

## Structural Engineering\_Past Question Collection

1. In a bar of Length  $L$ , diameter  $D$  and cross-sectional Area  $A$ , the strain produced is  $S$  under the action of load  $W$ , The young's modulus of elasticity for the bar is:

[Civil Er. 6th 2079/02/21]

- A.  $W/DLS$
- B.  $WL/DS$
- C.  $W/AS$
- D.  $SDA/WL$

**Correct Answer: C**

Explanation:

✓ To find the Young's modulus of elasticity for the bar, we start by the fact that Young's modulus ( $E$ ) is defined as the ratio of stress to strain.

1. Stress is calculated as the applied force (load) divided by the cross-sectional area:

$$\text{Stress} = \frac{W}{A}$$

2. Strain is given as

$S$

, which is the ratio of the change in length to the original length.

3. Young's modulus is then given by:

$$E = \frac{\text{Stress}}{\text{Strain}}$$

$$= \frac{\frac{W}{A}}{S} = \frac{W}{A \cdot S}$$

The length  $L$  and diameter  $D$  are provided but not necessary for the calculation since the strain  $S$  already incorporates the length, and the cross-sectional area  $A$  is directly given.

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## 2. Product of young's modulus and moment of Inertia is called:

[Civil Er. 6th 2079/02/21]

- A. Modulus of rigidity
- B. Bulk Modulus
- C. Flexural rigidity
- D. Torsional rigidity

Correct Answer: C



(i) Torsional rigidity =  $GJ$

(ii) Torsional flexibility =  $\frac{L}{GJ}$

(iii) Torsional stiffness (K) =  $\frac{GJ}{L}$

According to torsional equation

$$\frac{\tau}{r} = \frac{T}{J} = \frac{G\theta}{L}$$

Explanation:

✓ The product of Young's modulus ( $E$ ) and the moment of inertia ( $I$ ) is called flexural rigidity.

- ✓ The flexural rigidity combines these two properties into a single value that represents the bending stiffness of a beam.
- ✓ Flexural rigidity is a property of a beam that affects how much it will deflect under a load.
- ✓ Flexural rigidity is represented by the term EI.
- ✓ It is always a positive quantity.

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**3. The maximum twisting moment a shaft can resist, is the product of the permissible shear stress and:**

**[Civil Er. 6th 2079/02/21]**

- A. moment of Inertia
- B. Polar moment of Inertia
- C. Polar modulus
- D. Modulus of rigidity

**Correct Answer: C**

Explanation:

- ✓ Since ,torsion equation is given by:

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G \times \phi}{L}$$

Where:

- T is the torque or twisting moment.
- J is the polar moment of inertia.
- G is the shear modulus (modulus of rigidity).
- 

$\phi$

is the angle of twist in radians.



- L is the length of the shaft.

-

$\tau$

is the maximum shear stress at radius r.

Arranging above equation

$$T = \frac{J}{r} \times \tau$$

Like I/y is section modulus in a beam during bending J/r is called polar modulus in Torsion.

$$T = \text{polar modulus} \times \tau$$

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**4. A structure member subjected to tensile force in a direction parallel to its longitudinal axis is generally known as:**

[Civil Er. 6th 2079/02/21]

- A. A tie
- B. A tie member
- C. A tension member
- D. All of these

**Correct Answer: D**

Explanation:

A structural member subjected to a tensile force in a direction parallel to its longitudinal axis is generally known as a tie rod, tie, or a tension member.

✓ Tie rods are often used for cross bracing to stiffen structures and resist wind loads. They are also called bracing struts.

✓ Tie are typically slender, and their supports are usually assumed to be pin connections

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5. The bending moment on a section is maximum where shear force is:  
[Civil Er. 6th 2079/02/21]

- A. Zero
- B. Changes its sign
- C. Maximum
- D. All of these

**Correct Answer: A**

Explanation:

Here, the correct answer is both a. zero b. changes its sign The bending moment is maximum at a section where the shear force is zero or changes its sign. This is because:

● **Relationship Between Shear Force and Bending Moment:**

The rate of change of the bending moment (M) with respect to distance (x) is equal to the shear force (V) at that section:

$$\frac{dM}{dx} = V$$

When  $V = 0$ , the slope of the bending moment diagram is zero, indicating a local maximum or minimum in the bending moment.

● **Sign Change in Shear Force:**

When the shear force changes its sign (crosses zero), it implies a transition from positive to negative or vice versa. This corresponds to a point where the bending moment reaches its maximum or minimum value.

But here if we had to choose one as the best answer, it would be: a. zero Although one might also describe this condition as the point where the shear force changes its sign, if we have to choose a single option the most precise answer is 0 because the mathematical condition for a maximum bending moment is that its derivative (the shear force) is zero.

**Bonus Points:** ✓ A maximum bending moment occurs where the shear force changes from positive to negative. Conversely, a minimum bending moment occurs where the shear force changes from negative to positive. ✓ It is important to consider all locations where the shear force is zero to determine the absolute maximum bending moment, because there may be multiple points of zero shear along the length of the beam

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## 6. The relationship between the radius of curvature $R$ , bending moment $M$ and flexural rigidity $EI$ is given by:

[Civil Er. 6th 2079/02/21]

- A.  $R = (M/EI)$
- B.  $M = (EI/R)$
- C.  $EI = (R/M)$
- D.  $E = (MI/R)$

**Correct Answer: B**

### Explanation:

The relationship between the radius of curvature ( $R$ ), bending moment ( $M$ ), and flexural rigidity ( $EI$ ) is expressed by the equation  $1/R = M/EI$ .

✓ Radius of Curvature ( $R$ ) This term represents the radius of the circle that would match the curve of the bent beam at a specific point. It is a measure of how sharply the beam is bending at that location. A smaller radius of curvature indicates a tighter bend.

The curvature is equal to  $1/R$ .

✓ Bending Moment ( $M$ ): This is the internal moment within the beam caused by external loads, which results in bending.

✓  $EI$  is called flexural rigidity.

✓ The equation  $1/R = M/EI$  is derived by relating the strain in the beam fibers to the curvature.

### **Deriving the equation**

✓ It is assumed that plane sections remain plane after deformation, which results in linear strain variation over the cross-section.

✓ The stress is proportional to the strain, as described by Hooke's Law, if the material is homogeneous and behaves in a linear-elastic manner.

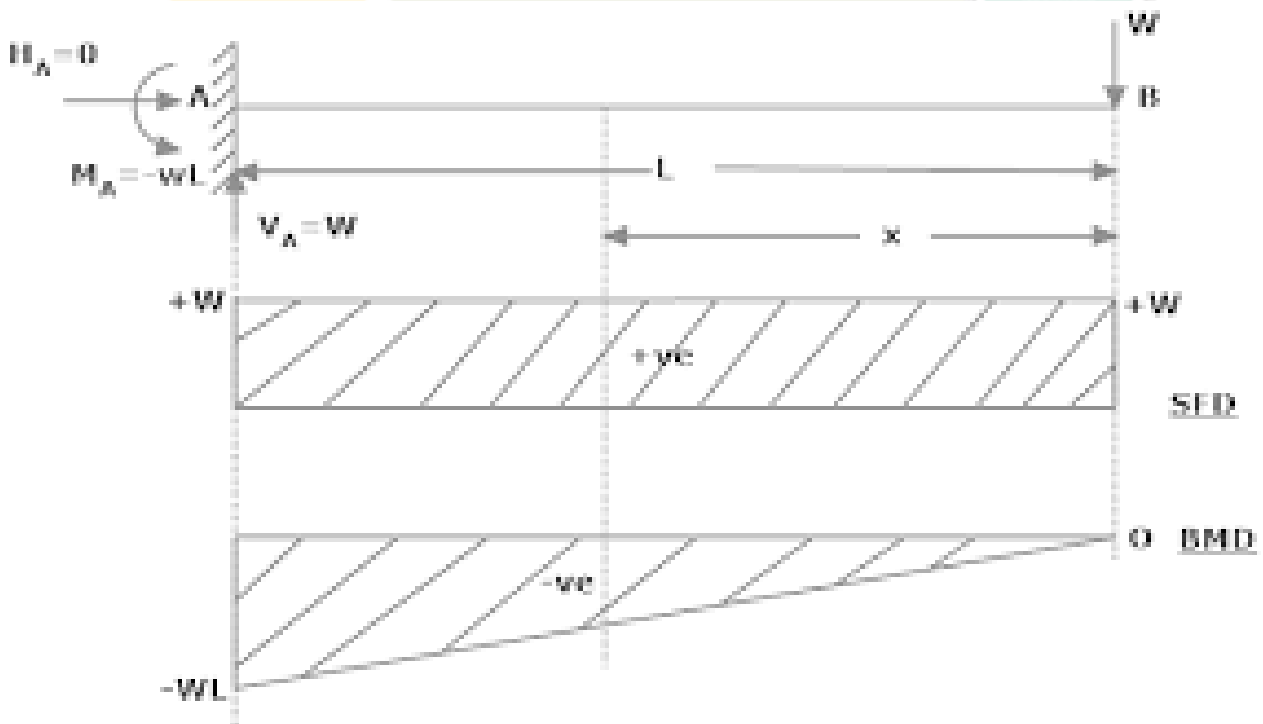
- ✓ The flexure formula which relates stress to bending moment is combined with the stress-strain relationship.
- ✓ When the slope is small, the curvature can be approximated by the second derivative of the beam deflection,  $d^2y/dx^2$ . This approximation is based on the assumption that  $(dy/dx)^2$  is negligible when compared to 1.

7. The bending moment diagram for a cantilever whose free end is subjected to a point load will be of shape:

[Civil Er. 6th 2079/02/21]

- A. Triangle
- B. Parabola
- C. Rectangle
- D. Cubic parabola

Correct Answer: A



8. Shape of BM over length having no external load is always:

[Civil Er. 6th 2079/02/21]

- A. Linear
- B. Parabolic
- C. Cubical
- D. Circular

**Correct Answer: A**

Explanation:

- ✓ Point Load : Linear (Triangular )
- ✓ UDL: Parabolic
- ✓ UVL: Cubic Parabola

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**9. Principal plane are subjected to:**

[Civil Er. 6th 2079/02/21]

- A. Normal stresses only
- B. Tangential stresses only
- C. Normal stresses as well as tangential stresses
- D. None the above

**Correct Answer: A**

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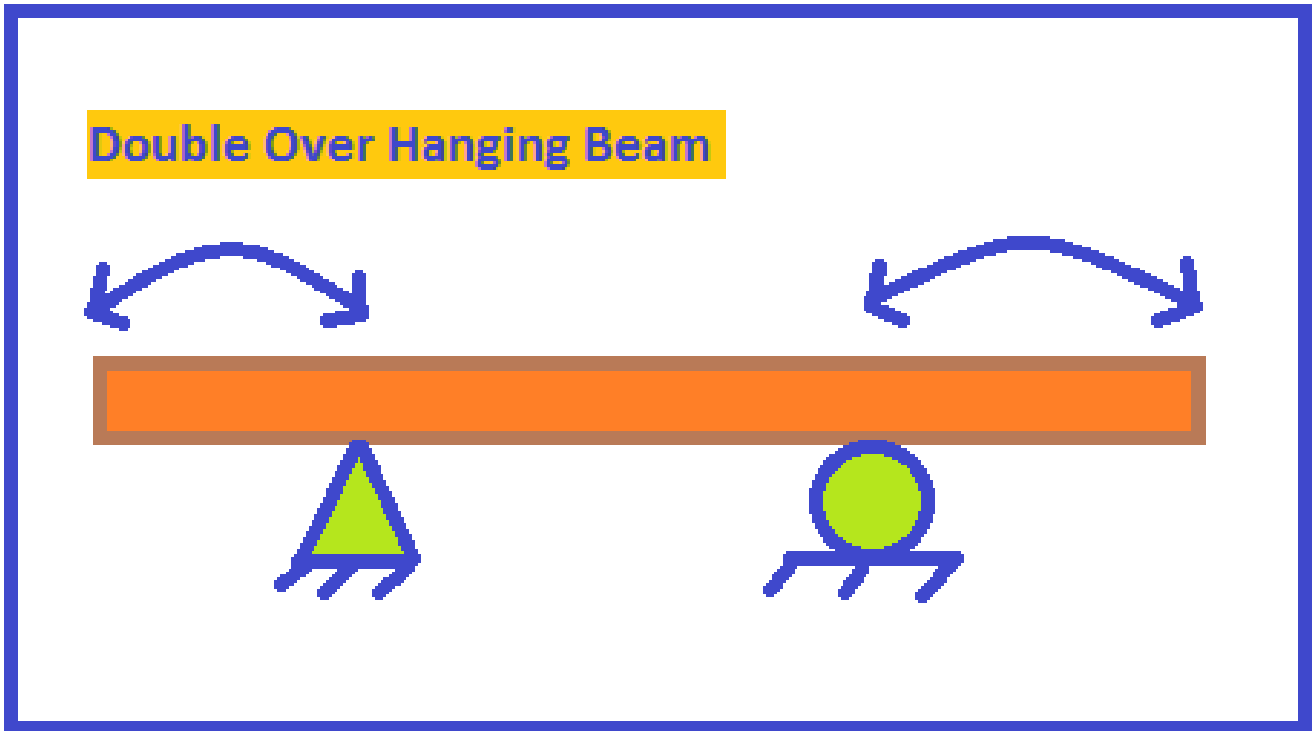
**10. Which of the following is statically determinate structure?**

[Civil Er. 6th 2079/02/21]

- A. Two hinged arch.
- B. Fixed beam
- C. Double over hanging beam
- D. Continuous beam

**Correct Answer: C**





Explanation:

✓ The statically determinate structure among the given options is the **double overhanging beam**

✓ **Fixed Beam:** Fixed at both ends, it has 6 reactions (3 per support) but only 3 equilibrium equations. **Statically indeterminate.**

**Double Overhanging Beam :** Typically supported by two simple supports (e.g., a pin and a roller), resulting in 3 reactions. With 3 equilibrium equations, it is **statically determinate.**

● **Continuous Beam :** Has more than two supports, leading to more reactions than equilibrium equations. **Statically indeterminate.**

● **Two-Hinged Arch :** With 4 reactions and only 3 equilibrium equations, it is **statically indeterminate.**

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11. A truss containing 'j' joints and 'm' members will be a simple truss if:

[Civil Er. 6th 2079/02/21]

A.  $m=2j-3$

- B.  $m = 2j - 3$
- C.  $m < 2j - 3$
- D. None of these

**Correct Answer: A**

Explanation:

A **simple truss** is a type of truss structure constructed by starting with a basic triangular element and adding two members to create a new joint. This method of construction ensures the truss is internally stable.

**Key characteristics and concepts related to simple trusses:**

- **Triangular Element:** A simple truss begins with a basic triangle, the simplest stable configuration.
- **Construction:** Expanded by adding two new members connected to existing joints to form a new joint, repeated to build the overall structure.
- **Internal Stability:** Considered internally stable as each joint is fixed by at least two non-parallel members, preventing rigid body motion.
- **Planar Trusses:** Often planar, with all members lying in a single plane, commonly used in roofs and bridges.
- **Member Forces:** Members are assumed to be connected by frictionless pins, carrying only axial forces (tension or compression).
- **Determinacy:** Evaluated using the formula  $m + r = 2j$ , where:
  - $m$  = number of members
  - $r$  = number of reactions
  - $j$  = number of jointsIf this equation is satisfied, the truss is statically determinate.
- **Examples:** Common simple trusses include Pratt, Howe, and Warren trusses, though not all consist entirely of triangles.

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**12. A member in a truss is subjected to only:**

**[Civil Er. 6th 2079/02/21]**

- A. Axial tension
- B. Axial Compression
- C. Axial Compression or tension
- D. Axial force and moment

**Correct Answer: C**

Explanation:

- ✓ Ideally a truss member should experience only axial forces, meaning either tension or compression.
  
- ✓ Connection are all pin-jointed.

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**13. What type of load is exerted by the weight of the structure itself?**

**[Civil Er. 7th Level 2080/10/27]**

- A. Dead load
- B. Live load
- C. Snow load
- D. Wind load

**Correct Answer: A**

Explanation:

**Types of Loads in Structural Design:**

**Dead Loads:** Permanent, fixed loads like the weight of structural members, walls, roofing, and fixtures.

**Live Loads:** Temporary, variable loads from occupants, furniture, vehicles, and equipment. Includes:

- **Building Loads:** Uniform or concentrated loads.
- **Traffic/Train Loads**
- **Impact Loads:** From vehicles, machinery.
- **Environmental Loads:**
  - **Wind Loads:** Lateral pressure.

- **Snow Loads:** Vertical accumulation.
- **Earthquake Loads:** Dynamic, lateral forces.
- **Hydrostatic/Soil Pressure:** On retaining structures.

**Construction Loads:** Occur during assembly, often critical for structural stability.

**Other Loads:**

- **Impulsive Loads:** Collisions, impacts.
- **Cyclic Loads:** Repeated stress.
- **Support Settlements:** Due to shifting foundations.

**Load Characteristics:**

- **Duration:** Long-term (dead loads) vs. temporary (live loads).
- **Distribution:** Concentrated (point load) vs. distributed (area load).
- **Temporal Variation:** Changes over time.

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14. The method used to analyze indeterminate structures by considering the rotation at the ends of beams or members is called the .....

[Civil Er. 7th Level 2080/10/27]

- A. Influence Line Method
- B. Unit Load Method
- C. Slope-Deflection Method
- D. Moment Distribution Method

**Correct Answer: C**

Explanation:

- ✓ slope-deflection method is used to analyze statically indeterminate beams and frames.
- ✓ Relates internal moments to joint displacements (rotations and translations).

**Key Equation:**

$$M = \frac{2EI}{L} (2\theta_{\text{near}} + \theta_{\text{far}} - 3\frac{\Delta}{L}) + FEM$$

Where **EI** is flexural rigidity, **L** is the member length,  **$\theta$**  is the joint rotation,  **$\Delta$**  is support settlement, and **FEM** represents fixed-end moments due to external loads. .

Chord rotation ( $\Delta/L$ ) due to support movement or sidesway, sidesway as lateral joint

displacement, and fixed-end moments (FEMs) caused by external loads on fixed supports. **Limitations:** Less efficient for highly indeterminate structures; matrix stiffness or moment distribution methods are preferred.

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**15. The stress in a member subjected to a force is.....**

**[Civil Er. 7th Level 2080/10/27]**

- A. Load per unit area
- B. The resistant offered by the material per unit area to a force
- C. Continued deformation under sustained load
- D. The strain per unit length

**Correct Answer: B**

Explanation:

✓ Suppose you try to pull a piece of chalk apart by applying tension on both ends. Internal forces are created in response to the force you applied that try to keep the chalk one and prevent itself from being ripped apart. This resisting force developed inside (not the force you applied) per unit area is called stress.

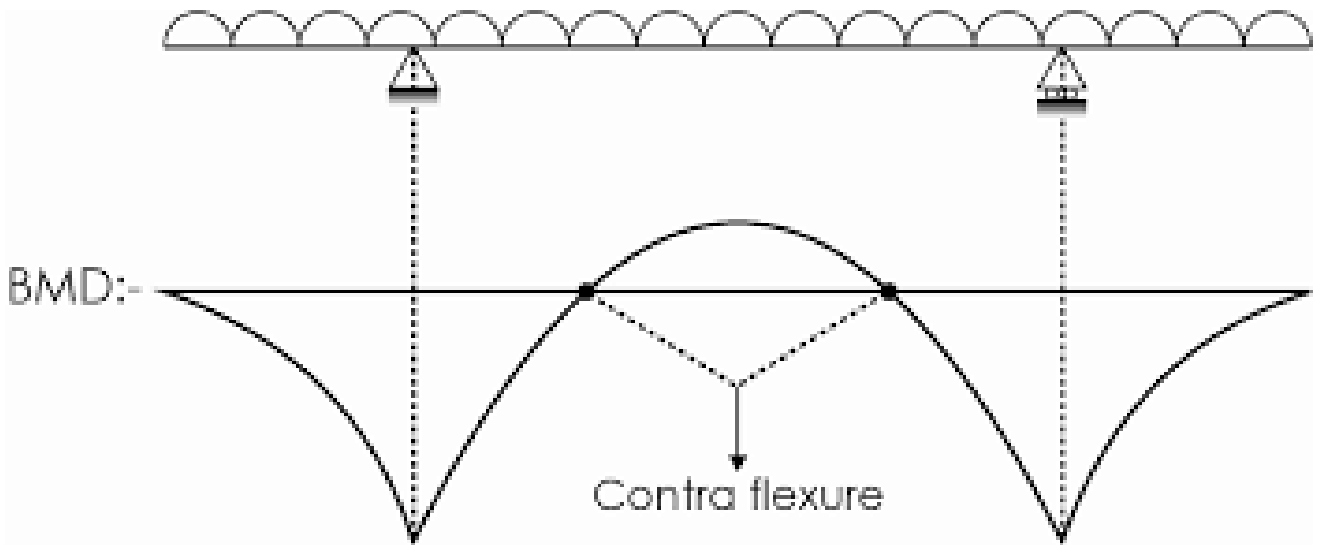
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**16. If the bending moment changes from positive to negative, the section where such change occurs is known as .....**

**[Civil Er. 7th Level 2080/10/27]**

- A. Point of inflection
- B. Crest point
- C. Point of contraflexure
- D. Neutral point

**Correct Answer: C**



Explanation:

✓ Both inflection points and points of contraflexure refer to the same location on a beam where the bending moment is zero, the curvature changes, and the deflected shape transitions from concave up to concave down, or vice-versa.

✓ However here we need have to select one option. Mathematically speaking a point of inflection in a curve is the point where the curvature changes sign. While the term point of contraflexure is used specifically in bending (contra-"flexure"). So, we choose contraflexure as the answer.

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### 17. Centre of mass and centre of gravity of a rigid body.....

[Civil Er. 7th Level 2080/10/27]

- A. Always coincide with each other
- B. Never coincide with each other
- C. May or may not coincide with each other
- D. None of the above

**Correct Answer: C**

Explanation:

✓ Centre of mass and center of gravity coincide only when the gravity acting across the particles of the body is considered constant.

✓ The center of mass is a point that represents the average position of all the mass in an object.

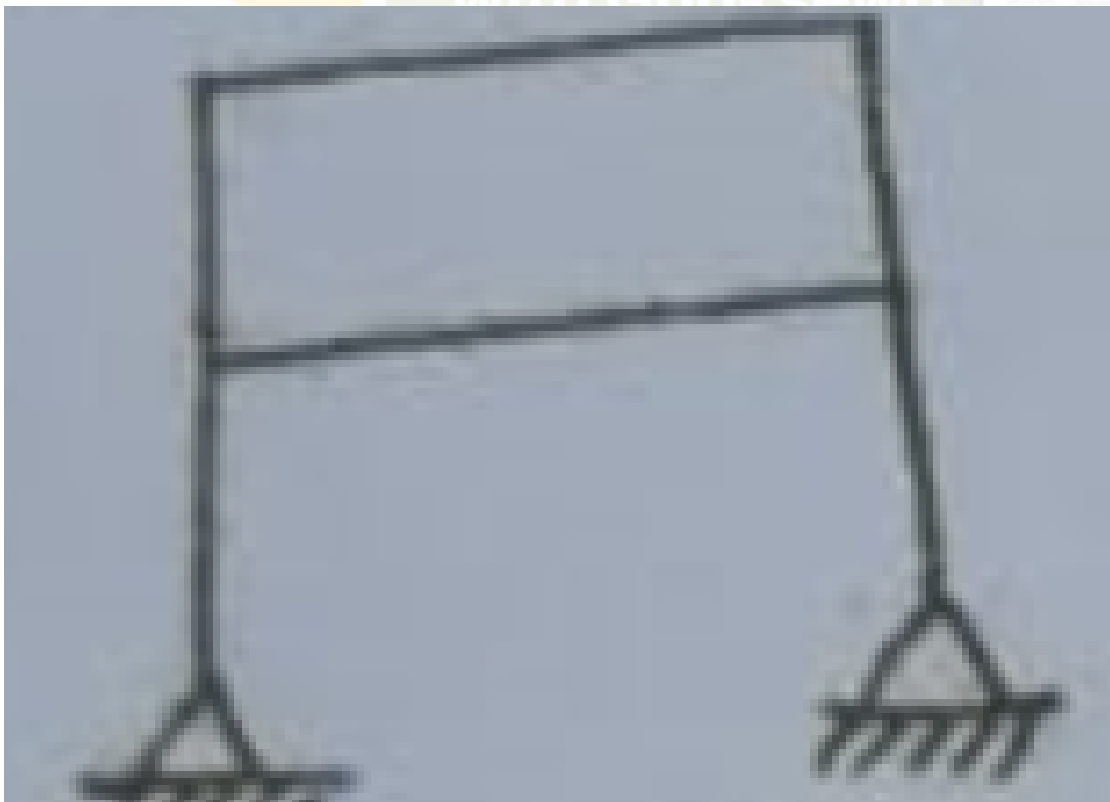
✓ The center of gravity is a point where the entire weight of an object can be considered to be concentrated, and the force of gravity can be assumed to act through this point.

Note: The centre of gravity of the body coincides with centre of mass in uniform gravity or gravity - free space.

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**18. Find the degree of kinematic indeterminacy of the frame shown below if the axial deformation is ignored.**

[Civil Er. 7th Level 2080/10/27]



- A. 14
- B. 10
- C. 8
- D. 6

**Correct Answer: C**

Explanation:

- ✓ In a plane frame, when axial forces are ignored, each joint has two degrees of freedom: one for horizontal displacement and one for rotation about the z-axis.
- ✓ This is because we are assuming that the members are inextensible, meaning they don't change in length, so axial deformation is negligible.
- ✓  $1+2+1+1+2+1=8$

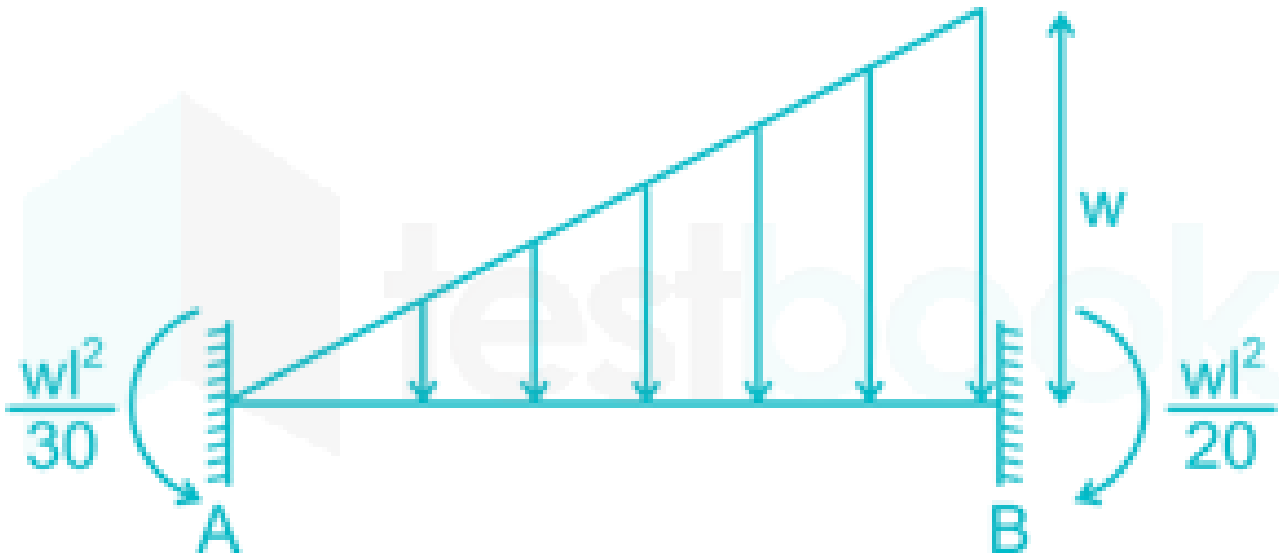
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**19. A fixed beam AB is subjected to a triangular load varying from zero at the end A to W per unit length at end B. What is the ratio of fixed end moment at A to B?**

**[Civil Er. 7th Level 2080/10/27]**

- A. 1/3
- B. 1
- C. 2/3
- D. 3/2

**Correct Answer: C**

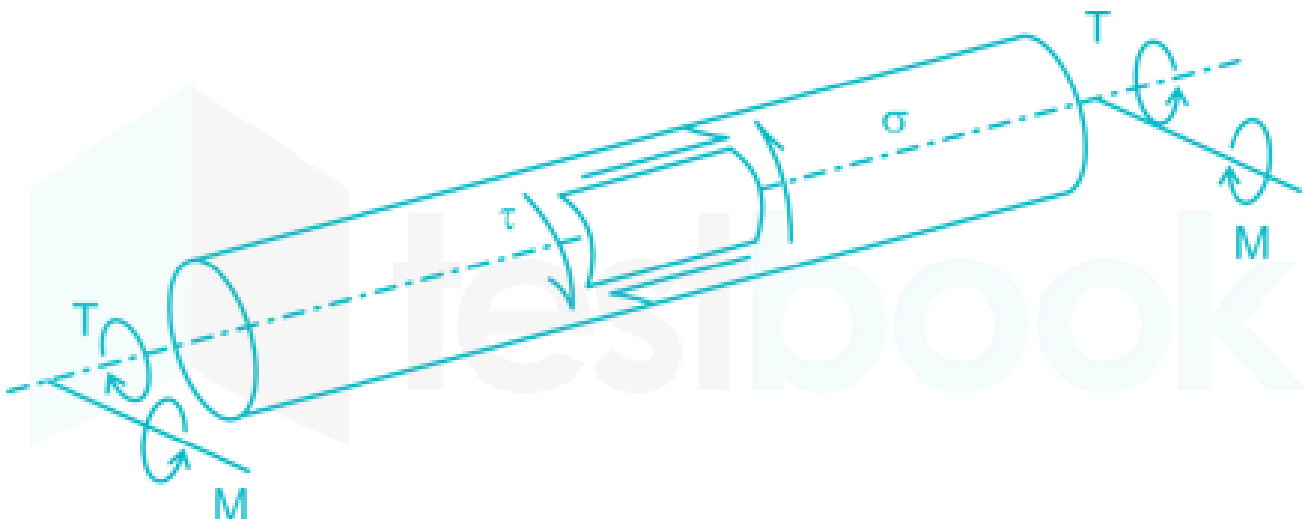


20. A circular shaft is subjected to a twisting moment 'T' and bending moment 'M'. The ratio of maximum bending stress to maximum shear stress is given by.....

[Civil Er. 7th Level 2080/10/27]

- A.  $2M/T$
- B.  $M/T$
- C.  $2T/M$
- D.  $T/M$

**Correct Answer: A**



Explanation:

✓ Maximum bending stress:

$$= 32M/\pi d^3$$

✓ Maximum shear stress:

$$= 16T/\pi d^3$$

Ratio:  $2M/T$

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21. The flexure formula is valid only for.....

[Civil Er. 7th Level 2080/10/27]

- A. Static loads
- B. Dynamic loads
- C. Static load with negligible residual stress
- D. Dynamic load with negligible residual stress

Correct Answer: C

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

$M$  : Moment of resistance

$I$  : Moment of inertia of the section about neutral Axis (NA)

$E$  : Modulus of elasticity of the material

$R$  : Radius of curvature of NA

$\sigma$  : Bending stress at a point

$y$  : Distance of a point from the neutral axis

$$\sigma = \frac{M}{I} y$$

$$\sigma \propto y$$

Explanation:

✓ The flexural formula (also known as the bending equation). It is based on several assumptions, including:

. The material is linearly elastic (follows Hooke's law),

. Loads are static or quasi-static (not rapidly changing),

. Residual stresses are either absent or negligible,

. Plane sections remain plane after bending.

