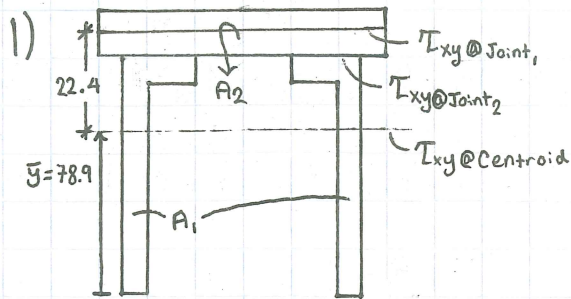


CIVIO2 - STRUCTURES and MATERIALS

Topic: Example Bridge Design Part II



Shear

[A] $\text{Max } T_{xy} = 4 \text{ MPa}$

$$T_{xy} = \frac{VQ}{Ib} \Rightarrow V = \frac{T_{xy} I b}{Q}$$

$$Q_1 = A_1 \cdot \text{dist} = 78.9 \times 1.27 \times 2 \times \frac{78.9}{2}$$

$$Q_1 = 7906 \text{ mm}^3$$

$$\frac{P_5}{2} = \frac{T_{xy} \cdot I \cdot b}{Q_1} \Rightarrow \frac{P_5}{2} = \frac{4 \cdot 587 \times 10^3 (1.27 \cdot 2)}{7906}$$

$$P_5 = 1509 \text{ N}$$

Shear at Glue Joint₂

$$V = \frac{T_{xy} I \cdot b}{Q}$$

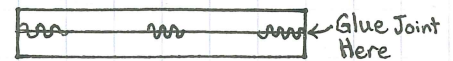
$$Q_2 = A_2 \cdot \text{dist} = 1.27 \times 2 \times 120 \times (22.4)$$

$$Q_2 = 6806 \text{ mm}^3$$

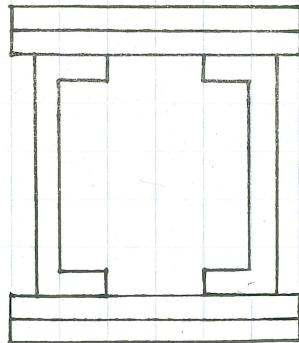
$$\frac{P_6}{2} = \frac{T_{xy} \cdot I \cdot b}{Q_2} \Rightarrow \frac{P_6}{2} = \frac{2 \times 587 \times 10^3 \times (2 \times 10)}{6806}$$

$$P_6 = 6899 \text{ N}$$

Shear at Glue Joint₁



Shear at [B]



I = Bigger

Q = Bigger

$$T_{xy} = \frac{VQ}{Ib}$$

Diagram illustrating the cross-section of a beam for three different cases (Case 1, Case 2, Case 3) under tension.

- Case 1:** A rectangular beam with a width of 80 and a height of b .
- Case 2:** A beam with a top flange of width 20 and a height of b .
- Case 3:** A beam with a top flange of width 20 and a curved top surface.

The vertical axis is labeled y , and the tension is indicated by a downward arrow.

Case 1 - Restrained on 2 sides, Constant σ

Case 2 - Restrained on 1 side, Constant σ

Case 3 - Restrained on 2 sides, variable σ —

Case 4 - Shear Stress

Axial Stress $\rightarrow$ Moments



$\sigma = \frac{My}{I}$

Case 1 Buckling Top Centre

$$\begin{aligned}\sigma_{cr} &= \frac{K \pi^2 E}{12(1-\mu^2)} \left(\frac{t}{b} \right)^2 \\ &= \frac{4 \pi^2 4000}{12(1-0.2^2)} \left(\frac{1.27 \cdot 2}{80} \right)^2 \\ &= 13.8 \text{ MPa}\end{aligned}$$

$$= \frac{4 \pi^2 4000}{12(1 - 0.2^2)} \left(\frac{1.27 \cdot 2}{80} \right)^2$$

$$= 13.8 \text{ MPa}$$

Since $> 6 \text{ MPa}$ ignore this buckling

Case 2

$$\sigma_{cr} = \frac{0.425 \pi^2 E}{12(1-\mu^2)} \left(\frac{t}{b} \right)^2$$

$$t = 1.27 \times 2 \quad b = 20$$

$$\sigma_{cr} = 23.5 \text{ MPa}$$

How to Respond if $\sigma_{cr} < 6 \text{ MPa}$?

Make this $\sigma = \sigma_{cr}$ Solve for M, Solve for P

$\sigma = \frac{My}{I}$

Diagram illustrating the stress distribution in a rectangular cross-section. The top edge is labeled y_{top} . The neutral axis is labeled $\bar{y}$. The stress distribution is shown as a diagonal line from the bottom-left to the top-right. The formula $\sigma = \frac{My}{I}$ is written next to the diagram.

Case 3

$$b = 23.6 - 1.27 \times 2$$

$$t = 1.27 \text{ mm}$$

$K=6$

Diagram of a rectangular cross-section under bending. The width is labeled as 1.27×2 . The height is labeled as b . The bending moment is labeled as $\frac{My}{I}$. The maximum stress is labeled as $\sigma_{cr} = \text{known}$.

$$\sigma_{cr} = \frac{M(236 - 1.27 \times 2)}{I}$$

✓ zero