Stresses in Beams

MECH 2333

Summer 2020

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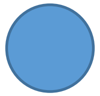
Formula for Bending and Shear Stress

I=(pi()*D$^{4)}$/64

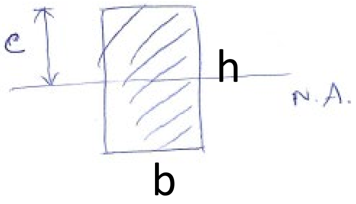


$$f_b = \frac{Mc}{I} = \frac{M}{S}$$

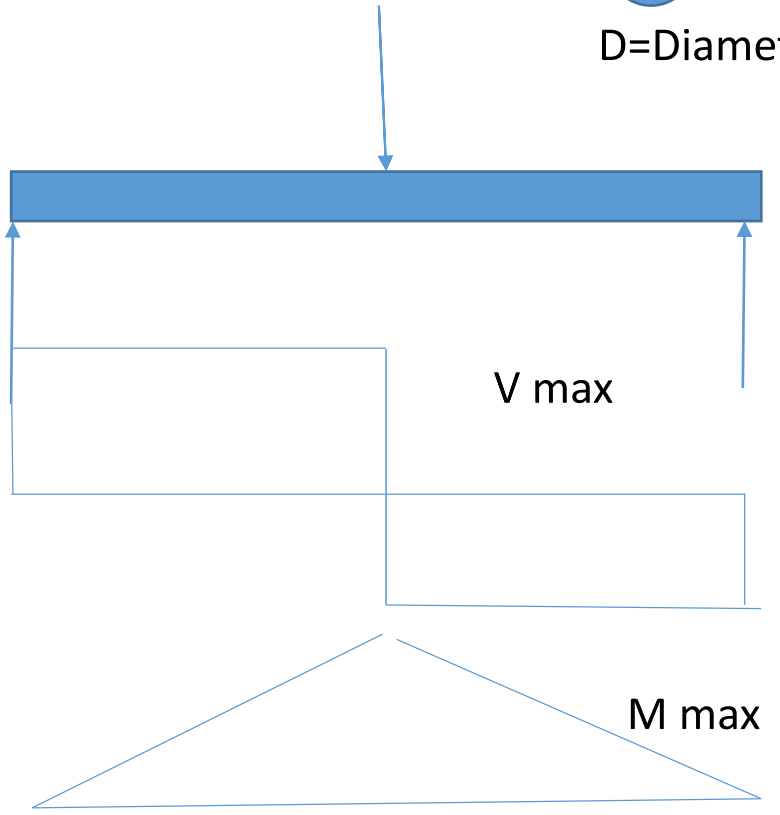
Bending Stress, N/mm^2 , PSI, MPa, Pa, Ksi

