Shaikh Sir's Diploma Classes

Strength of Materials-22306

Question wise Question bank

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Subject : Strength of Material 22306

Question : 1

This question contains 7 questions from all chapters, of 2 marks each

Q1] Attempt any Five . **[10 Marks]**

a] Theory : Unit 1 Moment of inertia
b] Theory : Unit 2 Simple stresses and strains
c] Theory : Unit 3 Properties of material and constants
d] Theory : Unit 4 SFD and BMD
e] Theory : Unit 4 Bending and shear stresses in beams
f] Theory : Unit 5 : Torsion
g] Theory : Unit 6 : Direct and bending stresses

Theory questions and answers

Q.1. Define Moment of Inertia and state its SI unit.

ANS : Moment of inertia is defined as,
“Second moment of an area about an axis is called Moment of inertia.”

or

” A quantity expressing the body’s tendency to resist angular acceleration, it is equal to sum of product of mass of particles to the square of distances from the axis of rotation.”

Moment of inertia = $area \times (distance\ from\ axis)^2$

SI unit of moment of inertia is $m^4\ (or\ mm^4)$

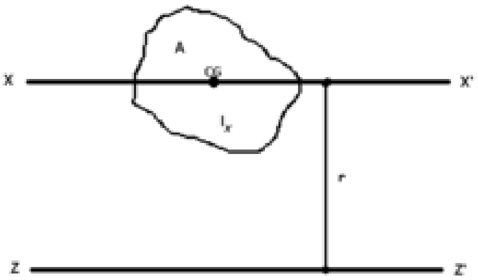
Q.2. Define radius of Gyration.

ANS : Moment of inertia is defined as,
“Radius of gyration of a body about an axis is a distance such that when square of that distance is multiplied by the area of that body gives Moment of inertia of that body.”

$$k = \sqrt{\frac{I}{A}}$$

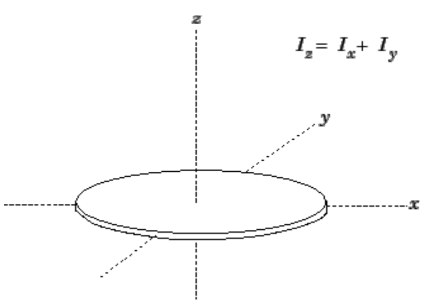
Q.3. State Parallel axis theorem.

It states that,
“ The moment of inertia of a lamina about any axis parallel to the centroidal axis is equal to the Moment of inertia of the body about its centroidal axis plus the product of the area and square of distance between these two axes.” $Izz = Ixx + A.h^2$



Q.4. State Perpendicular axis theorem.

It states that,
“ The moment of inertia of a lamina about an axis perpendicular to plane of lamina about and axis perpendicular to the lamina and passing through its centroidal is equal to sum of its moment of inertia about two mutually perpendicular axes lying in the plane.”



Q.5. Define Polar moment of Inertia.

“It is defined as the moment of inertia of body about its centroidal axis which is perpendicular to the plane of the body.”

UNIT 2: SIMPLE STRESSES AND STRAINS

Q.1. State Hooks law and define Moduli of elasticity

“Hooke’s law states that within an elastic limit stress is proportional to strain.”
Within elastic limits,

$$Stress \propto Strain$$

$$\frac{Stress}{Strain} = Constant = Modulus\ of\ Elasticity$$

This constant is known as Modulus of elasticity..
Based on types of stresses and strains there are three moduli of elasticity

1.Youngs modulus: It is ratio of tensil/comp. stress to tensile/comp.strain.

$$Youngs\ Modulus\,(E) = \frac{Tensile/Compressive\ Stress}{Tensile/Compressive\ Strain}$$

2. Shear modulus(Modulus of elasticity): It is ratio of Shear stress to Shear strain.

$$Modulus\ of\ rigidity\,(G) = \frac{Shear\ Stress}{Shear\ Strain}$$

3.Bulk modulus: It is ratio of Volumetric stress and volumetric strain.

$$Bulk\ Modulus\,(K) = \frac{Volumetric\ Stress}{Volumetric\ Strain}$$

Q.2. State the relation between three moduli of elasticity.

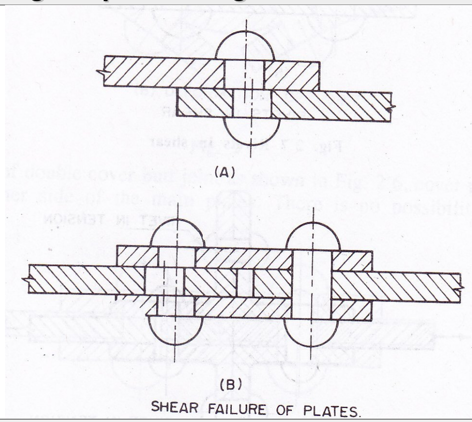
Relation between E and K and G

$$E = 3K(1-2\mu)$$

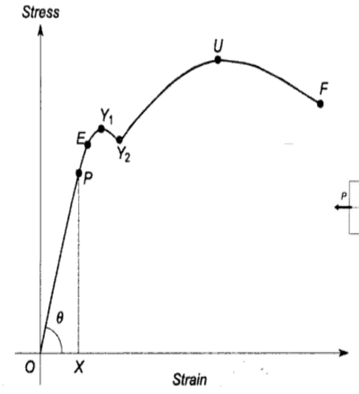
$$E = 2G(1+\mu)$$

$$E = \frac{9GK}{G+3K}$$

Q.3.Draw diagram for the single and double shear.



Q.4. Draw stress strain curve for the ductile material (mild stress).



Stress-strain Diagram of Ductile Materials

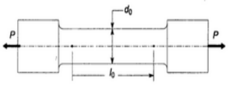
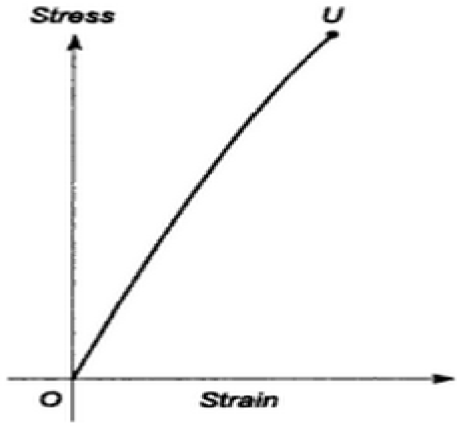


Fig. 2.1 Specimen of Tension-test

Limit of proportionality- In the range of OP the strain is proportional to the stress and the graph is straight line. Point P is called as the limit of proportionality. It is the value of the stress up to which stress and strain has the constant ratio and the Hook's law is obeyed.
Elastic limit- at the point E, the curve deviates from the straight line and the stress –strain graph from P to E in nonlinear. If the load is increased beyond the P up to the point E, the material behaves in the elastic manner that is on the removal of the load, the whole deformation will vanish. The value of stress corresponding to point E up to which the material behaves in an elastic manner is called the elastic limit.
Upper Yield point: Point Y1 is called upper yield point. At this point there is an increase in the strain even though there is no increase in stress (load) A formation of creep makes specimen plastic and the material begins to flow. the value of stress corresponding to point Y1 is called yield stress or yield strength. The yield stress is defined as that unit stress which will cause an increase in length without an increase in load.
Lower yield point: A load may rise and fall while yielding occurs. This is indicated by wavy appearance of the stress-strain graph between Y1 and Y2 .Point Y2 corresponding to lower yield point. after yielding has ceased at Y2, further stresses and strain can be obtained by increasing the load.
Ultimate Load Point-: after increasing the load beyond the yield point, the stress-strain curve rises till the point U is reached which is called ultimate load; the stress corresponding to this point is called ultimate stress or ultimate tensile strength.
Breaking load point: up to F, the cross-sectional area of the specimen goes on uniformly decreasing forming a neck or waist and the load required to cause further extension is also reduced. As the elongation continues, cross-sectional area becomes smaller and smaller and ultimately the specimen is broken at F into two pieces giving cup cone type of ductile fracture. Point F is called as breaking load point and the stress corresponding to this point is called breaking stress & rupture stress.

Q.5.Draw Stress strain diagram for brittle material ?

For brittle material there are no elastic limit or yield points it fails all of sudden at a stage. so there is only ultimate stress.



Stress-strain Diagram of Brittle Materials

Q.6.What do u mean by thermal Stresses?

Ans : Thermal stresses are the stresses induced in the body due to change in temperature. But mere change in temperature does not produces the thermal stresses, but when the expansion/compression due to temperature changes is prevented, then only thermal stresses are developed. They may tensile or compressive in nature.
The formula for the free expansion of the bar due to change in temperature is given by,

$$\delta L = \alpha T L$$

Thermal Stress is Given by

$$\sigma = \alpha T E$$

Where
L= original length of the body,
T= Rise in Temperature
E=Young's Modulus
$\alpha = Coefficient\ of\ Linear\ expansion\ for\ tha\ material$
$\delta L = Change\ of\ Length$

UNIT 3: MECHANICAL PROPERTIES AND ELASTIC CONSTANTS OF METALS

Q.1. Define the following terms 1)Elasticity 2) Plasticity 3)Ductility 4) Malleability 5) Stiffness 6) Brittleness 7) Hardness 8) Toughness 9)Flexibility

Ans :
Elasticity : It is defined as the ability of the material to regain its original shape and size after deformation, when the external forces are removed. Steel is an elastic material within elastic limit.
Plasticity : It is defined as the ability of the material to retain the deformation produced under the load on permanent basis.
Ductility : It is defined as the ability of the material to deform to a greater extent before the sign of crack, when subjected to tensile forces. Mild steel, copper and alluminum are ductile materials. Ductile metals can be formed brawn or bent in required shape.
Malleability : It is defined as the ability of the material to deform to a greater extent before the sign of crack, when it is subjected to compressive force. Malleable metals can be rolled, forged or extruded. Low carbon steel, copper and alluminum are examples of malleable material.
Stiffness(or Rigidity) : It is defined as the ability of the material to resist the deformation under the action of external

load. The material which shows less deformation is more stiff under given load..