So, static loading with negligible residual stress is the most appropriate condition for the validity of the flexural formula.

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**22. Find the modulus of elasticity (E) of a bar material if its c/s area is A, length is l, applied load is P and elongation is delta**

**[ Civil Er. B & Arch. 2073/11/02 ]**

A.  $\frac{p\Delta}{lA}$

B.  $\frac{\Delta A}{pl}$

C.  $\frac{pA}{\Delta l}$

D.  $\frac{pl}{\Delta A}$

**Correct Answer: D**

Explanation:

✓ We know,

$$E = \text{Stress/Strain}$$

Where:

. Stress= $F/A$

. Strain= $\Delta L/L$

So the formula becomes

$$E = (P.L/A.\Delta L)$$

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**23. Which of the following stress is used in identifying the quality of structural steel?**

[ Civil Er. B & Arch. 2073/11/02 ]

- A. Ultimate stress
- B. Proof stress
- C. Yield stress
- D. None of the above.

**Correct Answer: C**

Explanation:

✓ The stress used to identify the quality of structural steel is typically yield stress (or yield strength).

✓ Yield stress is the point at which steel begins to exhibit large plastic deformation on relatively low or no increase in stress. Knowing this value ensures the steel can support the expected loads without permanent deformation.

✓ In structural engineering, yield stress is the primary criterion for assessing the quality of structural steel.

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**24. The theorem of three moments for the solutions of continuous beam is formulated by**

[ Civil Er. B & Arch. 2073/11/02 ]

- A. Young
- B. Maxwell
- C. Williot-Mohr
- D. Clapeyron

**Correct Answer: D**

Explanation:

- ✓ The theorem of three moments, also known as Clapeyron's theorem
- ✓ Formulated by the French engineer Émile Clapeyron in 1857.
- ✓ This theorem establishes a relationship among the bending moments at three consecutive supports of a continuous beam, aiding in the analysis of such structures in civil engineering and structural analysis.

Some important methods/theorems

- ✓ Moment Distribution Method – Hardy Cross in 1930.
- ✓ Slope Deflection Method – Originally by Heinrich Mandrel and Otto Moht.

Refined version by Maney.

- ✓ Stiffness Matrix Method – R. W. Clough
- ✓ Finite Element Method (FEM) – Ray W. Clough , John H. Argyris
- ✓ Unit Load Method (Virtual Work Method) – Developed by John Bernoulli in 1717.
- ✓ Moment Area Method – Based on Mohr's theorem
- ✓ Conjugate Beam Method- H. Muller Breslau

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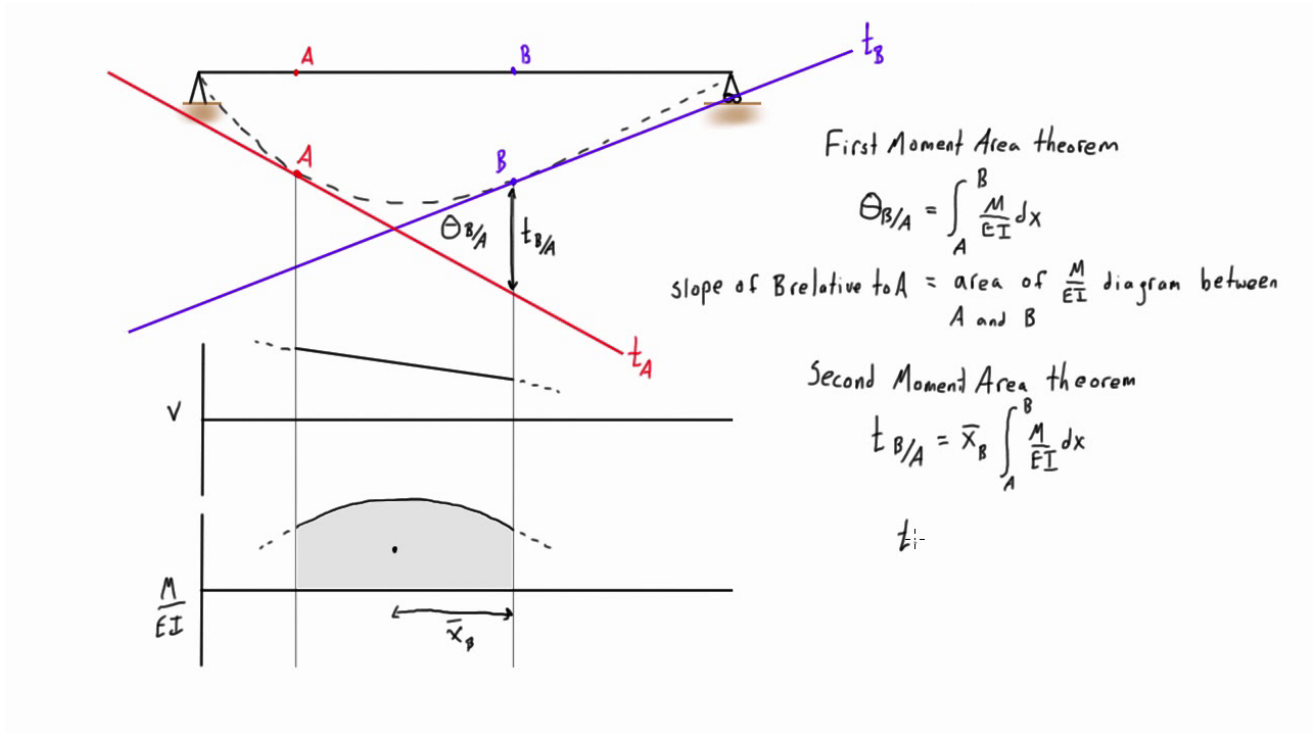
**25. For the application of moment area method, for finding deflection at the section in the beam**

**[ Civil Er. B & Arch. 2073/11/02 ]**

- A. The position of at least one tangent to the elastic curve at any section should be known

- B. The  $M/EI$  diagram must be a triangle
- C. The beam must be of uniform moment of inertia
- D. The B.M. diagram if known is sufficient

**Correct Answer: D**



Explanation:

- ✓ The moment-area method is a structural analysis technique used to determine the slopes and deflections of beams and frames subjected to bending.
- ✓ Developed by Mohr, it utilizes two key theorems:
- ✓ Change in Slope: The difference in slope between two points on a beam is equal to the area under the moment diagram divided by the flexural rigidity  $EI$  between those points:

$$\theta_{A/B} = \int_A^B \frac{M}{EI} dx$$

- ✓ Tangential Deviation: The vertical deviation of a point from a tangent line drawn at another point is given by the first moment of the area under the moment diagram:

$$t_{A/B} = \int_A^B \frac{M}{EI} \bar{x} dx$$

✓ This method simplifies calculations for beams with various loading conditions and is particularly effective for statically determinate structures

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**26. Wind load mainly depends on**  
[ Civil Er. B & Arch. 2073/11/02 ]

- A. Velocity of the wind
- B. Shape and height of the bldg.
- C. Texture of the building, surface and stiffness
- D. All of the above

**Correct Answer: D**

Explanation:

✓ Wind load constitutes a primarily horizontal force resulting from air movement relative to earth.

✓ The IS-875(Part 3)-1987 provides comprehensive details for calculating wind loads on structures.

✓ Wind load mainly depends on wind speed, the shape and size of structure and the surrounding terrain and environment. It also depends on the building's height, roof shape, and it has openings like doors and windows.

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**27. The slope deflection method is a structural analysis for**  
[ Civil Er. B & Arch. 2073/11/02 ]

- A. Beams and columns

- B. Foundation
- C. Column only
- D. Beam only

**Correct Answer: A**

Explanation:

✓ Slope deflection method is a displacement method. In this method, unknowns are taken as a joint replacement.

✓ In slope deflection method, all joints are considered rigid.

✓ It is generally used for the analysis of statically indeterminate structure such as beam, frame and columns.

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**28. In the slope deflection equations, the deformations are considered to be caused by**

**[ Civil Er. B & Arch. 2073/11/02 ]**

- A. Bending moment and shear force
- B. Bending moment only
- C. Shear force and axial force
- D. Bending moment, shear force and axial force

**Correct Answer: B**

Explanation:

The general slope deflection equation is given by,

$$M_{AB} = 2E \left( \frac{I}{L} \right) \left[ 2\theta_A + \theta_B - \frac{3}{L} \Delta \right]$$

+

$$(FEM)_{AB}$$

$$M_{BA} = 2E \left( \frac{I}{L} \right) \left[ 2\theta_B + \theta_A - \frac{3}{L} \Delta \right]$$

+

$(FEM)_{BA}$

✓ In this method we relate the frame's internal end moments in terms of its degree of freedom

$\theta_A, \theta_B, \Delta$

. Also the FEM caused by loading is also related (as shown by the last part of above equation).

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**29. The maximum stress used in the analysis of bending beyond elastic limit is**

[ Civil Er. Sanitary 2073/10/25 ]

[ Civil Er. Hydro 2071/11/14 ]

- A. Ultimate stress
- B. Allowable's stress
- C. Yield stress
- D. All of the above

**Correct Answer: C**

Explanation:

✓ When analyzing bending beyond the elastic limit, we consider the yield stress, because:

. Elastic limit is the point up to which the material behaves elastically (i.e., returns to original shape after load removal).

. Beyond this, the material starts to yield (permanent deformation).

So, the maximum stress considered for design or analysis in plastic bending is yield stress.

. ✓ Allowable stress is used in elastic design, with safety factor.

. ✓ Ultimate stress is the max stress before failure.

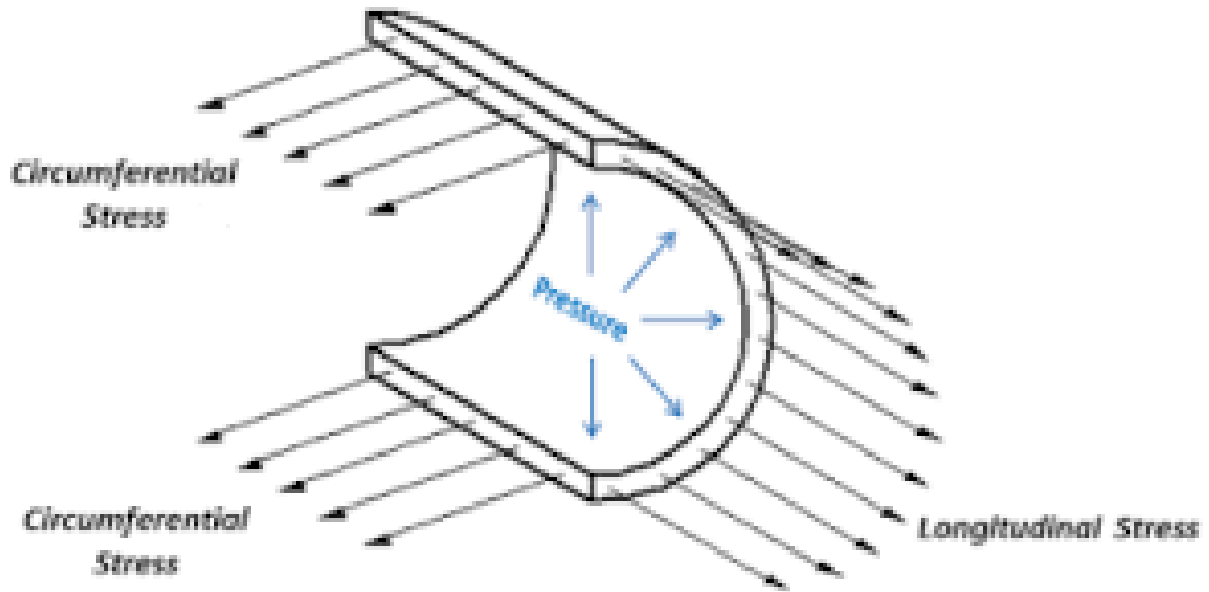
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**30. Hoop stress is**

**[ Civil Er. Sanitary 2073/10/25 ]**

- A. Compressive
- B. Circumferential tensile stress
- C. Radial stress
- D. None of the above.

**Correct Answer: B**



Explanation:

✓ Hoop Stress (Circumferential Stress):

This is the stress acting along the circumference of the cylinder and is caused by the fluid pressure trying to split the cylinder longitudinally.

$$\sigma_h = \frac{p \cdot r}{t}$$

P = internal pressure,

r = internal radius of the shell,

t = thickness of the shell.

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**31. The stress due to temperature change depends on**

**[ Civil Er. Sanitary 2073/10/25 ]**

- A. Length of member
- B. Area of cross section
- C. End supporting condition
- D. None of the above

**Correct Answer: C**

Explanation:

✓ The stress due to temperature change primarily depends on end support conditions (option c). When a material is constrained (e.g., fixed at both ends), it cannot expand or contract freely, leading to the development of thermal stress. While the length of the member and area of cross-section can influence stress distribution, the key factor in inducing thermal stress is how the material is supported and constrained during temperature changes. Therefore, option c is correct.

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### 32. The centre of gravity of a rectangle lies at a point where

[ Civil Er. Sanitary 2073/10/25 ]

- A. Its diagonal intersect
- B. Mid-point of its longest side
- C. Mid-point of its shortest side
- D. None of the above

**Correct Answer: A**

Explanation:

- ✓ Centre of gravity always lies on the line of symmetry. For 2-D figures the intersection of any two lines of symmetry if present gives the centre of gravity.
- ✓ The centre of gravity of rectangle (also known as centroid) is located at the point where its two diagonals intersect. This point represents the balance point of the rectangle.

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### 33. Moment of inertia about the neutral axis of a beam having rectangular cross section with width and depth 'd' is given by

[ Civil Er. Sanitary 2073/10/25 ]

A.  $\frac{bd^3}{12}$

B.  $\frac{bd^2}{6}$

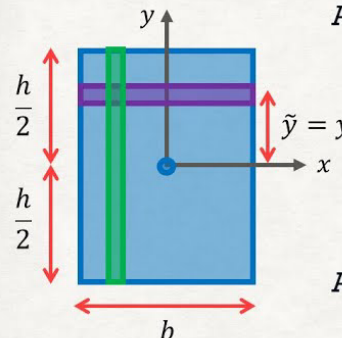
C.  $\frac{bd^2}{3}$

D.  $\frac{bd^3}{3}$

**Correct Answer: A**

**Moment of Inertia of a Rectangle:**

We can apply the preceding formula to determine the moment of inertia for a **rectangle**. As the moment of inertia is dependant on where the axis is located, we will set the origin of the axis at the **centroid** of the rectangle:



About the  $x$  Axis ( $I_x$ ):

$dA = b \cdot dy$

$$I_x = \int \tilde{y}^2 dA = \int_{-h/2}^{h/2} by^2 dy = \frac{b}{3} \left[ \left(\frac{h}{2}\right)^3 - \left(-\frac{h}{2}\right)^3 \right] = \frac{bh^3}{12}$$

About the  $y$  Axis ( $I_y$ ):

$$I_y = \int \tilde{x}^2 dA = \int_{-b/2}^{b/2} hx^2 dx = \frac{h}{3} \left[ \left(\frac{b}{2}\right)^3 - \left(-\frac{b}{2}\right)^3 \right] = \frac{hb^3}{12}$$

Moment of Inertia of a Rectangle:

$I_x = \frac{bh^3}{12}$	$I_y = \frac{hb^3}{12}$
-------------------------	-------------------------

Explanation:

✓ Replace h with d , we get

$$I = \frac{b \cdot d^3}{12}$$

**34. Modulus of Elasticity is known as**

**[ Civil Er. General 2073/11/16 ]**

A. Multiplication of direct stress and strain

B. Ratio of direct stress to strain within limit of proportionality

- C. Equal to direct stress to strain
- D. None of the above

**Correct Answer: B**

Explanation:

Modulus of elasticity or coefficient of elasticity:

✓ It is defined as the ratio of stress to the the corresponding strain produced, within limit of proportionality.

. It is written as,

$$K = (\text{Stress}/\text{Strain})$$

✓ Young's modulus is also known as modulus of elasticity.

Note: Shear modulus is also known as modulus of rigidity.

✓ The ratio of shear stress and shear strain is called shear modulus.

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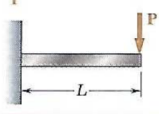
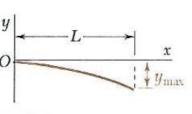
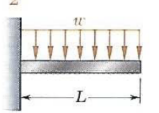
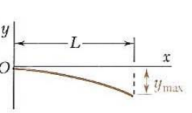
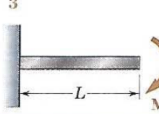
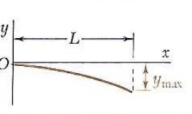
**35. Cantilever beam loaded at free end and also at middle of the beam, will have maximum bending moment at**

**[ Civil Er. General 2073/11/16]**

- A. Free end of the beam
- B. Middle of the beam.
- C. Between Middle and free end of the beam.
- D. Fixed end of the beam

**Correct Answer: D**

## Appendix: Beam deflection formulae

Beam and Loading	Elastic Curve	Maximum Deflection	Slope at End	Equation of Elastic Curve
		$-\frac{PL^3}{3EI}$	$-\frac{PL^2}{2EI}$	$y = \frac{P}{6EI}(x^3 - 3Lx^2)$
		$-\frac{wL^4}{8EI}$	$-\frac{wL^3}{6EI}$	$y = -\frac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
		$-\frac{ML^2}{2EI}$	$-\frac{ML}{EI}$	$y = -\frac{M}{2EI}x^2$

### Explanation:

- ✓ For a cantilever beam loaded at the free end and also in the middle, the maximum bending moment occurs at the fixed end of the beam.
- ✓ This is because the bending moment is highest where the beam is anchored, and it decreases towards the free end where it is zero.
- ✓ The moment distribution varies along the length of the beam, but the peak value is always at the fixed support.

## 36. Limit strength for concrete structure in compression should be

[ Civil Er. General 2073/11/16]

- A. Crushing strength
- B. Modulus of rupture
- C. Yield stress
- D. Buckling

**Correct Answer: A**

### Explanation:

- ✓ For concrete structures in compression, the limit strength is governed by the

crushing strength of concrete. This is the maximum compressive stress that concrete can withstand before failure.

- ✓ Crushing strength refers to the compressive strength of concrete, typically tested using a cube or cylinder.
- ✓ Modulus of rupture refers to the flexural (bending) strength, not compression.
- ✓ Yield stress is more relevant to ductile materials like steel, not concrete.
- ✓ Buckling is a failure mode in slender compression members, but the limit strength in compression of concrete itself is defined by its crushing strength.

---

**37. Find the number of member in a structure if the number of joints is 4 for a determinate structure**

[ Civil Er. General 2073/11/16]

[Civil Er. Sanitary 2069/10/08]

- A. 3
- B. 5
- C. 4
- D. 6

**Correct Answer: B**

Explanation:

- ✓ Let the structure be truss
- ✓ For a determinate structure,  
 $m = 2j - 3$   
on solving ....  $m = 5$

**38. Torsion is produced in a beam due to**  
**[ Civil Er. General 2073/11/16]**

- A. Magnitude of load
- B. Types of support
- C. Eccentricity of load from centroidal axis
- D. Type of beam

**Correct Answer: C**

Explanation:

✓ Torsion in a beam is produced primarily due to:

1. Eccentric Loading: When loads are applied away from the beam's shear center, causing twisting.
2. Asymmetric Cross-Sections: Non-symmetrical beam shapes can lead to uneven distribution of stresses, resulting in torsion.
3. External Moments: Application of moments at points not aligned with the shear center can induce torsional effects.

Note: Shear center is a point through which if the external force passes, then the section will be subjected to bending only and there will be no twisting of the section

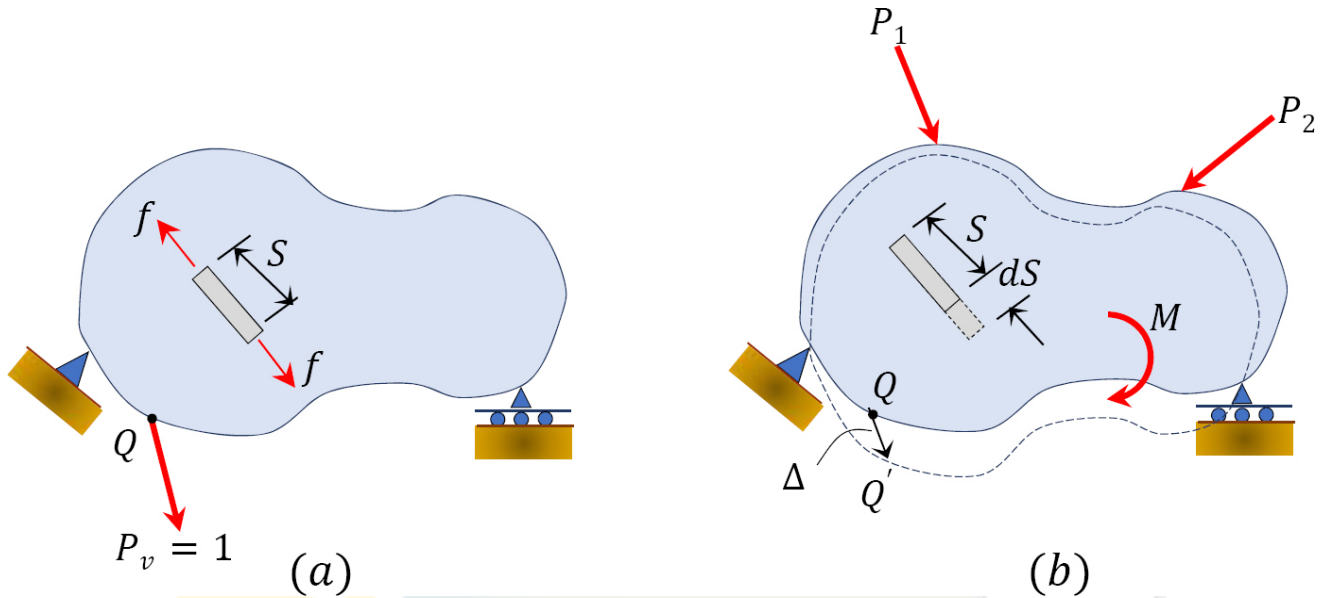
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**39. Unit load method is used to determine**  
**[ Civil Er. General 2073/11/16]**

- A. Slope and deflection
- B. Combined load on beam

- C. Vertical load
- D. Deflection only

**Correct Answer: A**



Explanation:

✓ The unit load method is used to determine the slope and deflection at specified points in beams, frames, or trusses. This method involves applying a virtual unit load at the point of interest and using the principle of virtual work to relate external and internal work, allowing for the calculation of deflections in both statically determinate and indeterminate structures.

✓ The unit load method is derived from Castigliano's theorem.

✓ Based on the principle of conservation of energy.

---

40. The moment of inertia of a triangular section about its CG is,  
 [ Civil Er. General 2073/11/16]

A.  $\frac{bh^3}{36}$

B.  $\frac{bh^3}{12}$

C.  $\frac{bh^3}{2}$

D.  $\frac{bh^3}{64}$

**Correct Answer: A**

Explanation:

About base is

$$\frac{bh^3}{12}$$

.

MOI of some figures about centroidal axis.

give me the list in a single line the Moment of inertia of different other common shapes about their cg

Here is a list of the moment of inertia for different common shapes about their centroidal axes:

- Rectangle:

$$I_x = \frac{1}{12} bh^3$$

- Triangle:

$$I_x = \frac{1}{36} bh^3$$

- Circle:

$$I = \frac{\pi}{4} r^4$$

- Semi-Circle:

$$I_x = \frac{\pi r^4}{8}$$

- Quarter Circle:

$$I_x = \frac{\pi r^4}{16}$$

- Hollow Circular ring (Annulus):

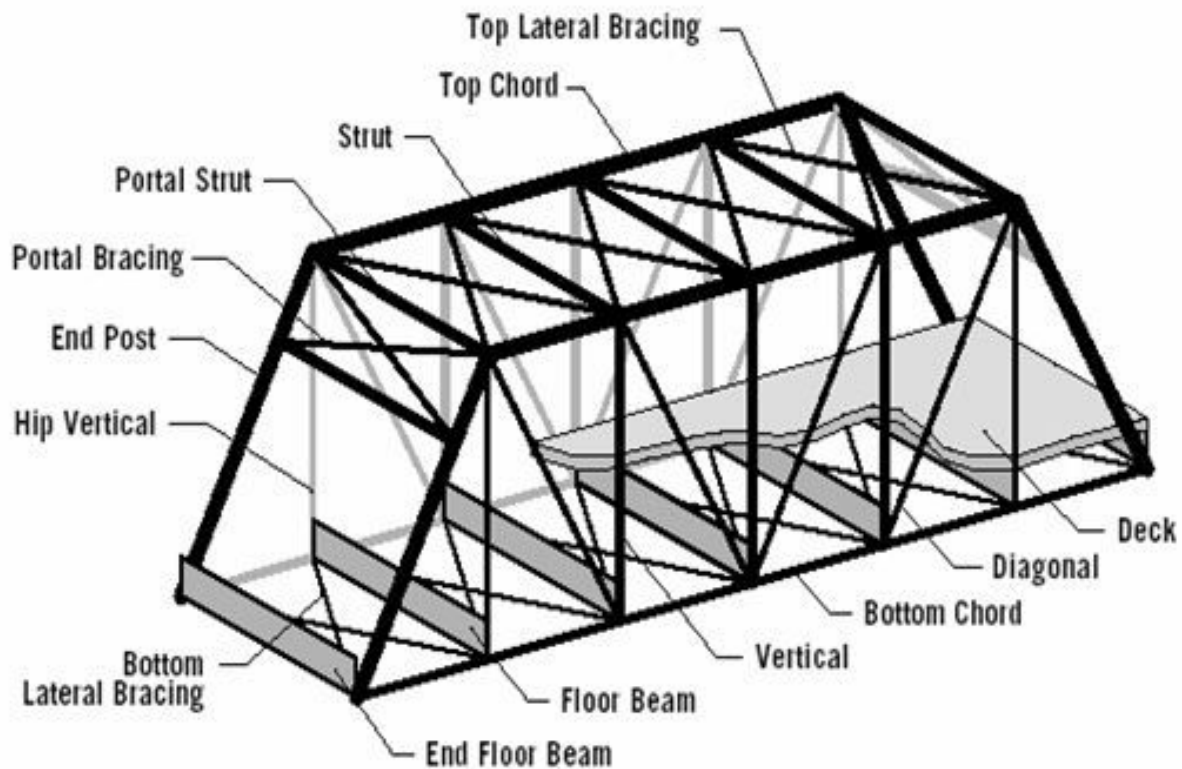
$$I = \frac{\pi}{4} (r_o^4 - r_i^4)$$

---

**41. Hudson's formula gives the dead weight of a truss bridge as a function of [ Civil Er. Highway 2071/11/9]**

- A. bottom chord area
- B. top chord area
- C. effective span of bridge
- D. heaviest axle load of engine

**Correct Answer: A**



Explanation:

- ✓ Hudson's formula calculates the dead weight of a truss bridge based on the area of the bottom chord.
- ✓ The formula is expressed as:  $w = 0.75 A$   
 where,  $w$  represents the weight of the truss and bracing in N/m, and  $A$  is the net area of the largest chord truss in  $\text{mm}^2$ .
- ✓ Formula emphasizes the importance of the bottom chord area in determining the overall structural weight of the bridge

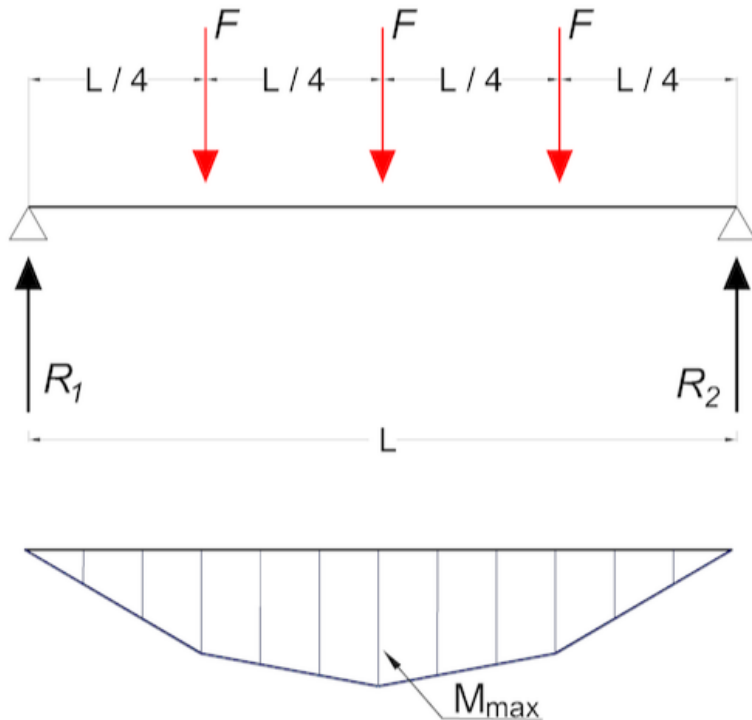
**42. The maximum bending moment due to a moving load on a simply supported beam occurs**

**[ Civil Er. Highway 2071/11/9]**

- A. at the mid span
- B. at the supports

- C. under the load.
- D. anywhere on the beam

**Correct Answer: C**



Explanation:

✓ The maximum bending moment occurs at the point of application of the load as the Bending Moment diagram always has a peak under the load. To be more specific the the maximum bending moment due to a moving load on a simply supported beam occurs under the load when the load is situated at midspan of the beam.

---

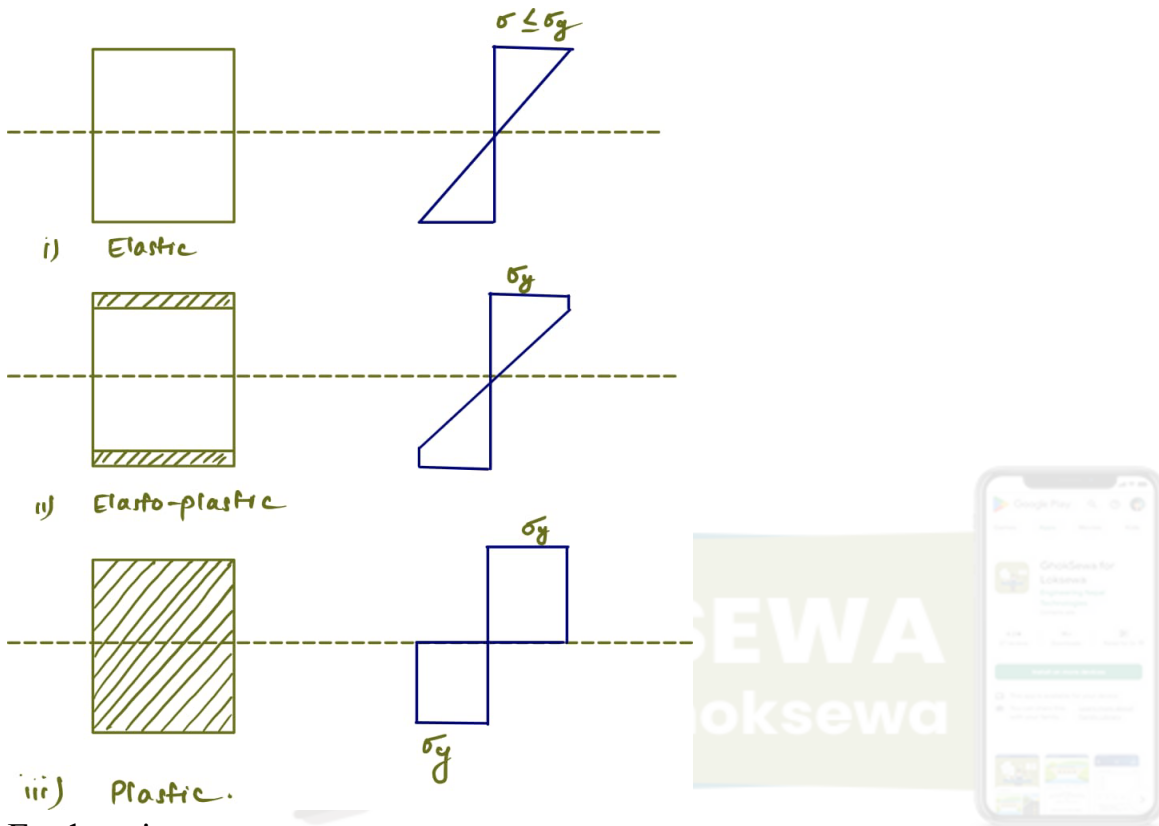
**43. The Yield moment of a cross section is defined as the moment that will just produce the yield stress in**

**[ Civil Er. Highway 2071/11/9]**

- A. the outer most fibre of the section

- B. the inner most fibre of the section
- C. the neutral fibre of the section
- D. the fibre everywhere

**Correct Answer: A**



Explanation:

✓ The flexure formula for beam holds true only for materials under linear elastic behaviour. However when the BM stress is increased the outermost fiber reaches yield stress first since

$$\sigma = \frac{My}{I}$$

Since  $y$  is greatest for the outer fiber it reaches yielding first.

