$L = 2m = 200\ cm$

$T_1 = 10°C$

$T_2 = 80°C$

$T = T_2 - T_1 = 80 - 10 = 70°C$

$E = 1.0 \times 10^5\ MN/m^2$

$= 1.0 \times 10^{11}\ N/m^2$

$\alpha = 0.000012$

Expansion(e) $= \alpha TL$

$= 0.000012 \times 70 \times 200$

$= 0.168\ cm.$

thermal stress $\sigma = \alpha TE$

$= 0.000012 \times 70 \times 1.0 \times 10^{11}\ N/m^2$

$= 84 \times 10^6\ N/m^2$

$= 84\ N/mm^2$

Volumetric strain

The Ratio of change in Volume to the Original Volume of the body is called Volumetric strain. It is denoted by e_v.

$$e_v = \frac{\delta V}{V}$$

$$e_v = \frac{\delta L}{L}(1 - 2\mu)$$

1) A Steel bar 300 mm Long, 50 mm Wide & 40 mm thick is Subjected to a pull of 300 kN in the direction of its Length. Determine the change in Volume. $E = 2\times10^5\ N/mm^2$ & $\mu = 0.25$.

$L = 300\ mm$

$b = 50\ mm$

$t = 40\ mm$

$P = 300\times10^3\ N$

$E = 2\times10^5\ N/mm^2$

$\mu = 0.25$

$$V = L\times b\times t = 300\times50\times40\ mm^3$$

$$= 600000\ mm^3$$

$$\frac{dL}{L} = \frac{\text{stress}}{E}$$

$$E = \frac{\sigma}{e}$$

$$e = \frac{\sigma}{E}$$

$$\frac{dL}{L} = \frac{\sigma}{E}$$

$$\sigma = \frac{P}{A} = \frac{P}{b\times t}$$

$$= \frac{300\times10^3}{50\times40}$$

$$= 150\ N/mm^2.$$

$$\frac{dL}{L} = \frac{150}{2\times10^5} = 0.00075$$

$$e_v = \frac{dL}{L}(1-2\mu)$$

$$= 0.00075(1-2\times0.25) = 0.000375$$

$$\frac{dV}{V} = 0.000375$$

$$dV = 0.000375 \times 600000 = 225\ mm^3$$

Relationship b/w E & C:

$$C = \frac{E}{2(1+\mu)}$$

Relationship b/w k & E

$$k = \frac{E}{3(1-2\mu)}$$

Principal Planes & Principal stresses

The Planes which have no shear stress, are known as Principal planes.

The Normal stresses acting on a Principal plane are known as Principal stresses.

Stresses on Oblique Section are determined by the following Methods

- → Analytical Method
- → Graphical Method

σ_n (Normal stress) $= \sigma_1 \cos^2\theta$

σ_t (shear stress) $= \frac{\sigma_1}{2} \sin 2\theta$

Max. shear stress $= \frac{\sigma}{2}$

1) A Rectangular bar of Cross-Sectional Area $10000 mm^2$ is Subjected to an Axial Load of 20kN. Determine the Normal & Shear stresses on a Section which is inclined at an angle of 30° with Normal c/s of bar.

$A = 10000 \ mm^2$

$P = 20 \ kN = 20000 \ N$

$\theta = 30°$

$\sigma = \frac{P}{A} = \frac{20000}{10000} = 2 \ N/mm^2$

$\sigma_n = \sigma \cos^2\theta$

$= 2 \times \cos^2 30°$

$= 2 \times 0.866^2$

$= 1.5 \ N/mm^2$

$\sigma_t = \frac{\sigma}{2} \sin 2\theta$

$= \frac{2}{2} (\sin 2 \times 30)$

$= 0.866 \ N/mm^2$

2) The Tensile stresses at a point across two Mutually Perpendicular planes are $120 \ N/mm^2$ & $60 \ N/mm^2$. Determine the Normal, tangential & Resultant stresses on a plane inclined at 30° to the axis of Minor Stress

Major Principal stress $\sigma_1 = 120\ N/mm^2$

Minor Principal stress $\sigma_2 = 60\ N/mm^2$

$\theta = 30°$.

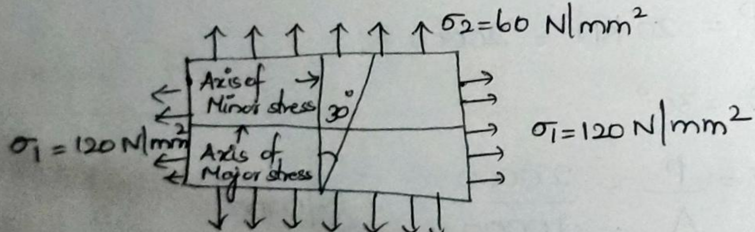
$$\sigma_n = \frac{\sigma_1 + \sigma_2}{2} + \frac{\sigma_1 - \sigma_2}{2} \cos 2\theta$$

(For 2 Mutually ⊥lar planes)

$$= \frac{120+60}{2} + \frac{120-60}{2} \cos 2 \times 30°$$

$$= 90 + 30 \cos 60°$$

$$= 105\ N/mm^2.$$



$$\sigma_t = \frac{\sigma_1 - \sigma_2}{2} \sin 2\theta$$

$$= \frac{120-60}{2} \sin (2 \times 30°)$$

$$= 30 \times 0.866$$

$$= 25.98\ N/mm^2$$

$$\sigma_R = \sqrt{\sigma_n^2 + \sigma_t^2}$$

$$= \sqrt{105^2 + 25.98^2}$$

$$= 108.16\ N/mm^2$$

Mohr's Circle:

It is the Graphical Method of finding Normal, Tangential & Resultant stresses on a Oblique Plane.

20/10/24
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