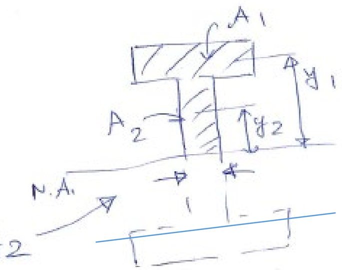
S= Section Modulus

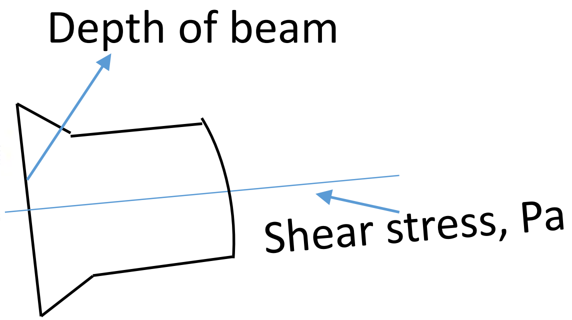
$$S = I/c$$



I=(1/12)*bh^3







$$S_v = \frac{VQ}{Ib}$$

$$Q = \Sigma A y = A_1 y_1 + A_2 y_2$$

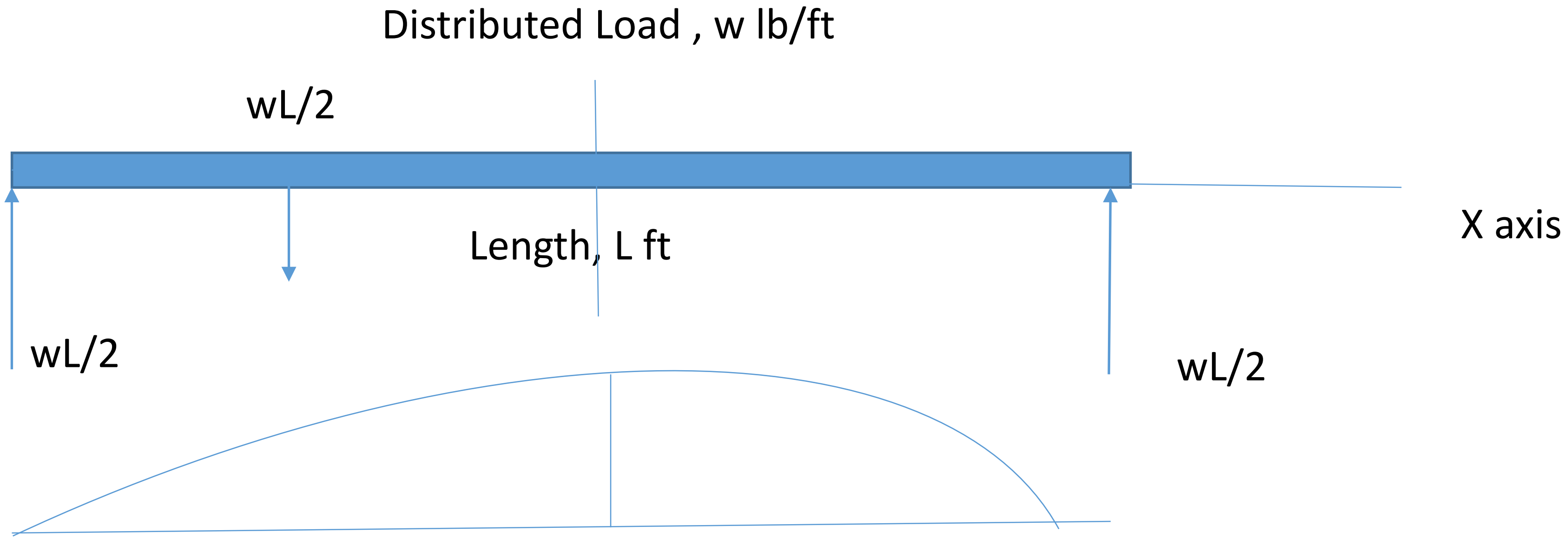
I = From steel table

b = width of section

Shear Stress, N/mm^2 ,Psi, Mpa, Pa, ksi

Maximum Moment Calculation

Consider a beam , L ft long loaded with distributed load w lb/ft, Calculate Maximum moment