Brittleness : it is defined as the property of material which shows negligible plastic deformation before fracture takes place. Brittleness is opposite property to the ductility.

Hardness: It is defined as the resistance of the material to penetration or permanent deformation. It usually indicates the resistance to abrasion, scratching, cutting or shaping.

Toughness : Toughness is the ability of a material to absorb energy and plastically deform without fracturing.

One definition of material toughness is the **"***Amount of energy per unit volume that a material can absorb before rupturing.***"**

Flexibility : Flexibility is defined as the ease with which material can be deformed or bent. This property is opposite of the stiffness .

Q.2. Define Creep ?

Ans: When a component is under constant load, it may undergo slow and progressive plastic deformation over a period of time. This time dependent strain is called CREEP. Creep is defined as slow and progressive deformation of the material with time under constant stress. Creep deformation is a function of stress level and temperature. Therefore, Creep deformation is higher at higher temperature and creep becomes important for components operating at elevated temperature.

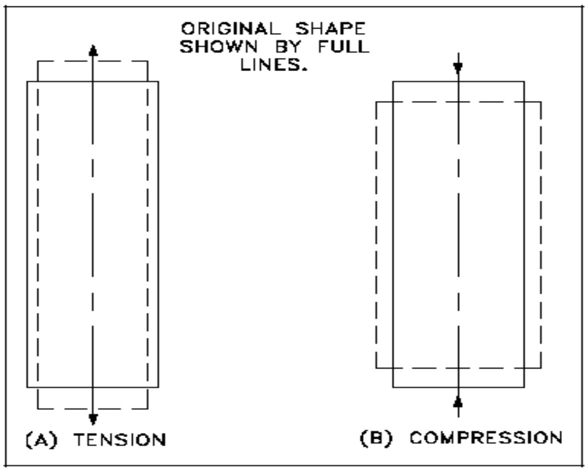
Q.3. Define Fatigue.

Fatigue Failure "The phenomenon of decreased resistance of material to repeated stresses is called fatigue failure."

It has been observed that materials fail under fluctuating stresses, at a stress lower than ultimate tensile strength of material. Sometimes the magnitude is even smaller than yield stress, further the magnitude of stress causing fatigue failure decreases as number of stress cycle increases

Q.4.Define and explain Poisson's ratio

Poisson's ratio : The ratio of lateral strain to the



longitudinal strain is constant for a given material, when the material is stressed within the elastic limit. This ratio is called Poisson's ratio and it is generally denoted by μ .

$$Poisson's\,ratio = \frac{Lateral\,strain}{linear\,strain} = \frac{\frac{\delta d}{d}}{\frac{\delta l}{l}} = \frac{\delta d \times l}{\delta l \times d}$$

Q.5.Define Strain energy, Resilience and Proof resilience.

Strain Energy

When a piece of bar is subjected to a tensile or a compressive load, P, then there is a change in length which is proportional to the load P within elastic limit. It is said that work is done and is stored in the form of strain energy within a bar or material. On removal of the loading, the material returns to its original position due to release of stored energy.

It may be defined as

The work done by the load in straining material or bar. It is denoted by U.

Resilience

Strain energy per unit volume stored in a material is called resilience.

Proof Resilience

Strain energy at elastic limit in a material or bar is known as Proof Resilience.

Strain energy is measured in N-m, N-mm or Joule.

UNIT 4: SFD-BMD AND SHEAR STRESS AND BENDING STRESSES

Q.1. Define Shear force and Bending moment. (imp)

Ans :

Shear force: The algebraic sum of vertical forces at any section of a beam either to the left or to the right of the section is called the shear force at that section.

Bending Moment: The algebraic sum of moments of all forces a at any section of a beam either to the left or to the right of the section is called the bending moment at that section.

Shear Force diagram (SFD): A diagram which shows the variation of the shear force along the length of the beam is called the SFD.

Bending moment diagram : A diagram which shows the variation of the bending moment along the length of the beam is called BMD.

Q.2 .State the relation between B.M., S.F. and rate of loading.

Ans:

1.Relation between rate of loading and Shear force

$$dQ/dx = -F$$

The slope of shear force diagram is equal to magnitude of distributed load.

2. Relation between shear force and bending moment

$$dM/dx=Q$$

The slope of bending moment diagram is equal to shear force.

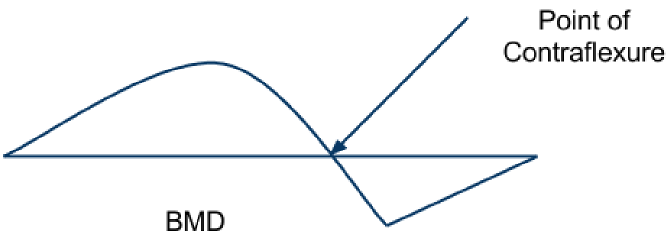
It means " rate of change of bending moment is equal to shear force"

here F= load, Q= shear force and M= bending moment.

Q.3.Define the Point of Contra-flexure ?

Ans:"Point of contra-flexure(POC) is defined as a point in the bending moment diagram where bending moment changes its sign."

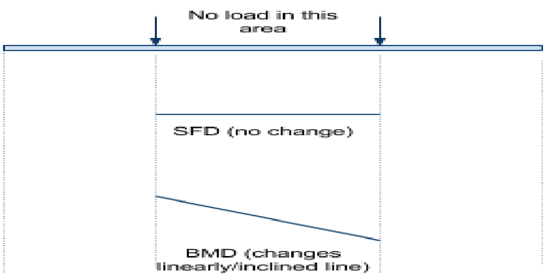
In other words,bending moment diagram the point where the bending moment curve cuts the "zero" line is called the point of contra-flexure.



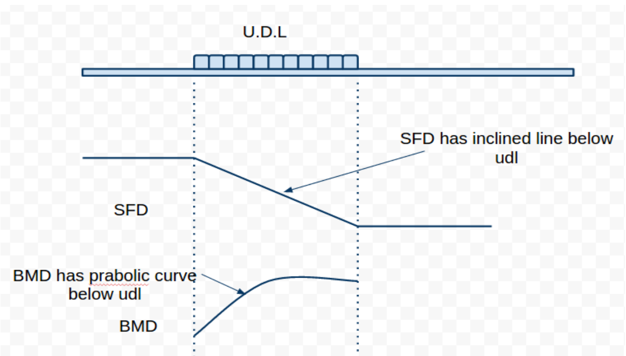
A bending moment diagram may have one or more points or contra-flexure.
The bending moment changes its sign at point of contra-flexure. at point of contra-flexure the bending moment is zero as well as fiber stress is also zero.

Q.4. Show how the following parts of BMD are related to the shear force and loading
a) Nature of Bmd between two point loads
b) Nature of BM and SF between udl..
c) BM maximum at a point in a beam and value SF at that point

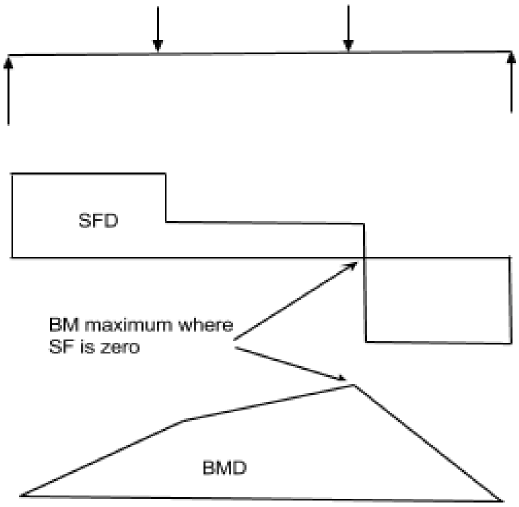
ANS :a) If there is no load between two points, then the shear force does not change (shear force line in SFD is straight) but bending moment changes linearly (in BMD there is inclined line).



2.If there is a UDL between two points, then the shear force changes linearly (there is inclined line in SFD) but the bending moment changes in parabolic manner (there is parabolic curve in the BMD)
3. BM is



Maximum at the point where the shear force is zero..



Q.5.State the assumptions in Pure(simple) bending.(VVimp)

Assumptions
1. The material of the beam is homogeneous and isotropic and follows the Hooke's Law
2. The transverse section of the beam which is plane before bending, will remain plane after bending.
3. Young's modulus for the material is same for tension and compression
4. Each layer is free to expand or contract independently.
5. the beam in initially straight and of constant cross-section

Q 6: State the Flexural formula (Bending Eqn), State meaning of each term in it?

The bending equation is given as,

$$\frac{M}{I}=\frac{f}{y}=\frac{E}{R}$$

Where M= Bending moment in N-mm
I= Moment of Inertia in mm4
f= bending stress in N/mm2
y= Distance of extreme fiber from neutral axis in mm
E= Young's modulus in N/mm2
R= Radius of curvature in mm

Q.7.What is Neutral axis in case of Bending?

In a beam subjected to bending, at a level between the top and bottom of beam, there is a layer which is neither shortened nor elongated. This layer has neither tension nor compression on it, this layer is called neutral axis.

For a circular cross-section neutral axis is at centre of circle , for rectangular section the neutral axis is at a distance of half the thickness from upper or lower end.

Q:8.What do you mean by Section modulus ? State the formula for section modulus of rectangular and circular section.

