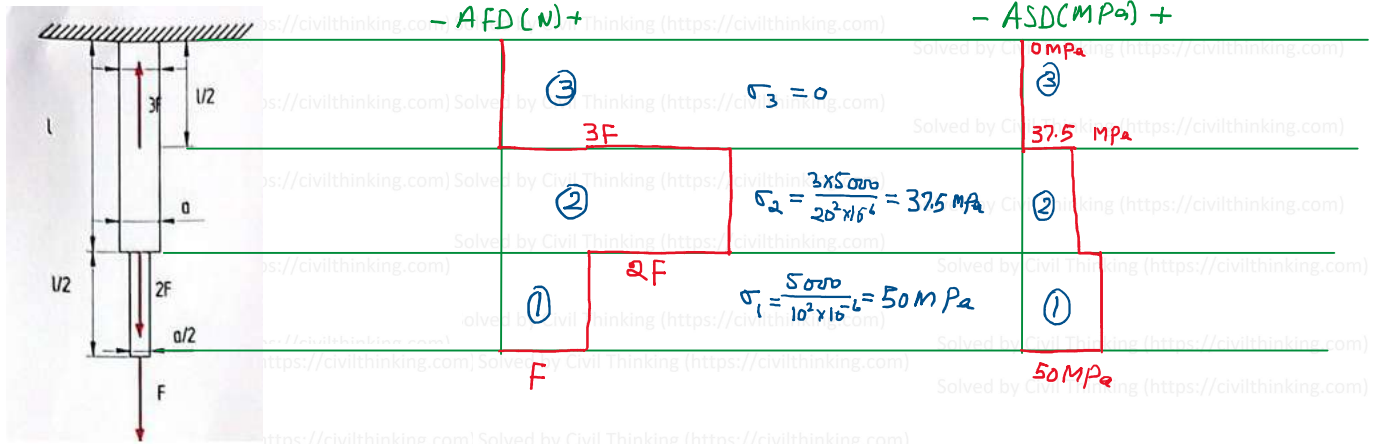
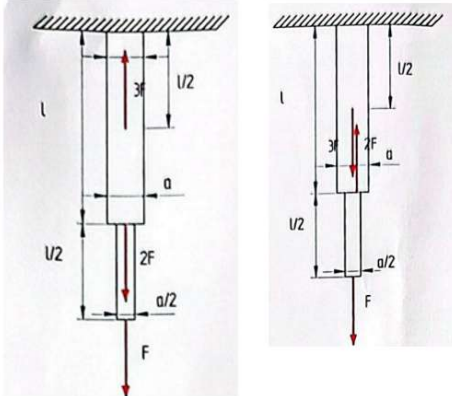


Solid Mechanics: Axial Load Diagram, Axial Stress
Diagram: Problem 4 solution

Draw a graph of tensile or compressive forces and stresses and calculate the total deformation of a square steel bar with the given data $l=4\text{m}$ $b=20\text{mm}$ $F=5000\text{N}$ and $E=210\text{ GPa}$ for the following cases:



$$\begin{aligned}\delta l_{\text{Total}} &= \frac{F_1 L_1}{A_1 E_1} + \frac{F_2 L_2}{A_2 E_2} + \frac{F_3 L_3}{A_3 E_3} \\ &= \frac{F L/2}{\left(\frac{a}{2}\right)^2 \times E} + \frac{3F \cdot L/2}{a^2 E} + 0 \\ &= \frac{FL}{a^2 E} \left[\frac{1/2}{1/4} + \frac{3/2}{1} \right] \\ &= 0.00083333\text{m} = 0.83\text{ mm}\end{aligned}$$

$$\left(\frac{5000 \times 4}{20^2 \times 10^{-6} \times 210 \times 10^9} \right) \times \left(\frac{1}{4} + \frac{3}{1} \right)$$

