5)^2 + 2[\frac{1}{12}2(4)^3 + 8(1.5)^2] = 98.667$ in^4

$\tau = VQ/Ib = 18[8(2)(1.5)]/98.667(2+2)$ note!

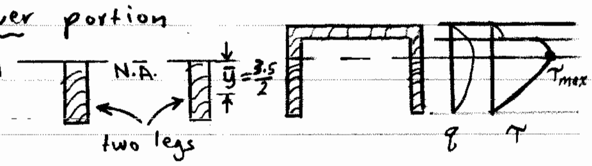
$= 1.095$ ksi < 1.5 ksi $\Rightarrow$ The glue is adequate



From τ distribution, τ_{max} is clearly at the centroid. $\Rightarrow$

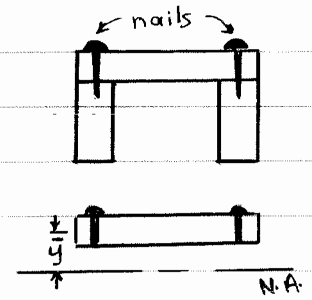
$\tau_{max} = VQ/Ib$ $\Leftarrow$ easier to take the lower portion

$= 18[2(2\times3.5)(\frac{3.5}{2})]/98.667(2+2)$ (2 = two legs)



$\rightarrow$ **$\tau_{max} = 1.12$ ksi @ the centroid**

Example 4 :

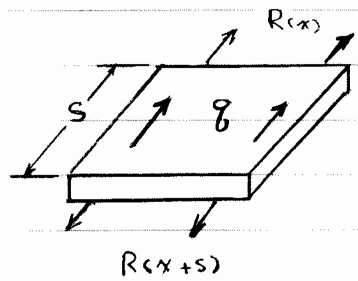


If the glue in Example 3 is replaced by two nails on the cross section as shown in the figure, what is the required spacing of the nails (along the beam)? The shear capacity of the nails is $R_n = 22.$ k.

Soln. :

$$q = \frac{VQ}{I} = \frac{18[8(2)(1.5)]}{98.667} = 4.3784 \text{ k/in}$$

$R_n = q(s)$ (See figure)



$2(22.) = 4.3784\, s \Rightarrow s = 2(22)/4.3784$ (2 = two nails)

$\Rightarrow$ **$s = 10.0$ in**

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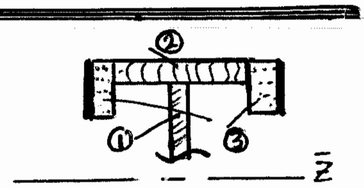
* Important :

Q for composite area is the total of Q_i : $Q = \sum_{i=1}^{n} Q_i = \sum_{i=1}^{n}(A_i \bar{y}_i)$



$Q_{\bar{z}} = Q_{①} + Q_{②} + Q_{③}$