**44. In case of a simply supported rectangular beam of span  $L$  and loaded**

with a central load,  $W$ , the length of elasto-plastic zone of the plastic hinge is  
 [ Civil Er. Highway 2071/11/9]

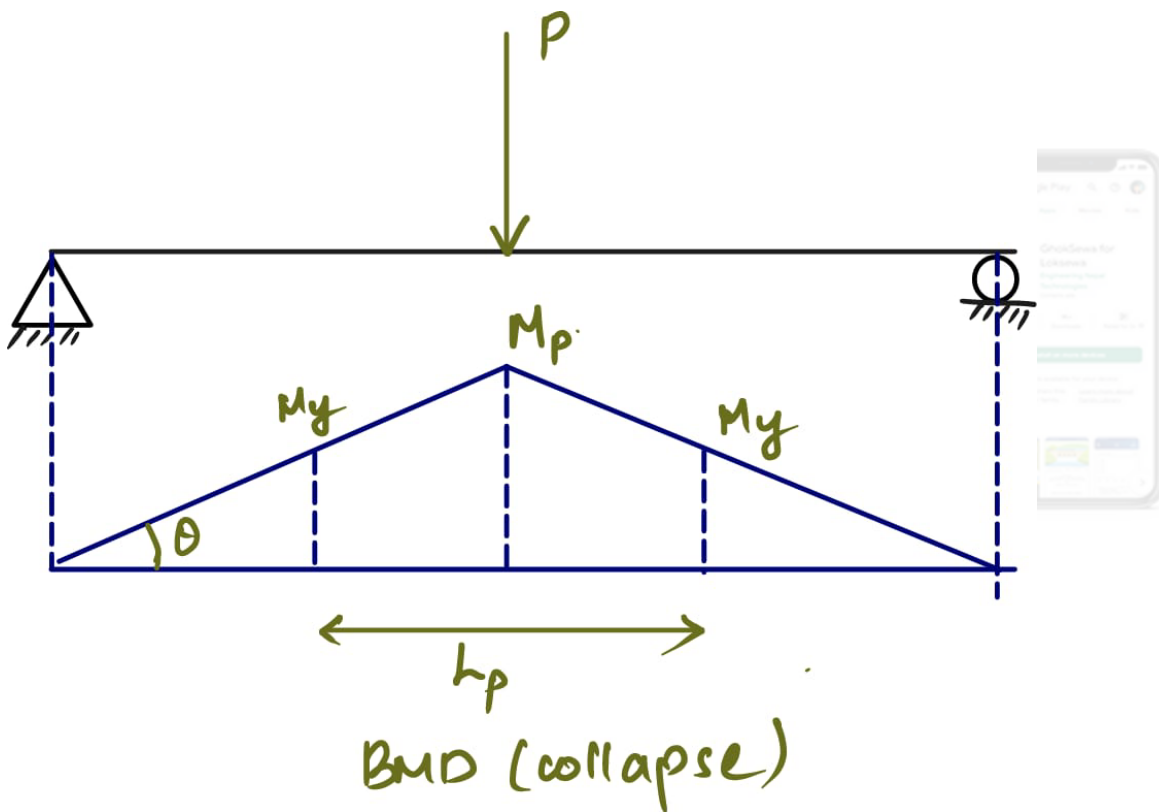
A.  $\frac{l}{2}$

B.  $\frac{l}{3}$

C.  $\frac{l}{4}$

D.  $\frac{l}{8}$

**Correct Answer: B**



Explanation:

✓ For a point load length of elasto plastic region is given by,

$$L_p = \left[ 1 - \frac{1}{SF} \right] L$$

L

where, SF = shape factor of the section.

L = length of beam

For rectangular section  $SF = 1.5$

So  $L_p = 1/3 L$

Detailed Derivation and Solution:

1.

$$\frac{M_p}{M_y} = S.F = \frac{3}{2}$$

2.

$$\tan \theta = \frac{M_p}{L/2} = \frac{M_y}{L/2 - L_p/2}$$

3. Rearranging:

$$\frac{M_y}{M_p} = 1 - \frac{L_p}{L}$$

4. Final expression for

$$L_p = L \left( 1 - \frac{1}{S.F} \right)$$

5. Substituting

$$S.F = \frac{3}{2}$$

we get,

$$L_p = L \left( 1 - \frac{2}{3} \right) = \frac{1}{3} L$$

✓ For a circular section the length is

$$\frac{2}{5} l$$



Note:

✓ For a udl across the span length of elasto plastic region is given by,

$$L_p = L \sqrt{1 - \frac{1}{SF}}$$

Since the BMD is a parabola.

Note: for I- section (L/5)

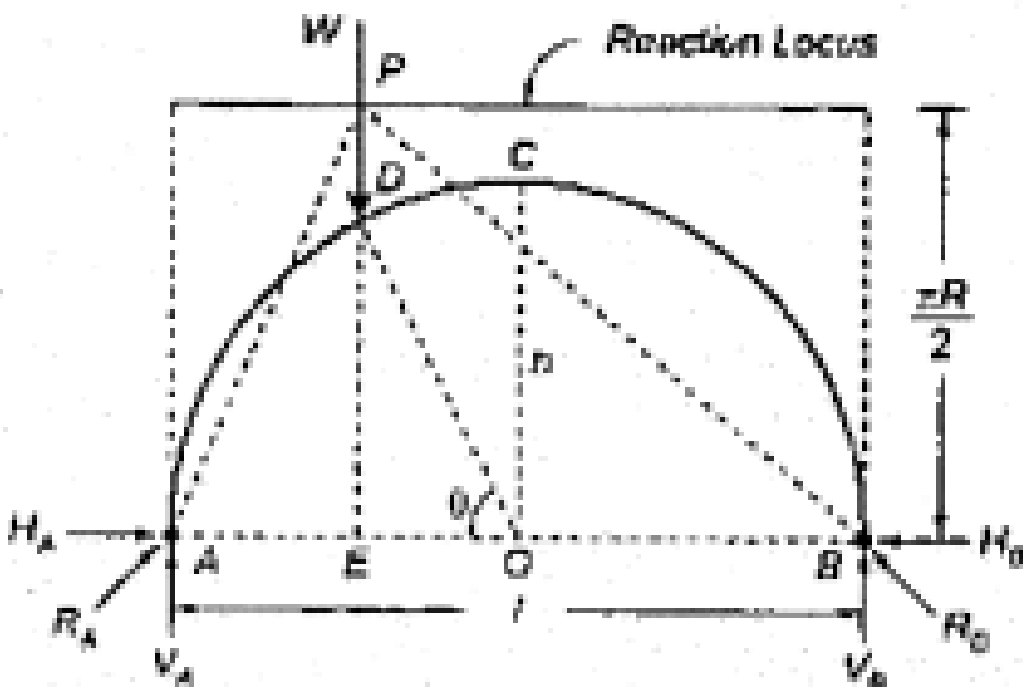
45. The reaction locus of a two hinged semicircular arch, is  
 [ Civil Er. Highway 2071/11/9]

- A. straight line
- B. parabola
- C. circle
- D. hyperbola


**LOKSEWA**  
 with Ghoksewa



**Correct Answer: A**



The reaction locus of a two hinged semicircular arch, is a straight line.

✓ The locus of the reaction of a two-hinged semicircular arch is a straight line. This line is parallel to the line joining the abutments and reaches a height of

$$\frac{\pi R}{2}$$

at its maximum point.

✓ In contrast, the locus for a two-hinged parabolic arch forms a parabolic curve.

---

**46. A material is said to be perfectly elastic if**

[ Civil Er. Highway 2071/11/9]

[ Note: 2069/10/06 Civil Er.Highway explanation]

[Civil Er. 6th 2079/02/21]

- A. it regains its original shape on removed of the load
- B. it regains its original shape partially on removal of the load
- C. it does not regain its original shape at all
- D. None of the above

**Correct Answer: A**

---

**47. If a composite bar of steel and copper is heated, then the copper bar will be subjected to**

[ Civil Er. B & Arch 2071/11/10]

- A. Compression
- B. Shear
- C. Tension
- D. Torsion

**Correct Answer: A**

Explanation:

✓ Since copper has more coefficient of linear expansion than steel, copper will try to expand more while steel will restrain copper from expanding. As a result copper will be in compression and steel in tension.

---

**48. If a three hinged parabolic arch carries a uniformly distributed load on its entire span, every. section of the arch resists only..**

**[ Civil Er. B & Arch 2071/11/10]**

- A. Pure compressive force
- B. Pure tensile force
- C. Shear force
- D. Bending moment

**Correct Answer: A**

Explanation:

✓ A linear arch is a compression member in which the shear force and bending moment is zero throughout the span and it is subjected to normal thrust only.

✓ This arch has a parabolic shape and when subjected to a uniform horizontally distributed vertical load, then from the analysis of cables it follows that only compressive forces will be resisted by the arch.

✓ Under these conditions the arch shape is called a funicular arch because no bending or shear forces occur within the arch.

---

**49. The area under stress strain curve represents**

**[ Civil Er. B & Arch 2071/11/10]**

- A. Workdone
- B. Ductility
- C. Strain energy
- D. Residual stress

**Correct Answer: C**

Explanation:

More specifically it represents the strain energy per unit volume of the material.

Some important terms

- ✓ **Proof Resilience:** The total strain energy stored within the proportional limit.
- ✓ **Modulus of resilience:** Proof Resilience per unit volume of the material. Physically it represents the largest amount of strain energy per unit volume the material can absorb without causing permanent damage to the material.
- ✓ **Modulus of toughness:** Entire area under the stress strain diagram and indicates the maximum amount of strain energy per unit volume the material can absorb just before it fractures.

Note: Strain energy per unit volume is also called the strain energy density.

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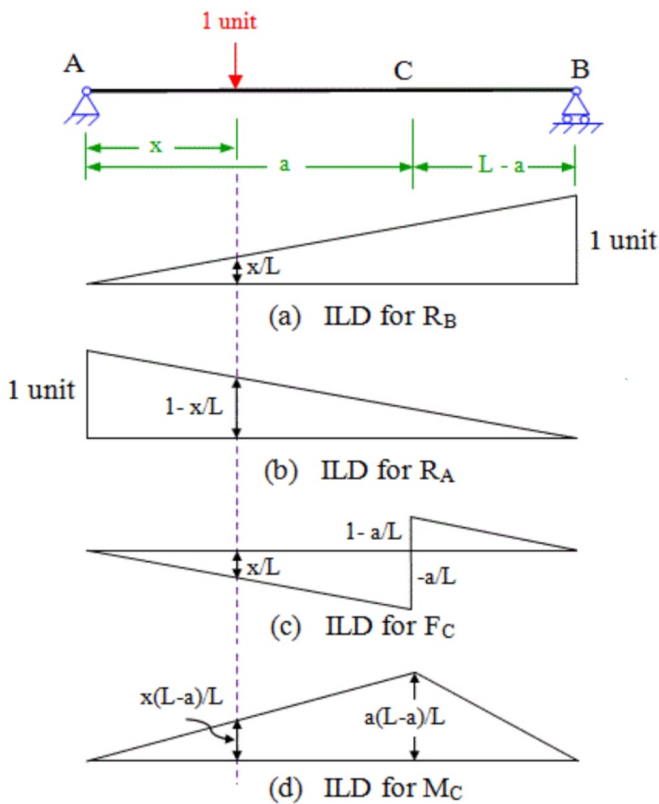
**50. The influence line diagram for reaction at a support of a simply supported beam is**

**[ Civil Er. B & Arch 2071/11/10 ]**

- A. A triangle with ordinate 1. at that support
- B. A triangle with ordinate 1. at other support
- C. A rectangle with ordinate of 1

D. A rectangle with ordinate of 1/2

**Correct Answer: A**



51. The allowable axial tensile stress in rolled mild steel I-Beams and channels is (in  $\text{kg/cm}^2$ )

[ Civil Er. B & Arch 2071/11/10]

- A. 142
- B. 150
- C. 181
- D. 212.5

**Correct Answer: B**

Explanation:

✓ The allowable axial tensile stress in rolled mild steel I-beams and channels is typically 60% of the yield strength of the material.

✓ For mild steel, which often has a yield strength (

$f_y$ 

) of approximately  $250 \text{ kg/cm}^2$ , this results in an allowable axial tensile stress of about  $150 \text{ kg/cm}^2$ .

Other important allowable stress for structural steel:

- ✓ Direct tensile stress:  $0.60 f_y$
- ✓ Direct compressive stress:  $0.60 f_y$
- ✓ Bending tensile stress:  $0.66 f_y$
- ✓ Bending compressive stress:  $0.66 f_y$
- ✓ Shear stress:  $0.40 f_y$
- ✓ Bearing stress:  $0.75 f_y$

---

**52. Maximum shear stress developed in a beam of rectangular section bears a constant ratio to the average shear stress and this ratio is equal to:**

[ Civil Er. B & Arch 2071/11/10]

[ Civil Er. Highway 2071/11/9]

- A. 1.33
- B. 1.50
- C. 2.00
- D. 2.50

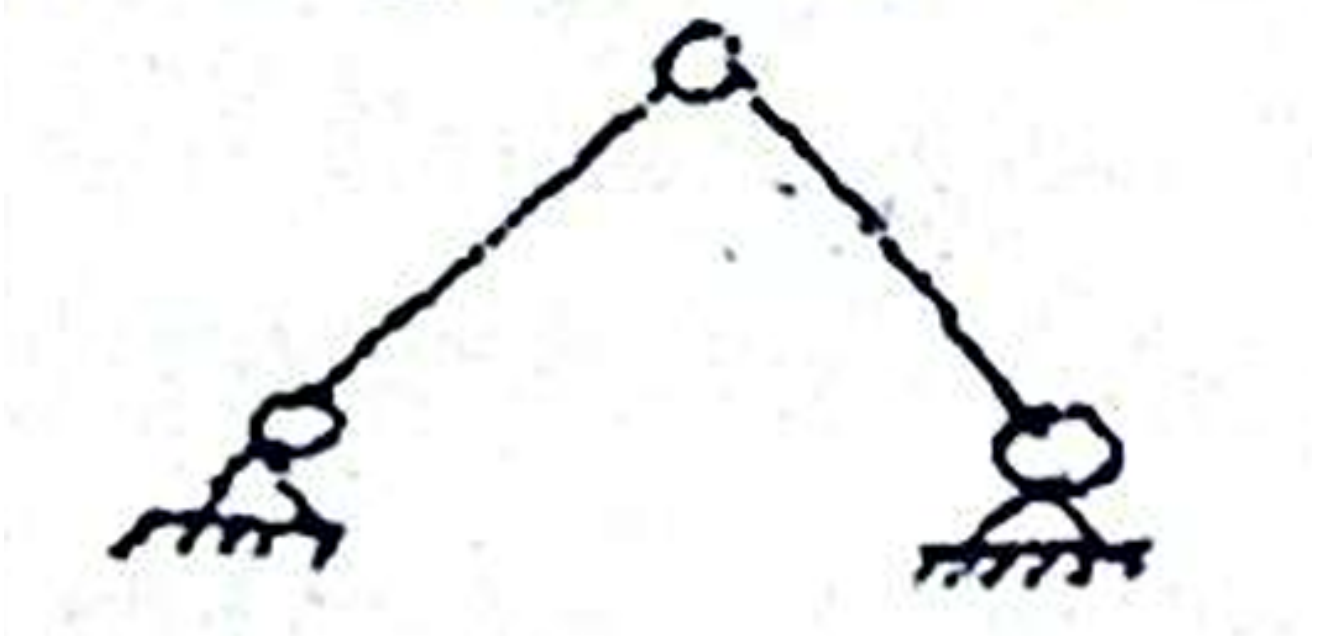
**Correct Answer: B**

Explanation:

- ✓ The ratio of maximum and average shear stresses on a rectangular section is  $3/2$ .
- ✓ The ratio of maximum and average shear stresses in Circular section is  $4/3$ .

53. The degree of Kinematic indeterminacy of the pin-jointed frame shown below is

[ Civil Er. Hydro 2071/11/14]



- A. 0
- B. 1
- C. 2
- D. 4



Correct Answer: C

Degree of kinematic indeterminacy	Type of structure
$D_k = 2j - r_e$	Pin jointed plane frame
$D_k = 3j - r_e$	For 2d rigid frame when all members are axially extensible
$D_k = 3j - r_e - m$	For 2d rigid frame if m members are axially inextensible/rigid
$D_k = 3(j + j') - r_e - m + r_r$	For 2d rigid frame with hybrid joint
$D_k = 6(j + j') - r_e - m + r_r$	For 3d rigid frame
$D_k = 2(j + j') - r_e - m + r_r$	For 2D pin jointed truss
$D_k = 3(j + j') - r_e - m + r_r$	For 3D pin jointed truss

Explanation:

✓ Degree of kinematic indeterminacy of a pin joint frame/truss is given by,

$$2j - r.$$

here,  $j = 3$  and  $r = 4$

---

**54. Castigliano's theorems are valid for:**

[ Civil Er. Hydro 2071/11/14 ]

- A. elastic structure
- B. truss
- C. beam
- D. linear structure

**Correct Answer: A**

Explanation:

Castigliano's First Theorem:

✓ The partial derivative of the total strain energy with respect to a displacement gives the corresponding force at that point.

✓ It applies to both linearly and non-linearly elastic structures, provided the temperature is constant and the supports are fixed.

$$P = \frac{\partial U}{\partial \delta}$$

Castigliano's Second Theorem:

✓ The partial derivative of the total strain energy with respect to a force gives the corresponding displacement at the point of application in its line of action.

✓ This theorem is valid only for linearly elastic structures under constant temperature

and fixed supports.

$$\delta = \frac{\partial U}{\partial P}$$

Note that in both cases:

- ✓ Force can refer to a point load or a moment.
- ✓ Displacement can refer to linear translation or angular rotation.

---

**55. The moment of inertia, of a triangular section with base of 4cm and a depth of 9 cm, along its centroidal axis is equal to:**

[ Civil Er. Hydro 2071/11/14]

A.  $36cm^4$

B.  $81cm^4$

C.  $9cm^4$

D.  $4cm^4$

**Correct Answer: B**

Explanation:

✓

$$I = \frac{bh^3}{36}$$

Where:

-

$$b = 4 \text{ cm}$$

$$h = 9 \text{ cm}$$

Substituting the values:

$$I = \frac{4 \times (9)^3}{36} = \frac{4 \times 729}{36} = \frac{2916}{36}$$
$$= 81 \text{ cm}^4$$

Thus, the moment of inertia of the triangular section about its centroidal axis is

$$81 \text{ cm}^4$$

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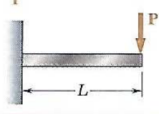
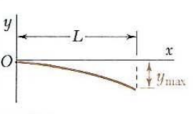
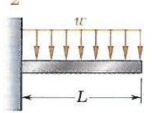
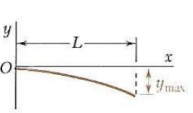
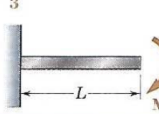
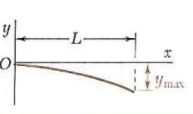
56. A cantilever subjected to a uniformly distributed load of intensity  $w/m$  is propped by a rigid prop to the same level of the support. The reaction at the prop is

[ Civil Er. Hydro 2071/11/14]

- A.  $3/8 wl$
- B.  $wl/2$
- C.  $wl$
- D.  $5/8wl$

**Correct Answer: A**

## Appendix: Beam deflection formulae

Beam and Loading	Elastic Curve	Maximum Deflection	Slope at End	Equation of Elastic Curve
		$-\frac{PL^3}{3EI}$	$-\frac{PL^2}{2EI}$	$y = \frac{P}{6EI}(x^3 - 3Lx^2)$
		$-\frac{wL^4}{8EI}$	$-\frac{wL^3}{6EI}$	$y = -\frac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
		$-\frac{ML^2}{2EI}$	$-\frac{ML}{EI}$	$y = -\frac{M}{2EI}x^2$

Explanation:

$$\frac{wL^4}{8EI} = \frac{RL^3}{3EI}$$

(By compatibility at the prop)

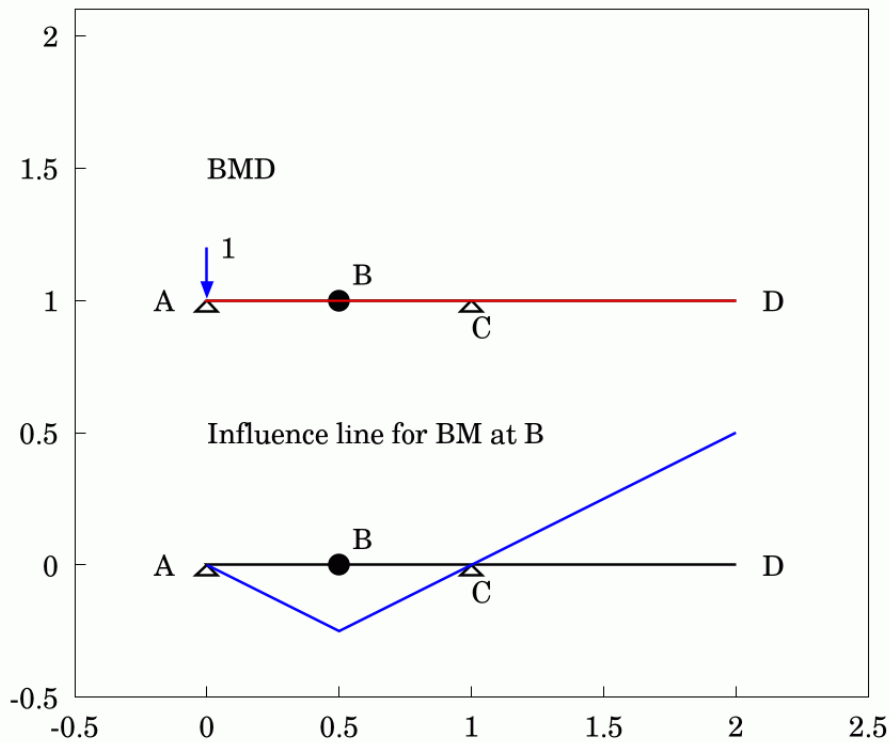
$$R = \frac{3wL}{8}$$

57. The ordinates of influence line diagram for Bending Moment always have the dimension of

[ Civil Er. Hydro 2071/11/14 ]

- A. Force
- B. Length
- C. Force \*Length
- D. Force/Length

**Correct Answer: B**



Explanation:

- ✓ Since ordinate (length) \* force gives moment.
- ✓ Remember unit load is introduced while calculating ILD is without any dimension so that we can multiply it with whatever force (with any unit) we want.
- ✓ For shear and other force related quantity the ordinate has no dimension.

**58. A member which does not regain its original shape after removing a load producing deformation is called**

[ Civil Er. Hydro 2071/11/14]

- A. Plastic
- B. elastic
- C. rigid
- D. None of the above

**Correct Answer: A**

Explanation:

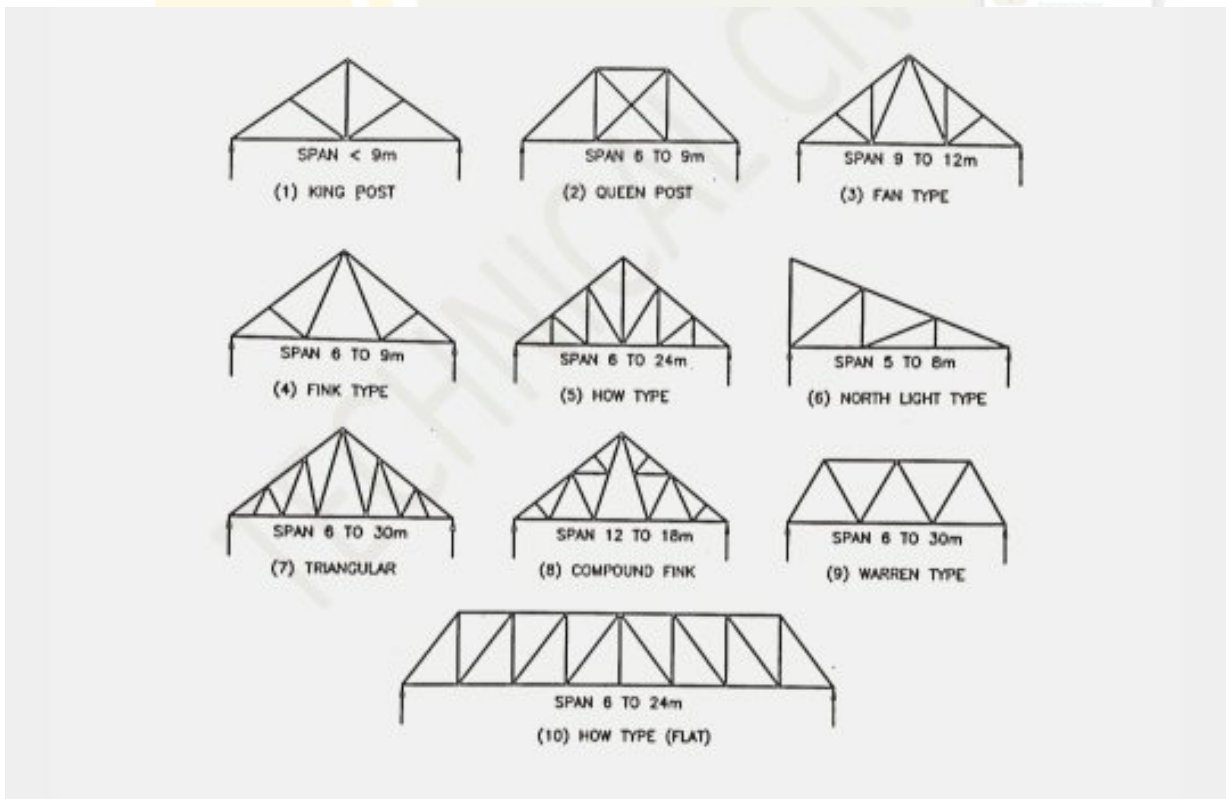
- ✓ Elastic: regains original shape and size on load removal i.e. 0 residual strain
- ✓ Plastic: doesn't regain original shape and size on load removal. permanent strain
- ✓ Rigid: doesn't deform at all in the first place.

**59. For determining the forces in the members of a truss by graphic static, the method of substitution will be required in the case of**

**[ Civil Er. Hydro 2071/11/14 ]**

- A. Fink truss
- B. Howe truss
- C. King post truss
- D. Warren truss

**Correct Answer: A**



Explanation:

- ✓ The graphical method involves drawing it's truss and loads to scale and then using graphical techniques to analyze forces and reactions

- ✓ It is useful when no of member in truss is more
- ✓ The example of graphical methods are Bow notation or Columann's graphical method

---

60. Which of the followings is not one of the "Elastic Constants"?

[ Civil Er. Hydro 2071/11/14]

- A. Young's modulus
- B. Poisson's ratio.
- C. Section modulus
- D. Shear modulus

**Correct Answer: C**

Explanation:

- ✓ The section modulus is a geometric property used in structural engineering to measure the bending strength of a cross-section. It is defined as:

$$Z = \frac{I}{y_{\max}}$$

where:

-

$Z$

is the section modulus,

-

$I$

is the moment of inertia of the cross-section about the neutral axis,

-

$y_{\max}$

is the distance from the neutral axis to the most distant point of the cross-section.

---

**61. The amount of work done by the external forces to produce the deformation of a member is equal to**

**[ Civil Er. Hydro 2071/11/14]**

- A. Strain energy stored by member
- B. Stress to the member
- C. Displacement of member
- D. Moment due to the force

**Correct Answer: A**

Explanation:

This is the principle of conservation of energy.

---

**62. Load required to produce unit deflection is known as:**

**[ Civil Er. Hydro 2071/11/14]**

- A. toughness
- B. stiffness
- C. flexibility
- D. None of the above

**Correct Answer: B**

Explanation:

- ✓ Toughness is the ability of a material to absorb energy and deform plastically without fracturing.
- ✓ It represents the area under the stress-strain curve.
- ✓ A tough material can withstand shock and impact loads.
- ✓ Example: Structural steel is tougher than cast iron.

- ✓ Stiffness is the resistance of a structural element to deformation under applied load.
- ✓ A stiff material or structure does not bend or deflect easily.
- ✓ Stiffness=Force/Displacement
- ✓ Flexibility is the ability of a structure to deform easily when subjected to load.
- ✓ It is the inverse of stiffness:
- ✓ Remember from springs.

$$F = kx$$

F = force

k = stiffness

x = deflection

$k = F/x$  i.e Force per unit deflection.

Same analogy to structures.

---

**63. Ductility is the property of**  
[ Civil Er. Hydro 2071/11/14]

- A. Sand
- B. Stone
- C. Steel
- D. Brick

**Correct Answer: C**

Explanation:

- ✓ Ductility: Ductility is often measured quantitatively as the percentage elongation in length or the percentage reduction in area of the specimen prior to failure.

