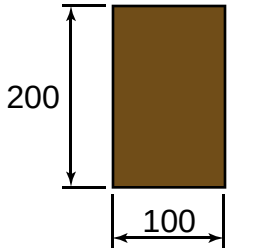
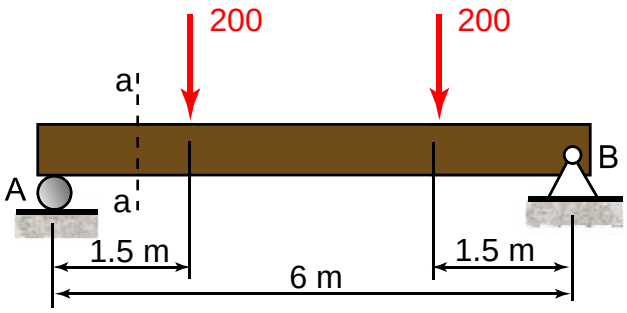
Chapter 6
Shearing Stresses in Beams and Thin-Walled Members

INTRODUCTION

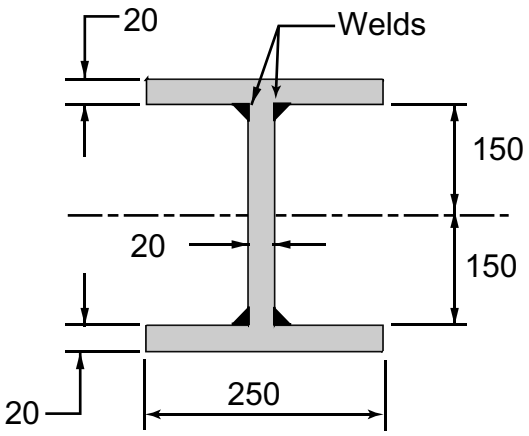
Shearing Stresses in Beams

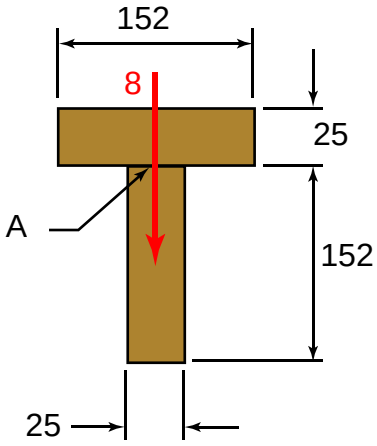


Cross-section

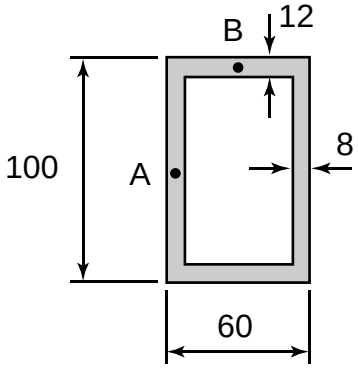


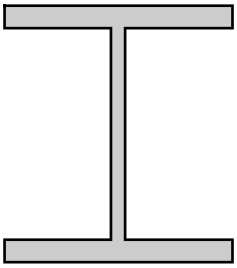
Shearing Forces and Stresses in Built-Up Members



