UNIT I

STRESS STRAIN AND DEFORMATION OF SOLIDS, STATES OF STRESS

1. Define: Stress

When an external force acts on a body, it undergoes deformation. At the same time the body resists deformation. The magnitude of the resisting force is numerically equal to the applied force. This internal resisting force per unit area is called stress.

Stress = Force/Area

$\boldsymbol{\sigma} = P/A$ (unit is N/mm^2)

2. Define: Strain

When a body is subjected to an external force, there is some change of dimension in the body. Numerically the strain is equal to the ratio of change in length to the original length of the body.

Strain = Change in length/Original length

$e = \partial L/L$

3. Define: Elastic limit

Some external force is acting on the body, the body tends to deformation. If the force is released from the body its regain to the original position. This is called elastic limit

4. State: Hooke's law.

It states that when a material is loaded within its elastic limit, the stress is directly proportional to the strain.

Stress α Strain

$\sigma \alpha e$

$\sigma = Ee$

Where, E - Young's modulus in N/mm^2

σ - Stress

e - Strain

5. Define: Young's modulus

The ratio of stress and strain is constant with in the elastic limit. This constant is known as Young's modulus.

E = Stress /Strain

6. Define: Longitudinal strain

When a body is subjected to axial load P, there is an axial deformation in the length of the body. The ratio of axial deformation to the original length of the body is called lateral strain.

Longitudinal strain= Change in length/Original length

$= \partial L/L$

7. Define: Lateral strain

The strain at right angles to the direction of the applied load is called lateral strain.

Lateral strain= Change in breadth (depth)/Original breadth (depth)

$= \partial \mathbf{b}/b$ or $\partial \mathbf{d}/d$

8. Define: shear stress and shear strain.

The two equal and opposite force act tangentially on any cross sectional plane of the body tending to slide one part of the body over the other part. The stress induced is called shear stress and the corresponding strain is known as shear strain.

9. Define: volumetric strain

The ratio of change in volume to the original volume of the body is called volumetric strain.

Volumetric strain= change in volume / original volume

$$e_v = \partial \mathbf{V}/V$$

10. Define: Poisson's ratio

When a body is stressed, within its elastic limit, the ratio of lateral strain to the longitudinal strain is constant for a given material.

Poisson' ratio (μ or 1/m) = Lateral strain /Longitudinal strain

11. Define: Bulk-modulus

The ratio of direct stress to volumetric strain is called as bulk modulus..

Bulk modulus, K = Direct stress / Volumetric strain

12. Define: Shear modulus or Modulus of rigidity

The ratio of shear stress to shear strain is called as bulk modulus..

Shear modulus, G = shear stress / shear strain

13. State the relationship between Young's Modulus and Modulus of Rigidity.

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

Where,

E - Young's Modulus

G – Modulus of rigidity

μ - Poisson's ratio

14. Give the relationship between Bulk Modulus and Young's Modulus.

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

Where,E - Young's Modulus

K - Bulk Modulus

μ- Poisson's ratio

15. What is principle of super position?

The resultant deformation of the body is equal to the algebric sum of the deformation of the individual section. Such principle is called as principle of super position

16. What is compound bar?

A composite bar composed of two or more different materials joined together such that the system is elongated or compressed in a single unit.

17. What you mean by thermal stresses?

If the body is allowed to expand or contract freely, with the rise or fall of temperature no stress is developed, but if free expansion is prevented the stress developed is called temperature stress or strain.

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18. Define principle stresses and principle plane.

Principle stress: The magnitude of normal stress, acting on a principal plane is known as principal stresses.

Principle plane: The planes which have no shear stress are known as principal planes.

19. What is the radius of Mohr's circle?

Radius of Mohr's circle is equal to the maximum shear stress.

20. What is the use of Mohr's circle?

To find out the normal, resultant and principle stresses and their planes.

21. List the methods to find the stresses in oblique plane?

1. Analytical method
2. Graphical method

UNIT II
ANALYSIS OF PLANE TRUSS, THIN CYLINDERS / SHELL

1. What are the different types of frames?

The different types of frame are:

- Perfect frame
- Imperfect frame.

2. What is mean by perfect frame?

If a frame is composed of such members, which are just sufficient to keep the frame in equilibrium, when the frame is supporting the external load, then the frame is know as perfect frame. For a perfect frame, the number of members and number of joints are not given by, n = 2j – 3.

3. What is mean by Imperfect frame?

A frame in which number of members and number of joints are not given by n = 2j – 3 is know as imperfect frame. This means that number of members in an imperfect frame will be either more or less than (2j – 3).

4. What is mean by deficient frame?

If the number of member in a frame are less than (2j -3), then the frame is known as deficient frame.

5. What is mean by redundant frame?

If the number of member in a frame are more than (2j -3), then the frame is know as deficient frame.