---

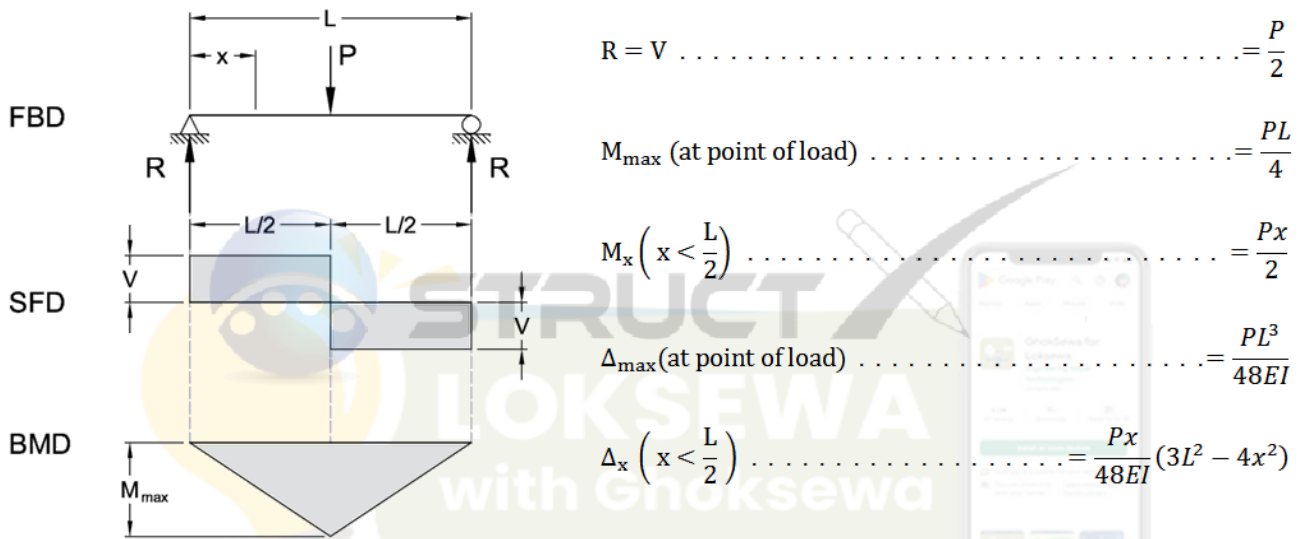
**64. Simply supported beam with a point load at the middle will have**

**maximum bending moment at**

[ Civil Er. B & Arch. 2073/11/02 ][Civil Er. Hydropower 2068/11/14]

- A. First support of the beam
- B. End support of the beam
- C. Middle of the beam
- D. Nearer to first support

**Correct Answer: C**



Explanation:

$$BM_{max} = \frac{PL}{2} \times \frac{L}{2} = \frac{PL}{4}$$

**65. The number of independent equations to be satisfied for static equilibrium of a plane structure**

[ Civil Er. Sanitary 2073/10/25 ]

- A. 1
- B. 2
- C. 3
- D. 6

**Correct Answer: C**

Explanation:

1.  $\sum F_x = 0$ : The sum of all horizontal forces must be zero.
2.  $\sum F_y = 0$ : The sum of all vertical forces must be zero.
3.  $\sum M = 0$ : The sum of all moments about any point must be zero.

**66. The maximum bending moment for a simply supported beam with a uniformly distributed load  $w$ /unit length, is**

[ Civil Er. Highway 2071/11/9 ]

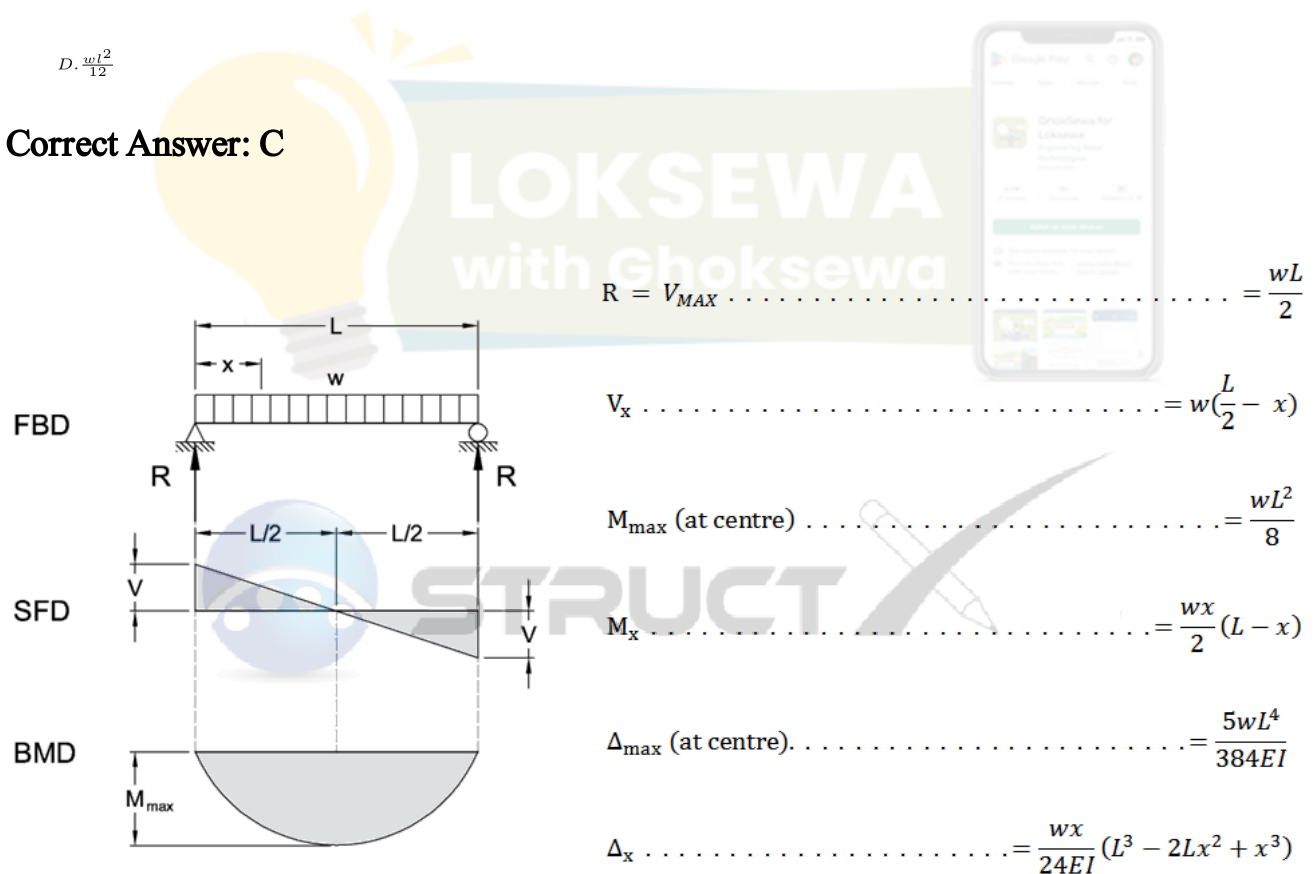
A.  $\frac{wL}{2}$

B.  $\frac{wl^2}{4}$

C.  $\frac{wl^2}{8}$

D.  $\frac{wl^2}{12}$

**Correct Answer: C**



Explanation:

$$BM_{max} = \frac{wL}{2} \times \frac{L}{2} - \frac{wL}{2} \times \frac{L}{4}$$

$$= \frac{wL^2}{8}$$

67. A beam has a solid circular cross-section having diameter 'd' if a section of the beam is subjected to a shear force 'F' the maximum shear stress in the cross section is given by

[ Civil Er. B & Arch 2071/11/10]


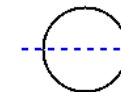
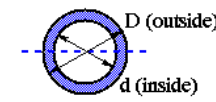
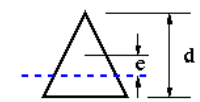
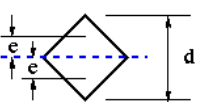
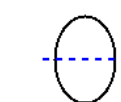
A.  $\frac{4}{3} \frac{F}{\pi d^2}$

B.  $\frac{16F}{3\pi d^2}$

C.  $\frac{8}{3} \frac{F}{\pi d^2}$

D.  $\frac{3}{16} \frac{F}{\pi d^2}$

Correct Answer: B

	$\tau = \frac{3V}{2A}$	$e = 0$
	$\tau = \frac{4V}{3A}$	$e = 0$
	$\tau = \frac{4V}{3A} \left( 1 + \frac{Dd}{D^2 + d^2} \right)$	$e = 0$
	$\tau = \frac{3V}{2A}$	$e = \frac{d}{8}$
	$\tau = \frac{9V}{8A}$	$e = \frac{d}{8}$
	$\tau = \frac{4V}{3A}$	$e = 0$

Explanation:

For a solid circular beam with radius subjected to a shear force , the maximum shear stress is given by:

$$\tau_{\max} = \frac{4F}{3\pi r^2}$$

In terms of diameter:

$$\tau_{\max} = \frac{16F}{3\pi d^2}$$

---

**68. When hinges are at the different level, the height of the crown above the level of the lower hinges is called**

**[ Civil Er. Hydro 2071/11/14]**

- A. Pitch of the arch
- B. Segment of the arch
- C. Rise of the arch
- D. Apex distance

**Correct Answer: C**

Explanation:

✓ Rise of arch: This is the vertical distance between the highest point of arch( the crown) and the level of supports(lower hinges).

---

**69. Consider the following statements:**

**a: The collapse load found in the plastic analysis of a continuous beam is affected by sinking of supports**

**b: Large elastic stresses are caused at the supports due to sinking of supports**

**[Civil Er. General 2071/11/2]**

- A. Both a and b are true
- B. a is true but b is false
- C. Both a and b are false

D. a is false but b is true

**Correct Answer: A**

Explanation:

✓ Sinking supports in a continuous beam do affect the plastic collapse load and also induce large elastic stresses at the supports.

✓ Statement A: The collapse load found in the plastic analysis of a continuous beam is affected by sinking of supports.

This is true because the formation of plastic hinges, which is crucial for determining the collapse load in plastic analysis, is influenced by the support conditions. If a support sinks, it changes the bending moment distribution within the beam, potentially requiring fewer plastic hinges to form for collapse, thus lowering the calculated collapse load.

✓ Statement B: Large elastic stresses are caused at the supports due to sinking of supports.

This is also true. Sinking supports introduce additional bending moments and shear forces at the supports, which can lead to significantly higher elastic stresses at those points. This is especially significant in indeterminate structures where the internal forces redistribute due to support settlement.

---

**70. Consider the following statements:**

**[Civil Er. General 2071/11/2]**

**In the case of close coiled spring carrying an axial loading the spring is subjected to**

**1. Torsion**

## 2. Axial force

## 3. Bending moment

the effect of which can be neglected, of these statements:

- A. 1, 2 & 3 are correct
- B. 1 & 2 are correct
- C. 1 & 3 are correct
- D. 2 & 3 are correct

**Correct Answer: C**

Explanation:

✓ A closed coil helical spring is a mechanical device made of a wire wound in a tight spiral form. It undergoes substantial deflection under load without permanent deformation. In a closed coil spring, the pitch is small, and each turn lies almost perpendicular to the axis of the helix.

✓ Key Terms:

-D: Mean coil diameter

-d: Wire diameter

-n: Number of coils

-l: Length of the wire

-

$\delta$

: Axial deflection

-

$\alpha$

: Angle of helix

-C: Spring index

-W: Axial load on the spring

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## Types of Stresses in a Helical Spring:

1. Direct Shear Stress : Caused by the axial load .
2. Torsional Stress: Caused by the moment .
3. Bending Stress: Caused by the component of the load normal to the spring axis.

### Relevant Formulas:

✓ Length of the wire:

$$l = n \times \pi D$$

✓ Axial Deflection:

$$\delta = \frac{64WD^3n}{Gd^4}$$

Where  $G$  is the modulus of rigidity.

✓ Torsional Shear Stress:

$$\tau_t = \frac{16WD}{\pi d^3}$$

✓ Direct Shear Stress:

$$\tau_d = \frac{W}{\pi d^2}$$

✓ Equivalent Shear Stress (considering direct shear, torsion, and curvature effects):

$$\tau_e = \frac{16WD}{\pi d^3} \times \frac{K}{C}$$

Where:

Wahl's factor ( $K$ ):

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

✓ Closed coil helical springs exhibit complex stress behavior under axial loads, including direct shear, torsional, and bending stresses.

---

**71. The maximum energy stored at elastic limit of a material is called**  
**[Civil Er. General 2071/11/2]**

- A. Resilience
- B. Proof resilience
- C. Modulus of resilience
- D. Bulk resilience

**Correct Answer: B**

Explanation:

(verified)

✓ The maximum energy stored at the elastic limit of a material is called proof resilience. This term refers to the maximum strain energy that can be absorbed by a material without causing permanent deformation. Additionally, the modulus of resilience is defined as the proof resilience per unit volume.

✓ Remember that modulus resilience is given by the area under the curve of the stress-strain diagram up to elastic limit. Since strain energy per unit volume =

$$\frac{1}{2} \text{ stress} \times \text{ strain}$$

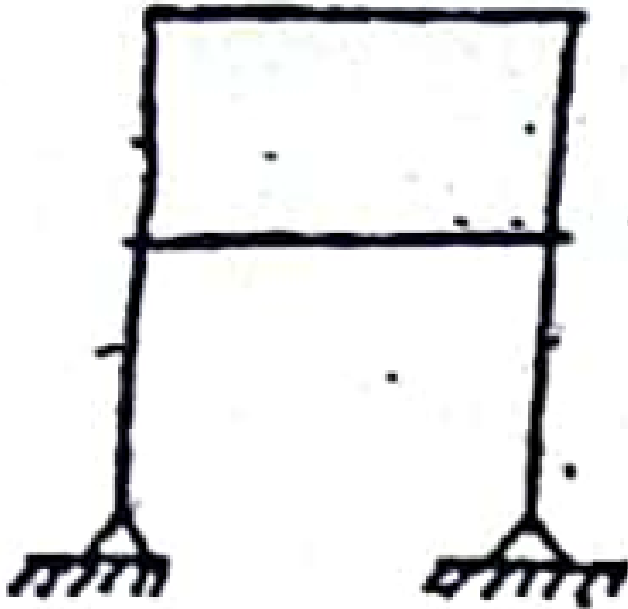
✓ Also, the maximum energy stored per unit volume up to fracture is called as modulus of toughness. It is represented by the whole area under the stress-strain curve.

---

**72. The degree of kinematic indeterminacy of the frame shown below if the**

axial deformation ignored

[Civil Er. General 2071/11/2]



- A. 8
- B. 10
- C. 12
- D. 14

with Ghoksewa

Correct Answer: A

Kinematic indeterminacy		
Joint Type	Possible Displacement/ degree of freedom	Dk
Plane frame	$\Delta x, \Delta y, \theta$	$3j - r$
Space frame	$\Delta x, \Delta y, \Delta z, \theta x, \theta y, \theta z$	$6j - r$
Plane truss	$\Delta x, \Delta y$	$2j - r$
Space truss	$\Delta x, \Delta y, \Delta z,$	$3j - r$

Explanation:

✓ Kinematic indeterminacy also known as degree of freedom.

✓  $3j - (r + m)$  for braced frame i.e. axial deformation ignored.

$$j = 6$$

$$r = 4$$

$$m = 6$$

$$: 3 * 6 - (4 + 6)$$

$$= 8$$

if unbraced frame,

$3j - r$  only

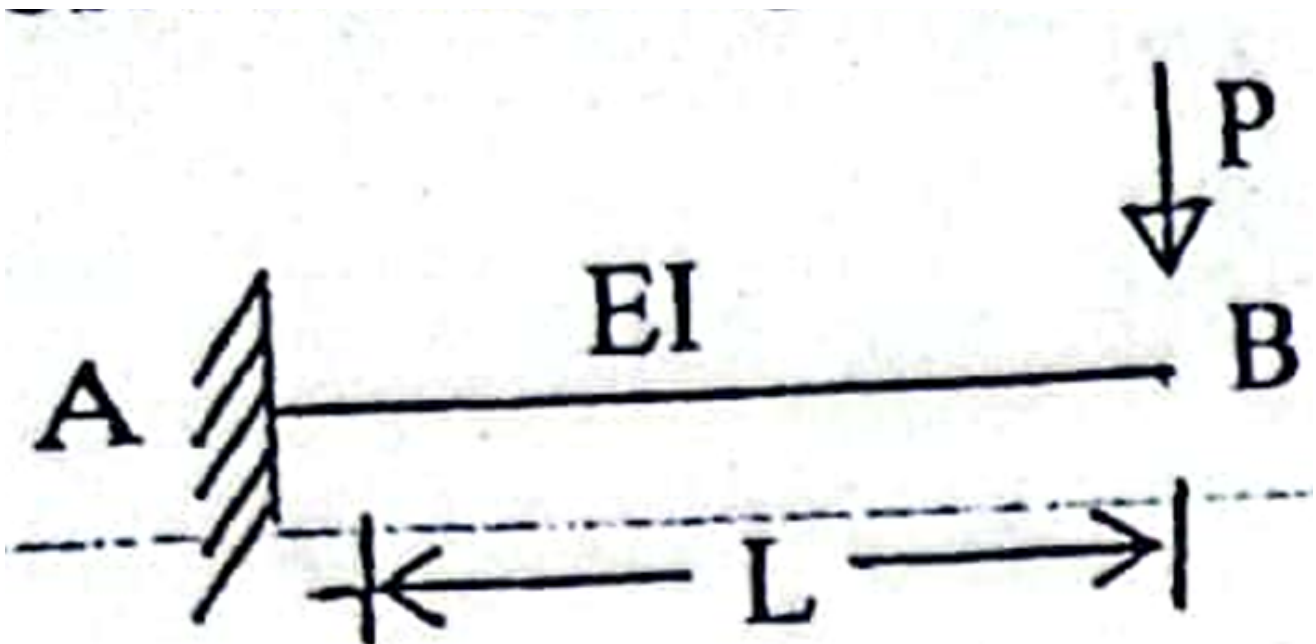
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73. The deflection at the free end F of cantilever beam AB as shown in the figure below having uniform flexural rigidity EI is:

[Civil Er. Highway 2070/11/10]

[Civil Er. Hydro 2071/11/14]

[Civil Er. Sanitary 2069/10/08]



A.  $\frac{PL^2}{48EI}$

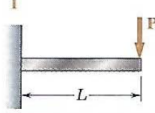
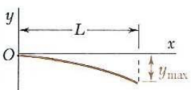
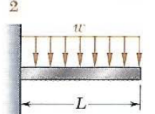
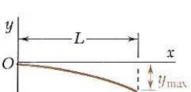
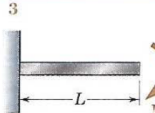
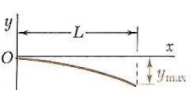
B.  $\frac{PL^3}{3EI}$

C.  $\frac{PL^2}{2EI}$

D.  $\frac{5PL^2}{384EI}$

**Correct Answer: B**

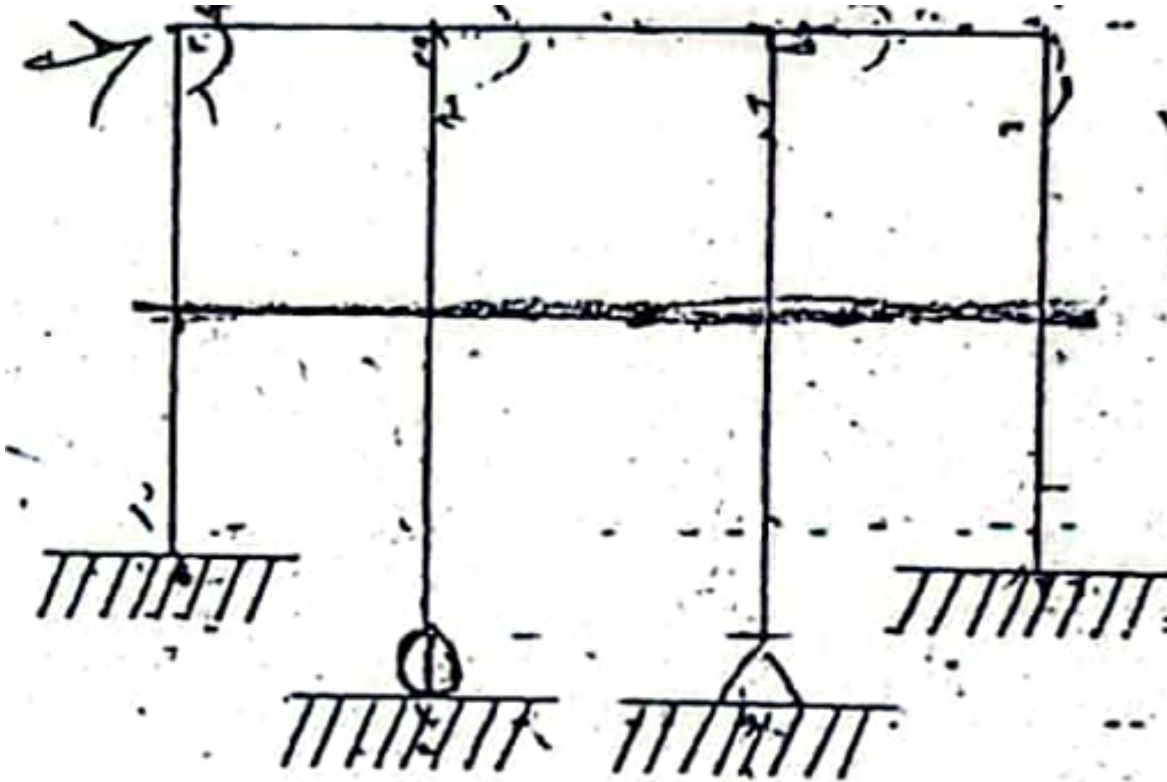
**Appendix: Beam deflection formulae**

Beam and Loading	Elastic Curve	Maximum Deflection	Slope at End	Equation of Elastic Curve
		$-\frac{PL^3}{3EI}$	$-\frac{PL^2}{2EI}$	$y = \frac{P}{6EI}(x^3 - 3Lx^2)$
		$-\frac{wL^4}{8EI}$	$-\frac{wL^3}{6EI}$	$y = -\frac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
		$-\frac{ML^2}{2EI}$	$-\frac{ML}{EI}$	$y = -\frac{M}{2EI}x^2$

**74. Degree of static indeterminacy of the plane frame is equal to :**

[Civil Er. B&Arch 2068/12/07]

[Civil Er. 2068/11/26]



- A. 15
- B. 12
- C. 9
- D. 18



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**Correct Answer: A**

Explanation:

- ✓ Total no. of unknown reaction =  $3+3+2+1 = 9$
  - ✓ External indeterminacy =  $9-3 = 6$
  - ✓ For internal indeterminacy count the number of closed loop : 3
  - ✓ So, internal indeterminacy =  $3*3 = 9$
  - ✓ Thus, Total indeterminacy =  $6+9 = 15$
- Or,
- ✓ To determine the static indeterminacy of a frame, use the formula:

$$D_s = 3m + r - 3j - c$$

where:

- m= number of members,
- r = number of external reactions,
- j= number of joints,
- c= number of internal hinges.

✓ Here, m= 14 , r = 9, j = 12, c= 0

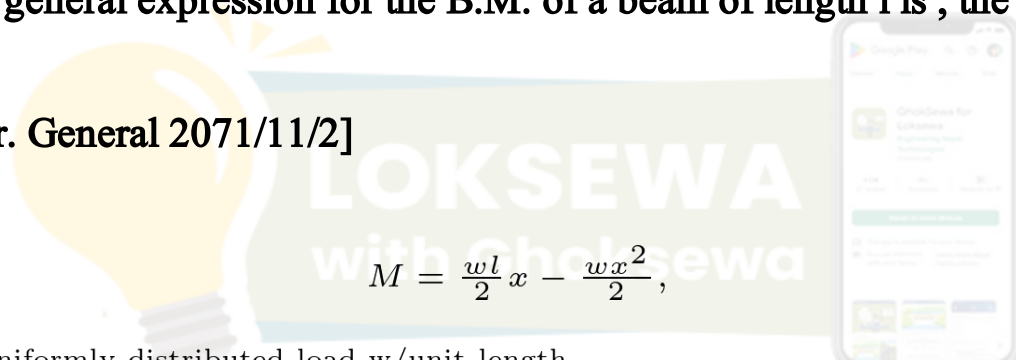
So,

$$D_s = 15$$

---

75. The general expression for the B.M. of a beam of length  $l$  is , the beam carries

[Civil Er. General 2071/11/2]


$$M = \frac{wl}{2}x - \frac{wx^2}{2},$$

- A. a uniformly distributed load  $w$ /unit length
- B. a load varying linearly from zero to  $w$ .
- C. An isolated load at mid span
- D. None of the above

**Correct Answer: A**

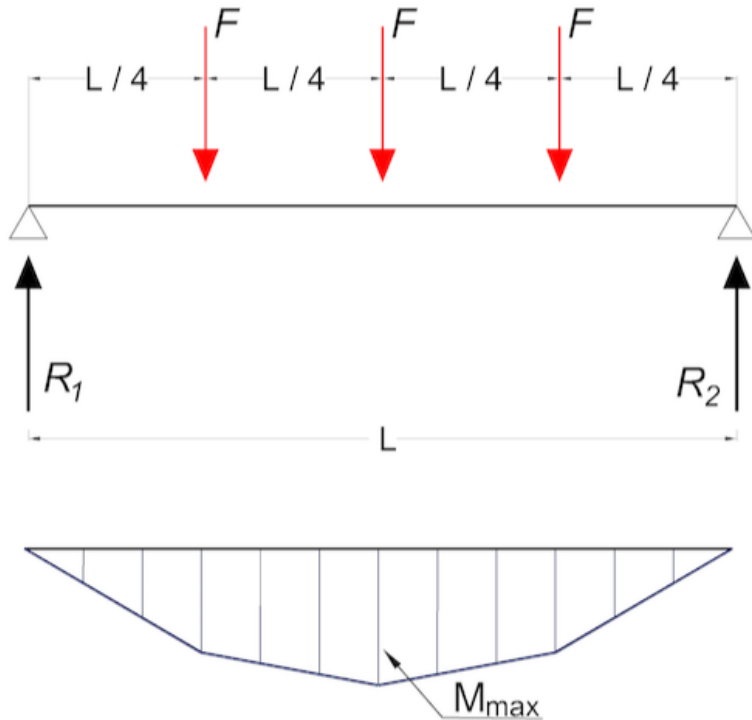
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76. The maximum Bending Moment due a train of wheel loads on a simply supported girder

[Civil Er. General 2071/11/2]

- A. Always occurs under a wheel load.
- B. Always occurs at center of span
- C. Never occurs under a wheel-load
- D. None of the above

**Correct Answer: A**



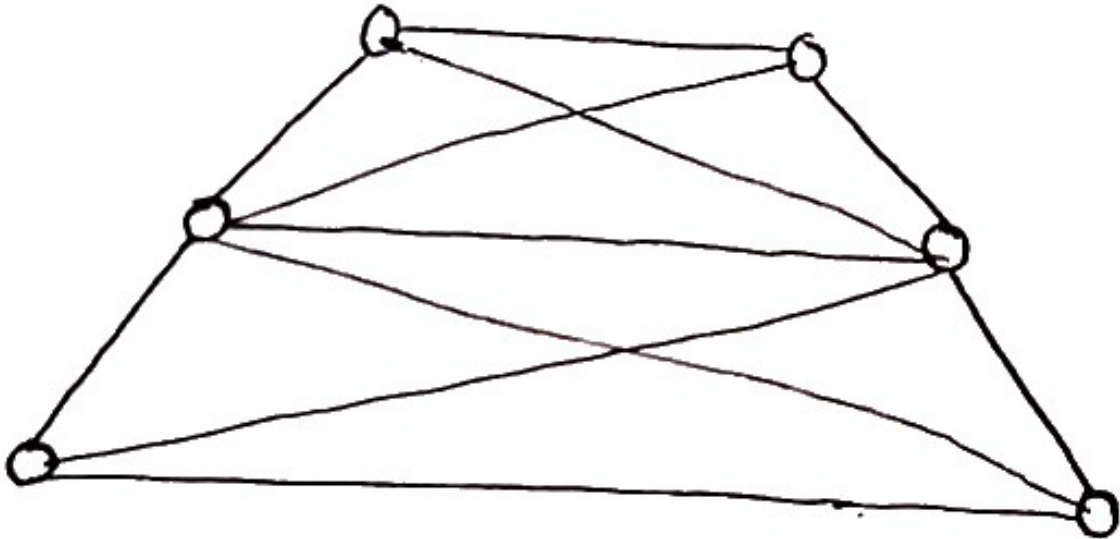
Explanation:

- ✓ When a train of wheel loads moves over a simply supported girder, the bending moment changes depending on the position of the wheel loads.
- ✓ The maximum bending moment occurs at the point of application of the load as the Bending Moment diagram always has a peak under the load. To be more specific the maximum bending moment due to a moving load on a simply supported beam occurs under the load when the load is situated at midspan of the beam.

---

**77. Given pin jointed frame is:**

**[Civil Er. 2068/11/26]**



- A. internally stable
- B. externally unstable
- C. unstable
- D. stable

**Correct Answer: A**

Explanation:

✓ **Statically Determinate Structures:** Those structures in which reactions and internal member forces can be obtained from equations of static equilibrium are only called statically determinate structures. e.g. simply supported Beam, 3 hinged arches.

✓ **Statically Indeterminate Structure:** Those structures where all the member forces and support reactions cannot be evaluated using equations of static equilibrium only and need additional compatibility equations are called statically indeterminate structures. e.g. fixed beam, continuous beam 2-hinged arch, propped cantilever. Below is the example of propped cantilever beam.

✓ **The Degree of internal indeterminacy for a plane truss is  $m - (2j - 3)$ .**

Here,

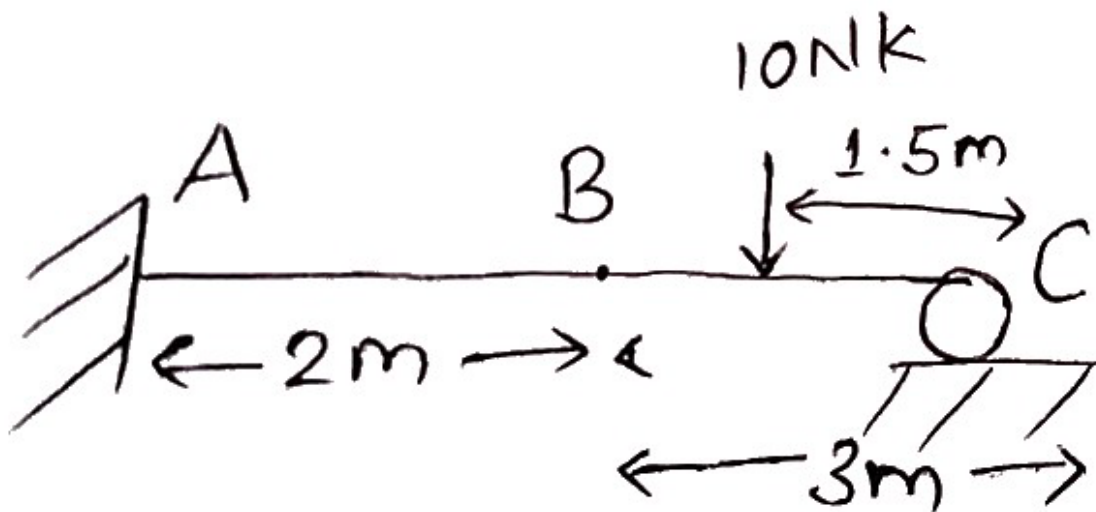
$$m = 11, j = 6,$$

$$\text{Therefore, } 11 - (2 \cdot 6 - 3) = 2.$$

- ✓ Degree of external indeterminacy:  $r - 3$
- ✓ Degree of internal indeterminacy:  $m - (2j - 3)$
- ✓ Degree of static indeterminacy:  
Degree of external Indeterminacy + Degree of internal indeterminacy
- ✓ if  $m < 2j - 3$ , internally unstable
- ✓ if  $m = 2j - 3$ , stable/unstable,
- ✓ statically determinate internally if stable internally
- ✓ if  $m > 2j - 3$ , over stiff, statically indeterminate internally

78. Bending moment at A of the following beam is equal to :

[Civil Er. 2068/11/26]



- A. 0
- B. 20 KN-m
- C. 30 KN-m
- D. 10 KN-m

**Correct Answer: D**

Explanation:

- ✓ Internal hinge at B.