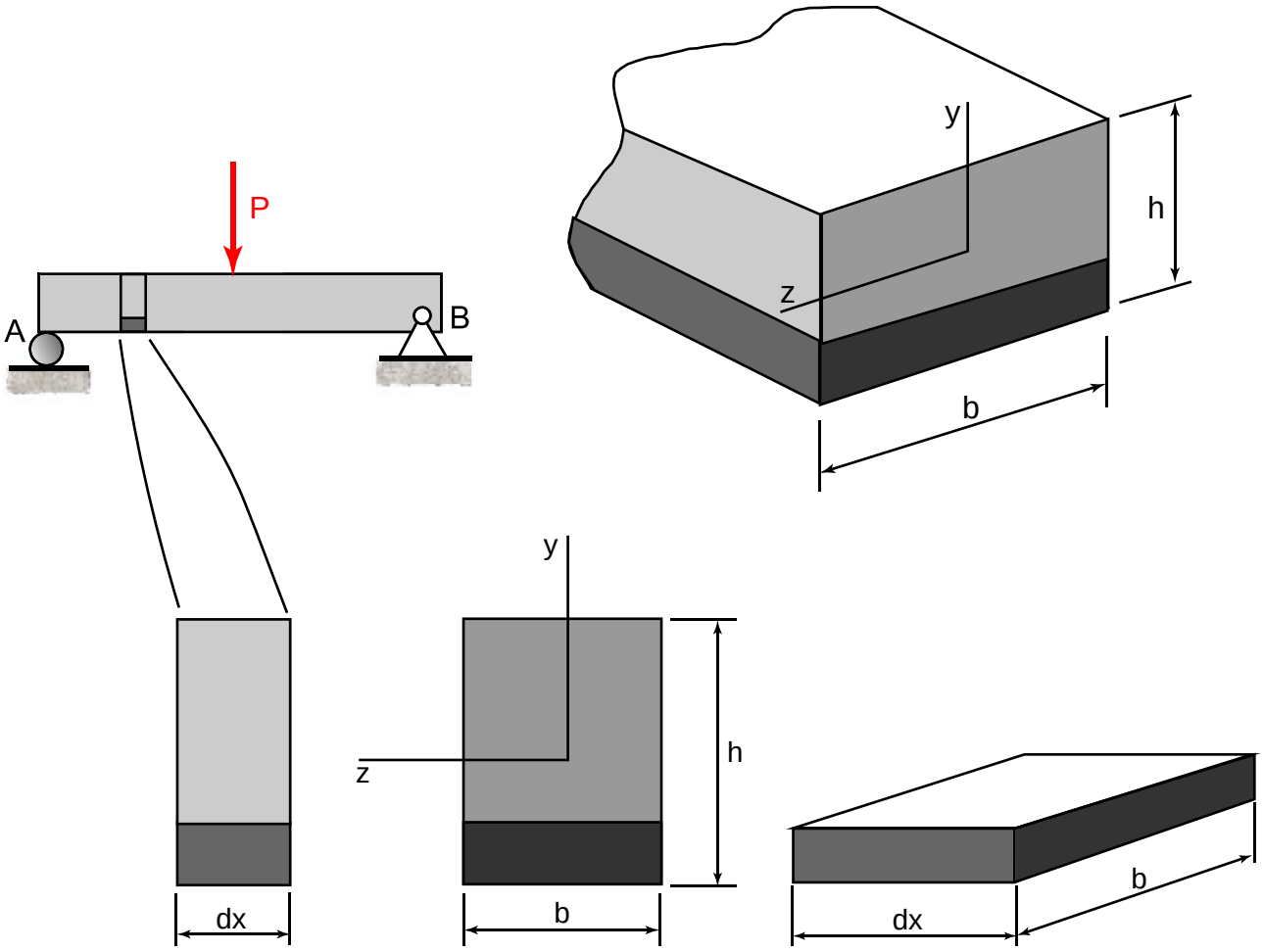


Shearing Stresses in Thin-Walled Members



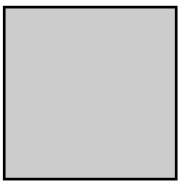


SHEARING STRESSES IN A BEAM



Cross-section

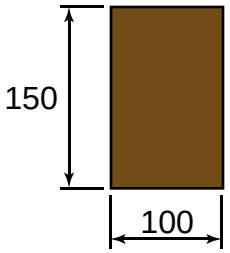
$$\tau = \frac{VQ}{Ib} = \frac{VQ}{It}$$



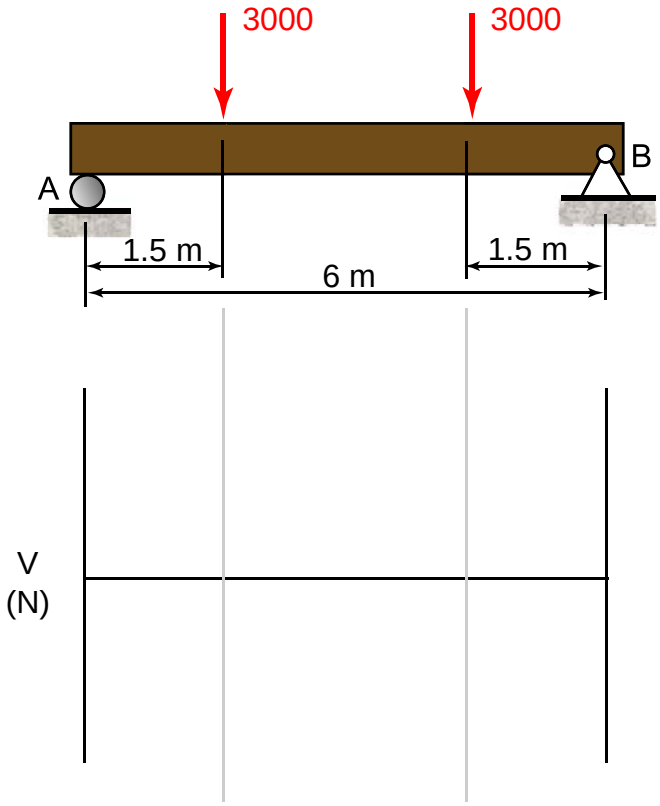
Example

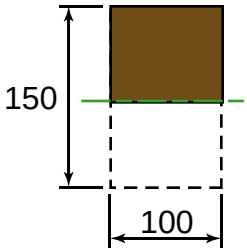
Determine the maximum shearing stress.

Units: N, mm (UNO).



Cross-section

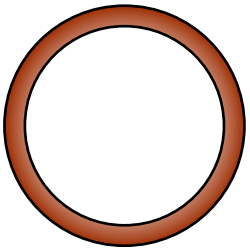




Example

Determine the maximum shear stress for the 6" diameter pipe. The pipe has a wall thickness of 0.28".

Units: lb, ft.



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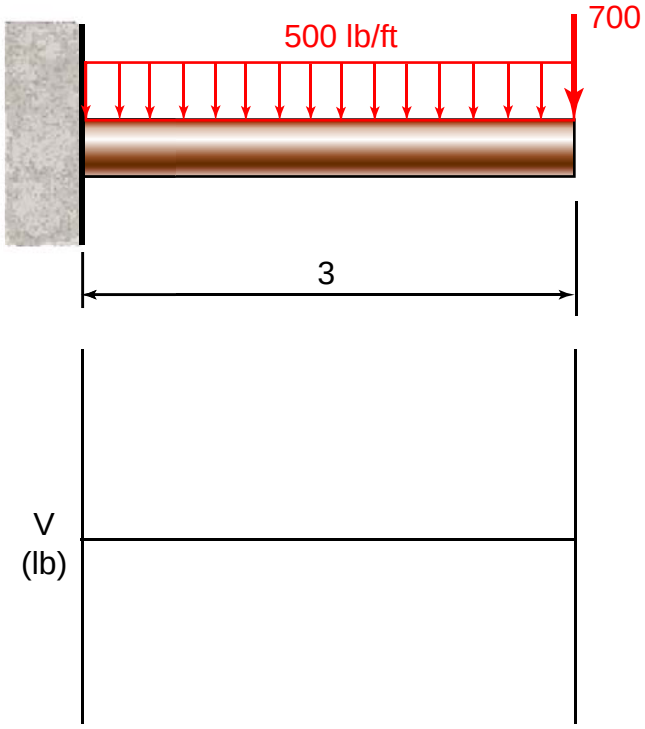
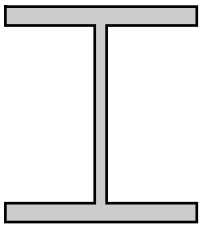
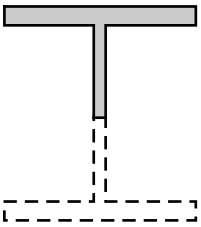