6. What are the assumptions made in finding out the forces in a frame?

The assumptions made in finding out the forces in a frame are:

1) The frame is a perfect frame
2) The frame carries load at the joints
3) All the members are pin-joined

7. How will you Analysis of a frame?

Analysis of a frame consists of

1) Determinations of the reactions at the supports

2) Determination of the forces in the members of the frame

8 . What are the methods for Analysis the frame?

- Methods of joints
- Methods of sections
- Method of tension coefficient
- Graphical method.

9. How method of joints applied to Trusses carrying Horizontal loads.

If a truss carries horizontal loads (with or without vertical loads) hinged at one end and supported on roller at the other end, the support reaction at the roller support end will be normal, whereas the support reaction at the hinged end will consist of i)horizontal reaction and (ii) vertical reaction

10. How method of joints applied to Trusses carrying inclined loads.

If a truss carries inclined loads hinged at one end and supported on roller at the other end, the support reaction at the roller support end will be normal. Whereas the support reaction at the hinged end will consist of (i) horizontal reaction and (ii) vertical reaction. The inclined loads are resolved into horizontal and vertical components.

11. What is mean by compressive and tensile force?

The forces in the member will be compressive if the member pushes the joint to which it is connected whereas the force in the member will be tensile if the member pulls the joint to which it is connected.

12. How will you determine the forces in a member by method of joints?

In method of joint after determining the reactions at the supports, the equilibrium of every support is considered. This means the sum all vertical forces as well as the horizontal forces acting on a joint is equated to zero. The joint should be selected in such a way that at any time there are only two members, in which the forces are unknown.

13. What are the benefits of method of sections compared with other methods?

1. This method is very quick

2. When the forces in few members of the truss are to be determined, then the method of section is mostly used.

14. Define thin cylinder?

If the thickness of the wall of the cylinder vessel is less than 1/15 to 1/20 of its internal diameter, the cylinder vessel is known as thin cylinder.

15. What are types of stress in a thin cylindrical vessel subjected to internal pressure?

These stresses are tensile and are know as

- Circumferential stress (or hoop stress)
- Longitudinal stress

16. What is mean by circumferential stress (or hoop stress) and longitudinal stress?

The stress acting along the circumference of the cylinder is called circumferential stress (or hoop stress) whereas the stress acting along the length of the cylinder is known as longitudinal stress.

17. What are the formula for finding circumferential stress and longitudinal stress?

Circumferential stress, f_1 = pd / 2t

longitudinal stress, f_2 = pd / 4t

18. What are maximum shear stresses at any point in a cylinder?

Maximum shear stresses at any point in a cylinder, subjected to internal fluid pressure is given by $(f_1 - f_2) / 2 = pd / 8t$

19. What are the formula for finding circumferential strain and longitudinal strain?

The circumferential strain (e_1) and longitudinal strain (e_2) are given by

$$e_1 = \frac{pd}{2tE\left[1 - \frac{\mu}{2}\right]}$$

$$e_2 = \frac{pd}{2tE}\left[\frac{1}{2} - \mu\right]$$

20. What are the formula for finding change in diameter, change in length and change volume of a cylindrical shell subjected to internal fluid pressure p?

$$\delta d = \frac{pd^2}{2tE}\left[1 - \frac{\mu}{2}\right]$$

$$\delta l = \frac{pdl}{2tE}\left[\frac{1}{2} - \mu\right]$$

$$\delta V = \frac{pd}{2tE}\left[\frac{5}{2} - 2\mu\right] \times Volume$$

UNIT –III

TRANSVERSE LOADING ON BEAMS

1. Define: Beam

BEAM is a structural member which is supported along the length and subjected to external loads acting transversely (i.e) perpendicular to the center line of the beam.

2. What is mean by transverse loading on beam?

If a load is acting on the beam which perpendicular to the central line of it then it is called transverse loading.

3. What is Cantilever beam?

A beam whose one end free and the other end is fixed is called cantilever beam.

4. What is simply supported beam?

A beam supported or resting free on the support at its both ends is called simply supported beam.

5. What is mean by over hanging beam?

If one or both of the end portions are extended beyond the support then it is called over hanging beam.

6. What is mean by concentrated loads?

A load which is acting at a point is called point load.

7. What is uniformly distributed load (udl).

If a load which is spread over a beam in such a manner that rate of loading 'w' is uniform through out the length then it is called as udl.

8. Define point of contra flexure? In which beam it occurs?

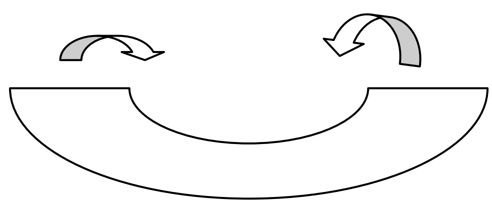
It is the point where the B.M is zero after changing its sign from positive to negative or vice versa. It occurs in overhanging beam.