✓ Sum of moment in right side of B

$$10 \times 1.5 -$$

$$R_c$$

$$\times 3 = 0$$

or,

$$R_c$$

$$= 5 \text{ KN}$$

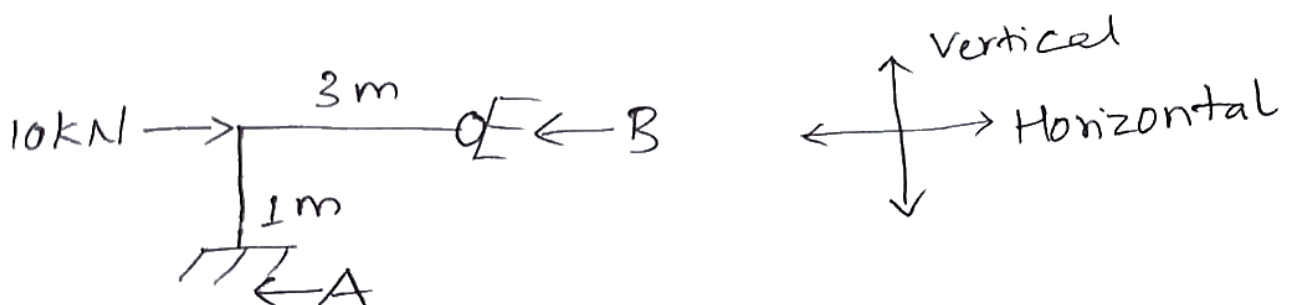
Now to find moment at A,

$$M_A$$

$$= 10 \times 3.5 - 5 \times 5 = 10 \text{ KN-m}$$

79. Horizontal reaction at B is equal to

[Civil Er. Highway 2067/12/10]



A. 30KN

B. 10 KN

C. 0

D. 5KN

**Correct Answer: C**

Explanation:

Horizontal Reaction at B

- Beam AB: 3m, fixed at A, roller at B.
- 10 kN horizontal force at A.

$$H_A = 10 \text{ kN}$$

(balances force).

$$H_B = 0 \text{ kN}$$

(roller cannot resist horizontal force).

Final Answer: 0 kN.

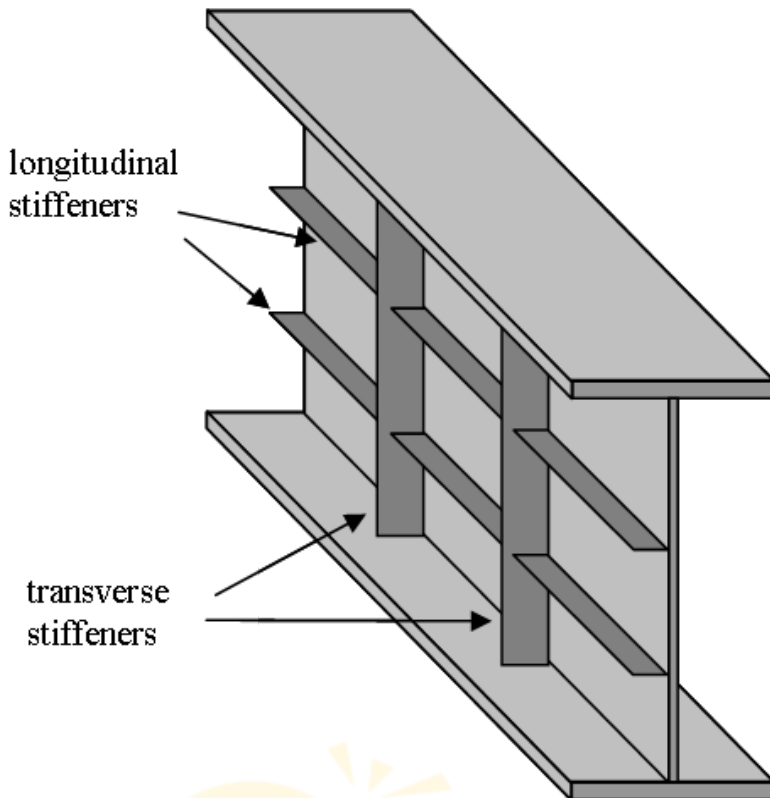
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**80. Bearing stiffeners are provided at**  
**[Civil Er. General 2071/11/2]**

- A. The support
- B. The support and mid span.
- C. The point of application of concentrated loads
- D. None of the above

**Correct Answer: C**





Explanation:

- ✓ Bearing stiffeners are provided at bearing positions in structural elements, particularly in plate girders and bridges.
- ✓ Their primary purpose is to prevent local crushing and buckling of the web due to concentrated loads or reactions from the superstructure.
- ✓ They ensure that vertical reactions are effectively transmitted into the bearings, enhancing the overall stability and load-carrying capacity of the structure

---

**81. The moment of inertia of a triangular section (height  $h$ , base  $b$ ) about its base, is**

**[Civil Er. General 2071/11/2]**

A.  $\frac{bh^2}{12}$

B.  $\frac{b^2h}{12}$

C.  $\frac{bh^3}{12}$

D.  $\frac{b^3h}{12}$

**Correct Answer: C**

Explanation:

About centroidal axis is

$$\frac{bh^3}{36}$$

---

**82. The locus of the moment of inertia about inclined axes to the principal axis, is**

**[Civil Er. General 2071/11/2]**

- A. Straight line
- B. Parabola
- C. Circle
- D. Ellipse

**Correct Answer: D**

Explanation:

- ✓ The locus of the moment of inertia about inclined axes to the principal axis forms an ellipse.
- ✓ This is due to the transformation equations that relate the moments of inertia about different axes.
- ✓ When calculating the moment of inertia for an inclined axis, the resulting values trace out an elliptical path in the plane defined by those axes.
- ✓ This behavior is consistent with the geometric properties of inertia and how it varies with orientation relative to principal axes

**83. When a bar is subjected to a change of temperature and its deformation is prevented, the stress induced in the bar is**  
[Civil Er. Irrigation 2071/11/16]

- A. Tensile stress
- B. Compressive stress
- C. Shear stress
- D. Thermal stress

**Correct Answer: D**

Explanation:

✓ It might be any basic stress: tension, compression or shear. So, the best answer is thermal stress.

. When the temperature of a material changes there will be corresponding change in dimension.

. When a member is free to expand or contract due to rise or fall of the temperature, no stress will be induced in the member.

. But, if the material is constrained (i.e. body is not allowed to expand or contract freely), change in length due to rise or fall of temperature is prevented, stresses are developed in the body which is known as thermal stress.

---

**84. The moment distribution method is best suited for:**

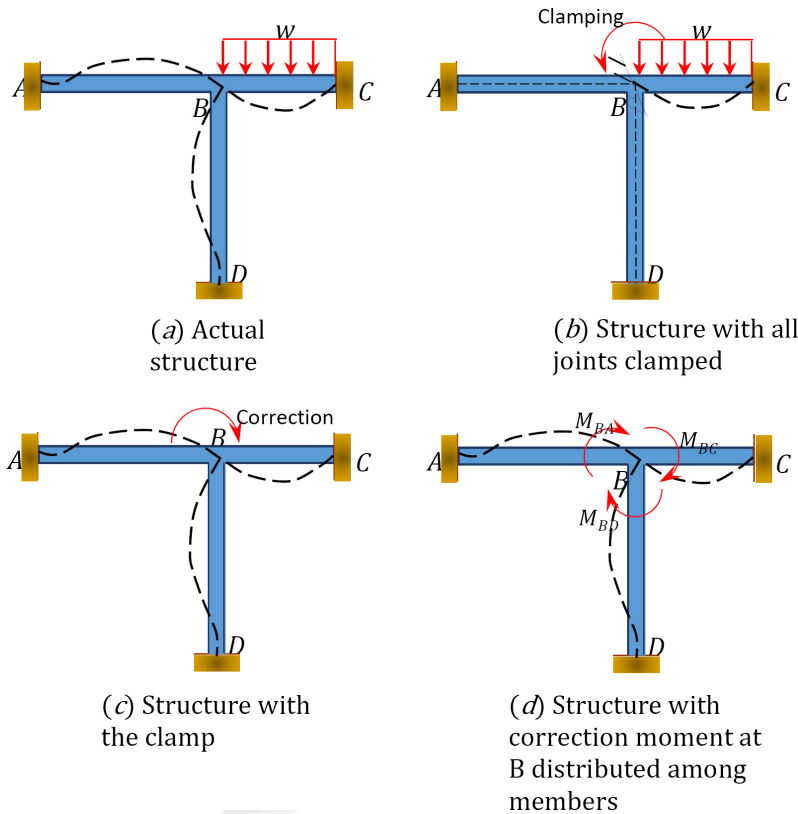
[Civil Er. B&Arch 2070/11/12]

[Civil Er. General 2070/11/8]

- A. trussed berm

- B. space frames
- C. rigid frames
- D. indeterminate pin jointed truss

**Correct Answer: C**



Explanation:

- ✓ The moment distribution method is best suited for analyzing statically indeterminate beams and rigid frames. It effectively handles both sway and non-sway frames, allowing for the calculation of moments at joints through an iterative process.
- ✓ This method simplifies the analysis by assuming all joints are initially fixed, then sequentially releasing them to distribute unbalanced moments until equilibrium is achieved.
- ✓ Advantageous for structures with multiple members and complex loading conditions,
- ✓ Popular choice among engineers for preliminary analyses of indeterminate structures

✓ Less effective for pin-jointed trusses and space frames due to the complexity of moment distribution in three-dimensional systems and the axial force considerations in trusses.

---

**85. The Young's modulus of elasticity of steel is:**

**[Civil Er. B&Arch 2070/11/12]**

- A. 150 KN/mm<sup>2</sup>
- B. 200 KN/mm<sup>2</sup>
- C. 275 KN/mm<sup>2</sup>
- D. 250 KN/mm<sup>2</sup>

**Correct Answer: B**

Explanation:

✓ As per IS 800:2007 physical properties of structural steel irrespective of its grade may be taken as:

- . Unit mass = 7850 kg/m<sup>3</sup>
- . Modulus of elasticity,  $E = 200 \text{ kN/mm}^2$
- . Poisson's ratio = 0.3
- . Modulus of rigidity,  $G = 0.769 \times 10^5 \text{ N/mm}^2$  (MPa)

---

**86. Creep of material is the property indicated by:**

**[Civil Er. B&Arch 2070/11/12]**

- A. elongation of the material caused by changes in material properties
- B. time dependent strain of the material.
- C. shortening caused by shrinkage of the member
- D. decrease in volume of the material affected by the weather conditions

**Correct Answer: B**

Explanation:

- ✓ Creep, sometimes also called as cold flow, is the slow, time-dependent deformation of a solid material under constant mechanical stress, typically occurring at elevated temperatures.
- ✓ It can happen even when the applied stress is below the material's yield strength.
- ✓ The rate of creep is influenced by factors such as material properties, temperature, and duration of stress exposure.

---

**87. The bending moment is maximum, where shear force is:**

**[Civil Er. Highway 2070/11/10]**

- A. maximum
- B. minimum
- C. equal
- D. changes sign

**Correct Answer: D**

Explanation:

- ✓ The rate of change of the bending moment along the length of the beam is equal to the shear force at that section.

$$\frac{dM}{dx} = V$$

So, the bending moment is maximum (or minimum) where the shear force is zero or changes sign.

$$\frac{dM}{dx} = V = 0$$

This is because it implies a horizontal tangent to the bending moment curve, which

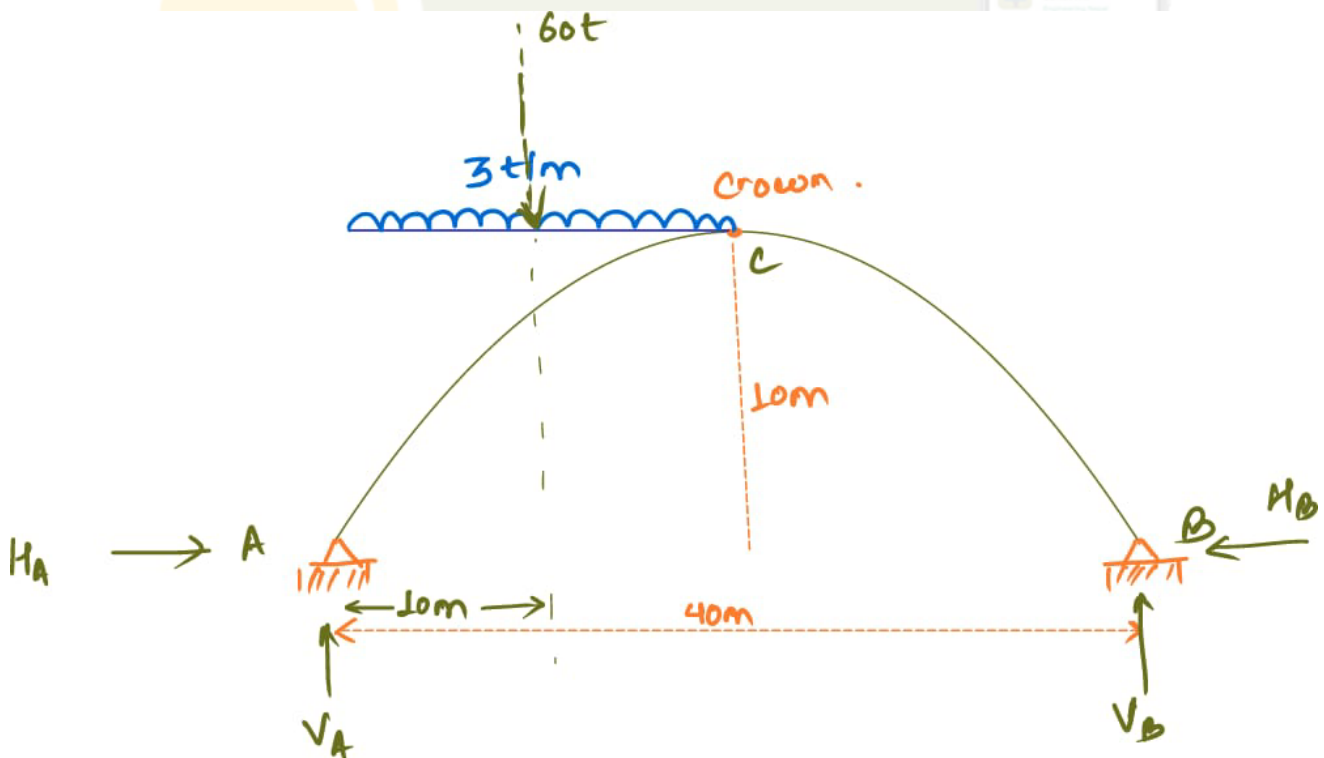
corresponds to a local maxima.

88. A three hinged symmetric parabolic arch is hinged at the springing and at the crown. The span and rise are 40 m and 10 m respectively. The left half of the arch is loaded with udl of 3 t/m. The horizontal thrust at the springing points will be:

[Civil Er. Highway 2070/11/10]

- A. 40 t
- B. 15 t
- C. 20 t
- D. 30 t

Correct Answer: D



Explanation:

Taking

$$\sum M_A = 0 \text{ (clockwise +)}$$

We get

$$V_B = 15t$$

Also,

$$V_A + V_B = 60t$$

or,

$$V_A = 45t$$

Taking

$$\sum M_C = 0$$

$$H_A = 30t$$



---

89. The maximum central deflection for a simply supported beam loaded with uniformly distributed load  $w$  is:

[Civil Er. Highway 2070/11/10]





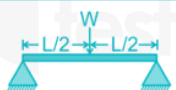



A.  $\frac{5}{384} \cdot \frac{wL^3}{EI}$

B.  $\frac{5}{384} \cdot \frac{wL^4}{EI}$

C.  $\frac{5}{384} \cdot \frac{wL^2}{EI}$

D.  $\frac{wL^4}{48EI}$

**Correct Answer: B**

SR. No.	TYPE OF BEAM	DEFLECTON
1		$\delta = \frac{ML^2}{2EI}$
2		$\delta = \frac{WL^3}{3EI}$
3		$\delta = \frac{WL^4}{8EI}$
4		$\delta = \frac{WL^4}{30EI}$
5		$\delta = \frac{WL^3}{48EI}$
6		$\delta = \frac{5WL^4}{384EI}$
7		$\delta = \frac{WL^3}{192EI}$
8		$\delta = \frac{WL^4}{384EI}$

90. The modulus of elasticity for mild steel is approximately equal to :  
[Civil Er. Highway 2070/11/10]

- A. 210 kN/mm<sup>2</sup>
- B. 10 kN/mm<sup>2</sup>
- C. 80 kN/mm<sup>2</sup>
- D. 100 kN/mm<sup>2</sup>

**Correct Answer: A**

Explanation:

✓ As per IS 800:2007 physical properties of structural steel irrespective of it's grade may be taken as:

.Unit mass = 7850 kg/m<sup>3</sup>

. Modulus of elasticity, E= 210 kN/mm<sup>2</sup>

. Poisson's ratio = 0.3

. Modulus of rigidity, G= 0.769\*10<sup>5</sup>

$\text{N/mm}^2(\text{MPa})$

---

**91. The ends of continuous beam should be:**

**[Civil Er. General 2070/11/8]**

- A. rolled
- B. hinged
- C. cantilever
- D. all of the above

**Correct Answer: D**

Explanation:

- ✓ Continuous beam is one which has more than two supports. i.e, it rest over three or more supports.
- ✓ The intermediate supports are always subjected to bending moment which is negative (Hogging moment).
- ✓ The ends of continuous beam can be supported by fixed supports, pinned supports or roller supports.

Note: If ends supports are simply supported, the B.M at ends will be zero and if, ends supports are fixed, then bending moment at ends supports will not be zero.

---

**92. Area of influence line diagram for fixed end moment of fixed beam of span L is:**

**[Civil Er. General 2070/11/8]**

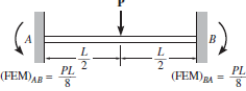
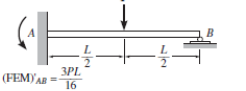
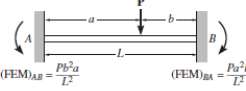
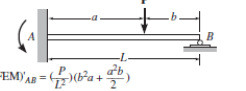
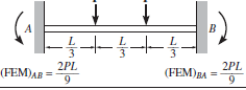
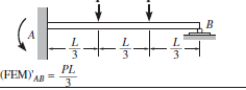
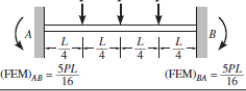
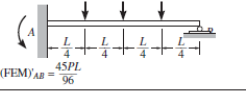
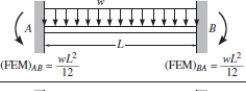
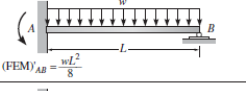
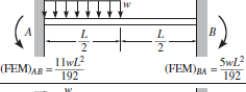
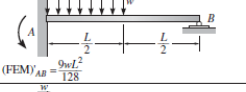
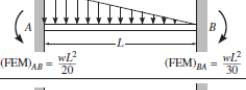
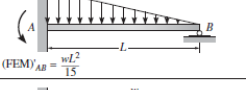
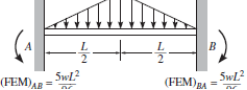
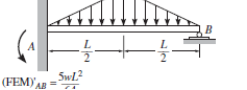
A.  $\frac{L^2}{24}$

B.  $\frac{L^2}{12}$

C.  $\frac{L^2}{8}$

D.  $\frac{L^2}{16}$

**Correct Answer: A**

 <p>(FEM)<sub>AB</sub> = <math>\frac{PL}{8}</math>      (FEM)<sub>BA</sub> = <math>\frac{PL}{8}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{3PL}{16}</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{Pb^2a}{L^2}</math>      (FEM)<sub>BA</sub> = <math>\frac{Pa^2b}{L^2}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{P}{12}(b^2a + a^2b)</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{2PL}{9}</math>      (FEM)<sub>BA</sub> = <math>\frac{2PL}{9}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{PL}{3}</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{5PL}{16}</math>      (FEM)<sub>BA</sub> = <math>\frac{5PL}{16}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{45PL}{96}</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{wL^2}{12}</math>      (FEM)<sub>BA</sub> = <math>\frac{wL^2}{12}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{wL^2}{8}</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{11wL^2}{192}</math>      (FEM)<sub>BA</sub> = <math>\frac{5wL^2}{192}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{9wL^2}{128}</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{wL^2}{20}</math>      (FEM)<sub>BA</sub> = <math>\frac{wL^2}{30}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{wL^2}{15}</math></p>
 <p>(FEM)<sub>AB</sub> = <math>\frac{5wL^2}{32}</math>      (FEM)<sub>BA</sub> = <math>\frac{5wL^2}{32}</math></p>	 <p>(FEM)<sub>AB</sub> = <math>\frac{5wL^2}{32}</math></p>



**93. The deflection of the free end of a cantilever subjected to a couple M at its free end and having a uniform flexural rigidity EI throughout its length 'L' is equal to :**

[Civil Er. General 2070/11/8]

[Civil Er. B&Arch 2070/11/12]

A.  $\frac{ML^2}{2EI}$

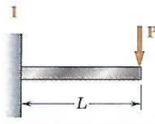
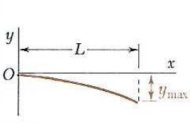
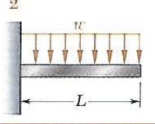
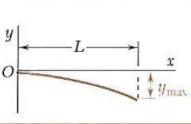
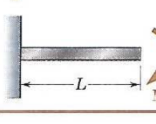
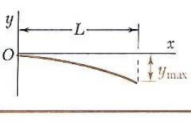
B.  $\frac{ML^2}{3EI}$

C.  $\frac{ML^2}{6EI}$

D.  $\frac{ML^2}{8EI}$

**Correct Answer: A**

**Appendix: Beam deflection formulae**

Beam and Loading	Elastic Curve	Maximum Deflection	Slope at End	Equation of Elastic Curve
		$-\frac{PL^3}{3EI}$	$-\frac{PL^2}{2EI}$	$y = \frac{P}{6EI}(x^3 - 3Lx^2)$
		$-\frac{wL^4}{8EI}$	$-\frac{wL^3}{6EI}$	$y = -\frac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
		$-\frac{ML^2}{2EI}$	$-\frac{ML}{EI}$	$y = -\frac{M}{2EI}x^2$

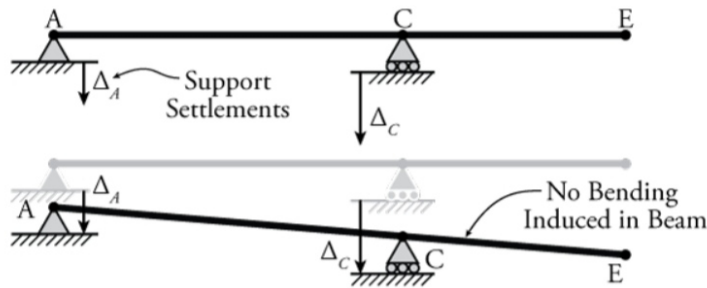
**94. Unequal settlement in the supports of a statically indeterminate structure develop:**

**[Civil Er. General 2070/11/8]**

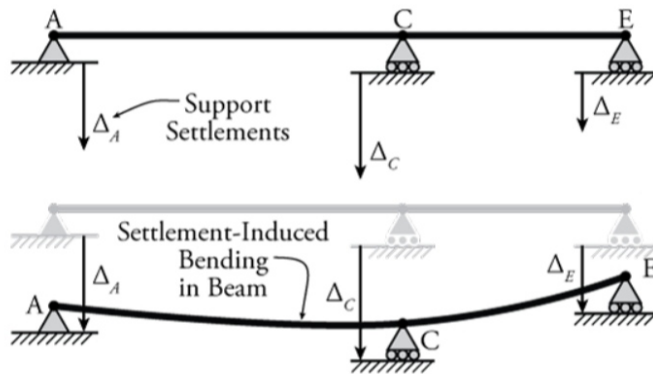
- A. member forces
- B. reactions from supports
- C. no reactions
- D. strains in some members

**Correct Answer: A**

DETERMINATE BEAM WITH SUPPORT SETTLEMENT



INDETERMINATE BEAM WITH SUPPORT SETTLEMENT



Explanation:

✓ Settlements occur due to soil erosion, dynamic effects during earthquakes, frost heave, or partial failure of supporting elements.

✓ Impact of settlement on Determinate Structures:

In externally determinate structures, settlements cause only rigid body rotation without inducing internal forces.

✓ Impact of settlement on Indeterminate Structures:

Settlements in indeterminate structures generate internal shears and moments due to over-constraints (extra restraints beyond stability needs).

✓ As shown in the example figure above If a middle support (e.g., point C) settles more than others, it effectively "pulls down" the beam, inducing bending. The bending depends on the relative settlement between supports, not the absolute displacement of point C.

✓ Compared with Determinate Beam the behavior resembles a determinate beam supported only at its ends (A and E) with a load applied at the middle (C), causing bending.

95. For a simply supported beam of 10 m span, the minimum effective depth to satisfy vertical deflection limit should be:

[Civil Er. Arch 2070/10/18]

- A. 400 mm
- B. 500 mm
- C. 700-mm
- D. 350 mm

**Correct Answer: B**

Explanation:

✓ IS 456:2000 suggests minimum effective depth to satisfy vertical deflection limit for a simply supported beam with a span up to 10 meters, the basic value for the span-to-effective depth ratio is 20.

So,  $10000/20=500\text{mm}$

96. The moment of inertia of a timber cross section 3 cm wide and 4 cm deep is:

[Civil Er. Arch 2070/10/18]

- A.  $4\text{cm}^4$ .
- B.  $12\text{cm}^4$
- C.  $14\text{cm}^4$
- D.  $16\text{cm}^4$

**Correct Answer: D**

Explanation:

The moment of inertia I for a rectangular timber cross-section can be calculated using the formula:

$$I = \frac{bh^3}{12}$$

where:

- b is the width of the section,
- h is the height (depth) of the section.

For a timber cross-section that is 3 cm wide and 4 cm deep:

- b = 3 cm
- h = 4 cm

Substituting these values into the formula gives:

$$I = \frac{3 \text{ cm} \cdot (4 \text{ cm})^3}{12}$$
$$= \frac{3 \cdot 64}{12} = \frac{192}{12} = 16 \text{ cm}^4$$

Thus, the moment of inertia of the timber cross-section is

$$16 \text{ cm}^4$$

---

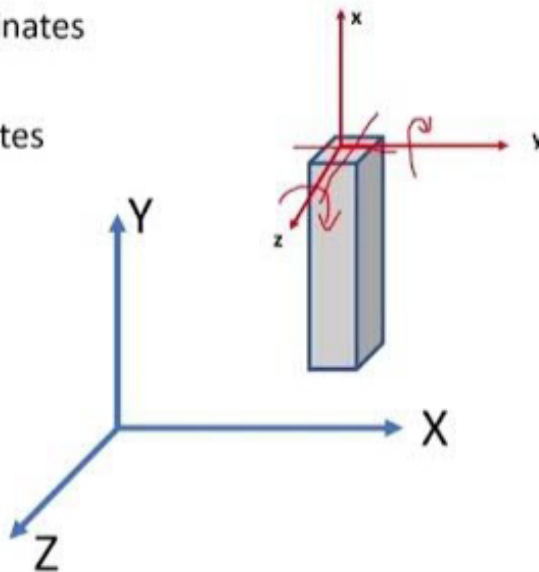
**97. In STAAD software, the vertical axis is represented as**  
**[Civil Er. Arch 2070/10/18]**

- A. X
- B. Y
- C. Z
- D. V

**Correct Answer: B**

## Co-ordinate system in STAAD

- Global co ordinates  
vs  
local co-ordinates



### Column

Moments  
Mz  
My

Shear  
Fz  
Fy

Axial  
Fx

### Explanation:

✓ In STAAD software, the vertical axis is typically represented as the Y-axis by default. However, users can reorient the global axis to set the Z-axis as vertical.

98. The most ductile substance from the following is:

[Civil Er. Arch 2070/10/18]

- A. mild steel
- B. cast iron
- C. deformed bar
- D. timber

**Correct Answer: A**

### Explanation:

✓ Ductility refers to metal's ability to be drawn into thin wires.

✓ The Ductility of the materials decreases as their temperature rises because metals weaken as their temperature rises.

Note: Normally if the percentage elongation exceeds 15 % the material is ductile and if it is less than 5% the material is brittle.

---

**99. The value of poisson's ratio always remain:**

**[Civil Er. Sanitary 2069/10/08]**

- A. less than one
- B. equal to one
- C. greater than one
- D. none of the above

**Correct Answer: D**

Explanation:

✓ Poisson's ratio, denoted by

$\nu$

, is the ratio of transverse strain to longitudinal strain in materials.

✓ Its value typically ranges from 0 to 0.5 for most materials, indicating that when a material is stretched, it contracts laterally.

✓ Theoretically, Poisson's ratio can vary between -1 and 0.5, but practical values are confined within the positive range.

✓ Materials like rubber can approach 0.5, while cork has a value close to 0, showing minimal lateral expansion.

✓ Materials with negative Poisson's ratio called auxetic materials. They shrink laterally when compressed longitudinally and vice-versa.