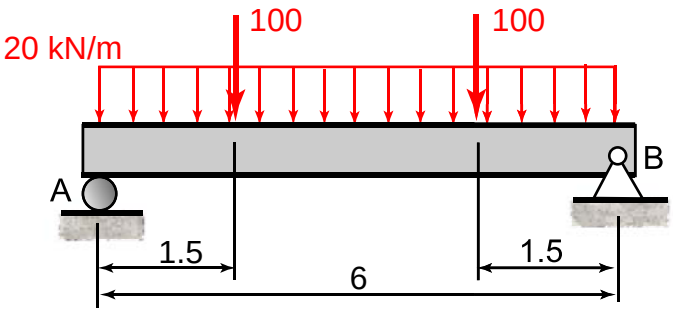
Example

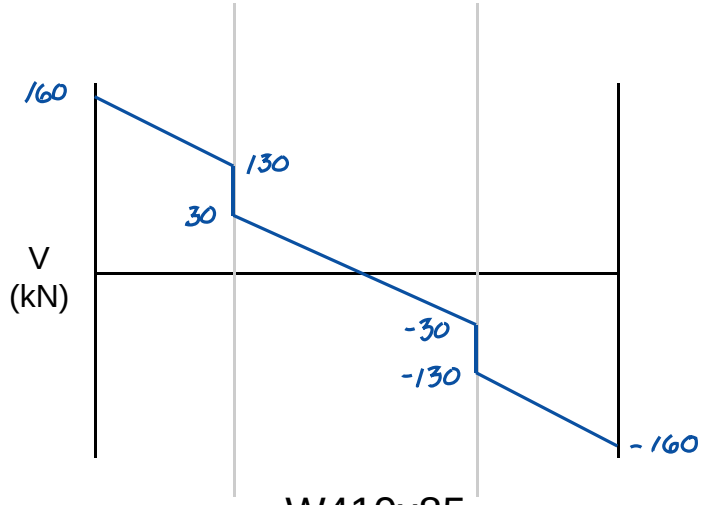
For the W410x85 section, determine the maximum shear stress.
Units: kN, m.



Cross-section







W410x85

Area, $A = 10800^{mm^2}$

Depth, $d = 417^{mm}$

Flange Width, $b_f = 181^{mm}$

Flange Thickness, $t_f = 18.2^{mm}$

Web Thickness, $t_w = 10.9^{mm}$

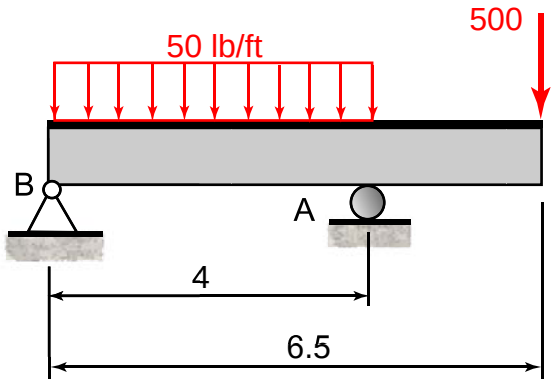
$I_x = 315x10^{6mm^4}$

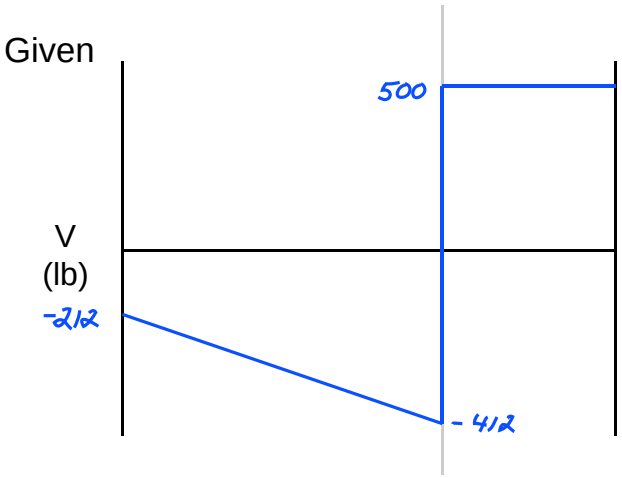
$I_y = 18.0x10^{6mm^4}$

Example

For the C7x9.8 channel section, determine the maximum shear stress.
Units: lb, ft.

Cross-section





C7x9.8

Area, $A = 2.87^{in^2}$

Depth, $d = 7.00^{in}$

Flange Width, $b_f = 2.09^{in}$

Flange Thickness, $t_f = 0.366^{in}$

Web Thickness, $t_w = 0.210^{in}$

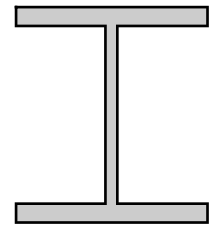
$I_x = 21.3^{in^4}$

$I_y = 0.968^{in^4}$

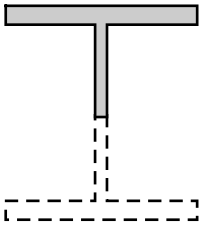
$\overline{x} = 0.540^{in}$

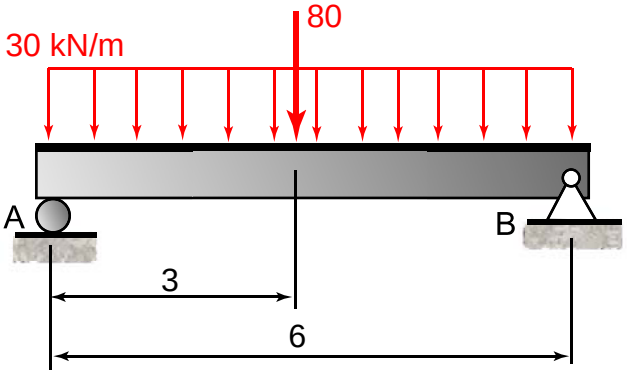
Example

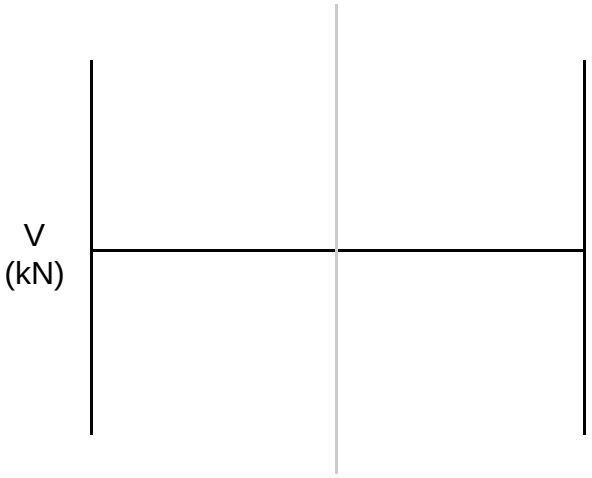
For the W310x107 section, determine the maximum shear stress.
Units: kN, m.