The ratio of moment of inertia at neutral axis to the maximum distance from neutral axis is called section Modulus. It is denoted by “Z” and its unit is mm3 .
In bending equation,

$$\frac{M}{I}=\frac{f}{y}\ ,\ M=\frac{f}{y}I\ ,\ simplifying\ M=\frac{I}{y}f\ ,$$
$$M=Z.f$$

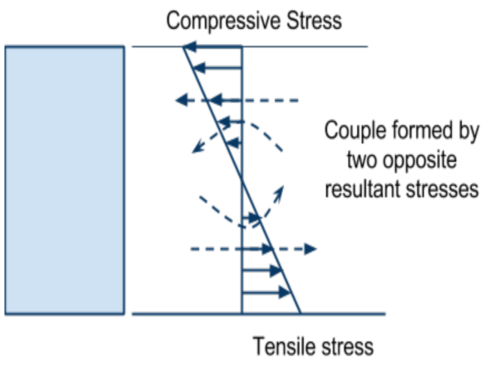
Here z=I/y is called section modulus.
Section modulus for rectangular

$$z=\frac{I}{Y}=\frac{\frac{bd^3}{12}}{\frac{d}{2}}=\frac{bd^2}{6}$$

Section Modulus for circular section

$$z=\frac{I}{Y}=\frac{\frac{\pi d^4}{64}}{\frac{d}{2}}=\frac{\pi d^3}{32}$$

Q:9. Define the term Moment of resistance .



In a beam subjected to bending ,at any section, compressive stresses are above/below neutral axis and tensile stresses are below/above. The resultants of these opposite stresses forms a couple. The moment of these couple is called moment of resistance.

"The algebraic sum of the moment about neutral axis of the internal forces developed in a beam due to bending is called the moment of resistance."

Q.10.What do you mean by Shear Stress in Beams?

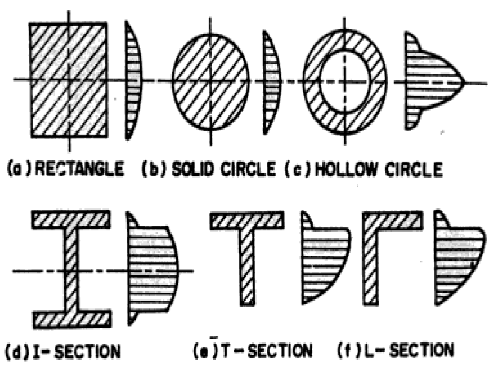
"When due to loading on a beam, internal stresses are developed in a section, which resist shear force are called as shear stress." it is denoted by 'q'or 'τ'

Equation of shear stress:

$$q=\frac{F.A.y}{I.b}$$ N/mm2

Where q= Shear stress at a section layer (N/mm2)
F= Shear Force at that section (N)
A = Area of section above that layer (mm2)
y= Distance of c.g of area under consideration from N-A (mm)
I= Moment of inertia (mm4)
b= width of section in mm

Q.7.Draw Shear stress distribution for different sections



Q.8.State the formula for Average shear stress and Maximum shear stress for rectangular and circular section.

ANS:

1) Rectangular section :

Average shear stress qav $=\frac{F}{bd}$

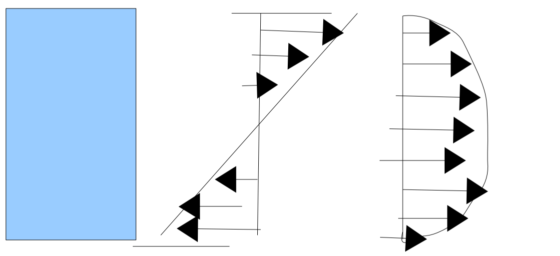
Maximum shear stress qmax$=\frac{3}{2}$ qavg

2) Circular section :

Average shear stress qav $=\frac{F}{area\ of\ circle}$

Maximum shear stress qmax$=\frac{4}{3}$ qavg

Q.7.Draw Bendign stress and shear stress distribution diagram for the rectangular section?



Beam Bending stress Shear Stress

UNIT 5: TORSION

Q:1: Explain the theory of pure torsion?

When equal and opposite forces are applied tangentially to the ends of a shaft,it is subjected to a twisting moment which is equal to the product of the force applied and the radius of the shaft. This causes the shaft either to remain stationary or to rotate with constant angular velocity. In either case, the stress and strain set up in the shaft will be the same.

When the shaft becomes subjected to equal and opposite torques at its two ends the shaft is said to be in torsion and as a result of which the shaft will have a tendency to shear off at every cross-section perpendicular to its longitudinal axis. So the effect of torsion is to produce shear stress in the material of the shaft.

Q:2: State the Assumptions in Pure Tension (VVIMP)

The following assumptions are made. while finding out shear stress in a circular shaft subjected to torsion:

1) The shaft circular in section remains circular after twisting.
2) The material of the shaft is uniform throughout.
3) A plane section of the shaft normal to its axis before twist remains plane after the application of torque.
4) The twist along the length of the shaft is uniform throughout.
5) All diameters of the normal cross-section which are originally straight remain straight after twisting and their magnitudes do not change.

5) Maximum shear stress induced in the shaft due to the application of torque does not exceed its elastic limit value.

Q:3: Define TORQUE and state its S.I.unit?

Ans : Torque is defined as the “Force that causes rotation of the body”..In is numerically equal to the Force multiplied by the radius at which it acts.

$$Torque = Force \times radius$$
$$= Newton \times Meter$$
$$= N-m$$

Q: 4: State the Torsional equation stating the meaning of every term in it

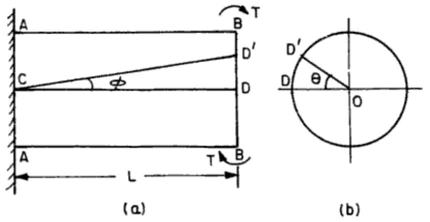


Fig. 21.2. Shaft fixed at *AA* and subjected to torque *T* at *BB*.

$$\frac{T}{J} = \frac{fs}{r} = \frac{c\theta}{l}$$

where T= Torque acting on shaft in N-mm

J= Polar moment of inertia in mm4

for solid shaft (J=$\frac{\Pi}{32} d^4$)

for hollow shaft (J=$\frac{\Pi}{32}(D^4 - d^4)$)

fs= Shear stress (N/mm2)

r =radius of shaft (mm)

C= modulus of rigidity (N/mm2)

$\theta = Angle\ of\ twist\ (radians)$

l = length of shaft (mm)

Strength Equations of torsion for the solid and hollow shaft.

For solid shaft $\qquad T = \frac{\pi}{16} \cdot f_s \cdot d^3$

For Hollow shaft $\qquad T = \frac{\pi}{16} \cdot f_s \cdot do^3 (1 - k^4)$

k= ration of inside diameter to outside diameter

Q:5: How power transmitted by shaft is calculated?

Power transmitted by a shaft is calculated in following steps

1) Calculate polar moment of inertia

for solid shaft (J=$\frac{\Pi}{64} d^4$) mm4

for hollow shaft (J=$\frac{\Pi}{64}(D^4 - d^4)$) mm4

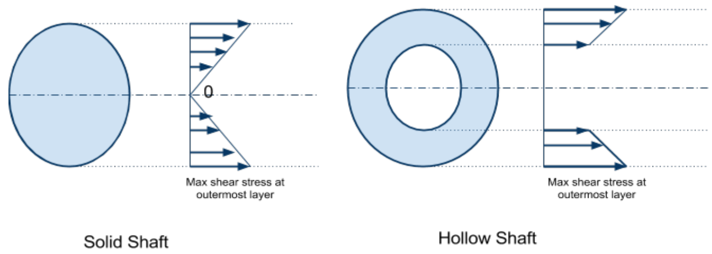
2) calculate torque transmission capacity

T= $\frac{fs}{r} \times J \quad N-mm$

3) Power is calculated by formula,

P= $\frac{2\Pi NT}{60} \quad Watts$

Q:6: Draw Shear stress distribution for the Solid and hollow shaft?



Q:7: Define Torsional stiffness?

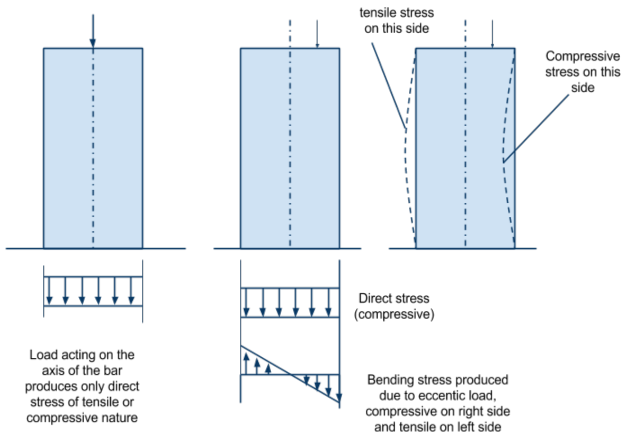
Torsional stiffness is defined as the ,”Torque required to produce unit angular deflection.”

$$Torsional\ stiffness = \frac{Torque}{angular\ deflection} N-m/rad$$

SI unit of torsional Stiffness is N-m/rad.

UNIT 6: DIRECT AND BENDING STRESSES

Concept:



When a member is subjected to load on the centroidal axis only direct stress (either tensile or compressive as per load) is produced in the member. But when the member is subjected to the eccentric load (load on axis another than centroidal axis) it results in direct stress as well as stress due to bending.. As shown in figure above. The bending stress has both tensile and compressive stresses..

Now when both direct and bending stresses are combined together on one side there is addition because both are of same nature(compressive) and on the other end there is subtraction because they are of opposite nature (direct is compressive and bending is tensile).

Q.1. State the formula for the maximum and minimum stress intensities in case of Direct and bending stresses.

Or.. Sketch the resultant stress distribution at the base section for condition that direct stress is equal/greater/less than bending stress

Or State the condition for the NO TENSION at the base of column.