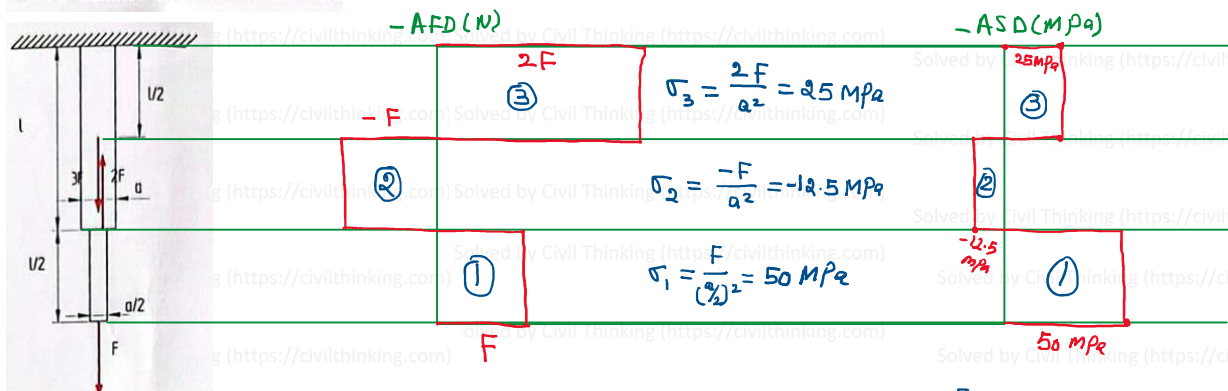
0.0008333333

$$\begin{aligned}\delta l_{\text{Total}} &= \frac{\sigma_1 L_1}{E_1} + \frac{\sigma_2 L_2}{E_2} + \frac{\sigma_3 L_3}{E_3} \\ &= \frac{\sigma_1 L/2}{E} + \frac{\sigma_2 L/2}{E} + 0 \\ &= \frac{L}{2E} (\sigma_1 + \sigma_2) \\ &= \frac{4}{2 \times 210 \times 10^9} (50 + 37.5) \times 10^6 \\ &= 0.00083333\text{m} = 0.83\text{ mm}\end{aligned}$$

$$\left(\frac{4}{2 \times 210 \times 10^9} \right) \times (50 + 37.5) \times 10^6$$

0.0008333333

$l=4\text{m}$ $b=20\text{mm}$ $F=5000\text{N}$ and $E=210\text{ GPa}$



$$\Delta L_{\text{Total}} = \Delta L_1 + \Delta L_2 + \Delta L_3$$

$$= \frac{\sigma_1 L_1}{E} + \frac{\sigma_2 L_2}{E} + \frac{\sigma_3 L_3}{E} \quad [\text{using ASD}]$$

$$= \frac{1}{E} \left[\sigma_1 \frac{l}{2} + \sigma_2 \frac{l}{2} + \sigma_3 \frac{l}{2} \right]$$

$$= \frac{l}{2E} [\sigma_1 + \sigma_2 + \sigma_3]$$

$$= \frac{4}{2 \times 210 \times 10^9} [50 + (-12.5) + 25] \times 10^6$$

$$= 0.000595 \text{ m} = 0.6 \text{ mm}$$

$$\Delta L_{\text{Total}} = \Delta L_1 + \Delta L_2 + \Delta L_3 = \frac{F_1 L_1}{A_1 E} + \frac{F_2 L_2}{A_2 E} + \frac{F_3 L_3}{A_3 E}$$

$$= \frac{1}{E} \left[\frac{F_1 L_1}{A_1} + \frac{F_2 L_2}{A_2} + \frac{F_3 L_3}{A_3} \right]$$

$$= \frac{1}{E} \left[\frac{FL}{2(\frac{b}{2})^2} + \frac{-FL}{2a^2} + \frac{2FL}{2a^2} \right]$$

$$= \frac{FL}{2a^2 E} \left[\frac{1}{\frac{1}{4}} - \frac{1}{1} + \frac{2}{1} \right]$$

$$= 0.000595 \text{ m} = 0.6 \text{ mm}$$

This problem was solved by Civil Thinking (<https://civilthinking.com>)

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