Cross-section







W310x107

Area, $A = 13600^{mm^2}$

Depth, $d = 311^{mm}$

Flange Width, $b_f = 306^{mm}$

Flange Thickness, $t_f = 17.0^{mm}$

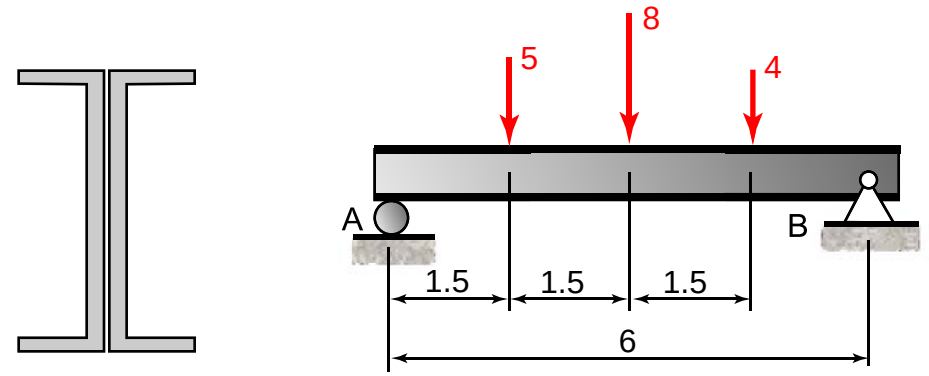
Web Thickness, $t_w = 10.9^{mm}$

$I_x = 248x10^{6mm^4}$

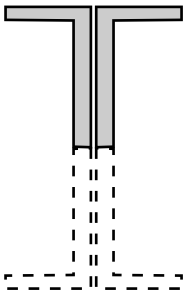
$I_y = 81.2x10^{6mm^4}$

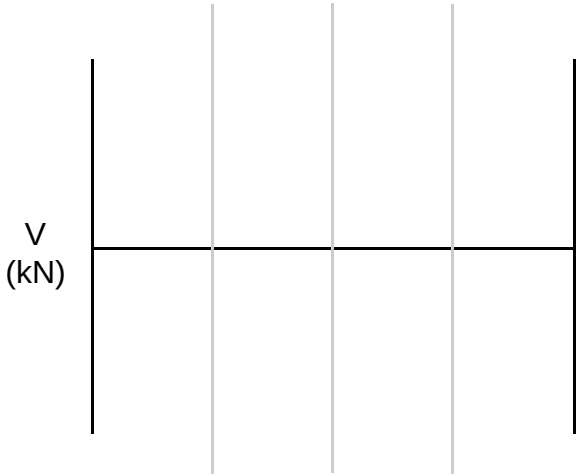
Example

Two rolled-steel C150x12.2 channels are welded back to back.
Determine the maximum shear stress.
Units: kN, m.