ANS :

Direct stress = $\sigma d = \frac{P}{A}$

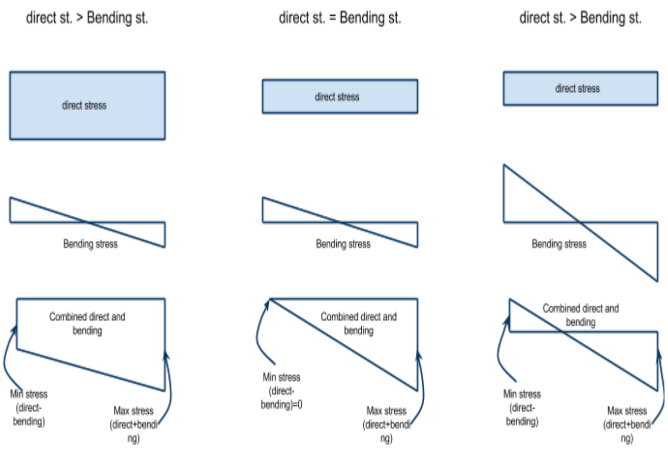
Bending stress = $\sigma b = \frac{P.e.y}{I}$

When these both stresses get combined on one side there is addition (due to same nature) and on another side there is subtraction. so the maximum and minimum stress formulas are

$$\sigma max = \frac{P}{A} + \frac{P.e.y}{I}$$

$$\sigma min = \frac{P}{A} - \frac{P.e.y}{I}$$

Three possible situations of the maximum and minimum stresses.



No tension at base condition

Q.2. What do u mean by limit of eccentricity?
or State the condition for "No tension at Base"...

If the stresses in the member are to be completely compressive (both maximum and minimum stresses to compressive),then ,

$$\sigma b \leq \sigma d$$

$$\frac{P.e.y}{I} \leq \frac{P}{A}$$

$$e \leq \frac{P}{A} \times \frac{I}{P.y}$$

$$e \leq \frac{I}{A.y}$$

Thus for the no tension at base the eccentricity must be less than (or equal to) $\frac{I}{A.y}$.

Q:3: What do you mean by Core or kernel of a section? Draw core of a section for the rectangular and circular section..
or Calculate limit of eccentricity for circular section of diameter D for no tension at base
or Calculate limit of eccentricity for a rectangular section width B and thickness D.

ANS : "The area within which the load may be applied so as to avoid tensile stresses is called the core or kernel of the section". In other words if the load is applied within the core then the stresses produced in the section are both (maximum and minimum) are of compressive nature."

Core for rectangular section :

Using the condition of no tension at base {considering eccentricity in plane bisecting thickness}

$$e \leq \frac{I}{A.y}$$

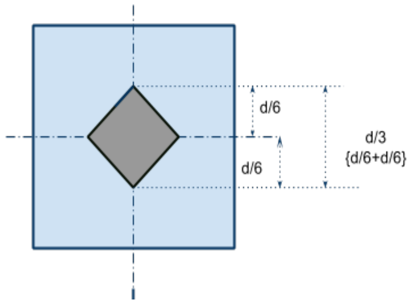
$$e \leq \frac{db3}{12} \times \frac{1}{b \times d} \times \frac{1}{b/2}$$

$$e \leq b/6$$

Thus the eccentricity for a rectangular section must be less than b/6..

Similarly if the eccentricity is in plane bisecting width, then the eccentricity will be d/6.

It is diagrammatically shown below.



Core for circular section :

Consider a solid circular section of diameter d as shown in figure below..

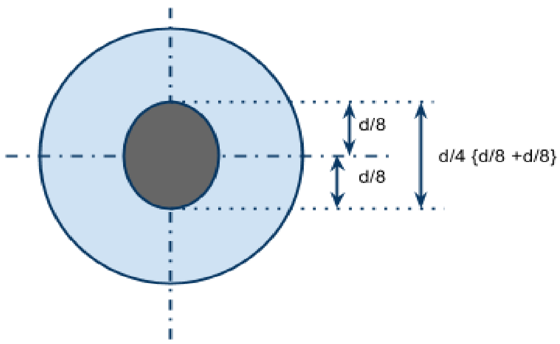
using condition for no tension ,

$$e \leq \frac{I}{A.y}$$

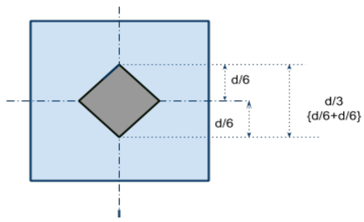
$$e \leq \frac{\Pi}{64} d4 \times \frac{1}{\frac{\Pi}{4} d2} \times \frac{1}{d/2}$$

$$e \leq d/8$$

Thus the eccentricity for the circular section must be less than d/8 from centre so as to avoid tensile stress. This is diagrammatically shown below.



Q.4. State the "Middle one third rule".



The rule states that,"for a rectangular section if the load is applied within middle one third of the section then no tension is developed in the section." the above diagram is explanation of this rule.

Shaikh sir’s Reliance Academy,Shahupuri, Kolhapur.

Subject : Strength of Material 22306

Question : 2

This question contains 4 questions from all chapters, of 4 marks each

Q2] Solve any Three. **[12 Marks]**

a] Unit 1 : Moment of Inertia : MI of composite section
b] Unit 2: Biaxial and Triaxial Stress stystem/Problems on Poissons Ratio
c] Unit 4 : SFD AND BMD PROBLEM or Standard cases
d] Theory question.

Types of Problems

No.	Type of Problem		
1	MI of Standard sections		
2	Problems on Poisson's ratio		
3	Problems on Bi axial or triaxial stress system		
4	Problems on sfd and bmd of standard cases		
5	Problems on temperature stresses		

Type 1 : Moment of Inertia of Standard section

1.Determine the MI of a triangular section having base 5 cm and 6 cm height about its base.

{**Ans:** $I_{base} = 900 \times 10^3 mm^4$}

2.A triangular section has base 100 mm and 300 mm height determine moment of inertia about 1)MI about axis passing through base 2)MI about axis passing through apex

{**Ans:** $I_{base} = 225 \times 10^6 mm^4, I_{gg} = 75 \times 10^6 mm^4, I_{apex} = 675 \times 10^6 mm^4$}

3.Find the moment of inertia of a hollow circular section having external diameter 100 mm and internal diameter 80mm about,
1) Axis passing through center 2) About tangent to the outer circle and parallel to xx axis.

{$I_{xx} = 2.89 \times 10^6 mm^4, I_{pq} = 9.94 \times 10^6 mm^4$}

4.Find the moment of inertia of a hollow rectangular section about its centre of gravity, if the external dimensions are 40 mm deep and 30 mm wide and internal dimension are 25 mm and 15 mm wide.

{$I_{xx} = 140470\, mm^4, I_{yy} = 82970\, mm^4$}

5. An isosceles triangular section ABC has base width 80 mm and height 60mm. Determine the moment of inertia of the section about the centre of gravity of the section and the base BC.

{$I_{xx} = 480 \times 10^3 mm^4, I_{pq} = 1440 \times 10^3\, mm^4$}

6.A hollow C.I. pipe with external diameter 100 mm and thickness of metal 10 mm is used as a strut. Calculate the moment of inertia and radius of gyration about its diameter.

{$I_{xx} = 2.89 \times 10^6 mm^4, K_{xx} = 32.017\, mm$}

7.A circular disc has M.I. about its any tangent is $6.283 \times 10^5 mm^4$. Find the diameter of the disc.

{$d = 40\, mm$}

8.An equilateral triangle has a side of 150 mm. Find the moment of inertia about any of its sides.

{$I_{pq} = 27.404 \times 10^6 mm^4$}

9.Find MI of an equilateral triangle of side 2m about its base.

{$I_{pq} = \qquad mm^4$}

10.A semicircular lamina has a base diameter 140mm. Calculate the moment of inertia
1) about centroidal axis 2) about base.

{$I_{xx} = 2.64 \times 10^6 mm^4, I_{pq} = 9.428 \times 10^6 mm^4$}

11.Calculate Polar MI of a square section having 200mm as side.
12.Calculate polar moment of inertia for a circle having diameter 250 mm.

Type 2. Problems on Poissons ratio.

1. A metal rod 20 mm diameter and 2 m long is subjected to a tensile force of 60 kN, it showed and elongation of 2 mm and reduction of diameter by 0.006 mm. Calculate the Poisson's ratio and three moduli of elasticity.
(Ans:Poisson's ratio = 0.3,E=190.99e3 N/mm2 ,G=73.45e3 N/mm2 ,K=159.15e3 N/mm2)

---

2. A bar of diameter 12 mm is tested on U.T.M and following observations were noted 1)Gauge length : 200mm 2) Load on Proportional limit :20kN 3)Change in length : 0.2 mm 4) Change in dia : 0.0025 mm. Determine E,G,K and u.
(Ans:Poisson's ratio = 0.208,E=176.85e3 N/mm2,G=73.19e3 N/mm2,K=100.94e3 N/mm2)

---

3. A metal bar 50mm×50mm in section is subjected to an axial compressive load of 500 kN. If the contraction of a 200mm gauge length was found to be 0.5 mm and the increase in thickness 0.04 mm, find Poisson's ratio and three moduli.
(Ans:E=80Gpa, Poisson's ratio=0.32)

4.In an experiment an alloy bar of 1m long and 20mm ×20mm in section was tested to increase through 0.1 mm, when subjected to an axial tensile load of 6.4 kN. If the value of bulk modulus of the bar is 133 GPa, find the value of Poisson's ratio
(Ans: Poisson's ratio=0.30)

---

5. A steel rod 4 m long and 20mm diameter is subjected to an axial tensile load of 45 kN. Find the change in length and diameter of the rod. E= 200 GPa, and m=4.
(Ans: Change in length=2.86mm, change in diameter =0.003575mm)

6.A steel rod 3m long and 25mm diameter is subjected to an axial tensile load of 60 kN. Calculate the change in length and diameter of rod. E=210 Gpa and u=0.28.
(Ans: Change in length=1.75mm, change in diameter =0.0041mm)

7.A steel bar 1.2 m long, 40mm wide and 20 mm thick is subjected to an axial tensile load of 50 kN in the direction of its length. Find the change in length and thickness of the bar . E=200 Gpa and Poisson's ratio =0.26.