9. What is mean by positive or sagging BM?

The BM is said to be positive if moment of the forces on the left side of beam is clockwise and on the right side of the beam is anti-clockwise.

(or)

The BM is said to be positive if the BM at that section is such that it tends to bend the beam to a curvature having concavity at the top.



10. What is mean by negative or hogging BM?

The BM is said to be negative if moment of the forces on the left side of beam is anti-clockwise and on the right side of the beam is clockwise.

(or)

The BM is said to be positive if the BM at that section is such that it tends to bend the beam to a curvature having convexity at the top.

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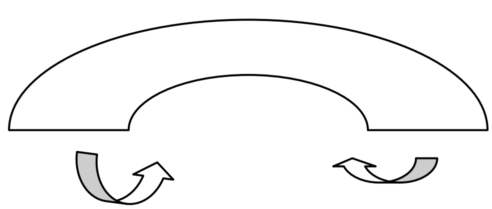

11. Define shear force and bending moment?

SF at any cross section is defined as algebraic sum of the vertical forces acting either side of beam.

BM at any cross section is defined as algebraic sum of the moments of all the forces which are placed either side from that point.

12. When will bending moment is maximum?

BM will be maximum when shear force change its sign.

13. What is maximum bending moment in a simply supported beam of span 'L' subjected to UDL of 'w' over entire span?

Max BM $=wL^2/8$

14. In a simply supported beam how will you locate point of maximum bending moment?

The bending moment is max. when SF is zero. Writing SF equation at that point and equating to zero we can find out the distances 'x' from one end .then find maximum bending moment at that point by taking moment on right or left hand side of beam.

15. What is shear force and bending moment diagram?

It shows the variation of the shear force and bending moment along the length of the beam.

16. What are the types of beams?

1. Cantilever beam
2. Simply supported beam
3. Fixed beam
4. Continuous beam
5. over hanging beam

17. What are the types of loads?

1. Concentrated load or point load
2. Uniform distributed load (udl)
3. Uniform varying load(uvl)

18. Write the assumptions in the theory of simple bending?

1. The material of the beam is homogeneous and isotropic.
2. The beam material is stressed within the elastic limit and thus obey hooke's law.
3. The transverse section which was plane before bending remains plains after bending also.
4. Each layer of the beam is free to expand or contract independently about the layer, above or below.
5. The value of E is the same in both compression and tension.

19. Write the theory of simple bending equation?

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

Where,

M - Maximum bending moment

I - Moment of inertia

f - Maximum stress induced
y- Distance from the neutral axis
E - Young's modulus
R – Radius of neutral layer.

20. Define: Neutral Axis

The N.A of any transverse section is defined as the line of intersection of the neutral layer with the transverse section.

21. Define: Moment of resistance

Due to pure bending, the layers above the N.A are subjected to compressive stresses, whereas the layers below the N.A are subjected to tensile stresses. Due to these stresses, the forces will be acting on the layers. These forces will have moment about the N.A. The total moment of these forces about the N.A for a section is known as moment of resistance of the section.

22. Define: Section modulus

Section modulus is defined as the ratio of moment of inertia of a section about the N.A to the distance of the outermost layer from the N.A.

Section modulus, $Z = \frac{I}{y_{max}}$

Where, I – M.O.I about N.A

y_{max} - Distance of the outermost layer from the N.A

UNIT –IV

DEFLECTION OF BEAMS AND SHEAR STRESSES

1. What are the methods for finding out the slope and deflection at a section?

The important methods used for finding out the slope and deflection at a section in a loaded beam are

1. Double integration method
2. Moment area method
3. Macaulay's method
4. Conjugate beam method

The first two methods are suitable for a single load, where as the last one is suitable for several loads.

2. Why moment area method is more useful, when compared with double integration?

Moment area method is more useful, as compared with double integration method because many problems which do not have a simple mathematical solution can be simplified by the moment area method.

3. Explain the Theorem for conjugate beam method?

Theorem I : "The slope at any section of a loaded beam, relative to the original axis of the beam is equal to the shear in the conjugate beam at the corresponding section"

Theorem II: "The deflection at any given section of a loaded beam, relative to the original position is equal to the Bending moment at the corresponding section of the conjugate beam"

4. Define method of Singularity functions?

In Macaulay's method a single equation is formed for all loading on a beam, the equation is constructed in such away that the constant of Integration apply to all portions of the beam. This method is also called method of singularity functions.

5. What are the points to be worth for conjugate beam method?

1. This method can be directly used for simply supported Beam
2. In this method for cantilevers and fixed beams, artificial constraints need to be supplied to the conjugate beam so that it is supported in a manner consistent with the constraints of the real beam.