M max= (w*L/2)*L/2-(w*L/2)*L/4=w*L^2/4-w*L^2/8=w*L^2/8

Example of Shearing Stresses in Beams

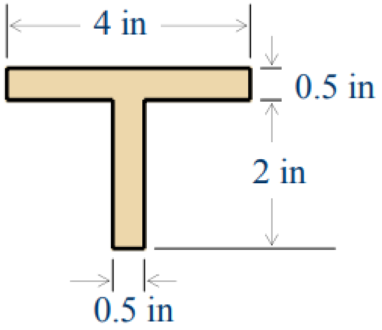
Shearing Stress in Beams

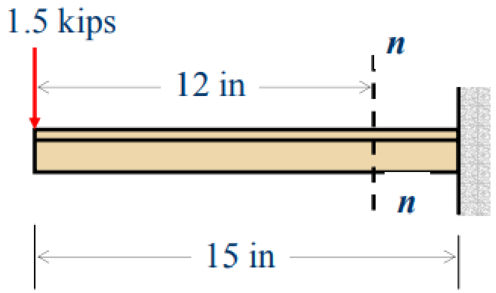
- Example 14

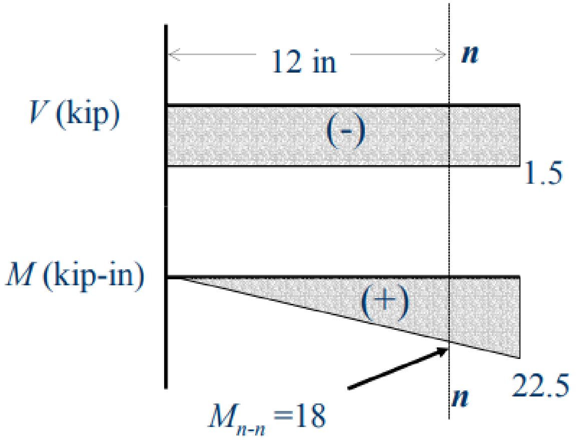
  A machine part has a T-shaped cross section and is acted upon in its plane of symmetry by the single force shown. Determine (a) the maximum compressive stress at section *n-n* and (b) the maximum shearing stress.

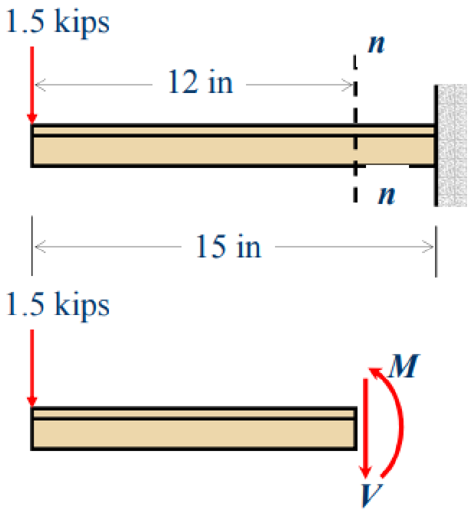
Solution

- Example 14 (cont'd)



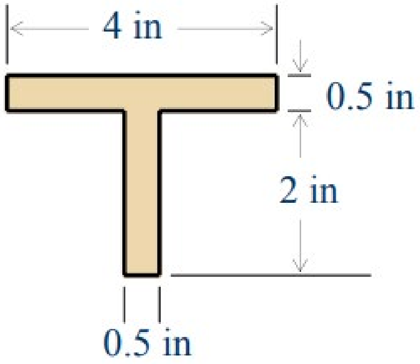






Example 14 (cont'd)

First, we need to locate the neutral axis. Let's make our reference from the bottom edge.



$$y_C = \frac{(1)(2\times0.5)+(2+0.25)(4\times0.5)}{2\times0.5+4\times0.5} = 1.833\text{ in}$$

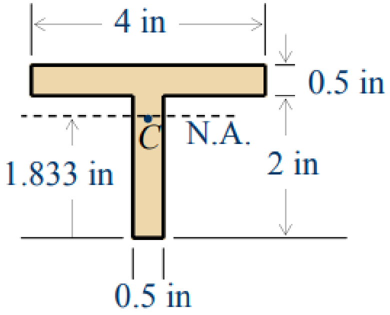
$$y_{ten} = 2.5-1.833 = 0.667\text{ in} \qquad y_{com} = 1.833\text{ in} = y_{max}$$

$$\text{Max. Stress} = \frac{M_r y_{max}}{I_x}$$

Example 14 (cont'd)

Next find the moment of inertia about the neutral axis:

$$I_x = \frac{0.5(1.833)^3}{3} + \frac{4(0.667)^3}{3} - \left[\frac{3.5(0.167)^3}{3}\right] = 1.417\text{ in}^4$$



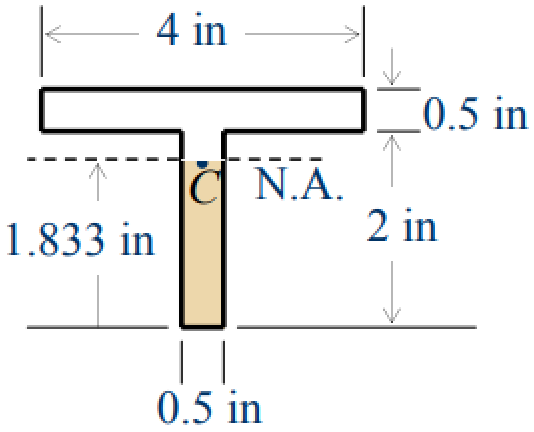
(a) Maximum normal stress is a compressive stress:

$$\sigma_{max} = \frac{M_{n-n} c_{max}}{I} = \frac{18(1.833)}{1.417} = 23.3\text{ ksi (C)}$$

