INTRODUCTION

Shearing Stresses in Beams

Shearing Forces and Stresses in Built-Up Members

Shearing Stresses in Thin-Walled Members
SHEARING STRESSES IN A BEAM

\[ \tau = \frac{VQ}{Ib} = \frac{VQ}{It} \]
Example
Determine the maximum shearing stress.
Units: N, mm (UNO).
Example
Determine the maximum shear stress for the 6" diameter pipe. The pipe has a wall thickness of 0.28".
Units: lb, ft.

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

Cross-section

W410x85
Area, $A = 10800 \text{ mm}^2$
Depth, $d = 417 \text{ mm}$
Flange Width, $b_f = 181 \text{ mm}$
Flange Thickness, $t_f = 18.2 \text{ mm}$
Web Thickness, $t_w = 10.9 \text{ mm}$
$I_x = 315 \times 10^6 \text{ mm}^4$
$I_y = 18.0 \times 10^6 \text{ mm}^4$
Example
For the C7x9.8 channel section, determine the maximum shear stress. Units: lb, ft.

Cross-section

Given

C7x9.8

Area, \( A = 2.87^{\text{in}^2} \)
Depth, \( d = 7.00^{\text{in}} \)
Flange Width, \( b_f = 2.09^{\text{in}} \)
Flange Thickness, \( t_f = 0.366^{\text{in}} \)
Web Thickness, \( t_w = 0.210^{\text{in}} \)

\( I_x = 21.3^{\text{in}^4} \)
\( I_y = 0.968^{\text{in}^4} \)
\( 
\bar{x} = 0.540^{\text{in}} \)
Example

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

Cross-section

W310x107
Area, $A = 13600 \text{ mm}^2$
Depth, $d = 311 \text{ mm}$
Flange Width, $b_f = 306 \text{ mm}$
Flange Thickness, $t_f = 17.0 \text{ mm}$
Web Thickness, $t_w = 10.9 \text{ mm}$
$I_x = 248 \times 10^6 \text{ mm}^4$
$I_y = 81.2 \times 10^6 \text{ mm}^4$
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, $A = 1540 \text{mm}^2$
Depth, $d = 152 \text{mm}$
Flange Width, $b_f = 48 \text{mm}$
Flange Thickness, $t_f = 8.7 \text{mm}$
Web Thickness, $t_w = 5.1 \text{mm}$
$I_x = 5.35 \times 10^6 \text{mm}^4$
$I_y = 0.276 \times 10^6 \text{mm}^4$
$x = 12.7 \text{mm}$
SHEARING STRESSES IN A BUILT-UP BEAM

\[ \tau = \frac{VQ}{I_b} = \frac{VQ}{I_t} \]
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:
\[ \bar{y} = 0.802" \]
\[ I = 1.09^{in^4} \]
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:
\[ I = 196 \text{in}^4 \]

W6x20
Area, \( A = 5.87 \text{in}^2 \)
Depth, \( d = 6.20 \text{in} \)
Flange Width, \( b_f = 6.02 \text{in} \)
Flange Thickness, \( t_f = 0.365 \text{in} \)
Web Thickness, \( t_w = 0.260 \text{in} \)
\( I_x = 41.4 \text{in}^4 \)
\( I_y = 13.3 \text{in}^4 \)
\( S_x = 13.4 \text{in}^3 \)
\( S_y = 4.41 \text{in}^3 \)
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.

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
$I_x$ = 17.2 x 10$^6$ mm$^4$
$I_y$ = 5.56 x 10$^6$ mm$^4$
$S_x$ = 219 x 10$^3$ mm$^3$
$S_y$ = 72.7 x 10$^3$ mm$^3$
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.
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:
\( \bar{y} = 9.74" \)  
\( I = 20,200"^3 \)
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.
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:
\[ \bar{y} = 11.5'' \quad I = 15,300''^3 \]
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:
\[ I = 301 \times 10^{-6} \text{in}^4 \]
SUMMARY

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