6. What is the formula to find a shear stress at a fiber in a section of a beam?

The shear stress at a fiber in a section of a beam is given by

$$q = \frac{FA\check{y}}{Ib}$$

Where, F = shear force acting at a section
A = Area of the section above the fiber
$\check{y}$ = Distance of C G of the Area A from Neutral axis
I = Moment of Inertia of whole section about N A
b = Actual width at the fiber

7. What is the shear stress distribution rectangular section?

The shear stress distribution in a rectangular section is parabolic and is given by

$$q = \frac{F}{2I}\left(\frac{d^2}{4} - y^2\right)$$

Where,
d - Depth of the beam
y - Distance of the fiber from NA

8. State the main assumptions while deriving the general formula for shear stresses

- The material is homogeneous, isotropic and elastic
- The modulus of elasticity in tension and compression are same.
- The shear stress is constant along the beam width

- The presence of shear stress does not affect the distribution of bending stress.

9. Define: Shear stress distribution

The variation of shear stress along the depth of the beam is called shear stress distribution

10. What is the ratio of maximum shear stress to the average shear stress for the rectangular section?

Q_{max} is 1.5 times the Q_{avg}.

11. What is the ratio of maximum shear stress to the average shear stress in the case of solid circular section?

Q_{max} is 4/3 times the Q_{avg}.

12. What is the shear stress distribution value of Flange portion of the I-section?

$$q = \frac{F}{2I}\left(\frac{D^2}{4} - y\right)$$

Where, D- depth

y- Distance from neutral axis

13. Where the shear stress is max for Triangular section?

In the case of triangular section, the shear stress is not max at N A. The shear stress is max at a height of h/2

14. Define: Mohr's Theorem for slope

The change of slope between two points of a loaded beam is equal to the area of BMD between two points divided by EI.

Slope, $\theta = \frac{A}{EI}$

15. Define: Mohr's Theorem for deflection

The deflection of a point with respect to tangent at second point is equal to the first moment of area of BMD between two points about the first point divided by EI.

Slope, $\theta = \frac{A}{EI}$

UNIT V

TORSION AND SPRINGS

1. Write down the expression for power transmitted by a shaft

P=2πNT/60

Where, N-speed in rpm

T-torque

2. Write down the expression for torque transmitted by hollow shaft

$T= (\pi/16)*Fs*((D4-d4)/d4$

Where, T-torque

q- Shear stress

D-outer diameter

d- Inner diameter

3. Write down the equation for maximum shear stress of a solid circular section in diameter 'D' when subjected to torque 'T' in a solid shaft.

$T=\pi/16 * Fs*D3$

where, T-torque

q - Shear stress

D – diameter

4. Define torsional rigidity

The torque required to introduce unit angle of twist in unit length is called torsional rigidity or stiffness of shaft.

5. What is composite shaft?

Some times a shaft is made up of composite section i.e. one type of shaft is sleeved over other types of shaft. At the time of sleeving, the two shafts are joined together, that the composite shaft behaves like a single shaft.

6. What is a spring?

A spring is an elastic member, which deflects, or distorts under the action of load and regains its original shape after the load is removed.

7. State any two functions of springs.

1. To measure forces in spring balance, meters and engine indicators.
2. To store energy.

8. What are the various types of springs?

i. Helical springs ii. Spiral springs

iii. Leaf springs iv. Disc spring or Belleville springs

9. Classify the helical springs.

1. Close – coiled or tension helical spring.
2. Open –coiled or compression helical spring.

10. What is spring index (C)?

The ratio of mean or pitch diameter to the diameter of wire for the spring is called the spring index.

11. What is solid length?

The length of a spring under the maximum compression is called its solid length. It is the product of total number of coils and the diameter of wire.

Ls = nt x d

Where, nt = total number of coils.

12. Define spring rate (stiffness).

The spring stiffness or spring constant is defined as the load required per unit deflection of the spring.

K= W/y

Where , W - load

y- Deflection

13. Define pitch.

Pitch of the spring is defined as the axial distance between the adjacent coils in uncompressed state. Mathematically

Pitch=free length n-1

14. Define helical springs.

The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile load.

15. What are the differences between closed coil & open coil helical springs?

Closed coil spring

The spring wires are coiled very closely, each turn is nearly at right angles to the axis of helix . Helix angle is less (7^0 to 10^o)

Open coil spring

The wires are coiled such that there is a gap between the two consecutive turns. Helix angle is large (>10o)

16. Write the assumptions in the theory of pure torsion.

1. The material is homogenous and isotropic.
2. The stresses are within elastic limit
3. C/S which are plane before applying twisting moment remain plane even after the application of twisting moment.
4. Radial lines remain radial even after applying torsional moment.
5. The twist along the shaft is uniform

17. Define : Polar Modulus

Polar modulus is defined as the ratio of polar moment of inertia to extreme radial distance of the fibre from the centre.