▪ Example 14 (cont'd)

(b) Maximum shearing stress:

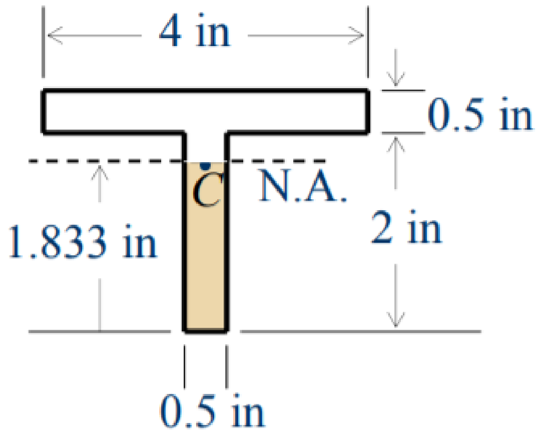
The maximum value of Q occurs at the neutral axis. Since in this cross section the width t is minimum at the neutral axis, the maximum shearing stress will occur there. Choosing the area below *a-a* at the neutral axis, we have



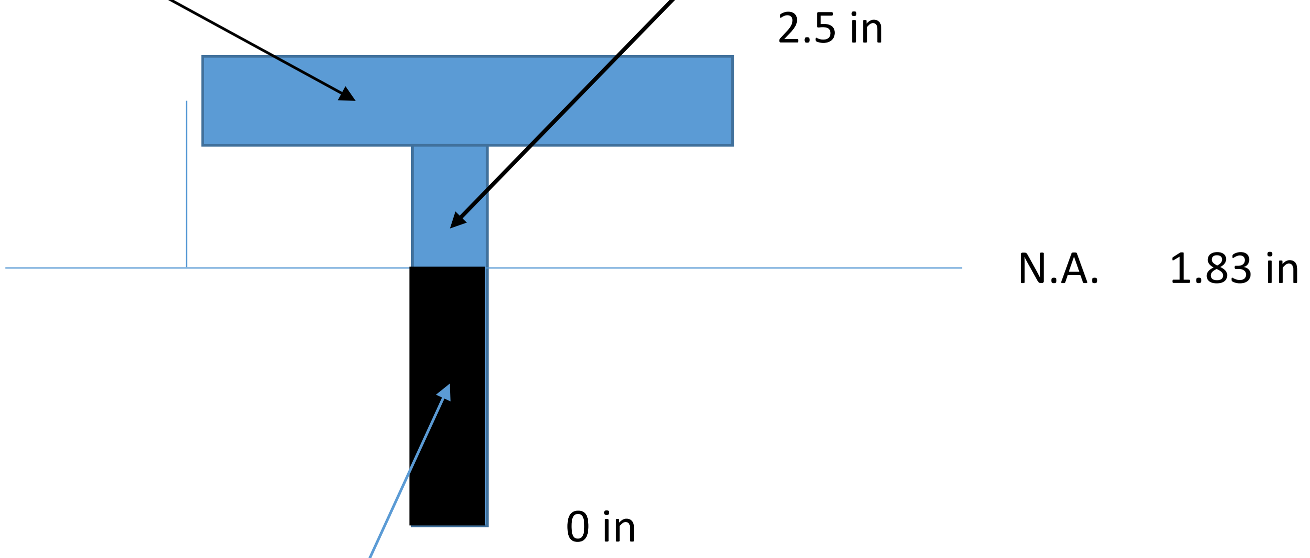
$$Q = \frac{1.833}{2}(0.5)(1.833) = 0.840\ \text{in}^3$$

$$\tau_{max} = \frac{VQ}{It} = \frac{1.5(0.840)}{1.417(0.5)} = 1.778\ \text{ksi}$$

Calculation of Q for Upper and lower sections of the beam from N.A.



$$Q=a1*y1+a2*y2=4*0.5*(2.5-1.833-.25)+(2-1.833)*0.5*(2-1.833)/2= ?$$



$$Q=A*y=(1.83*.5)*(1.83/2)=?$$

Average Web Shear Approach

- Webs I Steel beam resist 85 to 90 % of the shear.
- Therefore only consider Web in the equation.
- True for W and C beam

Fv=V/(d*tw)