Cross-section





C150x12.2

Area, $A = 1540^{mm^2}$

Depth, $d = 152^{mm}$

Flange Width, $b_f = 48^{mm}$

Flange Thickness, $t_f = 8.7^{mm}$

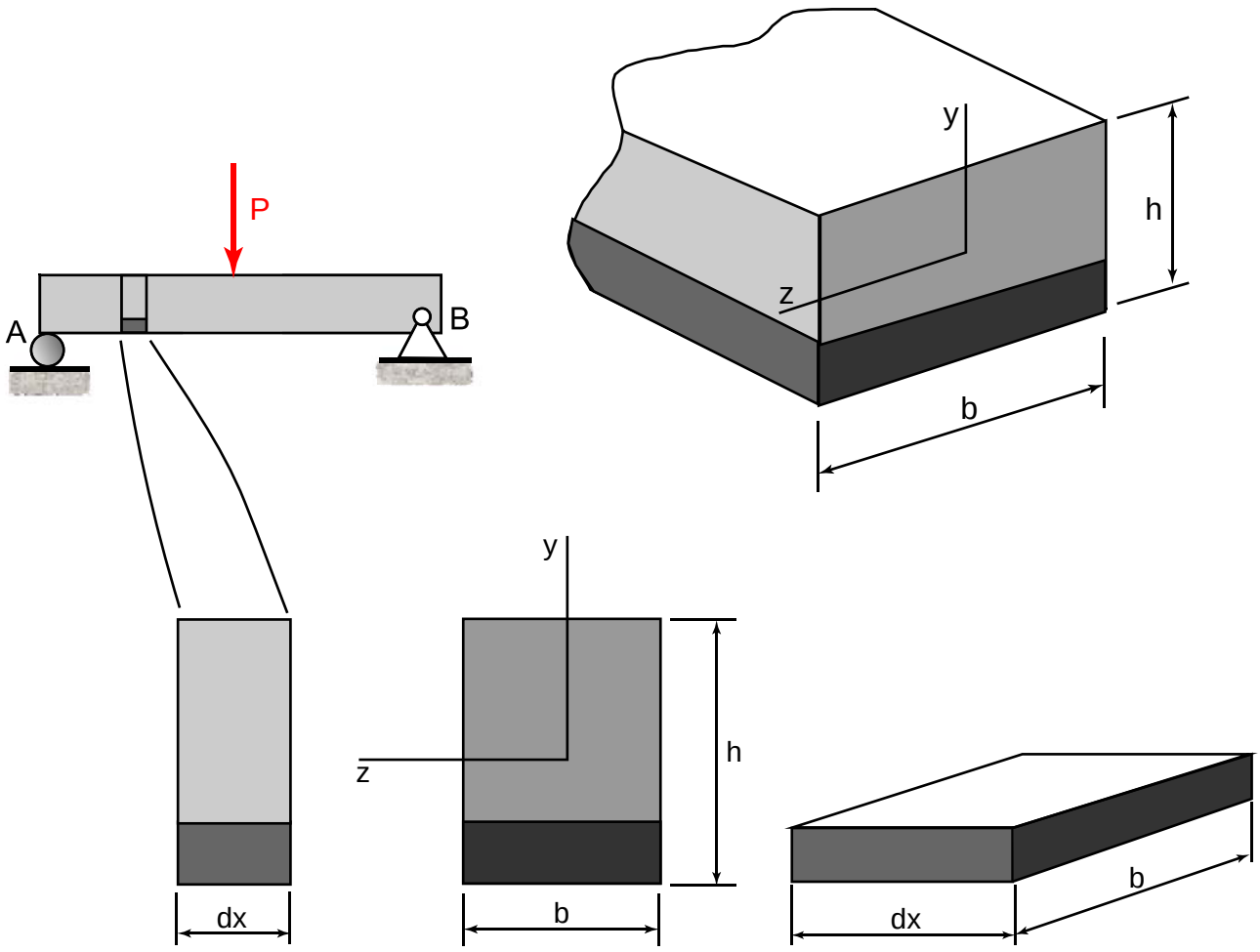
Web Thickness, $t_w = 5.1^{mm}$

$I_x = 5.35x10^{6mm^4}$

$I_y = 0.276x10^{6mm^4}$

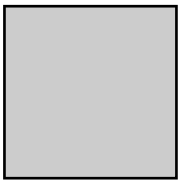
$\overline{x} = 12.7^{mm}$

SHEARING STRESSES IN A BUILT-UP BEAM



Cross-section

$$\tau = \frac{VQ}{Ib} = \frac{VQ}{It}$$



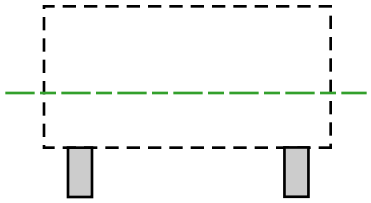
Example

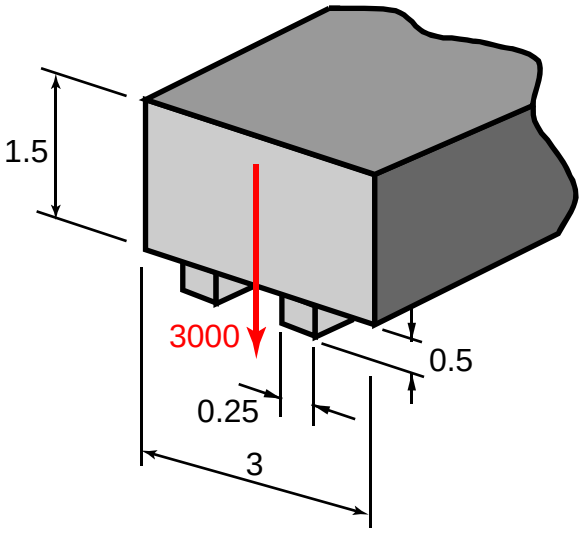
The two 0.25"x0.5" strips are glued to the 3"x1.5" main member. Determine the maximum shear stress in the glue between them. Units: lb, in.

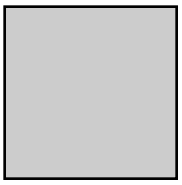
From a previous solution:

$\bar{y} = 0.802" \downarrow$

$I = 1.09^{in^4}$

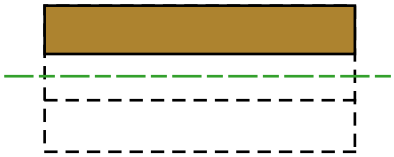


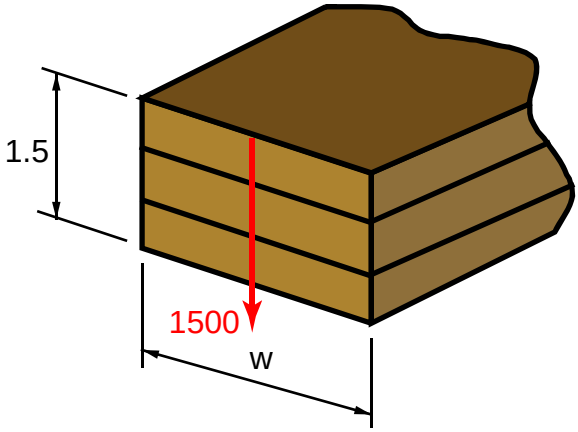


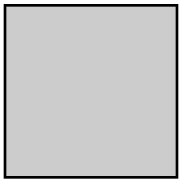


Example

The three 0.50" thick boards are glued together using a glue with a shear capacity of 350 psi. Based on the glue capacity, compute the minimum width of the boards to resist a vertical shear force of 1500 lb. Units: lb, in.







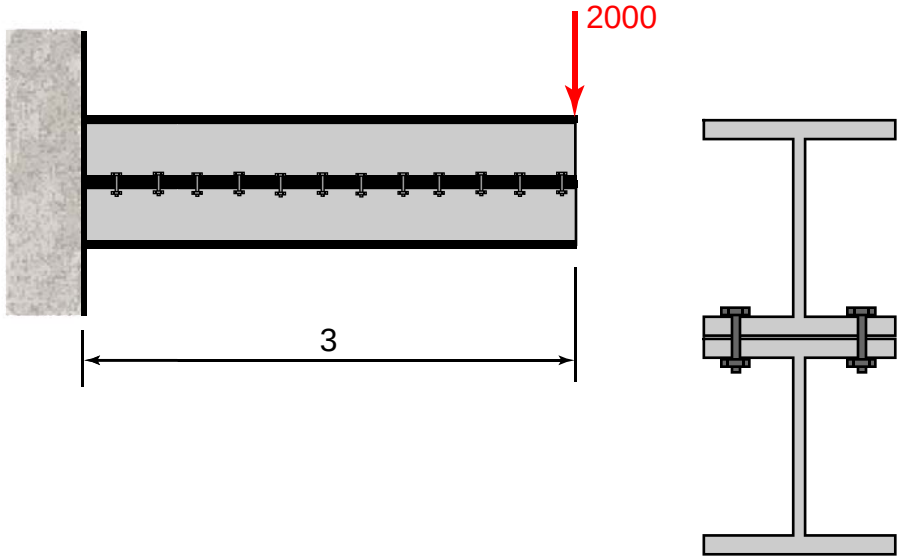
Example

The two beams are connected every 6" by bolts through the flanges. Determine the force in each bolt for the W6x20 built-up beam.