Since 1 is not the threshold for the ratio the answer is none. It would had been true if the option had 'always less than 0.5'

100. If 'S' is the axial force acting on an element 'ds' of a structural member which cross sectional area 'A' and modulus of elasticity "E" the total strain energy of the member on account of axial force 'S' is given by :

[Civil Er. Sanitary 2069/10/08] [Civil Er. 2068/11/26]

A.  $\int \frac{S ds}{2AE}$

B.  $\int \frac{S^2 ds}{AE}$

C.  $\int \frac{S^2 ds}{A}$

D.  $\int \frac{S^2 ds}{2AE}$

**Correct Answer: D**

Explanation:

✓ The strain energy stored in a structural member due to axial force can be derived as follows:

✓ Stress: The stress in the member is:

$$\sigma = \frac{S}{A}$$

✓ Strain: From Hooke's Law:

$$\epsilon = \frac{\sigma}{E} = \frac{S}{AE}$$

✓ Infinitesimal Strain Energy: The strain energy stored in an infinitesimal length of the member is given by:

$$dU = \frac{1}{2} \sigma \epsilon A ds$$

$$dU = \frac{1}{2} \left( \frac{S}{A} \right) \left( \frac{S}{AE} \right) A ds$$

$$dU = \frac{S^2}{2AE} ds$$

✓ Total Strain Energy: To find the total strain energy stored in the entire member, integrate over the length :

$$U = \int_0^L \frac{S^2}{2AE} ds$$

101. Moment of inertia of square section of side 'a' is:

[Civil Er. General 2069/10/02]

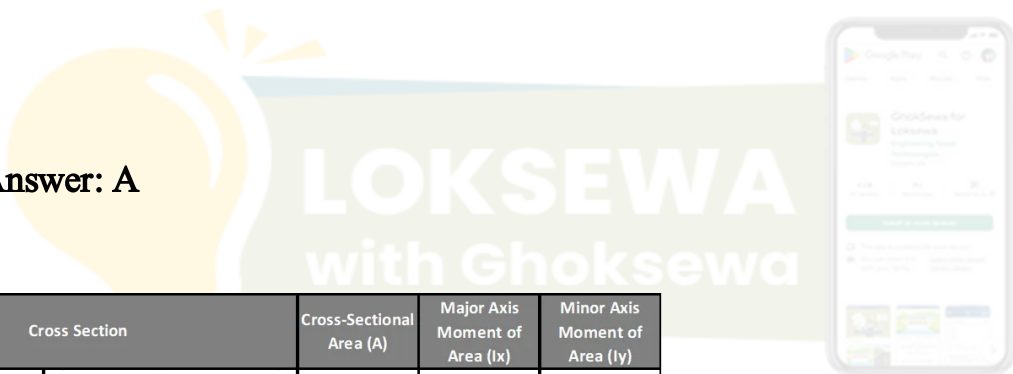
A.  $\frac{a^4}{12}$

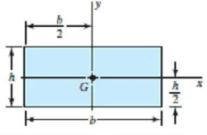
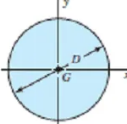
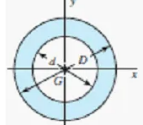
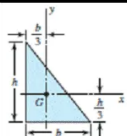
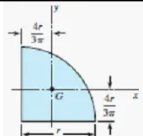
B.  $\frac{a^3}{12}$

C.  $\frac{a^5}{12}$

D.  $\frac{a^4}{6}$

Correct Answer: A



Cross Section		Cross-Sectional Area (A)	Major Axis Moment of Area (Ix)	Minor Axis Moment of Area (Iy)
Rectangle		bh	bh <sup>3</sup> /12	b <sup>3</sup> h/12
Circle		πD <sup>2</sup> /4	πD <sup>4</sup> /64	πD <sup>4</sup> /64
Circular Tube		π/4(D <sup>2</sup> - d <sup>2</sup> )	π/64(D <sup>4</sup> - d <sup>4</sup> )	π/64(D <sup>4</sup> - d <sup>4</sup> )
Right Triangle		bh/2	bh <sup>3</sup> /36	b <sup>3</sup> h/36
Quarter Circle		πr <sup>2</sup> /4	r <sup>4</sup> (π/16 - 4/(9π))	r <sup>4</sup> (π/16 - 4/(9π))

102. A structural member subjected to axial compressive stress is known as:  
[Civil Er. General 2069/10/02]

- A. column
- B. tie
- C. strut
- D. beam

**Correct Answer: C**

Explanation:

- ✓ A structural member subjected to an axial compressive force is known as a strut.
- ✓ When specifically oriented vertically, it is referred to as a column. Struts can be horizontal, inclined, or vertical, and they are designed to support loads primarily through axial compression
- ✓ A tie is a structural member that is subjected to tension, meaning it is pulled from opposite ends.

---

103. The radius of gyration of a rectangular section with dimensions  $b=7$  cm and  $d=12$  cm is:

[Civil Er. General 2069/10/02]

- A.  $\sqrt{12}$
- B.  $\sqrt{7}$
- C. 12
- D. 7

**Correct Answer: A**

Explanation:

To calculate the radius of gyration  $k$  for a rectangular section with breadth  $b = 7$  cm

and depth  $d = 12$  cm, use the formula:

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

where,

$$I = \frac{bd^3}{12}$$

is the moment of inertia and

$$A = b \cdot d$$

is the area.

Therefore ,

$$k = \sqrt{\frac{d^2}{12}}$$

Substituting the values:

$$k = \sqrt{12}$$

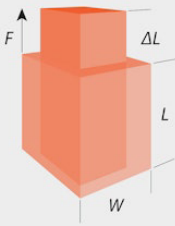
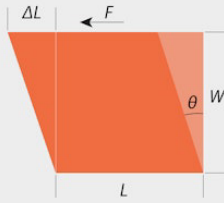
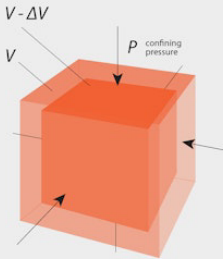
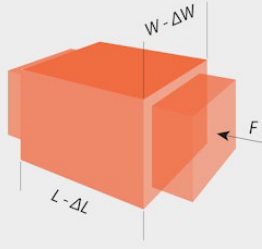


**104. When a body is subjected to three mutually perpendicular stresses of equal intensity, the ratio of direct stress to the corresponding volumetric strain is called:**

**[Civil Er. General 2069/10/02]**

- A. Young's Modulus
- B. Modulus of Rigidity
- C. Bulk Modulus
- D. Poisson's Ratio

**Correct Answer: C**

Young's modulus	Shear modulus	Bulk modulus	Poisson ratio
$E = \frac{F/W^2}{\Delta L/L}$	$\mu = \frac{F/WL}{\tan \theta} = \frac{F/WL}{\Delta L/L}$	$K = \frac{P}{\Delta V/V}$	$\nu = \frac{\Delta W/W}{\Delta L/L}$
			

105. A beam of span  $L$ , fixed at the both ends carries a uniformly distributed load of  $w$  per unit length over the whole span. The bending moment at the center of the beam is:  
 [Civil Er. General 2069/10/02]

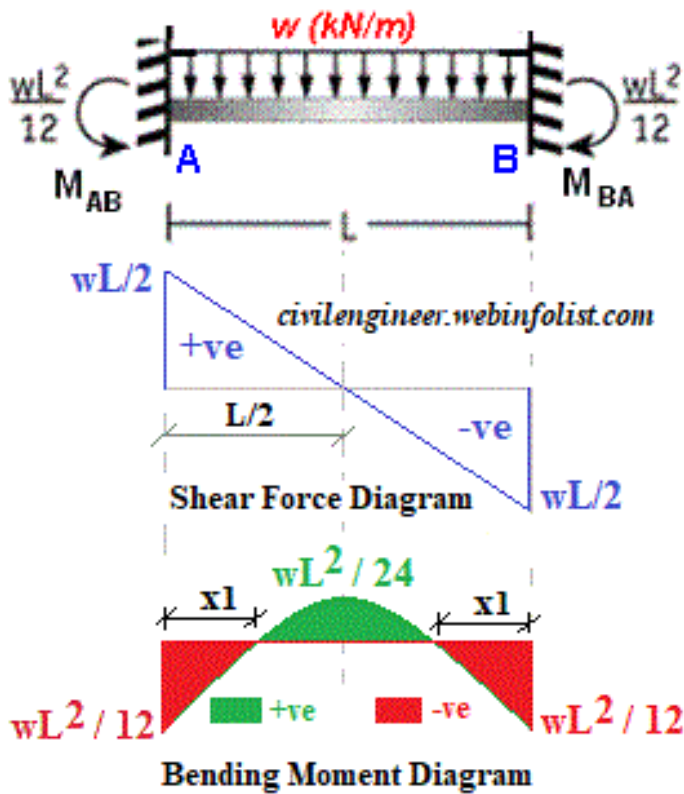
A.  $\frac{wL^2}{12}$

B.  $\frac{wL^2}{16}$

C.  $\frac{wL^2}{24}$

D.  $\frac{wL^2}{8}$

**Correct Answer: C**



Explanation:

For a beam fixed at both ends with a uniformly distributed load per unit length over the span, the bending moment at the center of the beam is given by:

$$M_{(center)} = \frac{wL^2}{24}$$

✓ Deflection at center

$$\delta_{max} = \frac{wL^4}{384EI}$$

✓ Moment at end

$$M_{end} = -\frac{wL^2}{12} \text{ (hogging)}$$

106. Force is the product of:

[Civil Er. General 2069/10/02]

- A. mass and acceleration
- B. mass and weight
- C. velocity and time
- D. velocity and time

**Correct Answer: A**

Explanation:

- ✓ Force: The interaction which after applying on a body changes or try to change the state of rest or state of motion of the body is called force.
- ✓ Force(F)= Mass(m)\*acceleration (a)
- ✓ This relationship is described by Newton's second law of motion.

---











**107. Bending moment at any section in a conjugate beam gives in the actual beam:**

**[Civil Er. General 2069/10/02]**

- A. slope
- B. curvature
- C. deflection
- D. bending moment

**Correct Answer: C**

Real support vs Conjugate support<sup>[3]</sup>

Real beam		Conjugate beam	
<b>Fixed support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta = 0</math></li> </ul> 		<b>Free end</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q} = 0</math></li> </ul> 	
<b>Free end</b> <ul style="list-style-type: none"> <li><math>v \neq 0</math></li> <li><math>\theta \neq 0</math></li> </ul> 		<b>Fixed support</b> <ul style="list-style-type: none"> <li><math>\bar{M} \neq 0</math></li> <li><math>\bar{Q} \neq 0</math></li> </ul> 	
<b>Hinged support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta \neq 0</math></li> </ul> 		<b>Hinged support</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q} \neq 0</math></li> </ul> 	
<b>Middle support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta</math>:continue</li> </ul> 		<b>Middle hinge</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q}</math>:continue</li> </ul> 	
<b>Middle hinge</b> <ul style="list-style-type: none"> <li><math>v</math>:continue</li> <li><math>\theta</math>:discontinue</li> </ul> 		<b>Middle support</b> <ul style="list-style-type: none"> <li><math>\bar{M}</math>:continue</li> <li><math>\bar{Q}</math>:discontinue</li> </ul> 	

Explanation:

- ✓ Bending Moment gives deflection.
- ✓ Shear force gives slope.

**LOKSEWA**  
with Ghoksewa

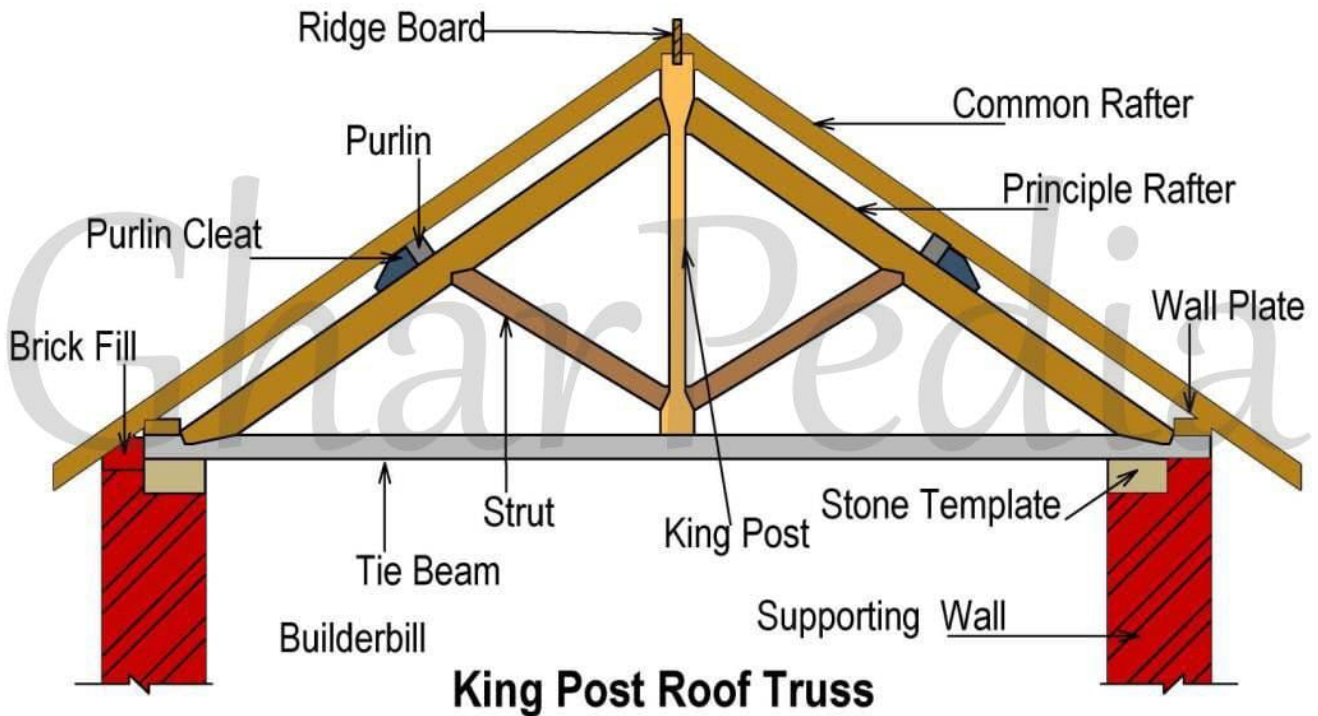


108. The function of king post in a roof truss is:

[Civil Er. General 2069/10/02]

- A. to support the framework of the roof
- B. to receive the ends of principal rafters
- C. to prevent the walls from spreading outward
- D. to prevent the tie beam from sagging at its centre

**Correct Answer: D**



109. The rate of change of bending moment is equal to :  
 [Civil Er. Irrigation 2069/11/08]

- A. shear force
- B. deflection
- C. slope
- D. rate of loading

**Correct Answer: A**

Explanation:

✓ Shear force at any section is the summation of all transverse loading, either to left or to the right of any section.

✓ Bending Moment at any section is resultant algebraic sum of moments caused by transverse forces either from left or right of section.

✓ Rate of change of shear force at any section is equal to load intensity at that section, i.e.,

$$(dV/dx) = W$$

✓ Rate of change of bending moment at any section is equal to shear force at that section. i.e.,

$$(dM/dx) = V$$

---

**110. Which of the following structural analysis is a force method?**

[Civil Er. Irrigation 2069/11/08]

[Civil Er. 2068/11/12]

- A. slope deflection
- B. By column analogy
- C. moment distribution
- D. none of the above

**Correct Answer: B**

Explanation:

✓ The Column Analogy Method is used to analyze indeterminate structures such as fixed beams, frames, and arches. It is particularly effective for structures with variable cross-sections and for calculating stiffness and carryover factors.

✓ This method is applicable to structures with a maximum of 3 degrees of static indeterminacy.

✓ It relies on the analogy between stresses in a column section and the moments caused by fixity at supports.

✓ It is suitable for analyzing fixed beams (with 3 degrees of indeterminacy) and portal or box frames within the same limit.

**111. Stiffness factor is calculated in structural members for analysing it by:**  
[Civil Er. Irrigation 2069/11/08]

- A. moment distribution method.
- B. slope deflection method
- C. column analogy method
- D. none of above

**Correct Answer: A**

Explanation:

Moment Distribution Method

- ✓ Developed by Hardy Cross in 1930.
- ✓ Method of successive approximation in structural analysis
- ✓ Stiffness Factor: Amount of Moment required to rotate an end or joint by 1 radian.  
Stiffness factor at joint is the sum of member stiffness factor at the joint.
- ✓ Distribution Factor: The fraction of total resisting moment supplied by the member.

$$\sum DF = \frac{M_i}{M} = \frac{K_i}{\sum K}$$

- At a joint sum of DFs is always 1 except for a fixed wall which is 0. Since an infinite moment is required to rotate the wall by 1 radian in theory.

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**112. Maximum bending moment at the centre of single span beams is:**  
[Civil Er. Irrigation 2069/11/08]

A.  $\frac{wL^2}{8}$


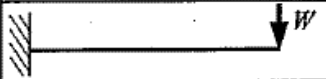
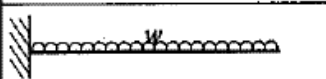
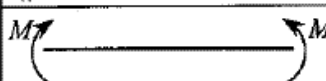
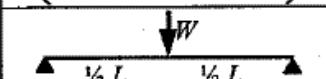
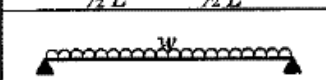
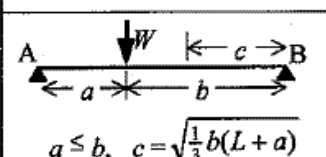
B.  $\frac{wL^2}{2}$

C.  $\frac{wL^2}{3}$

D. 0

Correct Answer: A

BEAM BENDING

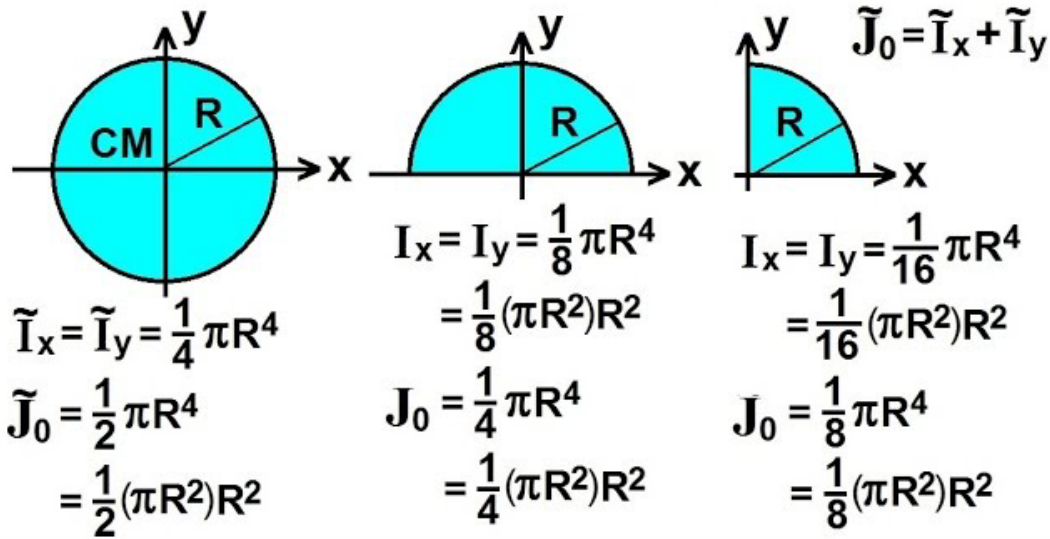
$L$ = overall length $W$ = point load, $M$ = moment $w$ = load per unit length	End Slope	Max Deflection	Max bending moment
	$\frac{ML}{EI}$	$\frac{ML^2}{2EI}$	$M$
	$\frac{WL^2}{2EI}$	$\frac{WL^3}{3EI}$	$WL$
	$\frac{wL^3}{6EI}$	$\frac{wL^4}{8EI}$	$\frac{wL^2}{2}$
	$\frac{ML}{2EI}$	$\frac{ML^2}{8EI}$	$M$
	$\frac{WL^2}{16EI}$	$\frac{WL^3}{48EI}$	$\frac{WL}{4}$
	$\frac{wL^3}{24EI}$	$\frac{5wL^4}{384EI}$	$\frac{wL^2}{8}$
 $a \leq b, c = \sqrt{\frac{1}{3}b(L+a)}$	$\theta_B = \frac{Wac^2}{2LEI}$ $\theta_A = \frac{L+b}{L+a} \theta_B$	$\frac{Wac^3}{3LEI}$ (at position c)	$\frac{Wab}{L}$ (under load)

113. Moment of Inertia of a circular section about its diameter is:  
 [Civil Er. Irrigation 2069/11/08]

- A.  $\frac{\pi d^4}{16}$
- B.  $\frac{\pi d^4}{32}$
- C.  $\frac{\pi d^2}{32}$
- D.  $\frac{\pi d^4}{64}$

Correct Answer: D

### Find the Moment of Inertia of a Circle

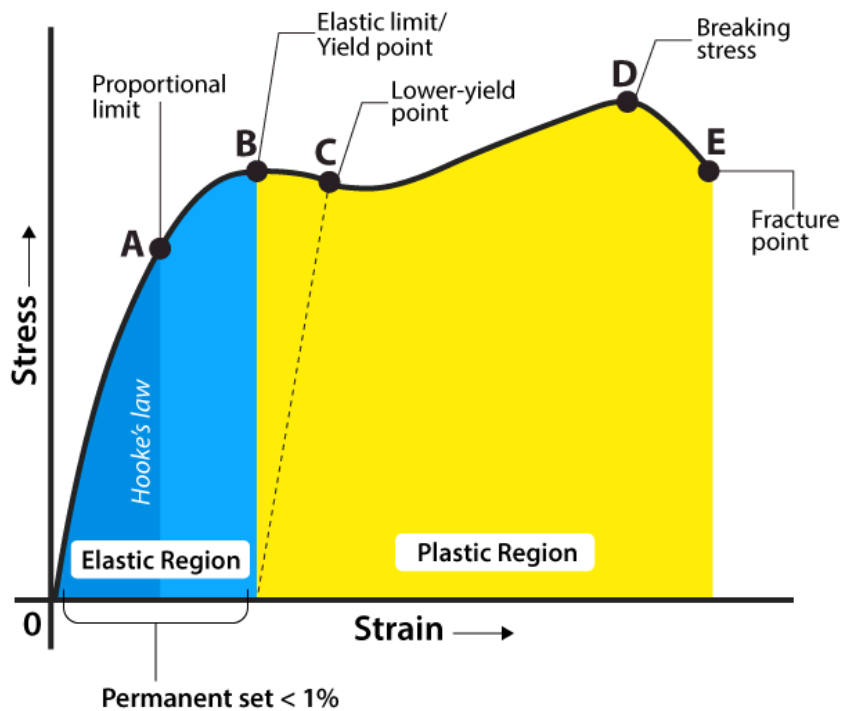


114. Hook's Law in engineering is applicable for:

[Civil Er. Highway 2069/10/06]

- A. elastic material
- B. plastic material
- C. inorganic material
- D. organic material

**Correct Answer: A**



### Explanation:

- ✓ Elastic material: Elastic materials are substances that can deform under stress and return to their original shape when the stress is removed.
- ✓ Plastic material: Plastic materials are the substances that undergoes permanent deformation and does not fully recover its original shape after stress is removed.
- ✓ Inorganic material: Inorganic materials don't contain carbon-hydrogen bonds.
- ✓ Organic material: Organic materials are primarily composed of carbon and hydrogen.

**115. The basic unknowns in displacement method of structural analysis are:**  
[Civil Er. Highway 2069/10/06]

- A. displacements
- B. forces
- C. displacement and forces

D. none of the above

**Correct Answer: A**

Explanation:

- ✓ The basic unknowns in displacement method of structural analysis are displacement.
- ✓ In the displacement method of structural analysis, the basic unknowns are primarily the displacements, including both translations and rotations at various points in the structure. This method focuses on establishing force-displacement relationships to compute these unknowns, which are then used to derive internal forces and moments through equilibrium equations.

---

**116. The value of support reaction of a simply supported single span beam of span 6 m. and loaded with two concentrated loads of 5 KN each placed at a distance of 2 m from either supports is:**

**[Civil Er. Highway 2069/10/06]**

- A. 6 KN
- B. 5 KN
- C. 12 kN
- D. 10 kN

**Correct Answer: B**

---

**117. Which of the following is not an elastic constant ?**

**[Civil Er. Highway 2069/10/06]**

- A. Young's modulus
- B. Shear modulus
- C. Poisson's ratio

#### D. Modulus of rupture

**Correct Answer: D**

Explanation:

✓ The modulus of rupture is the measure of the ultimate strength of a material in bending. It represents the maximum stress experienced by a material before failure when subjected to flexural loading. It is often used as an indicator of the tensile strength of brittle materials, such as concrete or ceramics. also called Flexural strength bend strength, is the stress a material experiences just before yielding in a flexure test. It is determined using a three-point bending test, where a specimen (circular or rectangular cross-section) is bent until it fractures or yields.

---

**118. The maximum bending moment in a uniformly loaded beam fixed at both ends with a load of intensity  $w$  per unit length ( $L$ ) throughout the span is:**

**[Civil Er. Highway 2069/10/06]**

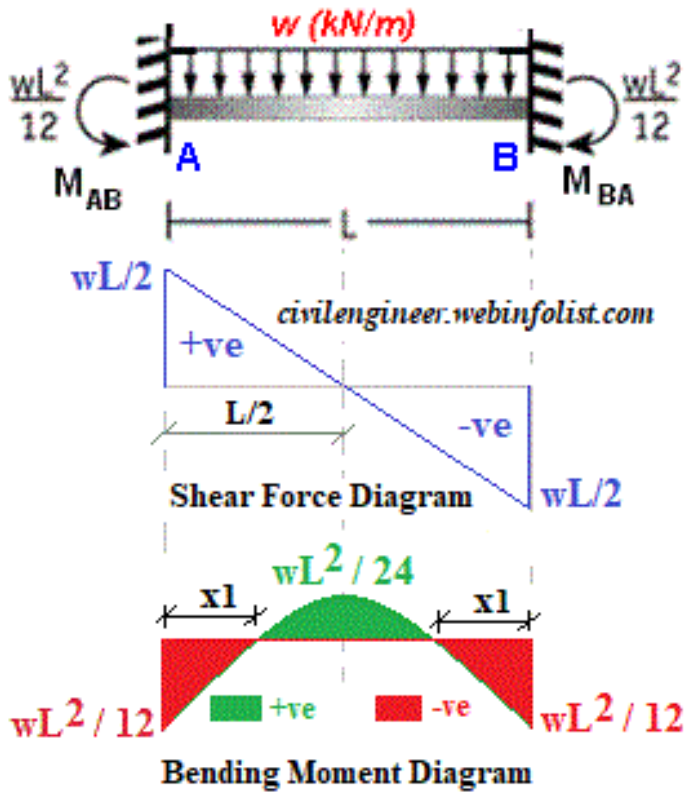
A.  $\frac{wL^2}{8}$

B.  $\frac{wL^2}{4}$

C.  $\frac{wL^2}{12}$

D.  $\frac{wL^2}{3}$

**Correct Answer: C**



Explanation:

✓ The maximum bending moment in a uniformly loaded beam fixed at both ends with a load intensity  $w$  per unit length throughout the span  $L$  is given by the formula:

$$M = -\frac{wL^2}{12}$$

✓ The maximum bending moment occurs at the fixed ends of the beam, where the constraints resist rotation and deflection due to the applied load.

. While the deflection is maximum at the middle with a value,

$$\Delta_{max} = \frac{wL^4}{384EI}$$

**119. Poisson's ratio for steel within elastic limit ranges from:**

**[Civil Er. 2068/11/12]**

- A. 0.15 to 0.2
- B. 0.25 to 0.24
- C. 0.25 to 0.33
- D. 0.33 to 0.35

**Correct Answer: C**

Explanation:

✓ Poisson's ratio: It is the ratio of lateral strain to longitudinal strain.

✓ For perfectly isotropic elastic material, Poisson's ratio is 0.25 but for most of the materials, the values lie in the range of 0.28 and 0.33. For steel, it is 0.3.

.Stainless steel: 0.30 – 0.31

.Steel: 0.27 – 0.30

.Cast iron: 0.21 – 0.26

.Cork: 0.0

.Rubber: 0.5

.Aluminium: 0.33

.Copper: 0.33

✓ Hence the value of Poisson's ratio for steel approximately lies between 0.25 to 0.33.

---

**120. The percentage of elongation of a material with applied a direct tensile**

test is:

[Civil Er. 2068/11/12]

- A. rigidity
- B. strength
- C. rupture
- D. ductility

**Correct Answer: D**

Explanation:

- ✓ Rigidity is the ability of a material or structure to resist deformation when subjected to external forces.
- ✓ A highly rigid object does not bend or stretch easily.
- ✓ Mathematically, it relates to the modulus of rigidity (shear Modulus)
- ✓ Strength refers to the maximum stress a material can withstand before failure.
- ✓ It includes tensile strength, compressive strength, and shear strength.
- ✓ A strong material can carry heavy loads without break
- ✓ Rupture is the breaking or fracturing of a material due to stress or force.
- ✓ It usually occurs after the material has deformed beyond its limit.
- ✓ Rupture point is the end of a stress-strain curve.
- ✓ Ductility is the ability of a material to undergo significant plastic deformation before rupture.
- ✓ Ductile materials (like steel) can be stretched into wires.
- ✓ It is a measure of how much a material can elongate or deform without breaking.

---

**121. In the influence line diagram for shear force at a section in a simply supported beam, the sum of maximum negative ordinate and maximum positive ordinate is:**

[Civil Er. 2068/11/12]

- A. 0
- B. -1
- C. 1
- D. none of the above

**Correct Answer: C**

**122. Maximum deflection of a simply supported single span beam with a concentrated -load 'p' at its centre is (use conventional notations):**

**[Civil Er. 2068/11/12]**

A.  $\frac{3WL^3}{584EI}$

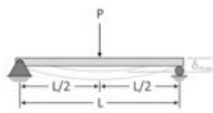
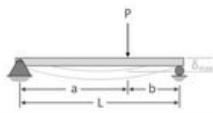
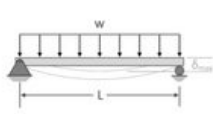
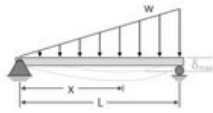
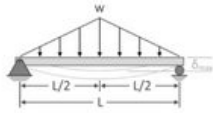

B.  $\frac{5WL^3}{384EI}$

C.  $\frac{WL^3}{48EI}$

D.  $\frac{WL^3}{24EI}$

**Correct Answer: C**



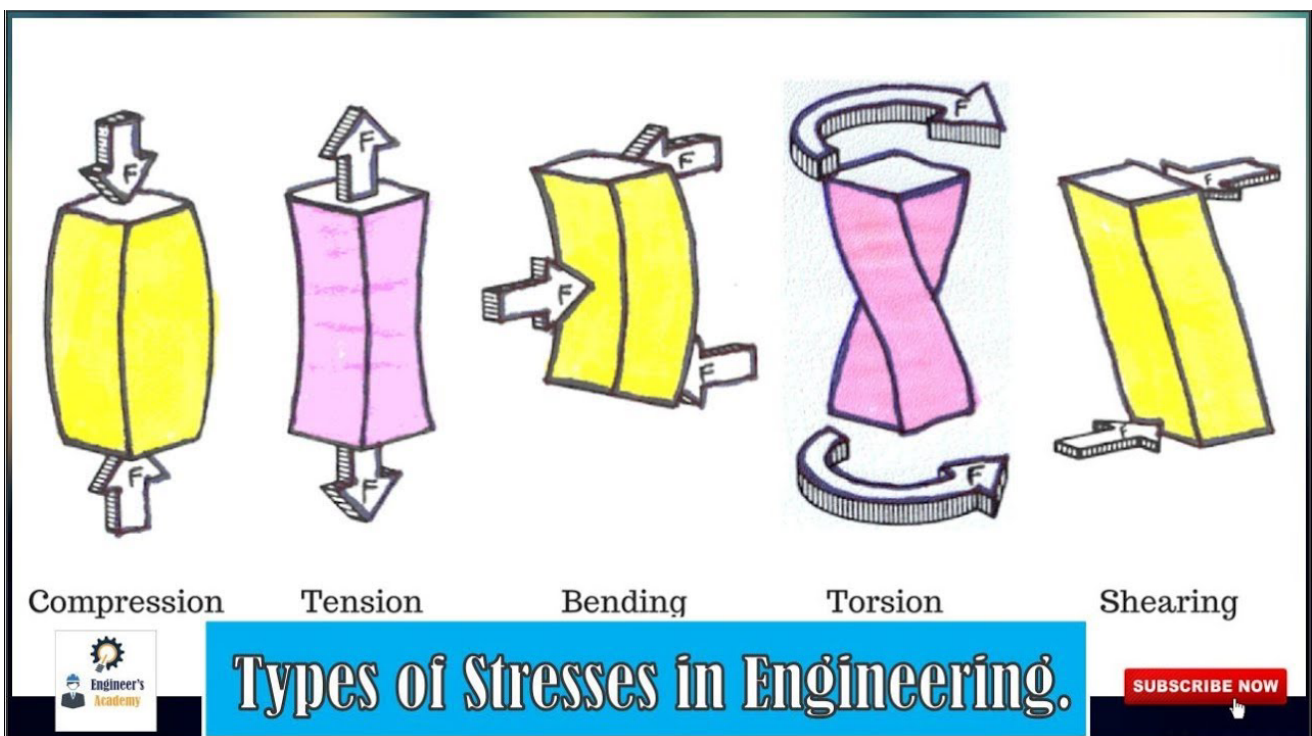
Beam and load cases	Maximum Beam Deflection
	$\delta_{max} = \frac{PL^3}{48EI}$
	$\delta_{max} = \frac{Pb(3L^2 - 4b^2)}{48EI}$
	$\delta_{max} = \frac{5wL^4}{384EI}$
	$\delta_{max} = \frac{0.00652wL^4}{EI}$
	$\delta_{max} = \frac{wL^4}{120EI}$
	$\delta_{max} = \frac{ML^2}{9\sqrt{3}EI}$

123. A localized compressive stress at the area of contact between two members known as:

[Civil Er. 2068/11/12]

- A. bending stress
- B. tensile stress
- C. shear stress
- D. bearing stress

**Correct Answer: D**



Explanation:

✓ Bearing stress (Crushing stress): This stress occurs when one object presses against another.