(Ans: Change in length=0.375mm, change in thickness=1.625×10-3mm)

8.A metal bar 40mm×40mm section, is subjected to an axial compressive load of 480 kN. The contraction of a 200 mm gauge length is found to be 0.4 mm and the increase in thickness 0.04 mm. Find Young's Modulus and Poisson's ratio.

(Ans: E= 150×103 n/mm2 , m=2)

----

9. For a metal bar of 20 mm diameter and 1m long is subjected to an axial pull of 60 KN Take

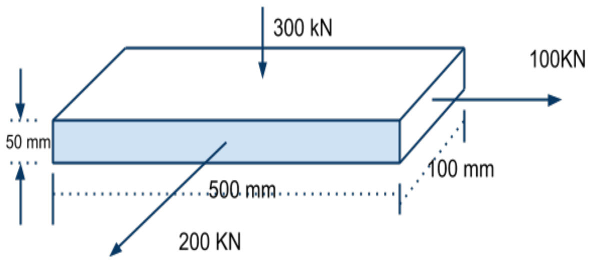
$E=1.8\times10^{5}\,N/mm^{2}$ ***and .Find the change in the diameter of the bar.***

Type 3: Problems on Bi-axial and Tri-axial stress system.

1. In a biaxial stress system the stresses along x direction is 60 N/mm2 tensile and along y direction 40 N/mm2 compressive .Find the maximum strain. Take E = 200Gpa and poisons ratio =0.25

----

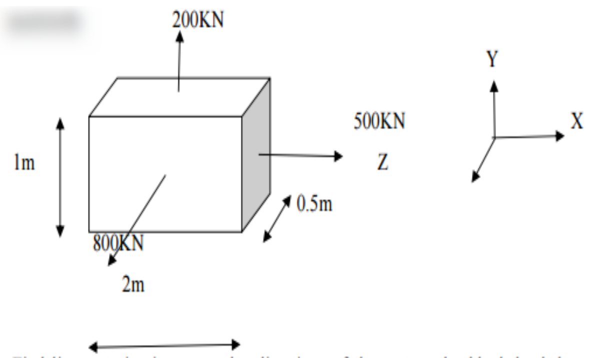
2. A rectangular bar 500mm long and 100 mm by 50mm in cross-section is subjected to forces as shown below.



What is the change in the volume of the bar? take modulus of elasticity of 200GPa and poisson's ratio as 0.25.

(Ans: dv= 137.5 mm3)

3.



Find linear strains in x, y and z directions of the rectangular block loaded as shown in the figure. Hence using the linear strains values , find the total strain in z direction. Take E= 200GPa. and Poisson's ratio= 0.25

4.A steel cube block of 50 mm side is subjected to a force of 6kN(tension), 8 kN(compression) and 4 kN(tension) along x, y and z direction respectively. Determine the change in volume of the block. Take E as 200 Gpa and m as 10/3.

{dv=0.2 m^3}

5 A metallic bar 250 mm × 100 mm × 50 mm is loaded as shown in Fig. 2.5.

Find the change in volume. Take E = 2 × 10^5 N/mm^2 and Poisson's ratio = 0.25.

Also find the change that should be made in the 4 MN load, in order that there should be no change in the volume of the bar.

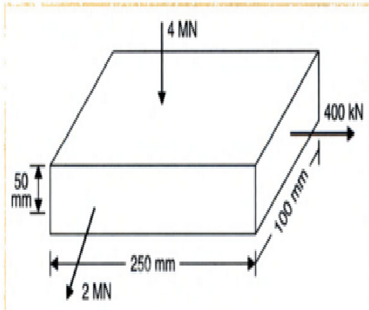


Fig. 2.5

(ans : 250 mm3)

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5. A steel bar 1.2 m long,50mm wide and 40 mm thick is subjected to an axial pull of 150 kN in the direction of its length. Determine the change in volume of the bar. Take E=200 GPa,m=4

(Ans:450 mm3)

6.A steel cube block of 100 mm side is subjected to a stress of 50 N/mm2 (tensile) in x direction, a stress of 40 N/mm2 (compressive) in y direction, a stress of 30 N/mm2 (tensile) in z direction, calculate strain in each direction and dv. E=200 Gpa, and Poisson ratio =0.25

(Ans:dv=100 mm3)

7.In a tri-axial stress system the stresses along the three directions are 100 N/mm2 (tensile) in x direction, 60 N/mm2 (tensile) in y direction, 30N/mm2 (comp) in z direction, calculate strain in each direction and change in volume take E=200Gpa and Poisson ratio as 0.25 take x=400,y=150,z=300

(ans dv= 5850 mm3)

----

8. A cube of 100 mm side is subjected to a tensile force of 200 kN on all faces (tensile). Find the strains in each direction. Also find the change in volume of the cube.Take E as 200 Gpa and m =4.

(ans dv=150mm3)

Type 4: SFD & BMD of standard cases

1. A simply supported beam of span l meters carries a point load of W N at centre. Draw shear force and bending moment diagram.

2. A simply supported beam of span l meters carries a udl of W N/m over entire span. Draw shear force and bending moment diagram.

3. A cantilever beam of span l meters carries a point load W N at free end. Draw shear force and bending moment diagram.

4. A cantilever beam of span l meters carries udl of W N/m over entire span. Draw shear force and bending moment diagram.

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Subject : Strngth of material -22306

Question : 3

This question contains 4 questions from all chapters, of 4marks each

Q3] Solve any THREE **[12 Marks]**

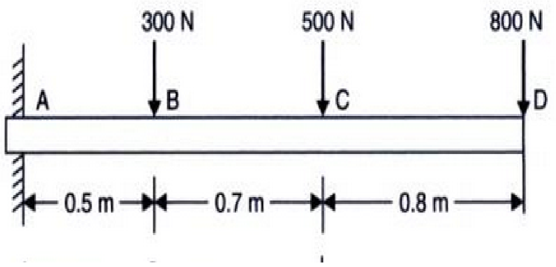
a] Unit 3: SFD and BMD of Cantilever beam
b] Unit 3:Problems on bending stresses {Flexural formula}
c] Unit 6: Problem on application of direct and bending stress {c clamp,tube}
d] Unit 5 :Problems on torsion simple

Types of Problems

No.	Type of Problem		
1	SFD and BMD of Cantilever beam		
2	Problems on bending stresses {Flexural formula}		
3	Problem on application of direct and bending stress {c clamp,tube}		
4	Problems on torsion simple		

Type 1. SFD & BMD for Cantilever Beam

Prob.1. Draw Shear force and Bending moment diagram for loading shown below.



Prob.2.** **Draw bending moment and shear force diagram of a cantilever beam having AB 4 meters long having its fixed end at A and loaded with a uniformly distributed load of 1 kN/m upto 2 meters from A and with a concentrated load of 2 kN at 1 m from B.

Prob.3.** **Draw bending moment and shear force diagram of a cantilever beam having AB 4 meters long having its fixed end at A and loaded with a uniformly distributed load of 1 kN/m upto 2 meters from A and with a concentrated load of 2 kN at 1 m from B.

Prob 4. A cantilever beam ABCD is fixed at A and free at D ,such that AB=1 m, BC= 2m, CD= 3.5 m. It carries an udl of 150 kN/m from B and D along with a point load of 500 kN at point C. Draw shear force and bending moment diagram for this beam.

Prob 5. A cantilever 2.4 m long carries point loads of 20 kN and 50 kN at free end and 1.68 m from free end respectively. It also carries uniformly distributed load of 30 kN/m starting from 0.24 m to 1.2 m from free end. Draw SFD and BMD.

Pr 6. Draw shear force and bending moment diagram for a cantilever beam AB of 4 m long having its fixed end at A and loaded with uniformly distributed load of 2 kN/m over entire span and point load of 3 kN acting upward at the free end of cantilever. Find point of contra-flexure if any.

Prob 7. Draw SFD and BMD locating all important features for a cantilever of 6m length and point loads of 15N at the center of the length of cantilever and 10N at the end of cantilever. There is udl of 5 KN/m. between the two point loads .

Type 2: Problems on Bending Formula(flexural formula)

1. A Circular beam 500 mm dia is simply supported over span of 6m. It carries point load of 81 KN at center. Find bending stress induced.

(Ans f= 9.92 N/mm^2)

2. A simply supported beam of span 4m carries UDL of 2 Kn/m over the entire span. if the bending stresses is not to exceed 165 N/mm2, find the value of section modulus for the beam and diameter of beam when it is circular.

(Ans d=)

3. A rectangular beam 200 x 450 mm is fixed at one end as a cantilever beam of span 4m it carries udl of 100 N/m over entire span. Find bending stress

(Ans f= $0.119\ N/mm^2$)

4. A rectangular beam 300 mm deep is simply supported over span of 4m. Find what udl beam can carry is bending stresses is limited to 120 MPa.

(Ans W = 90 N/mm)

5. A rectangular beam 60 mm wide and 150 mm deep is simply supported over a span of m. if the beam is subjected to audl of 4.5 KN/M and max. bending stress is limited to 40 MPa Find span of beam.

(Ans x= 4008 mm)

6. A rectangular beam 60 mm wide and 150 mm depth is simply supported over 6m. If beam has point load of 12KN at center. Find max. bending stress include.

(Ans F= $80.02\ N/mm^2$)

7. A beam is rectangular section supports A load of 20 kn at center of beam span 3.6 m. If depth is twice width and stress is limited to 7 mpa find dimension of beam.

(Ans x = 156.82 mm)

8. A simply supported beam 150mm wide and 300mm deep carries an uniformly distributed load over a span of 4m If the safe stresses are 28 MPa in bending and 2MPa in shear find the maximum uniformly distributed load that can be safely supported by the beam

9. Calculate max stress induced in a CI pipe of ext. dia 40 mm and internal dia 25 mm length of pipe is 4 m and simply supported and carries pt load of 80 kN at center.