Units: lb, ft

From a previous solution:

$I = 196^{in^4}$



W6x20

Area, $A = 5.87^{in^2}$

Depth, $d = 6.20^{in}$

Flange Width, $b_f = 6.02^{in}$

Flange Thickness, $t_f = 0.365^{in}$

Web Thickness, $t_w = 0.260^{in}$

$I_x = 41.4^{in^4}$

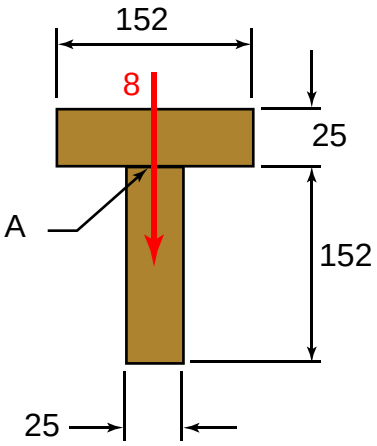
$I_y = 13.3^{in^4}$

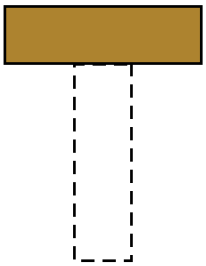
$S_x = 13.4^{in^3}$

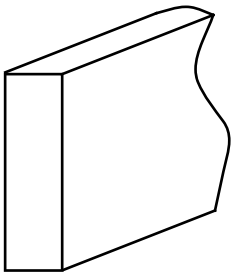
$S_y = 4.41^{in^3}$

Example

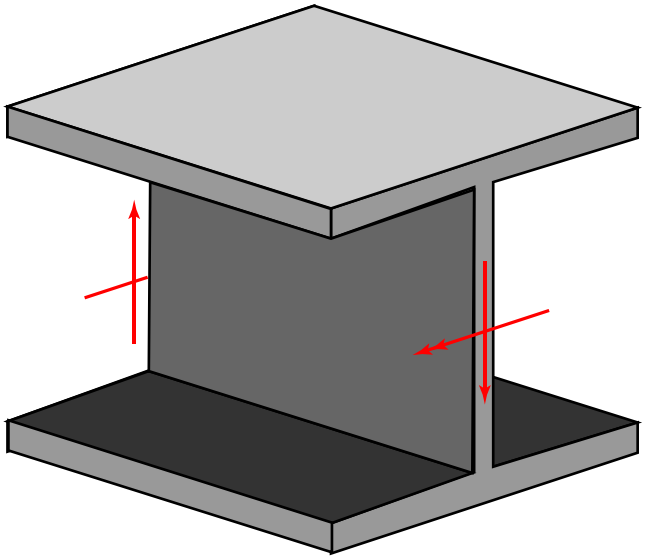
The two boards are glued at A and is subjected to a vertical shear force of 8 kN. Determine the shear stress in the glue.
Units: kN, mm.

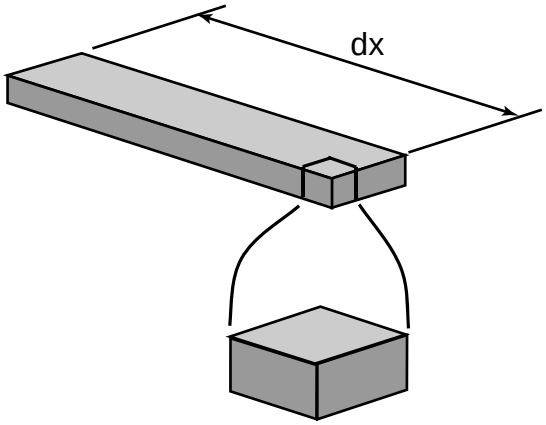


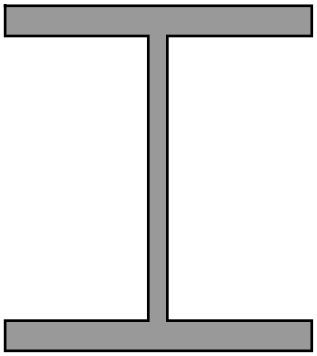


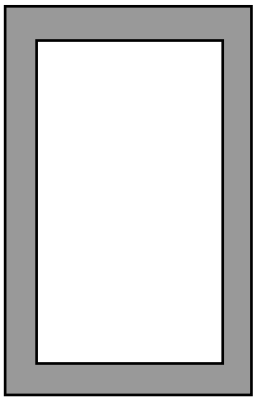


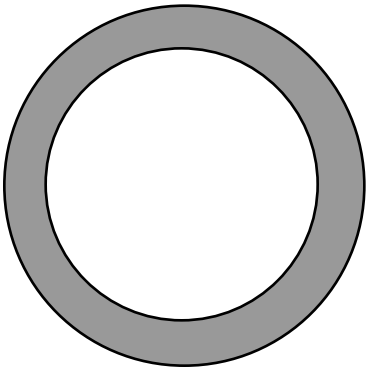
SHEARING STRESSES IN THIN-WALLED MEMBERS





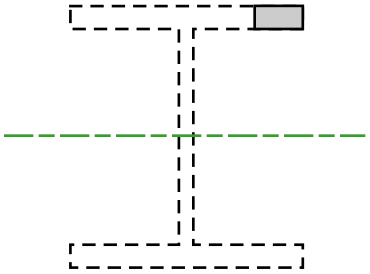


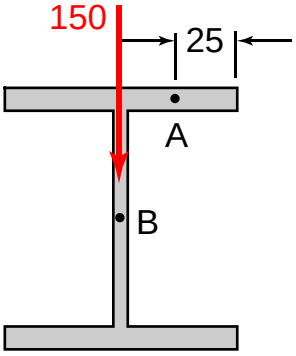




Example

Knowing that the vertical shear in the W150x29.8 beam is 150 kN, determine the shearing stress at (a) point A, (b) point B.
Units: kN, mm.

