COVENANT UNIVERSITY NIGERIA

TUTORIAL KIT OMEGA SEMESTER

PROGRAMME: BUILDING TECHNOLOGY

COURSE: BLD 224

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BLD 224: STRUCTURAL THEORY AND STRENGTH OF MATERIAL II

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1. A steel bar of rectangular cross-section, 3 cm by 2 cm, carries an axial load of 30 kN**.** Estimate the average tensile stress over a normal cross-section of the bar.

2. A cylindrical block is 30 cm long and has a circular cross-section 10 cm in Diameter. It carries a total compressive load of 70 KN**,** and under this load it Contracts by 0.02 cm. Estimate the average compressive stress over a normal Cross-section and the compressive strain.

3. Explain the following terms: Linear of proportionality, Elastic limit and Breaking point.
4. A steel bolt, 2.50 cm in diameter, carries a tensile load of 40 kN**.** Estimate the average tensile stress at the section *a* and at the screwed section b, where the diameter at the root of the thread is 2.10 cm.

5. A tensile test is carried out on a bar of mild steel of diameter 2 cm. The bar Yields under a load of 80 kN. It reaches a maximum load of 150 KN**,** and breaks finally at a load of 70 kN**.**
   Estimate:
   (1) The ultimate tensile stress;
   (ii) The tensile stress at the yield point;
   (iii) The average stress at the breaking point, if the diameter of the fractured neck is 1 cm.

6 Differentiate between brittle and ductile material and give examples

7 The piston of a hydraulic ram is 40 cm diameter, and the piston rod 6 cm diameter. The water pressure is 1 MN/m^2. Estimate the stress in the piston rod and the elongation of a length of 1 m of the rod when the piston is under Pressure from the piston-rod side. Take Young's modulus as E = 200 GN/m^2.

8 A bar of cross-section 2.25 cm by 2.25 cm is subjected to an axial pull of 20 **kN.** Calculate the normal stress and shearing stress on a plane the normal to which makes an angle of 60^o with the axis of the bar, the plane being Perpendicular to one face of the bar.

9 At a point of a material the two-dimensional stress system is defined by
бx = ***60.0*** MN/m2, tensile
бy = 45.0 MN/m2, compressive
ʈxy, = 37.5 MN/m2, shearing.

10. The state of stress at a point in a loaded structure is given by the strength tensile.

$$T\sigma = \begin{matrix} 140 & 60 & 0 \\ 60 & -90 & 0 \\ 0 & 0 & 0 \end{matrix}$$

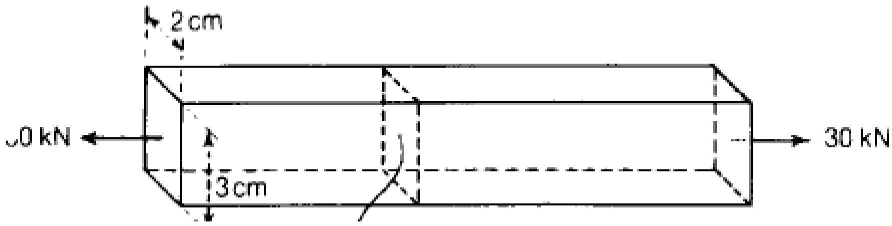
Determine

a. The maximum principal stress
b. The minimum principal stress
c. The maximum and minimum shear strain
d. The maximum and minimum shear stress

Taking E = 2.1 x 10^5N/mm^2 J = 0.32

SOLUTION

1.



The area of a normal cross-section of the bar is

Tension and compression: direct stresses

A = 0.03 x 0.02 = 0.6 x 10^{-3} m^2

The average tensile stress over this cross-section is then

Б= P/A

Б= 30 x 10^3/ 0.6 x 10^{-3} = 50MN/m^2.

2. The area of a normal cross-section is

A = ∏/4 $(0.10)^2$ = 7.85 X 10^{-3} m^2

The average compressive stress over this cross-section is then

Б = P/A = 70 X 10^3/7.85 X 10^{-3} = 8.92MN/m^2

The average compressive strain over the length of the cylinder is

E = 0.02 X 10^{-2}/ 30 X 10^{-2} = 0.67 X 10^{-3}

5. The original cross – section of the bar is

A_0 = ∏/4 $(0.020)^2$ = 0.314 X 10^{-3}m^2

(i) The average tensile stress at yielding is then

Бy = P_y/A_o = 80 X 103/ 0.314 X 10^{-3} = 254MN/m^2

Where $P_{y\,=}$ load at the yield point.

(ii) The ultimate stress is the normal stress at the maximum load

Бult = P_{max}/ A_o = 150 x 10^3 / 0.314 x 10^{-3} = 477MN/m^2

Where Pmax is maximum load

(iii) The cross-sectional area in the fracture neck is

$A_{F} = \prod/4\ (0.010)^2 = 0.0785 \text{ X } 10^{-3} m^2$

The average stress at the breaking point is then

$Бf = p_f / A_f = 70 \text{ X } 10^3 / 0.0785 \text{ x } 10^{-3} = 892 MN/m^2$

Where P_f = final breaking load.

8. We have θ = 60°, P = 20KN and A = $0.507 \text{ x } 10^{-3}$ m^2. Then

$Бx = 20 \text{ x } 10^3 / 0.507 \text{ x } 10^{-3} = 39.4\ MN/m^2$

The normal stress on the oblique plane is

$Б = бx \cos^2 60^o = (39.4 \text{ x } 10^6)1/4 = 9.85 MN/m^2$

The shearing stress on the oblique plan is

$½\ бx \sin 120^o = ½\ (39.4 \text{ x } 10^6)\ \sqrt{3}/2 = 17.05 MN/m^2$

10.

$$Тб = \begin{matrix} 140 & 60 & 0 \\ 60 & -90 & 0 \\ 0 & 0 & 0 \end{matrix} = \begin{matrix} бx & Ţxy & Ţxz \\ Ţyx & бy & Ţyz \\ Ţzx & Ţzy & бz \end{matrix}$$

Base on the similarity of matrix

$бx = 140\ N/mm^2$

$Ţxy = Ţyx = 60\ N/mm^2$

$бy = -90\ N/mm^2$

Maximum Principal Stress (б1) = $(бx + бy)/2 + 1/2\sqrt{}\ (бxx – бyy)^2 + 4Ţ^2xy$

Substituting into the equation

$Б1 = (140 – 90)/2 + 1/2\sqrt{}\ (140 +90)^2 + 4\ (60)^2$

$25 + ½\ \sqrt{}52,900 + 14,400$

$25 + ½\ \sqrt{}67300$

$25 + ½ \text{ X } 259.42$

$25 + 129.71$

$Б1 = 154.71 N/mm^2$

Minimum Principal Stress (б1) = $(бx + бy)/2 - 1/2\sqrt{}\ (бxx – бyy)^2 + 4Ţ^2xy$

Substituting into the equation

$Б2 = (140 – 90)/2 + 1/2\sqrt{}\ (140 +90)^2 + 4\ (60)^2$

$25 - \frac{1}{2}\sqrt{52{,}900 + 14{,}400}$

$25 - \frac{1}{2}\sqrt{67300}$

$25 - \frac{1}{2} \times 259.42$

$25 - 129.71$

$Б2 = -104.71\ N/mm^2$

SHEAR STRESS

$Ʈmax = \frac{1}{2}(б1 – б2)$

Substituting in the formula

$Ʈmax = \frac{1}{2}[(155 – (-105)] = 130\ N/mm^2$

$Ʈmin = -1/2\ [(155 + 105) = -130\ N/mm^2$