(Ans f =$15.02 \times 10^3\ N/mm$)

10. A beam of rectangular c/s has depth 150 mm is supported at one end as cantilever is bending stress is limited to 30 mpa find max. udl it can carry take I = $7.5 \times 10^6 mm^4$

(Ans W = 1.5 N/mm)

11. A cantilever beam 80 mm x 120 mm carried pt load of 6 kn at end, It bending stress is limited to 40 mpa find span.

(Ans L = 1280 mm)

12. A rectangular beam simply supported over span 4m, carries UDL of 50 Kn/m over span. It depth of section is 2:5 width find dimension of bending stress is limited to 60 mpa.

(Ans b = 117.02 mm, d = 292.55 mm)

Type 3: C clamp/Hook problems Problems

A rectangular rod of size 50 mm × 100 mm is bent into "C" shape as shown in Fig. 2 and applied load of 40 kN at point A. Calcualte resultant stress developed at section X – X.

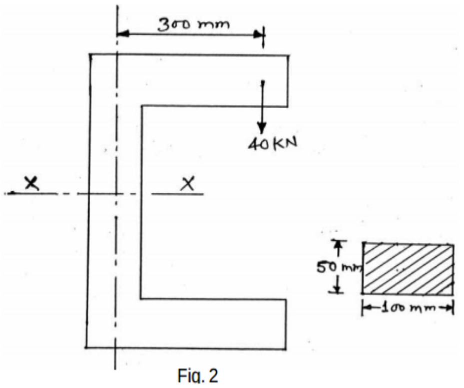
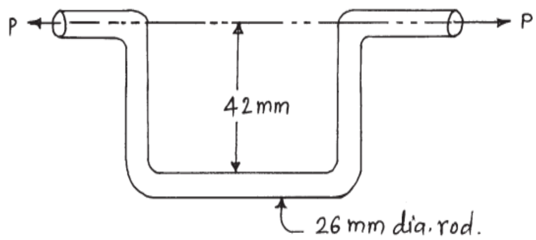


Fig. 2

e) A 26 mm diameter rod is bentup to form as offset link as shown Figure No. 2. If permissible tensile stress is 90 N/mm^2, calculate maximum value of 'P'.

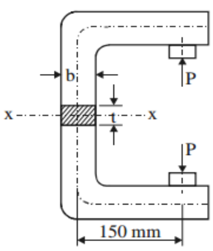


A C ɔf

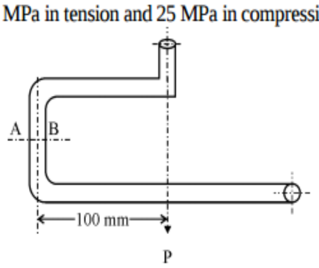
the s.

Fig. No. 2

Assuming that the C-clamp is made of steel casting with an allowable stress of 100 N/mm^2. Find its dimensions.



(e) A mild steel tube 50 mm external diameter and 10 mm thick is bent in the form of a hook. What maximum load 'P' the hook can lift, if the stresses on c/s. AB should not exceed 100 MPa in tension and 25 MPa in compression ?



Type 4: To find Power/Stress Transmitted by shaft

Prob 1.Find the power transmitted by a shaft of 25mm diameter running at 400 rpm. Take Allowable shear stress for shaft material as 65 Mpa.

{Ans:P=8.35 Kw}

Prob 2. A solid shaft of diameter 60 mm is running at 150 rpm. Find the power that can be transmitted by the shaft if permissible shear stress is 80 N/mm2 , Maximum torque is likely to exceed 30% more than mean torque. {i.e. Tmax=1.30 T avg}

{ Ans:P=40.84 Kw}

Prob 3. Find the power that can be transmitted by a hollow shaft having external diameter 200mm and internal diameter 120 mm. The shaft is running at 110 rpm. Allowable shear stress for the material is 63 Mpa. Maximum torque is likely to exceed 20% more than mean torque.

{ Ans:826.78 Kw}

Prob 4.A hollow shaft of external and internal diameters as 100mm and 40mm is transmitting power at 120 rpm. Find the power it can transmit if the shearing stress is not to exceed 50mpa.

{ Ans:120.13 KW}

Prob 5. Find the Power that a solid shaft of 100 mm diameter running at 500 rpm can transmit ,if angle of twist is 1.5 degrees in a length of 2m. Take G=70 GPa.

{ Ans:471 KW}

Prob 6.A hollow shaft of external and internal diameters as 80mm and 40mm is required to transmit torque from one pulley to another. What is the value of torque transmitted, if the angle of twist is not to exceed 3 degrees in a length of 2 meters. Take modulus of rigidity as 80 Gpa.

{ Ans:T=$2.63\times10^3 N-mm$}

Prob 7. What is the torque induced in a solid circular shaft of diameter 50 mm rotating at 100 rpm , if the permissible shear stress is not to exceed 75 Mpa.

{ Ans: $Torque = 1.84\times10^6 N-mm$ }

Prob 8. A solid circular shaft of 30 mm diameter is subjected to a torque of 250 N-M causing an angle of twist 3.74 degrees in a length of 2m. Determine the modulus of rigidity of the material of the shaft.

{ Ans: $G = 96.73\times10^3 N/mm^2$ }

9. A solid circular shaft of 100mm diameter transmits 120KW at 200 rpm. Find the maximum shear stress and angle of twist for a length of 6m.Take G=80 GPa.

{Ans : Stress= Mpa,Angle= deg}

Shaikh sir’s Reliance Academy,Shahupuri, Kolhapur.

Subject : Strength of materials

Question : 4

This question contains 5 questions from all chapters, of 4 marks each

Q4] Solve any Three . [12 Marks]

a] Unit 4: SFD and BMD of simply supported beam

b] Unit 2 : Problems on Poissons ratio and modulus of elasticity

c] Unit 2: Problems on Composite section of equal and unequal length

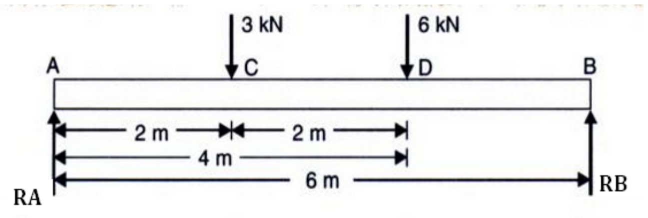
d] unit 4: Bending stresses in beams

Types of Problems

No.	Type of Problem		
1	SFD and BMD of simply supported beam		
2	Problems on Poisson's ratio and modulus of elasticity		
3	Problems on composite section of equal length		
4	Problems on composite section of Unequal length		
5	Problems on Bending stresses in beams		

Type 1. SFD & BMD of Simply supported beam (without overhanging)

1.Draw SFD and BMD for diagram

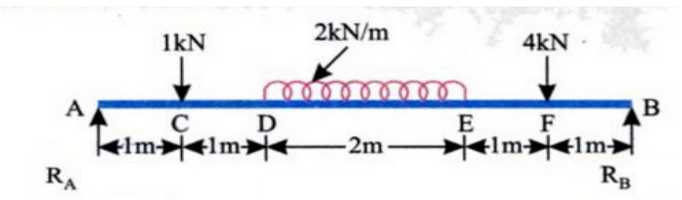


2.A simply supported beam of span 6 m carries two point loads of 30 kN each at 2 m and 4 m from left support. The beam also carries a U.D.L. of 20 kN/m between two point loads. Draw S.F.D. and B.M.D.

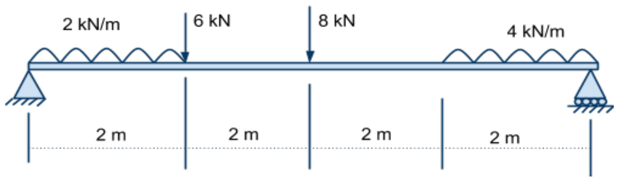
3. Draw S.F.D. and B.M.D. for a beam whose left support is hinge and right support is roller. The beam has following details :
(i) Span = 8 m
(ii) U.D.L. of 20 kN/m at 4 m from left support.
(iii) A point load of 120 kN at a distance of 6 m from LHS.

4. A simply supported beam is having span of 6 m. It carries two point loads of 50 KN and 20KN at 1m and 4m from left hand support respectively. Draw bending moment diagram and hence draw the qualitative deflected shape of the beam .

5. Draw Shear force and bending moment diagram



6. Draw Shear force and bending moment diagram.



7. A simply supported beam ABC has 5m span,is supported between A and C. It carries uld of 20 kN/m over its entire span. It also carries a point load of 45 kN at a distance of 2m from left hand support. Draw SFD and BMD

8. A simply supported beam ABCD is of 5m span, such that AB=2m, BC=1 m and CD=2m. It is loaded with 5 kN/m over AB and 2 kN/m ovr CD. Draw shear force and bending moment diagrams for the beam..

SFD & BMD OF OVERHANGING BEAM

1. A beam ABC is supported at A and B. It is loaded with u.d.l of 20kN/m on entire beam and a point load of 10 kn at C. Span Ab is 5m and overhang BC is 1m. Draw shear force and bending moment diagram..

2.A simply supported beam ABC which supported at A and B, 6 m apart with an overhang BC 2 m long, carries a udl of 15 kN/m over AB and a point load of 30 kN at C. Draw S.F. and B.M. diagrams.

3.An overhanging beam has two overhangs, each of 2m on both sides of supports. The distance between supports is 7m and the overall length of the beam is 11m . Two point loads each of 4KN are kept on free ends of the overhangs. Draw shear force and bending moment diagrams. Also find the value of maximum negative bending moment.

Type 2. Problems on Poissons ratio.

1. A metal rod 20 mm diameter and 2 m long is subjected to a tensile force of 60 kN, it showed and elongation of 2 mm and reduction of diameter by 0.006 mm. Calculate the Poisson's ratio and three moduli of elasticity.