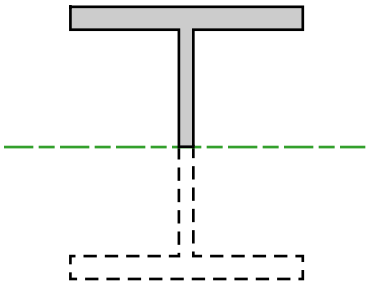




Cross-section

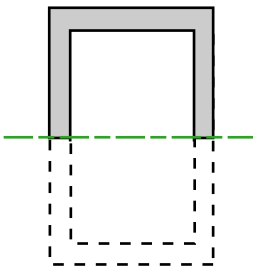
W150x29.8

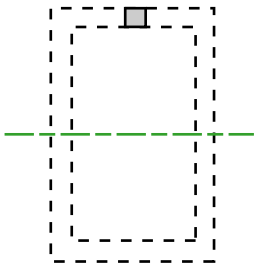
Area, $A = 3790^{mm^2}$
Depth, $d = 157^{mm}$
Flange Width, $b_f = 153^{mm}$
Flange Thickness, $t_f = 9.3^{mm}$
Web Thickness, $t_w = 6.6^{mm}$
$I_x = 17.2x10^{6mm^4}$
$I_y = 5.56x10^{6mm^4}$
$S_x = 219x10^{3mm^3}$
$S_y = 72.7x10^{3mm^3}$

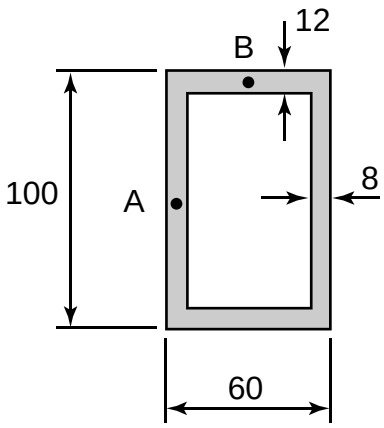


Example

Knowing that the vertical shear in the rectangular tube is 90 kN, determine the shearing stress at (a) point A, (b) point B.
Units: kN, mm.







Cross-section

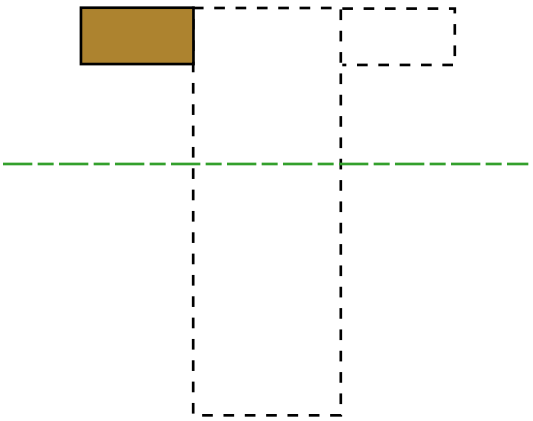
Example

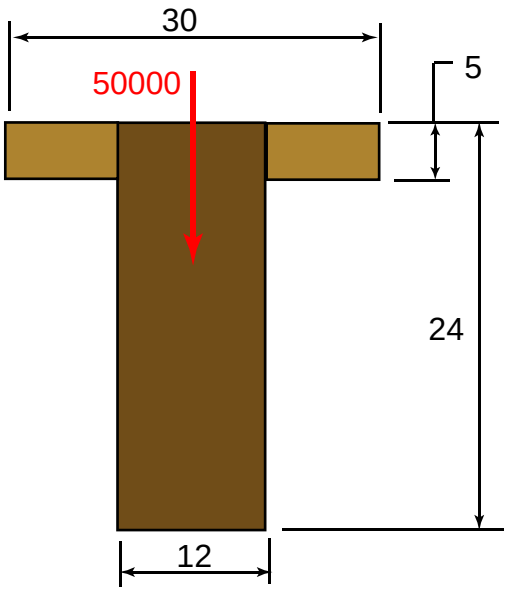
The three boards are glued together and the built-up member is subjected to a vertical shear force of 50000 lb. Determine the shear stress in the glue. Repeat the problem if the two horizontal boards are replaced with a single 30"x5" board. Units: lb, in.

Given:

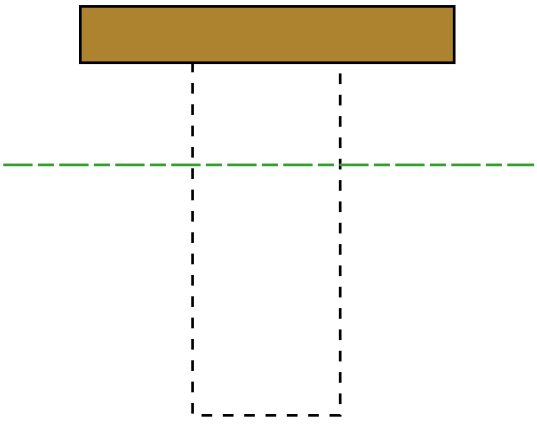
$\overline{y} = 9.74" \downarrow$

$I = 20,200^{in^4}$



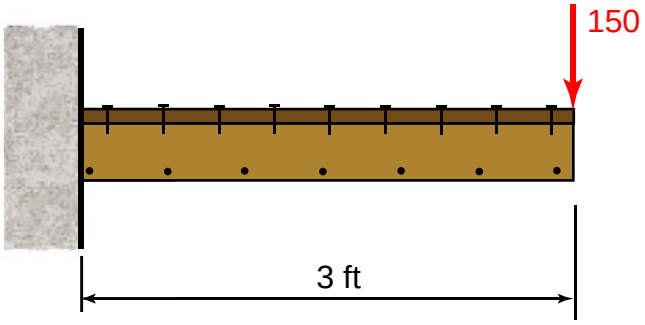


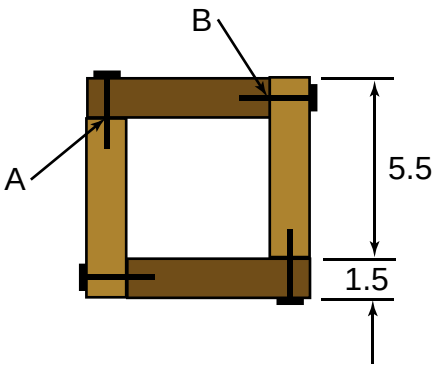
Cross-section



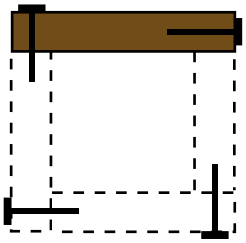
Example

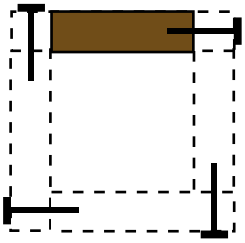
The built-up box beam is constructed by nailing four 2"x6" (nominal size) boards together. If each nail can support a shear force of 70 lb, determine the maximum spacing s of nails at A and B. Units: lb, in.