✓ Bearing stress =  $\text{Compressive force} / \text{Area of contact}$

✓ Bending stress: Bending stress is the internal stress developed within a structural member when it is subjected to bending moment.

- ✓ Tensile stress: Tensile stress is the stress that occurs when the material is subjected to a pulling force that tends to elongate it.
- ✓ Shear stress: Shear stress is the stress that occurs when a force is applied parallel to surface, causing the material to deform by sliding or shearing.


**124. The maximum deflection of a cantilever beam of length L subjected to point load at free end is as given below. where X is equal to ?:**  
**[Civil Er. 2068/11/12]**


A.  $1/3$

B.  $1/8$

C.  $1/16$

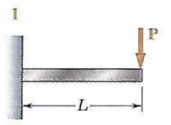
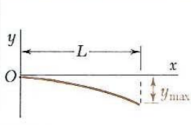
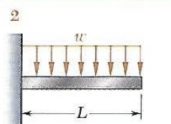
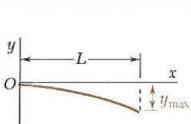
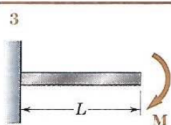
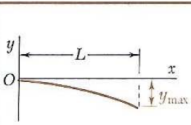
D.  $1/48$

$$\frac{XWL^3}{EI}$$




**Correct Answer: A**

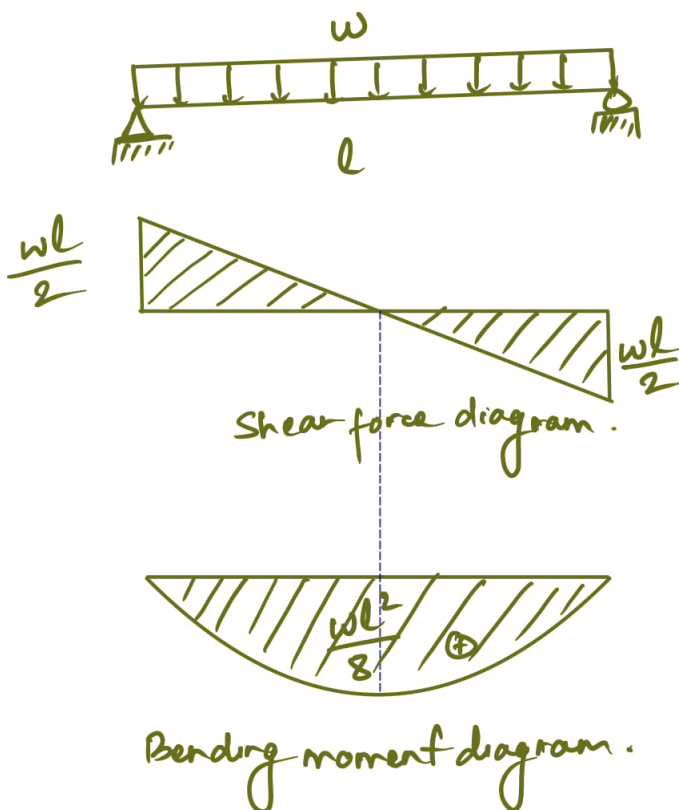
**Appendix: Beam deflection formulae**

Beam and Loading	Elastic Curve	Maximum Deflection	Slope at End	Equation of Elastic Curve
		$-\frac{PL^3}{3EI}$	$-\frac{PL^2}{2EI}$	$y = \frac{P}{6EI}(x^3 - 3Lx^2)$
		$-\frac{wL^4}{8EI}$	$-\frac{wL^3}{6EI}$	$y = -\frac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
		$-\frac{ML^2}{2EI}$	$-\frac{ML}{EI}$	$y = -\frac{M}{2EI}x^2$

125. A simply supported beam of span  $L$  carries a uniformly distributed load  $w$ . The maximum shear force  $v$  is:  
[Civil Er. B&Arch 2068/12/07]

- A.  $wL/4$
- B.  $wL/2$
- C.  $wL/16$
- D.  $wL/6$

Correct Answer: B



Explanation:

- ✓ Max Shear =  $wL/2$
- ✓ Max Bending Moment =

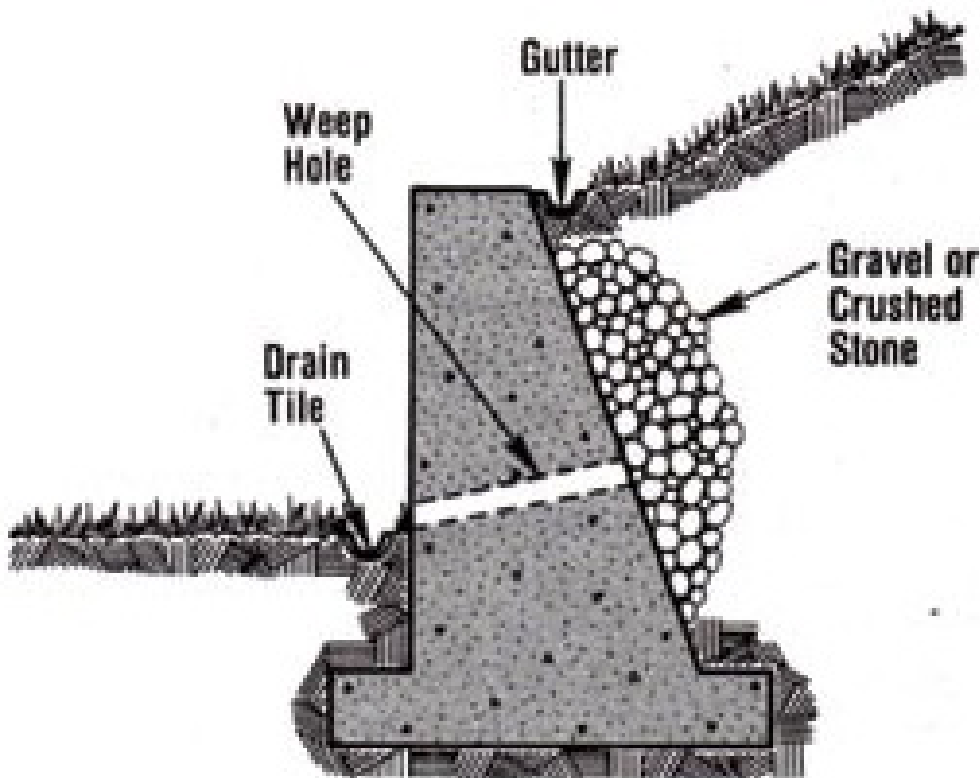
$$\frac{wL^2}{8}$$

126. In which of the structure 'weep holes' are provided?

[Civil Er. B&Arch 2068/12/07]

- A. shear wall
- B. retaining wall.
- C. beam
- D. column

**Correct Answer: B**



Explanation:

- ✓ Weep holes are created in retaining walls to facilitate drainage of excess water that accumulates behind the wall. This prevents the buildup of hydrostatic pressure, which can lead to structural failure due to increased lateral forces.
- ✓ Allow water to drain from the water lodge on the retaining wall.
- ✓ Remove hydrostatic pressure developed due to water lodge
- ✓ Prevent damage and dampness
- ✓ Helps moisture control
- ✓ Provide ventilation of the internal wall cavity

**127. Beams composed of more than one material, rigidly connected together so as to behave as one piece, are known as:**

**[Civil Er. B&Arch 2068/12/07]**

- A. compound beam
- B. indeterminate beam
- C. determinate beam
- D. composite beam

**Correct Answer: D**

Explanation:

✓ Composite Beam is the one in which the beam is made up of two or more material and rigidly connected together in such a way that they behaves as one piece.

✓ In composite beam, there is a common neutral axis through the centroid of the equivalent homogeneous section.

Note: Compound beam is a beam of different elements assembled together to form a single unit.

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**128. The ratio of the stresses produced by a suddenly applied load and a gradually applied load on a bar is:**

**[Civil Er. B&Arch 2068/12/07]**

- A. 1/4
- B. 1/2
- C. 1
- D. 2

**Correct Answer: D**

Explanation:

✓ The ratio of the stresses produced by a suddenly applied load to those produced by a gradually applied load on a bar is 2. This means that when a load is applied suddenly, the induced stress is twice that of a load applied gradually.

✓ Sudden Loading: The stress due to sudden loading is given by

$$\sigma_{sudden} = \frac{2P}{A}$$

.

✓ Gradual Loading: The stress due to gradual loading is given by

$$\sigma_{gradual} = \frac{P}{A}$$

.

Thus, the ratio is:

$$\text{Ratio} = \frac{\sigma_{sudden}}{\sigma_{gradual}} = \frac{2P/A}{P/A} = 2$$



**129. Bending moment of a cantilevered beam of span 'L' with UDL of intensity "W" over the entire span, at the mid-span should be:**

**[Civil Er. B&Arch2068/12/07]**

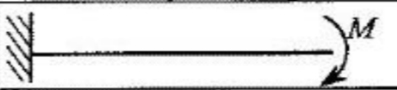
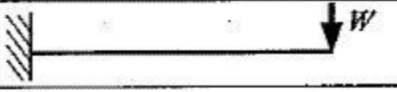
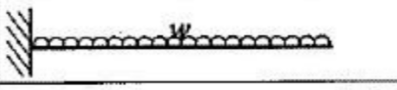
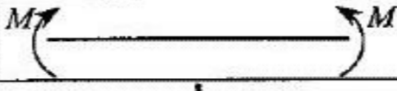
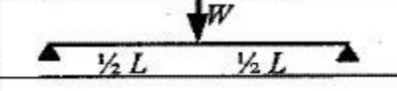
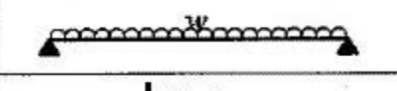
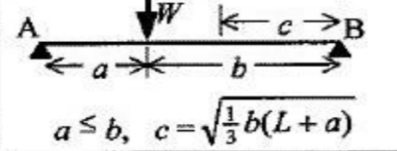
A.  $\frac{WL^2}{8}$

B.  $\frac{WL^2}{4}$

C.  $\frac{WL^2}{2}$

D.  $WL^2$

**Correct Answer: A**

$L =$ overall length $W =$ point load, $M =$ moment $w =$ load per unit length	End Slope	Max Deflection	Max bending moment
	$\frac{ML}{EI}$	$\frac{ML^2}{2EI}$	$M$
	$\frac{WL^2}{2EI}$	$\frac{WL^3}{3EI}$	$WL$
	$\frac{wL^3}{6EI}$	$\frac{wL^4}{8EI}$	$\frac{wL^2}{2}$
	$\frac{ML}{2EI}$	$\frac{ML^2}{8EI}$	$M$
	$\frac{WL^2}{16EI}$	$\frac{WL^3}{48EI}$	$\frac{WL}{4}$
	$\frac{wL^3}{24EI}$	$\frac{5wL^4}{384EI}$	$\frac{wL^2}{8}$
 $a \leq b, c = \sqrt{\frac{1}{3}b(L+a)}$	$\theta_B = \frac{Wac^2}{2LEI}$ $\theta_A = \frac{L+b}{L+a} \theta_B$	$\frac{Wac^3}{3LEI}$ (at position c)	$\frac{Wab}{L}$ (under load)

Explanation:

✓ Moment at mid section in cantilever beam is

$$M_x = \frac{wx^2}{2}$$

..... Where x is distance from free end

✓ Therefore at  $x = l/2$

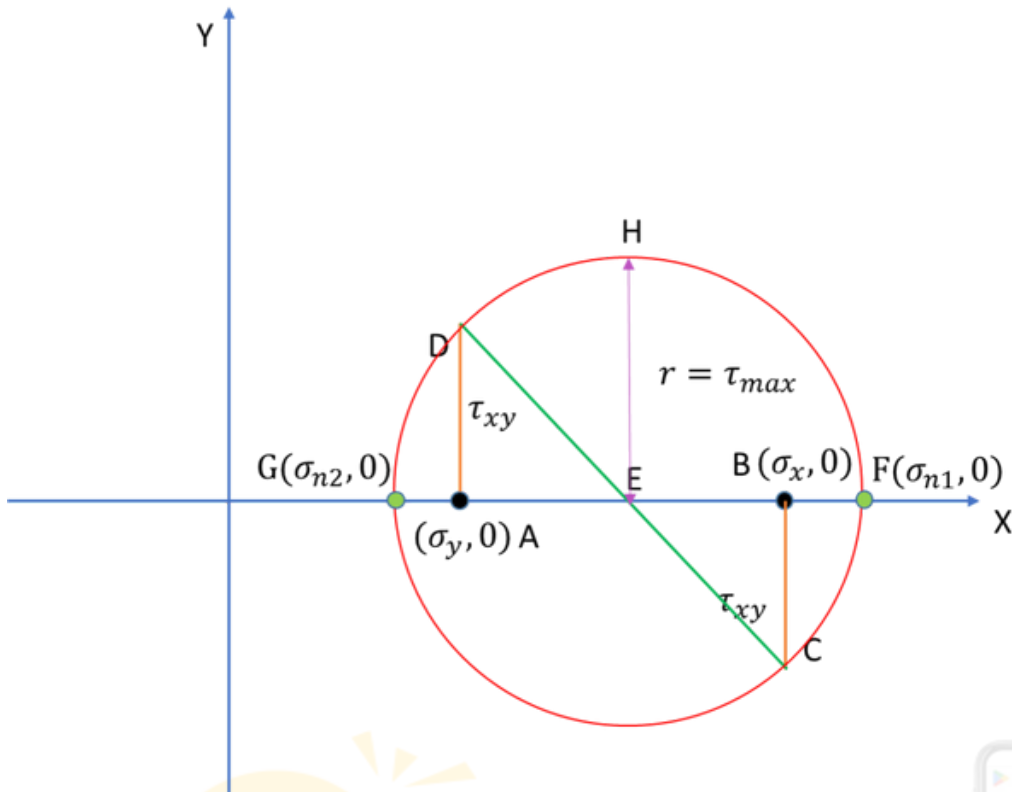
$$M_x = \frac{wl^2}{8}$$

130. For Mohr circle of radius R, the maximum shear stress is equal to :

[Civil Er. B&Arch 2068/12/07]

- A. 0.5 R
- B. R
- C. 2 R
- D. 3 R

Correct Answer: B



Explanation:

✓ The maximum shear stress in a Mohr circle is equal to the radius  $R$  of the circle. This relationship can be expressed mathematically as:

$$\tau_{\max} = \frac{\sigma_1 - \sigma_2}{2} = R$$

where

$\sigma_1$

and

$\sigma_2$

are the maximum and minimum principal stresses, respectively. Thus, the maximum shear stress occurs at the points where the Mohr circle intersects the horizontal axis.

131. If elongation due to temperature variation in the bar is prevented, the temperature stress produced will be given by:

[Civil Er. 2068/11/26]

1- Length of bar

E- Modulus of elasticity

$\alpha$  – Coefficient of linear expansion  
 $\Delta t$  – Change in temperature

A.  $\alpha \Delta t l$

B.  $\alpha \Delta t E$

C.  $\alpha l \Delta t E$

D.  $\alpha \Delta t$

Correct Answer: B

Explanation:

- ✓ Since stress = strain  $\times$  Young's modulus of elasticity
- ✓ Strain =  $\Delta L/L$
- ✓  $\Delta L = \alpha \Delta t * L$
- ✓ From above three equation..stress =  $\alpha \Delta t * E$

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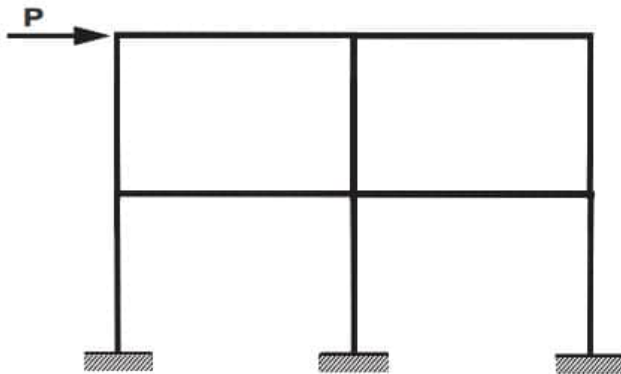
132. Portal Method of frame analysis for horizontal loads is appropriate for a frame:

[Civil Er. 2068/11/26]

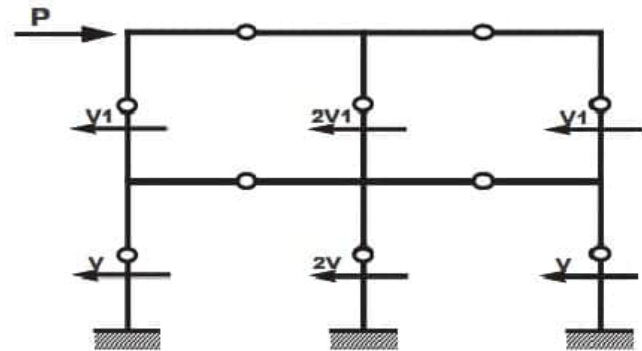
- A. that has a width greater than its height
- B. that has a height greater than its width
- C. which is thin and tall
- D. any width and any height

Correct Answer: A

## Approximate Lateral Load Analysis by Portal Method



**Real Structure**



**Approximation**

### Explanation:

The Portal Method of frame analysis is particularly suitable for analyzing frames subjected to horizontal loads, such as wind or seismic forces. This method is most appropriate for:

- ✓ Low-rise structures: Where shear deformations dominate and the height-to-width ratio is small, making the assumptions of the portal method valid.
- ✓ Statically indeterminate frames: The portal method simplifies complex frames into determinate structures by making specific assumptions about shear distribution and moments in columns and beams.

Note: The deformation in low-rise structures, where the height is smaller than its width, is characterized predominantly by shear deformations. In high rise building, where height is several times greater than its lateral dimensions, is dominated by bending action.

133. Number of unknowns to be determined in the stiffness method is equal to :

[Civil Er. Highway 2070/11/10]

- A. static indeterminacy
- B. kinematic indeterminacy
- C. kinetic indeterminacy
- D. none of the above

**Correct Answer: B**

Explanation:

✓ Force Method: Force is unknown and no. of unknowns =  $D_s$  (Degree of static indeterminacy)

✓ In stiffness/displacement method displacement is unknown:  
No. of unknowns =  $D_k$  (Degree of kinematic indeterminacy)

134. The slope and the deflection at a section in-a-loaded beam can not be found out by

[Civil Er. 2068/11/26]

- A. Rankine's method
- B. Virtual work method.
- C. Macaulay's method.
- D. Moment area method

**Correct Answer: A**

Explanation:

✓ The slope and deflection at a section in a loaded beam cannot be determined using Rankine's method, as it is not a recognized technique for analyzing beam deflections.

- ✓ The unit work method calculates deflection or rotation by applying a unit load/moment at the point of interest and using the principle of virtual work to relate internal forces to structural deformation.
  
- ✓ Macaulay's method to determine the slope and deflection at a point in a beam is suitable for beams subjected to concentrated loads and can be extended to uniformly distributed loads. It is applicable for prismatic beams only
- ✓ Moment Area Method: This method involves constructing moment-area diagrams to determine slopes and deflections. The area under the bending moment diagram represents the change in slope, while the first moment of area about a point gives the deflection at that point. It is particularly useful for beams with varying loading conditions.

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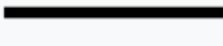








**135. Bending moment at any section in a conjugate beam gives in the actual beam:**

**[Civil Er. Hydropower 2068/11/14]**

- A. slope
- B. curvature
- C. deflection
- D. bending moment

**Correct Answer: C**

Real support vs Conjugate support<sup>[3]</sup>

Real beam		Conjugate beam	
<b>Fixed support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta = 0</math></li> </ul> 		<b>Free end</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q} = 0</math></li> </ul> 	
<b>Free end</b> <ul style="list-style-type: none"> <li><math>v \neq 0</math></li> <li><math>\theta \neq 0</math></li> </ul> 		<b>Fixed support</b> <ul style="list-style-type: none"> <li><math>\bar{M} \neq 0</math></li> <li><math>\bar{Q} \neq 0</math></li> </ul> 	
<b>Hinged support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta \neq 0</math></li> </ul> 		<b>Hinged support</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q} \neq 0</math></li> </ul> 	
<b>Middle support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta</math>:continue</li> </ul> 		<b>Middle hinge</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q}</math>:continue</li> </ul> 	
<b>Middle hinge</b> <ul style="list-style-type: none"> <li><math>v</math>:continue</li> <li><math>\theta</math>:discontinue</li> </ul> 		<b>Middle support</b> <ul style="list-style-type: none"> <li><math>\bar{M}</math>:continue</li> <li><math>\bar{Q}</math>:discontinue</li> </ul> 	

Explanation:

✓ A Conjugate beam is defined as an imaginary beam with the same dimension as that of the original beam but load at any point on the conjugate beam is equal to bending moment at that point divided by EI (Flexural Rigidity).

✓ The shear force in the conjugate beam at a point is a slope at the point in the real beam.

✓ The bending moment in the conjugate beam at a point is the deflection at the point in the real beam.

136. In general equation for the deflection of the beam,

[Civil Er. Hydropower 2068/11/14]

[Civil Er. General 2068/11/03]

$$M = EI \frac{d^2 y}{dx^2} \text{ where EI is:}$$

- A. young's modulus of elasticity
- B. flexural strength
- C. stiffening modulus
- D. sectional rigidity

**Correct Answer: B**

Explanation:

✓ EI represents flexural strength or rigidity of the beam, which is the product of the materials Young's modulus and the area moment of inertia of the beam's cross-section.

---

**137. The square root of the ratio of moment of inertia to the area of a cross section is called a**

**[Civil Er. Hydropower 2068/11/14]**

- A. section modulus
- B. slenderness ratio
- C. radius of gyration
- D. shear modulus

**Correct Answer: C**

Explanation:

✓ Radius of gyration: It is radial distance from the point to the axis of rotation where whole mass of the body is supposed to be concentrated.

$$I = M \cdot K^2$$

$$\text{or, } K = \sqrt{I/M}$$

where, I - Moment of inertia

M- Concentrated mass at a point

K- Radius of gyration

---

138. Three hinged system is a structure which is statically:

[Civil Er. Hydropower 2068/11/14]

[ Repeat Civil Er Hydropower 2068/11/14]

- A. determinate
- B. indeterminate
- C. unstable
- D. none of above

**Correct Answer: A**

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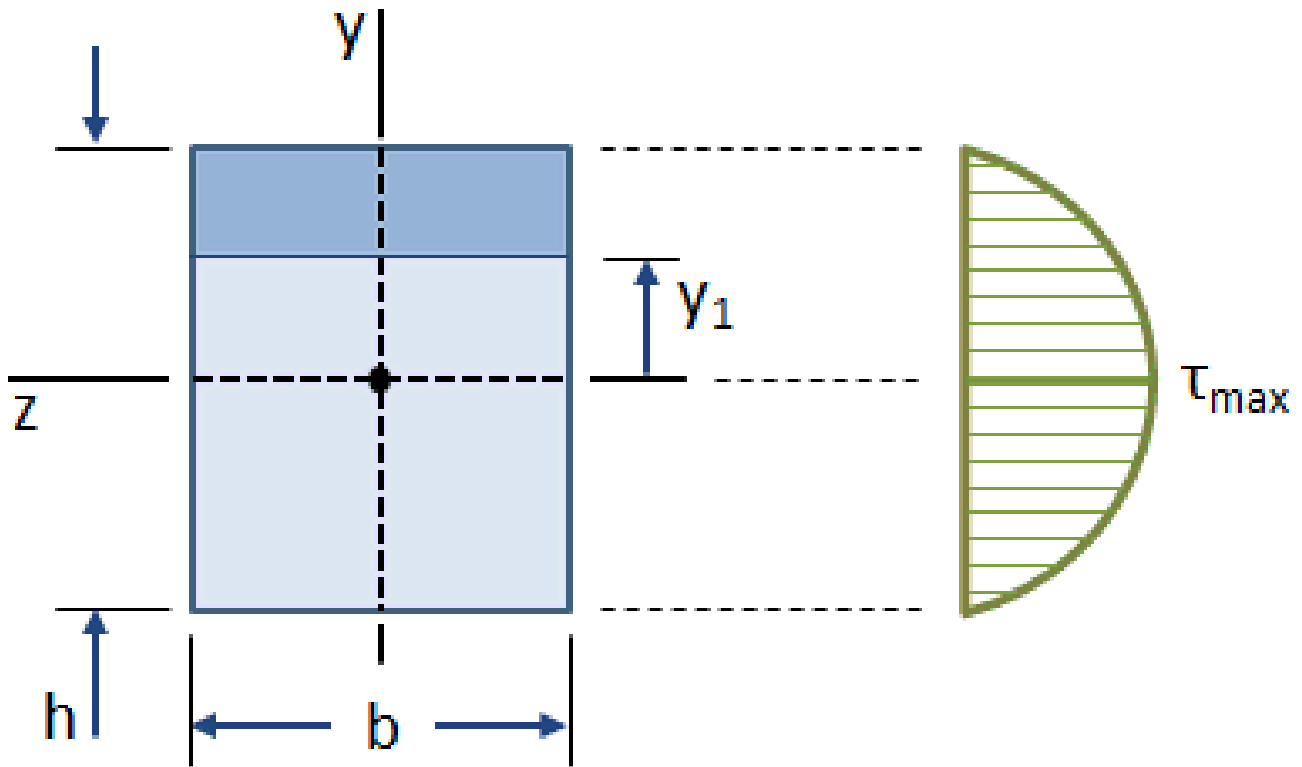
139. A rectangular section with depth 'd' and breadth 'b' of a beam subjected to shear force 'v' the magnitude of shear stress at the top edge of rectangle is:

[Civil Er. Hydropower 2068/11/14]

[Civil Er. Highway 2067/12/10]

- A.  $v/bd$
- B.  $3v/2bd$
- C.  $3v/4bd$
- D. zero

**Correct Answer: D**



Explanation:

✓ For a rectangular section the shear stress distribution is parabolic in nature.

✓ Max shear stress occurs at the middle while 0 at the ends.

✓

$$\tau_{max} = 1.5\tau_{avg}$$

For a Circular Cross-Section:

$$\tau_{max} = \frac{4V}{3A}$$

140. When the load does not pass through the shear centre of the steel beam, it produces

[Civil Er. Hydropower 2068/11/14]

- A. torsional moments only
- B. bending moments only
- C. shear force only
- D. torsional moment along with bending moment

**Correct Answer: D**

Explanation:

- ✓ Shear center is a point through which if the external force passes, then the section will be subjected to bending only and there will be no twisting of the section.
- ✓ In an Unsymmetrical section, if the external applied forces act at the centroid or any other point ( but not Shear Centre) of the section, then in addition to bending, twisting is also produced.
- ✓ To avoid twisting, it is necessary for the force to act through a particular point and this point is termed as shear centre.