(Ans:Poisson’s ratio = 0.3,E=190.99e3 N/mm2 ,G=73.45e3 N/mm2 ,K=159.15e3 N/mm2)

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2. A bar of diameter 12 mm is tested on U.T.M and following observations were noted 1)Gauge length : 200mm 2) Load on Proportional limit :20kN 3)Change in length : 0.2 mm 4) Change in dia : 0.0025 mm. Determine E,G,K and u.

(Ans:Poisson’s ratio = 0.208,E=176.85e3 N/mm2,G=73.19e3 N/mm2,K=100.94e3 N/mm2)

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3. A metal bar 50mm×50mm in section is subjected to an axial compressive load of 500 kN. If the contraction of a 200mm gauge length was found to be 0.5 mm and the increase in thickness 0.04 mm, find Poisson’s ratio and three moduli.

(Ans:E=80Gpa, Poisson's ratio=0.32)

4.In an experiment an alloy bar of 1m long and 20mm ×20mm in section was tested to increase through 0.1 mm, when subjected to an axial tensile load of 6.4 kN. If the value of bulk modulus of the bar is 133 GPa, find the value of Poisson's ratio

(Ans: Poisson's ratio=0.30)

---

5. A steel rod 4 m long and 20mm diameter is subjected to an axial tensile load of 45 kN. Find the change in length and diameter of the rod. E= 200 GPa, and m=4.

(Ans: Change in length=2.86mm, change in diameter =0.003575mm)

6.A steel rod 3m long and 25mm diameter is subjected to an axial tensile load of 60 kN. Calculate the change in length and diameter of rod. E=210 Gpa and u=0.28.

(Ans: Change in length=1.75mm, change in diameter =0.0041mm)

7.A steel bar 1.2 m long, 40mm wide and 20 mm thick is subjected to an axial tensile load of 50 kN in the direction of its length. Find the change in length and thickness of the bar . E=200 Gpa and Poisson's ratio =0.26.

(Ans: Change in length=0.375mm, change in thickness=1.625✕ 10-3mm)

8.A metal bar 40mm✕40mm section, is subjected to an axial compressive load of 480 kN. The contraction of a 200 mm gauge length is found to be 0.4 mm and the increase in thickness 0.04 mm. Find Young's Modulus and Poisson's ratio.

(Ans: E= 150✕103 n/mm2 , m=2)

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9. For a metal bar of 20 mm diameter and 1m long is subjected to an axial pull of 60 KN Take $E=1.8\times10^5\,N/mm^2$ and .Find the change in the diameter of the bar.

Type:3:Problems on composite sections

Load taken by material 1

$$F_1=W\times[\frac{E_1A_1}{E_1A_1+E_2A_2+...}]$$

Load taken by material 2

$$F_2=W\times[\frac{E_2A_2}{E_1A_1+E_2A_2+...}]$$

Stresses in materials may be calculated using

$$Stress\,induced\,material\,1(\sigma_1)=\frac{Load\,taken\,by\,material\,1}{Area\,of\,material\,1}$$

1. A copper rod 30 mm in diameter and 400 mm long is enclosed in a steel tube of internal diameter 30mm and thickness 10mm and are rigidly attached to act as a composite bar. Bar is subjected to an axial load of 200kN. Find 1. Stress in each material. 2. Load shared by each material 3.Elongation of the composite bar. Es=200 kN/mm2 and Ec=100 kN/mm2 .

(Ans:stress in copper=62.11Mpa,stress in steel=124.22Mpa,Ps=156 kN,Pc=44 kN & elongation=0.248 mm)

2.A mild steel rod 20 mm diameter and 300 mm long is enclosed centrally inside a hollow copper tube of external diameter 30mm and internal diameter 25mm. THe ends of the rod and tube are brazed together, and the composite bar is subjected to an axial pull of 40 kN. FInd the stresses in the rod and the tube E for steel is 200 GPa and for Copper is 100 GPa.

(Ans:stress in copper=47.4 Mpa,stress in steel=94.8 Mpa)

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3. A composite bar is made up of steel rod of diameter 20 mm rigidly fixed rigidly fitted into copper tube of internal diameter of 20mm and external diameter of 30mm. If this composite section which is 750 mm long is subjected to a Compressive load of 30 kN, find the stresses developed in the steel rod and copper tube. Take Es=200 GPa, Ec= 100 GPa. Also determine the change in length of bar..

(Ans:stress in copper=29.4 Mpa,stress in steel=58.8 Mpa, dl=0.22mm)

4.A composite bar is made up of a brass rod of 25mm diameter enclosed in a steel tube of 40 mm OD and 35 mm ID. The ends of the rod and tube are securely fixed. Find the stresses in brass and steel if it is subjected to a pull of 45 kN. Take Es=200 GPa,Eb=80 GPa.

(Ans:stress in barss=36.6 Mpa,stress in steel=91.5 Mpa)

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5. Two vertical rods are made up of steel and copper are 30 mm each and 400 mm long are rigidly held at top. A horizontal cross bar of copper is fixed to the rods at lower ends which carry 6000 N such that the cross bar remains horizontal even after loading. Calculate load shared by each rod. Es=200 Gpa and Ec=100Gpa.

(Ps=4000N,Pc=2000 N)

Type 4 Composite section of unequal length

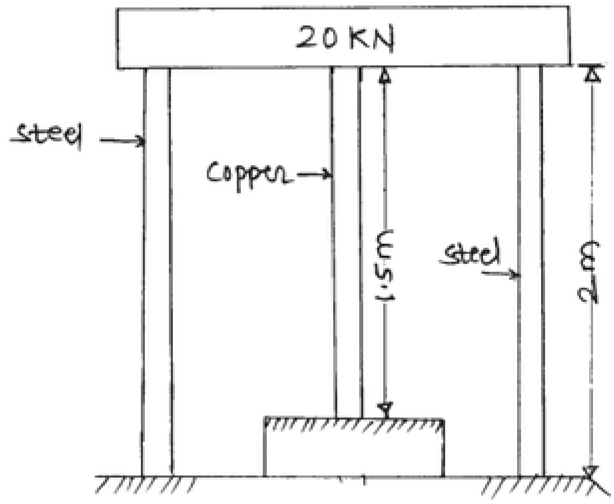
Load taken by material 1 (here length is also considered)

$$F_1=W\times[\frac{\frac{E_1A_1}{L_1}}{\frac{E_1A_1}{l_1}+\frac{E_2A_2}{l_2}+...}]$$ **similer for material 2**

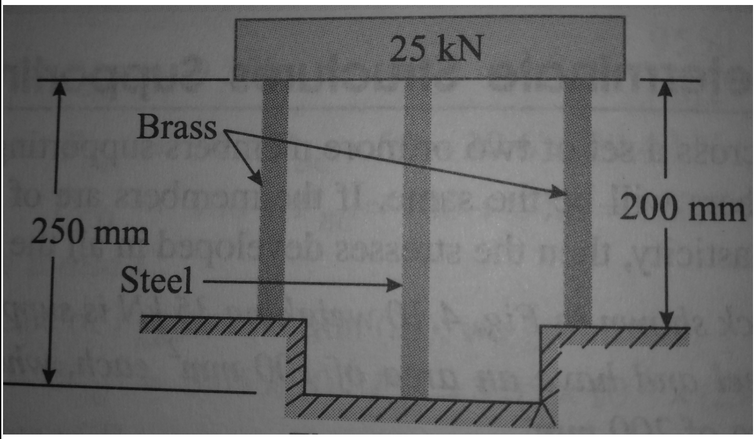
Stresses in matrials is calculated using

$$Stress\,induced\,material\,1(\sigma_1)=\frac{Load\,taken\,by\,material\,1}{Area\,of\,material\,1}$$

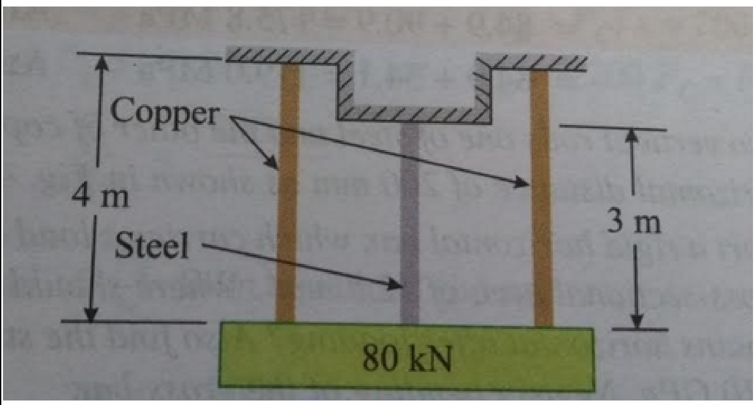
Problem 1 : Two steel rods and one copper rod each of 20 mm in diameter together support a load of 20 kN as shown in Fig. below. Find the stresses in the rod, Es = 210 GPa and Ec = 110 Gpa.



Problem 2: Two brass rods and one steel rod together support a load as shown in figure below. The crosssectional area of steel is 800 mm2 and cross section of each brass rod is 500 mm2. Together they support a load of 25 kN. Find the stresses induced in each rod
Take E for steel as 200 Gpa and E for Brass as 100 Gpa.



Problem 3 : A load of 80 kN is jointly supported by three rods of 20 mm diameter as shown in figure below. Find the stresses in steel and copper. Take E for copper as 100 Gpa and for steel as 200 Gpa.



Type 4: Problems on Bending Formula(flexural formula)

1. A Circular beam 500 mm dia is simply supported over span of 6m. It carries point load of 81 KN at center. Find bending stress induced.

(Ans f= 9.92 N/mm^2)

2. A simply supported beam of span 4m carries UDL of 2 Kn/m over the entire span. if the bending stresses is not to exceed 165 N/mm2, find the value of section modulus for the beam and diameter of beam when it is circular.

(Ans d=)

3. A rectangular beam 200 x 450 mm is fixed at one end as a cantilever beam of span 4m it carries udl of 100 N/m over entire span. Find bending stress

(Ans f= $0.119\, N/mm^2$***)***

4. A rectangular beam 300 mm deep is simply supported over span of 4m. Find what udl beam can carry is bending stresses is limited to 120 MPa.