Cross-section





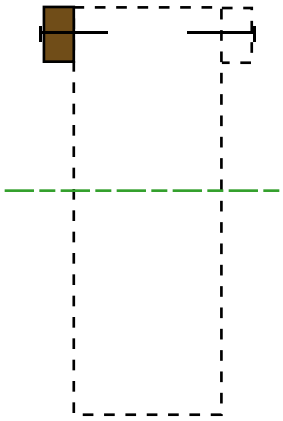
Example

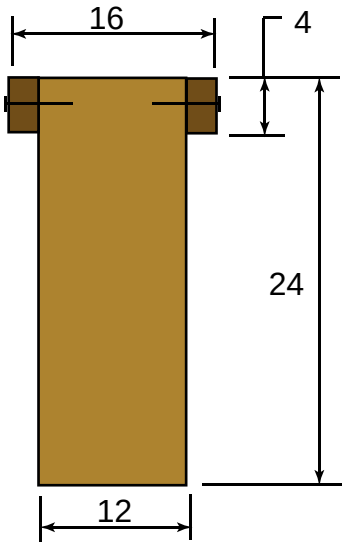
Compute the shear force in each nail to insure that the beams are securely bonded to each other. Assume a shear force of 5000 lbs and that each nail is spaced every 6". Units: lb, in.

Given:

$\overline{y} = 11.5" \downarrow$

$I = 15,300^{in^4}$





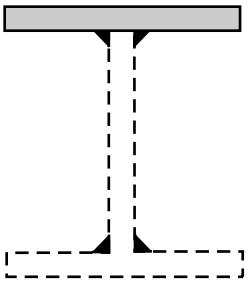
Cross-section

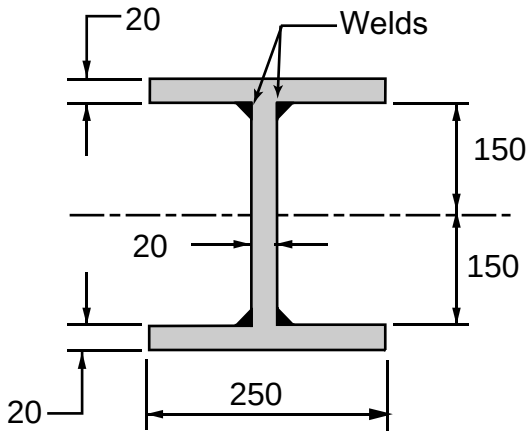
Example

If each of the four welds can support 80 kN/m, determine the required length of weld. Assume a shear force of 20 kN. Units: kN, mm.

From a previous solution:

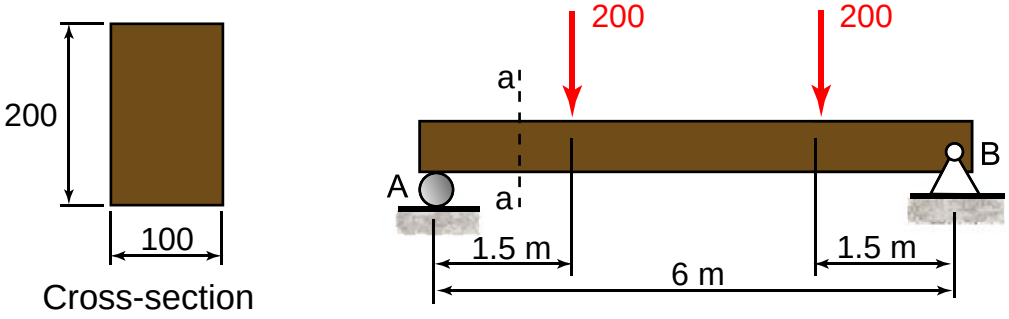
$I = 301x10^{-6in^4}$



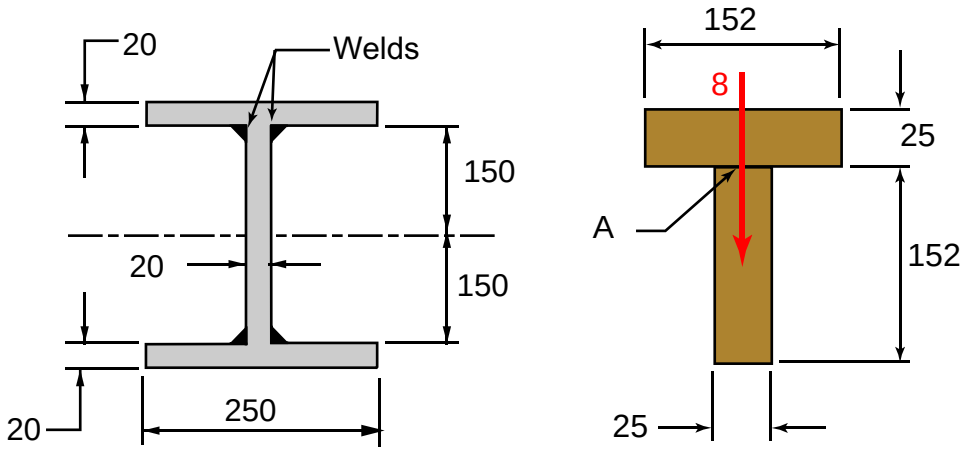


SUMMARY

Shearing Stresses in Beams



Shearing Forces and Stresses in Built-Up Members



Shearing Stresses in Thin-Walled Members