(Ans W = 90 N/mm)

5. A rectangular beam 60 mm wide and 150 mm deep is simply supported over a span of m. if the beam is subjected to audl of 4.5 KN/M and max. bending stress is limited to 40 MPa Find span of beam.

(Ans x= 4008 mm)

6. A rectangular beam 60 mm wide and 150 mm depth is simply supported over 6m. If beam has point load of 12KN at center. Find max. bending stress include.

(Ans F= $80.02\, N/mm^2$***)***

7. A beam is rectangular section supports A load of 20 kn at center of beam span 3.6 m. If depth is twice width and stress is limited to 7 mpa find dimension of beam.

(Ans x = 156.82 mm)

8. A simply supported beam 150mm wide and 300mm deep carries an uniformly distributed load over a span of 4m If the safe stresses are 28 MPa in bending and 2MPa in shear find the maximum uniformly distributed load that can be safely supported by the beam

9. Calculate max stress induced in a CI pipe of ext. dia 40 mm and internal dia 25 mm length of pipe is 4 m and simply supported and carries pt load of 80 kN at center.

(Ans f = $15.02 \times 10^3\, N/mm$***)***

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Subject : Strngth of material -22306

Question : 5 and 6
6 Marks Problems

Types of Problems

No.	Type of Problem	Q.B.Checked	Revision
1	Problems on Torsion of shaft		
2	Problem on Direct and bending stress		
3	Problem on Bending stresses in beams		
4	Problems on shear stress in beams		
5			
6			

Type 1: To find the diameter/diameters of shaft

prob 1: A solid steel shaft has to transmit 100 KW at 160 r.p.m. Taking allowable shear stress as 70 MPa, find the suitable diameter of the shaft. the Maximum torque transmitted in each revolution exceeds the mean by 20%.

{ Ans:d=80 mm}

Prob 2: Select a suitable diameter for a solid circular shaft to transmit 200 HP at 180 rpm. The allowable shear stress is 90 Mpa and allowable angle of twist is 1^0 ***for every 5m length of shaft . Take C/G = 82 GPa***

{ Ans: d from fs=..............., d from angle=...................., suitable diameter=.................... }

Prob 3: A shaft is transmitting power of 50.5 kw at 120 rpm. if the shear stress is not to exceed 40 MPa,find the suitable diameter of the shaft.

{ Ans:d=80 mm}

Prob 4: A solid shaft is subjected to torque of 1.6 KN-m. Find the necessary diameter of the shaft, if the allowable shear stress is 60 Mpa. the allowable twist is 1 degree for every 2m length of shaft c=80 Gpa.

{ Ans:d=51.4,d=69.56}

Prob 5: A shaft is transmitting 100 kW at 180 r.p.m if the allowable shear stress in the shaft material is 60 MPa, determine the suitable diameter for the shaft. The shaft is not to twist more than 1 degrees in a length of 3 meter. G=80 Gpa.

{ Ans:d=103.8}

Prob 6: A shaft has to transmit 105 KW at 160 rpm. If the shear stress is not to exceed 65 Mpa and angle of twist in the length of 3.5m must not exceed 1 degree, find the diameter of the shaft. Take C=80 GPa

{ Ans: d=78.86 mm, d=63.27 mm}

Prob 7. A solid circular shaft of 100 mm diameter is transmitting 120 kW at 150 r.p.m. Find the intensity of shear stress in the shaft.

{ Ans:fs=39 Mpa}

W-15 Prob 8 :A solid circular shaft of diameter 100 mm and length 2.7 m is subjected to a torque of 30 kN.m. Assume, G = 75 GPa. Find maximum stress induced.

Hollow Shaft

1.A hollow circular shaft of 30mm outside diameter and 20mm inside diameter is subjected to torque of 40N.m. Find the shear stress at outside surface and at inside surface of the shaft.

Prob 2. A hollow shaft is to transmit 200 kW at 80 RPM. If the shear stress is not to exceed 60 MPa and internal diameter is 0.6 of the external diameter, find the diameter of the shaft.

{ Ans:D=132 mm,d= 79.2 mm}

Prob 3: A hollow shaft of diameter ratio ⅗ is required to transmit torque of 61465 N-m. the shear stress is not to exceed 63 MPa and twist in a length of 3m diameter is 1.4 degrees. Calculate the minimum external diameter satisfying these conditions Take G=84 Gpa.

{ Ans: Based on shear D=178.72 & d=107.23mm , Based on rigidity D=180.13 & 108.07 mm }

Prob 4: A hollow shaft is required to transmit a torque of 36 kN-m. The inside diameter is 0.6 times the external diameter. Calculate both diameters if the allowable shear stress is 83 MPa.

{Ans: D=.136.40, d=.81.84 mm. }

Prob 5: A hollow shaft is required to transmit a torque of 40 kN-m. The inside diameter is 0.5 times the external diameter. Calculate both diameters if the allowable shear stress is 50 MPa.

{Ans: D=163.19 mm, d=97.91 }

Comparison of shaft

Problem 1. A solid circular shaft of diameter 200mm has same cross section as that of hollow shaft of same material with inside diameter as 150mm. Find ratio of power transmitted by two shafts at same speed.

Problem 2 : Compare the weight of a solid shaft with that of hollow shaft to transmit given power at a given speed with a given maximum shear stress. The inside diameter of the hollow shaft is 2/3 of the outside diameter.

Problem 3.A solid circular shaft is replaced by a hollow circular shaft of the same material to transmit the same power. If the inside diameter of the hollow is 3/4 of outside diameter, find the saving in material, if any, by this replacement.

Problem 4 .A hollow shaft is of the same external diameter as that of the solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length. Then show that the ratio of torque transmitted by hollow shaft to the torque transmitted by solid shaft is 0.9375.

Problem 5 : To transmit the same torque, a solid circular shaft 80 mm in diameter is to be replaced by a hollow circular shaft having external diameter 1.5 times the internal diameter. The material for solid and hollow shaft is the same. Determine the diameters of the hollow shaft.

Type 1: Problem on direct and bending stress

1. A rectangular mild steel flat 150mm. wide and 12.mm thick carry tensile load of 180kn at on eccentricity of 10mm in plane bisecting the thickness find max and min intensity of stress.

2. A rectangular column 300mm wide and 500mm deep carries load of 100 kn at the eccentricity of 30 mm in the plane bisecting thickness calculate max and min stresses. Show values on diagram

3. A circular section 300mm dia carries 100kN at eccentricity of 30mm find max and min stress eccentricity.

(Ans 2.54 N/mm2,0.283 mpa

4. A hollow circular section having external dia 300mm and internal dia 250mm carries a load of 100Kn at an eccentricity of 125mm calculate the max and min intensities of the stress in the section.

(Ans max st=13.73,4.47 Mpa

5. A hollow rectangular column section 600mm by 300mm outer dimensions and 500mm by 250mm internal dimension carries a load of 15Kn at an eccentricity of 100 mm in the plane bisecting thickness calculate the maximum and minimum intensities of stress in section.

(Ans = $\sigma_{min} = 0.111\, N/mm^2$***)***

6. A circular bar having 200mm diameter is subjected to a load of 300 Kn is acting an eccentricity of "e" mm from center if max. stress is limited to 12 N/mm^2 ***. find the value of e.***

(Ans = e = 6.44mm)

7. A rectangular mild steel flat 150 mm wide and 120 mm thick carries a load of 180 Kn in a plane bisecting thickness if max stress is 14 MPa Find e.

(Ans = e = 10 mm)

8) A short column of external dia 40 cm and internal diameter 20 cm carries eccentric load of 80 kN. Find the greatest eccentricity which the load can have without producting tension on the cross section.

8) A square column has co-centric circular cavity of 37.5 mm in diameter. If the maximum load of 220KN is applied at an eccentricity of 10mm with respect to xx axis and maximum compressive stress is limited to 80 MPa. Find the size of the square column.

9) A diamond shaped pier with diagonals 3m and 6m is subjected to an eccentric load of 1500 kN at a distance of 1m from centroid and on the longer diagonal. Calculate the maximum stress induced in the section.

Type 4: Problems on Bending Formula(flexural formula) 6 marks

1. A simply supported wooden beam of span 1.3 m is having cross-section of 150 mm wide and 250 mm deep carries a point load W at its centre. The permissible stresses are 7 N/mm2 in bending and 1 N/mm2 in shearing. Calculate safe load W.

2. A cantilever is 2m long and is subjected to a udl of 2 kN/m . The cross section of cantilever is tee section with flange 80 by 10 mm and web 10 by 120mm, such that total depth is 130 mm. The flange is at top and web is vertical. Determine the maximum tensile and compressive stress developed and their positions.

3.A hollow steel tube having external and internal diameter of 100 mm and 75 mm respectively is simply supported over a span of 5m. The tube carries a concentrated load of W N at centre. What is the value of W if maximum bending stress is not to exceed 100 MPA.

4. A T section has flange 100mm by 25 mm and web 125 mm by 15 mm, overall depth is 150 mm. It has a span of 2.5 meters. Find the point load which the cantilever beam can carry at its free end, if the bending stress is not to exceed 50 MPa.

{1.6 KN}

Type 5: Problems on Shear Stresses in Beams 6 marks

1. An I Section has following dimensions
Flanges = 150 mm by 20 mm
Web 300mm by 10 mm
Find the maximum shear stress developed in the beam for shear force of 50 kN.

2. An I section beam 350 by 200 mm web thickness of 12.5 mm and a flange thickness of 25 mm. Ti carries a shearing force of 200 kN at a section. Sketch shear stress distribution diagram.

3. A hollow rectangular beam section square in size having outer dimensions 120 mm by 120 mm with uniform thickness of material 20 mm is carrying a shear force of 125 KN. Calculate the maximum shear stress induced in the section.