---

**141. When a cantilever beam of length  $l$  is loaded with a uniformly varying load of maximum intensity  $w$  at free end, the shape of bending moment diagram is:**

[Civil Er. Hydropower 2068/11/14]

- A. a straight line
- B. a triangle
- C. a simple parabola
- D. cubic parabola

**Correct Answer: D**

Explanation:

- ✓ Shear force: Simple Parabola
- ✓ Bending Moment: Cubic Parabola

---

142. The rate of change of bending moment is equal to:

[Civil Er. General 2068/11/03]

- A. shear force
- B. deflection
- C. slope
- D. rate of loading

**Correct Answer: A**

Explanation:

✓

$$\frac{dM}{dx} = V$$

✓

$$\frac{dV}{dx} = w$$



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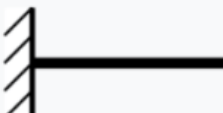






143. The fixed support in a real beam becomes the conjugate beam in a :

[Civil Er. General 2068/11/03]

- A. roller support
- B. hinged support
- C. fixed support
- D. free end

**Correct Answer: D**

Real support vs Conjugate support<sup>[3]</sup>

Real beam		Conjugate beam	
<b>Fixed support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta = 0</math></li> </ul> 		<b>Free end</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q} = 0</math></li> </ul> 	
<b>Free end</b> <ul style="list-style-type: none"> <li><math>v \neq 0</math></li> <li><math>\theta \neq 0</math></li> </ul> 		<b>Fixed support</b> <ul style="list-style-type: none"> <li><math>\bar{M} \neq 0</math></li> <li><math>\bar{Q} \neq 0</math></li> </ul> 	
<b>Hinged support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta \neq 0</math></li> </ul> 		<b>Hinged support</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q} \neq 0</math></li> </ul> 	
<b>Middle support</b> <ul style="list-style-type: none"> <li><math>v = 0</math></li> <li><math>\theta</math>:continue</li> </ul> 		<b>Middle hinge</b> <ul style="list-style-type: none"> <li><math>\bar{M} = 0</math></li> <li><math>\bar{Q}</math>:continue</li> </ul> 	
<b>Middle hinge</b> <ul style="list-style-type: none"> <li><math>v</math>:continue</li> <li><math>\theta</math>:discontinue</li> </ul> 		<b>Middle support</b> <ul style="list-style-type: none"> <li><math>\bar{M}</math>:continue</li> <li><math>\bar{Q}</math>:discontinue</li> </ul> 	

144. If a normal cross section A of a member is subjected to a tensile force P, the resulting normal stress in a oblique plane inclined at angle  $\theta$  to transverse plane will be:

[Civil Er. General 2068/11/03]

A.  $\frac{P}{A} \sin^2 \theta$

B.  $\frac{P}{A} \cos^2 \theta$

C.  $\frac{P}{2A} \sin^2 \theta$

D.  $\frac{P}{2A} \cos^2 \theta$

**Correct Answer: B**

Explanation:

✓ While shear stress in the plane is given by

$$\tau = \frac{P}{2A} \sin 2\theta$$

145. Moment of inertia is expressed in unit:

[Civil Er. General 2068/11/03]

- A. cm<sup>3</sup>
- B. cm<sup>2</sup>
- C. cm
- D. cm<sup>4</sup>

**Correct Answer: D**

Explanation:

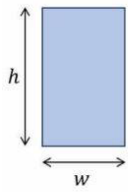
- ✓ Moment of inertia (Area moment of inertia): Area moment of inertia, also known as second moment of area, is a geometric property of a cross-section that indicates its resistance to bending.
- ✓ The area moment of inertia is a mathematical property that describes how an area is distributed about a specific axis.
- ✓ Unit: m<sup>4</sup> or mm<sup>4</sup> or cm<sup>4</sup>

146. Moment of inertia of a circular cross section with a diameter 'd' is equal to :

[Civil Er. General 2068/11/03]

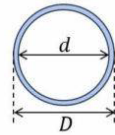
- A.  $\frac{\pi d^3}{32}$
- B.  $\frac{\pi d^4}{32}$
- C.  $\frac{\pi d^3}{64}$
- D.  $\frac{\pi d^4}{64}$

**Correct Answer: D**



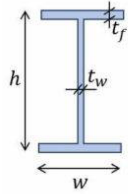
$$I_y = \frac{wh^3}{12}$$

$$I_z = \frac{hw^3}{12}$$



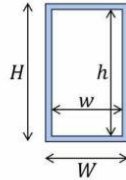
$$I_y = \frac{(D^4 - d^4) \cdot \pi}{64}$$

$$I_z = \frac{(D^4 - d^4) \cdot \pi}{64}$$



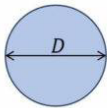
$$I_y = \frac{wh^3}{12} - \frac{(w-t_w)(h-2t_w)^3}{12}$$

$$I_z = \frac{hw^3}{12} - \frac{(w-t_w)^3 \cdot (h-2t_w)}{12}$$



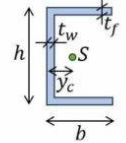
$$I_y = \frac{WH^3 - wh^3}{12}$$

$$I_z = \frac{HW^3 - hw^3}{12}$$



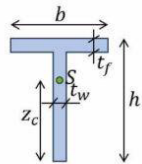
$$I_y = \frac{\pi D^4}{64}$$

$$I_z = \frac{\pi D^4}{64}$$



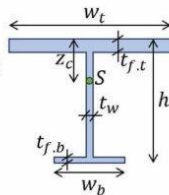
$$I_y = \frac{wh^3 - (b-t_w) \cdot (h-2t_f)^3}{12}$$

$I_z = \text{Formula too long}$   
→ Formula found in blogpost



$I_y = \text{Formula too long}$   
→ Formula found in blogpost

$$I_z = \frac{t_f \cdot b^3}{12} + \frac{h \cdot t_w^3}{12}$$



$I_y = \text{Formula too long}$   
→ Formula found in blogpost

$$I_z = \frac{t_{f,t} \cdot b_t^3}{12} + \frac{(h-t_{f,t}-t_{f,b}) \cdot t_w^3}{12} + \frac{t_{f,b} \cdot w_b^3}{12}$$

Explanation:



✓ The Moment of Inertia of a circle about the centroidal axis is:

$$I_{xx} = I_{yy} = (\pi d^4 / 64)$$

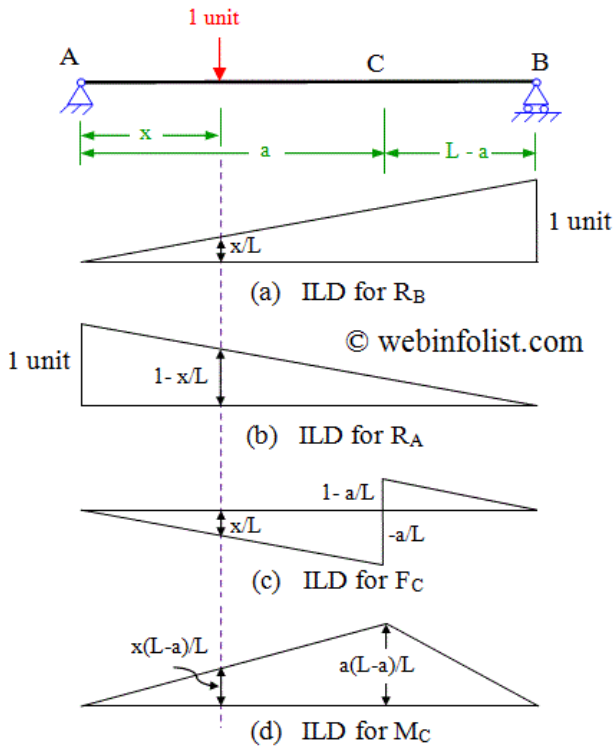
$$= (\pi r^4 / 4)$$

147. The method of analysis used to identify critical loading condition in a beam due to moving load is:

[Civil Er. General 2068/11/03]

- A. dynamic analysis
- B. kinetic energy.
- C. influence line diagrams
- D. none of above

**Correct Answer: C**



**Figure 1 Influence Line diagram**

Explanation:

✓ Influence line diagram represents the variation of a specific structural response ( like shear force, bending moment, or deflection) at a particular point in the beam as a unit load moves across its entire length.

✓ Response plot of the member force is also a ILD.

✓ ILD can be drawn for any type of structure i.e. determinate and indeterminate structure.

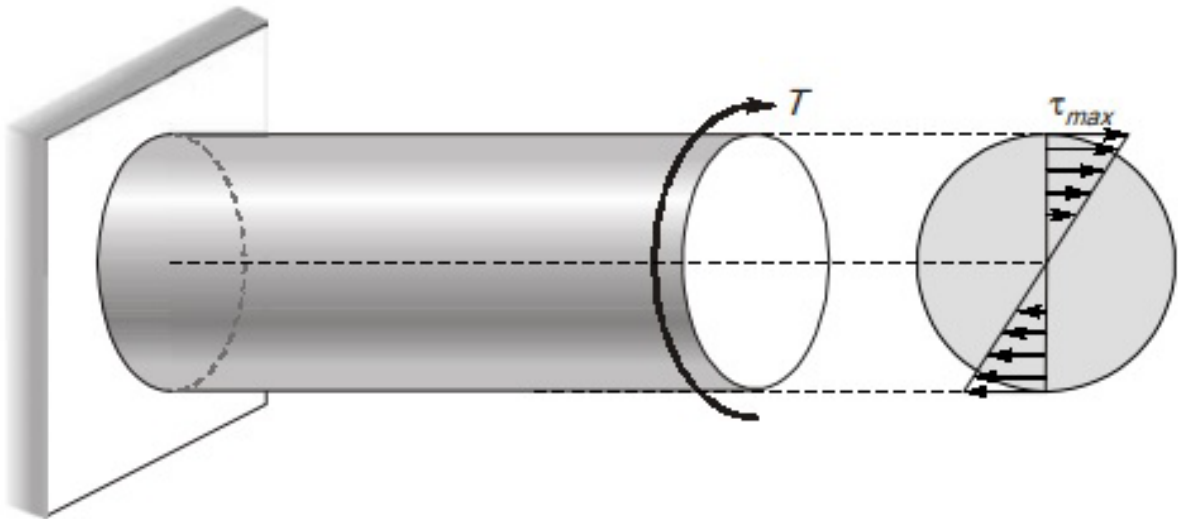
✓ It is based upon Muller-Breslau principle.

**148. When a shaft is subjected to torsion, the shear stress induced in the shaft varies from:**

**[Civil Er. General 2068/11/03]**

- A. minimum at centre to maximum at circumference
- B. maximum at centre to minimum at circumference
- C. zero at centre to maximum at circumference
- D. maximum at centre to zero at circumference

**Correct Answer: C**



Explanation:

✓ When a shaft is subjected to torsion, the shear stress induced in the shaft varies from zero at center to maximum at the edge.

✓ This linear distribution of shear stress occurs because it depends on the distance from the axis of the shaft, following the relationship

$$\frac{\tau}{r} = \frac{T}{J} = \frac{G\theta}{L}$$

where  $T$  is the torque,  $r$  is the radius, and  $J$  is the polar moment of inertia.

✓ From above equation it is clear that for a given  $T$  and  $J$ .

$$\tau \propto r$$

---

**149. The modulus of elasticity in the case of rigid body is:**

[Civil Er. General 2068/11/03]

- A. equal to zero
- B. the ratio of stress to strain
- C. equal to five times that of a flexible body
- D. equal to infinite

**Correct Answer: D**

Explanation:

✓ Perfectly rigid body does not deform under any applied stress, resulting in zero strain.

✓ Since the modulus of elasticity (E) is defined as the ratio of stress to strain (

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

)

✓ Thus modulus of elasticity for a perfectly rigid body is considered to be infinite.

---

**150. The ratio of lateral strain to axial strain of a homogeneous material is known:**

[Civil Er. General 2068/11/03][Civil Er. General 2070/11/8]

- A. Yield ratio
- B. Hooke's ratio
- C. Poisson's ratio
- D. Plastic ratio

**Correct Answer: C**

Explanation:

✓ Strain: Strain is defined as the ratio of change in dimension to the original dimension.

- ✓ Longitudinal strain: The ratio of change in length to the original length is called longitudinal strain.
- ✓ Lateral strain: The ratio of change in diameter/breadth to original diameter/breadth is called the lateral strain.
- ✓ Poisson's ratio: The ratio of lateral strain to longitudinal strain is called the Poisson's ratio.
- ✓ Poisson's ratio = - [Lateral strain/Longitudinal strain]
- ✓ The engineering range of Poisson's ratio 0 to 0.5.
- ✓ The theoretical range is -1 to 0.5.
- ✓ Hooke's ratio: The ratio of stress to strain within elastic limit of a material.
- ✓ Yield ratio: The ratio of yield strength to ultimate tensile strength of a material.

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**151. A simply supported beam of span  $l$  carries a uniformly distributed load  $w$ . The maximum bending moment is:**  
[Civil Er. Hydropower 2068/11/14]

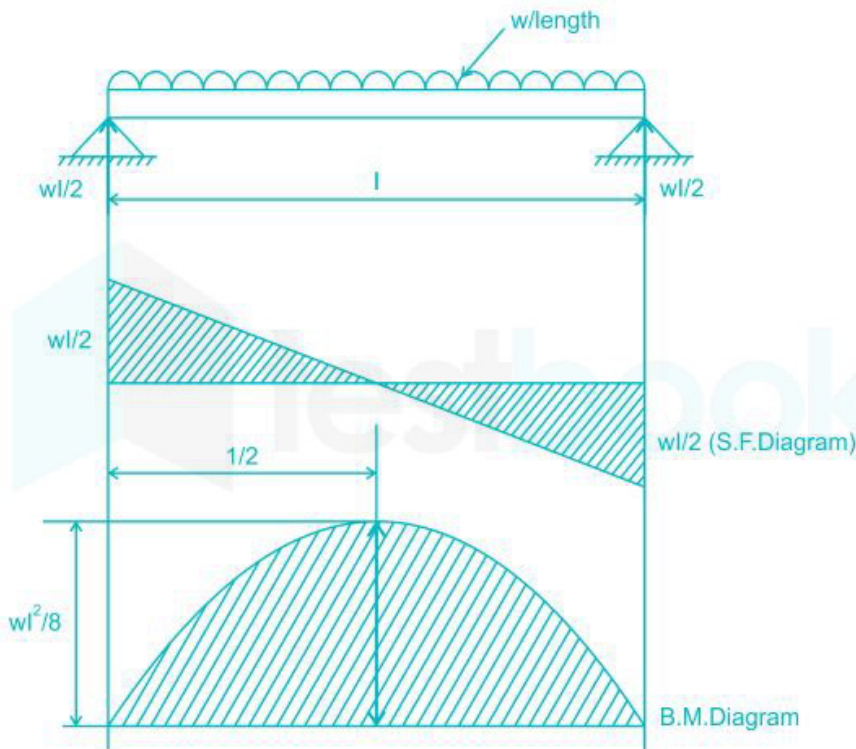
A.  $\frac{wl}{2}$

B.  $\frac{wl}{4}$

C.  $\frac{wl^2}{8}$

D.  $\frac{wl}{12}$

**Correct Answer: C**



Explanation:

✓ Let's assume a section x-x at a distance x from support (from left).

Bending Moment ( $M_x$ ) at a section x-x is given by

$$M_x = (wl/2) * x - wx * (x/2)$$

$$= (wlx/2) - (wx^2/2)$$

S.F at any X-section x-x is

$$V_x = w(l/2 - x)$$

S.F will be zero at  $x = l/2$

B.M will be maximum where shear force is zero.

So,

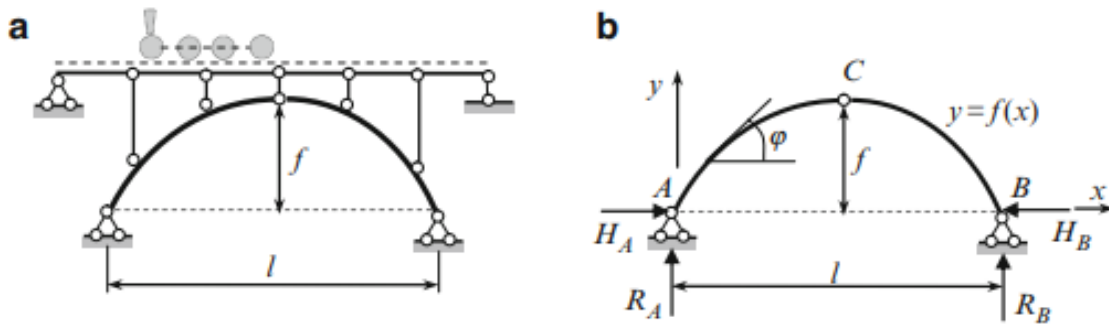
$$\text{Maximum B.M (} x=l/2 \text{)} = wl^2/8$$

**152. Three hinged system is a structure which is statically:**

**[Civil Er. Hydropower 2068/11/14]**

- A. determinate
- B. indeterminate
- C. unstable
- D. none of above

**Correct Answer: A**



**Fig. 4.1 (a) Design diagrams for deck-arch bridge; (b) Design diagram of three-hinged arch**

Explanation:

✓ A three-hinged system, such as an arch, is statically determinate. This means that its reactions and internal forces can be determined using only the equations of static equilibrium.

✓ As we know,

No. of support reactions,  $R = 4$

Equations of static equilibrium,  $R_e = 3$

Additional equation due to released reaction at hinge at crown,  $R_r = 1$

Degree of static determinacy,  $D_s = R - (R_e + R_r) = 4 - (3 + 1) = 0$

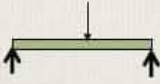
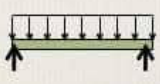

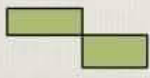
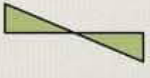
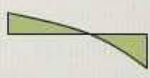


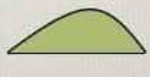
**153. When a cantilever beam of length  $L$  is loaded with a uniformly varying load of maximum intensity  $w$  at free end, the shape of bending moment diagram is:**

**[Civil Er. Hydropower 2068/11/14]**

- A. a straight line
- B. a triangle
- C. a simple parabola
- D. cubic parabola

**Correct Answer: D**

### SF and BM diagram

	P	Constant	Linear
Load			
Shear			
Moment			

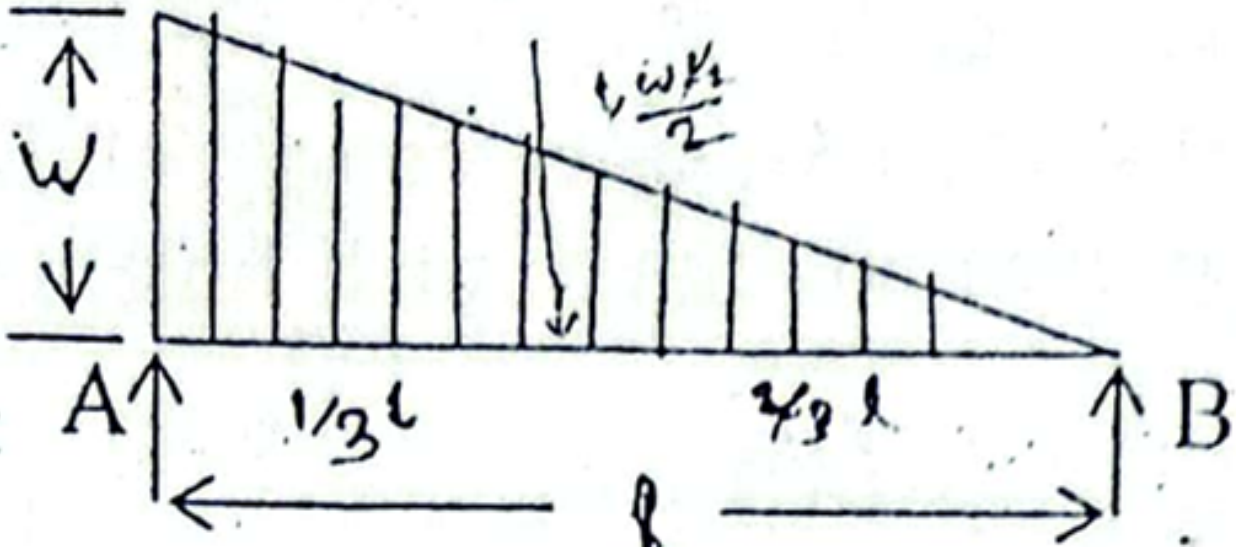


Explanation:

- ✓ For uniformly varied load BM is cubic parabola.
- ✓ For uniformly distributed load it is parabolic (square)
- ✓ For point load BMD is linear (straight line)

**154. For the beam shown in figure, the shear force at A is equal to:**

**[Civil Er. 2068/11/26]**



- A.  $wl/6$
- B.  $wl/3$
- C.  $wl$
- D.  $2wl/3$

**Correct Answer: B**

Explanation:

✓ Resultant force = area of triangle =  $wl/2$

acts at a distance of  $l/3$  from A.

✓ Taking moment about A and equating to 0 we get,

$$\frac{wl}{2} \times \frac{l}{3} - R_B \times l = 0$$

$$R_B = \frac{wl}{6}$$

$$R_A = \frac{wl}{2} - \frac{wl}{6} = \frac{wl}{3}$$

✓ Here, shear at A = reaction at A. So answer is (b).

**155. Hooke's Law holds good up to:**

[Civil Er. Hydropower 2068/11/14]



- A. Yield point
- B. Elastic limit
- C. Plastic limit
- D. Breaking point

**Correct Answer: B**

Explanation:

✓ Hooke's law is valid up to the limit of proportionality, which is the point where the stress-strain relationship remains linear. The limit of proportionality is a more specific term for the linear region of deformation. But since elastic limit and proportional limit are practically the same the best answer given the options is Elastic limit.

✓ Originally Hooke's law as stated by Hooke states that "for relatively small deformations of an object, the displacement or size of the deformation is directly proportional to the deforming force or load."

✓ Developed by Robert Hooke in 1660 AD.

---

**156. If the modulus of elasticity is equal to zero. the material is said to be:**  
[Civil Er. Hydropower 2068/11/14]

- A. plastic
- B. flexible
- C. rigid
- D. none of these

**Correct Answer: A**

Explanation:

✓ Since

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

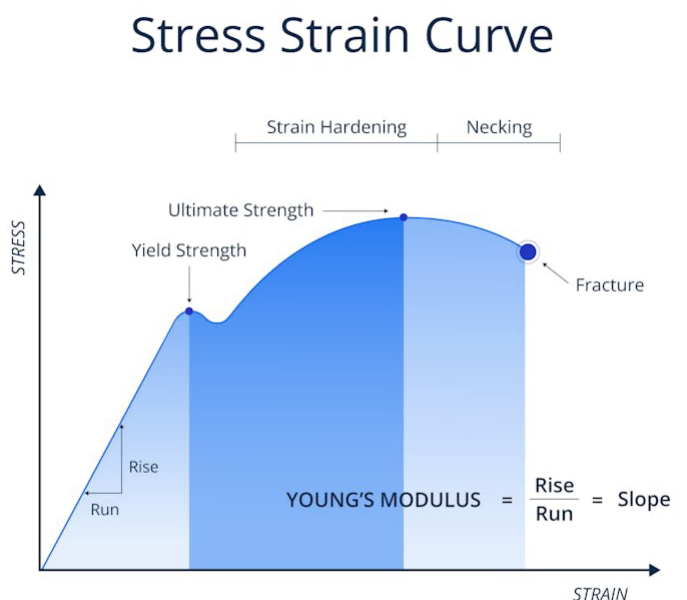
- ✓ Clearly, to get  $E$  equals to zero strain must be infinite which is in plastic material
- ✓ If modulus of elasticity is infinite then the material is said to be perfectly rigid since that means infinite force needed for a unit strain or body doesn't undergoes any deformation under stress .

157. At yield point a test piece:

[Civil Er. Hydropower 2068/11/14]

- A. materials obeys Hooke's law
- B. materials behave in an elastic manner
- C. materials regain its original shape on removal of load
- D. material undergoes plastic deformation

Correct Answer: D



Explanation:

- ✓ Yielding by definition is undergoing large plastic deformation at a small or almost no increase in stress.

158. A simply supported beam of span 'L' is carrying a point load 'W' at mid span. What is the deflection at center of the beam?

[Civil Er. Highway 2067/12/10]

A.  $\frac{WL^2}{EI}$

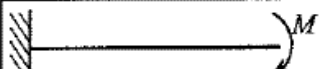
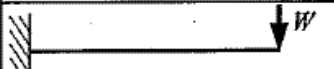
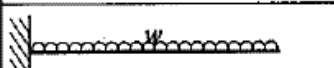
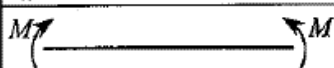
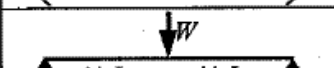
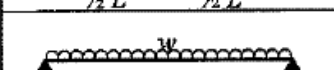
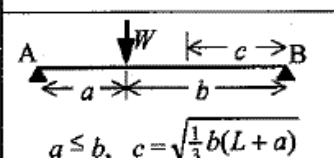
B.  $\frac{WL^3}{48EI}$

C.  $\frac{5WL^3}{384EI}$

D.  $\frac{WL^3}{EI}$

Correct Answer: B

BEAM BENDING

$L =$ overall length $W =$ point load, $M =$ moment $w =$ load per unit length	End Slope	Max Deflection	Max bending moment
	$\frac{ML}{EI}$	$\frac{ML^2}{2EI}$	$M$
	$\frac{WL^2}{2EI}$	$\frac{WL^3}{3EI}$	$WL$
	$\frac{wL^3}{6EI}$	$\frac{wL^4}{8EI}$	$\frac{wL^2}{2}$
	$\frac{ML}{2EI}$	$\frac{ML^2}{8EI}$	$M$
	$\frac{WL^2}{16EI}$	$\frac{WL^3}{48EI}$	$\frac{WL}{4}$
	$\frac{wL^3}{24EI}$	$\frac{5wL^4}{384EI}$	$\frac{wL^2}{8}$
 $a \leq b, c = \sqrt{\frac{1}{3}b(L+a)}$	$\theta_B = \frac{Wac^2}{2LEI}$ $\theta_A = \frac{L+b}{L+a} \theta_B$	$\frac{Wac^3}{3LEI}$ (at position c)	$\frac{Wab}{L}$ (under load)

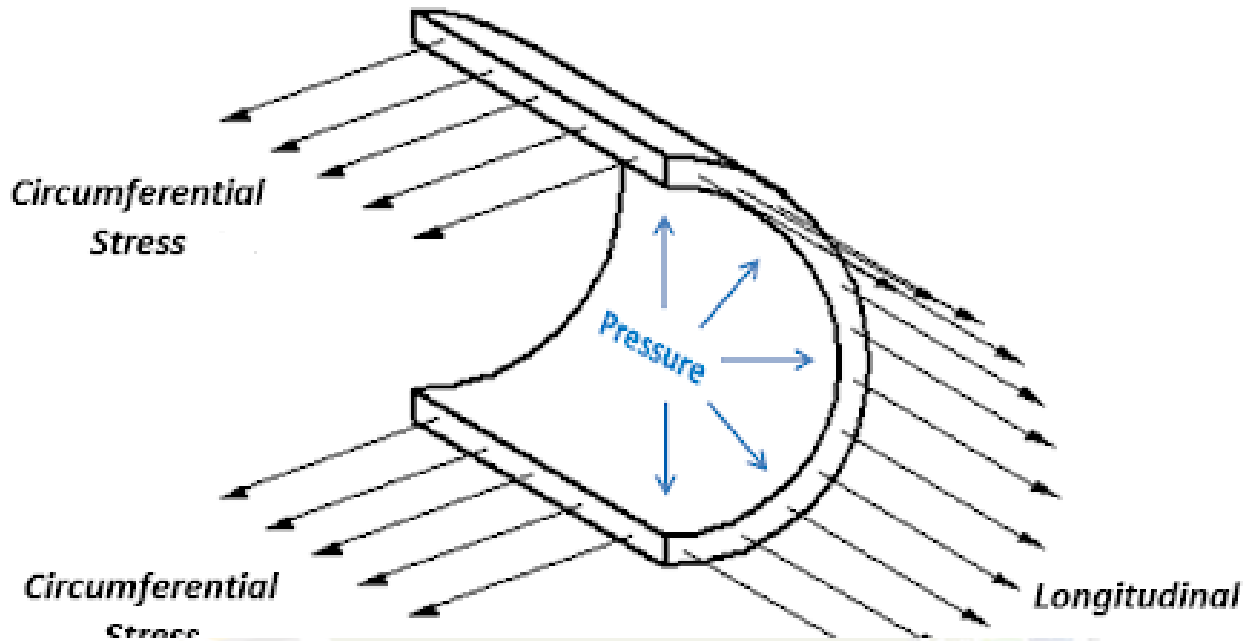


159. When a thin cylindrical shell is subjected to internal fluid pressure, which of the following stress is developed in its wall?

[Civil Er. Highway 2067/12/10]

- A. circumferential and longitudinal stress
- B. longitudinal stress
- C. normal stress
- D. circumferential stress

**Correct Answer: A**



Explanation:

✓ Thin shell : If the Diameter of the vessel is greater than or equal to 20 times the thickness of the vessel then the vessel is called a thin cylinder.

$$\frac{D}{t} > 20$$

1. Hoop Stress (Circumferential Stress):

This is the stress acting along the circumference of the cylinder and is caused by the fluid pressure trying to split the cylinder longitudinally.

$$\sigma_h = \frac{p \cdot r}{t}$$

P = internal pressure,

r = internal radius of the shell,

t = thickness of the shell.

## 2. Longitudinal Stress (Axial Stress):

This is the stress acting along the length of the cylinder, caused by the pressure trying to pull the cylinder apart along its axis.

$$\sigma_l = \frac{p \cdot r}{2t}$$

Both of these stresses are significant for the design and analysis of thin-walled pressure vessels. Hoop stress is typically larger than longitudinal stress, making it the critical factor in the design. Note that Hoop Stress = 2 times longitudinal stress

---

**160. In a circular shaft shear stress developed by twisting moment is directly proportional to:**

**[Civil Er. Highway 2067/12/10][Civil Er. B&Arch 2068/12/07]**

- A. moment of inertia of shaft
- B. radius of shaft
- C. length of shaft
- D. area of shaft

**Correct Answer: B**

Explanation:

$$\frac{\tau}{r} = \frac{T}{J} = \frac{G\theta}{L}$$

where  $T$  is the torque,  
 $r$  is the radius, and  
 $J$  is the polar moment of inertia.

From above equation it is clear that for a given  $T$  and  $J$ .

$$T \propto r$$

---

**161. Bending moment at point of inflection of a continuous beam subjected to uniformly distributed gravity load is:**

**[Civil Er. Highway 2067/12/10]**

- A. positive
- B. positive or negative
- C. zero
- D. negative

**Correct Answer: C**

Explanation:

- ✓ The point of inflection and the point of contraflexure are essentially the same in structural analysis. Both refer to locations along a beam where the bending moment is zero and changes sign, indicating a transition from hogging (negative) to sagging (positive) moments.
- ✓ The point of inflection is a broader term that applies to any curve changing concavity, while contraflexure specifically pertains to bending moments in beams.
- ✓ Thus, they can be used interchangeably in the context of beam analysis

---

**162. Nature of the axial force in the upper chord of a pin connected truss subjected to gravity load is:**

[Civil Er. Highway 2067/12/10]

- A. compressive
- B. tensile
- C. compressive or tensile
- D. zero

**Correct Answer: A**

Explanation:

✓ In a pin-connected truss subjected to a gravity load (i.e., vertical downward loads such as dead loads and live loads):

. The top chord (upper chord) of the truss usually resists compressive forces, because it acts like the top flange of a beam in bending.

. The bottom chord resists tensile forces.

. This is due to how internal forces are distributed: gravity loads cause the truss to bend downward, putting the upper members in compression.

So, the nature of axial force in the upper chord is compressive.

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**163. The ratio of linear stress to the linear strain is called:**

[Civil Er. Highway 2067/12/10]

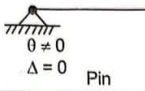
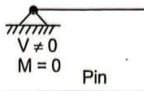
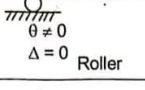
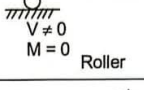
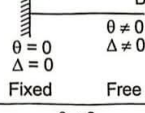
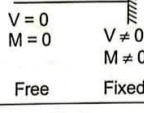
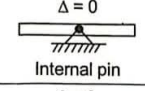
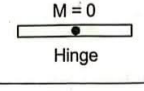
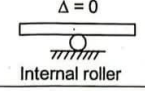
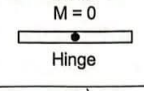
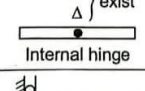
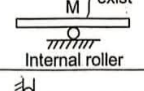
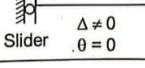
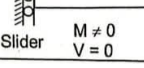
- A. modulus of rigidity
- B. modulus of elasticity
- C. bulk modulus
- D. poisson's ratio

**Correct Answer: B**

164. The moment at any point on the conjugate beam is equal to :  
 [Civil Er. Highway 2067/12/10]

- A. the deflection at the corresponding point on the real beam
- B. the slope at the corresponding point on the real beam
- C. the bending moment at the corresponding point on the real beam
- D. the shear force at the corresponding point on the real beam

Correct Answer: A

Real beam	Conjugate beam
 <p><math>\theta \neq 0</math> <math>\Delta = 0</math> Pin</p>	 <p><math>V \neq 0</math> <math>M = 0</math> Pin</p>
 <p><math>\theta \neq 0</math> <math>\Delta = 0</math> Roller</p>	 <p><math>V \neq 0</math> <math>M = 0</math> Roller</p>
 <p>A B <math>\theta = 0</math> <math>\theta \neq 0</math> <math>\Delta = 0</math> <math>\Delta \neq 0</math> Fixed Free</p>	 <p>A B <math>V = 0</math> <math>V \neq 0</math> <math>M = 0</math> <math>M \neq 0</math> Free Fixed</p>
 <p><math>\theta \neq 0</math> <math>\Delta = 0</math> Internal pin</p>	 <p><math>V \neq 0</math> <math>M = 0</math> Hinge</p>
 <p><math>\theta \neq 0</math> <math>\Delta = 0</math> Internal roller</p>	 <p><math>V \neq 0</math> <math>M = 0</math> Hinge</p>
 <p><math>\theta</math> } exist <math>\Delta</math> } exist Internal hinge</p>	 <p><math>V</math> } exist <math>M</math> } exist Internal roller</p>
 <p><math>\Delta \neq 0</math> <math>\theta = 0</math> Slider</p>	 <p><math>M \neq 0</math> <math>V = 0</math> Slider</p>

Explanation:

✓ The conjugate beam method determines a beam's slope and deflection using a fictitious beam (conjugate beam) with the same length as the real beam.

# Analogous Relationships

✓ Theorem 1: Shear in the conjugate beam → Slope in the real beam.

✓ Theorem 2: Bending moment in the conjugate beam → Deflection in the real



beam.

✓ Load on the real beam →

$$\frac{M}{EI}$$

loading on the conjugate beam.

✓ The slope at a point in the real beam = shear at the corresponding point in the conjugate beam.

✓ The deflection at a point in the real beam = moment at the corresponding point in the conjugate beam.

---

**165. For finding forces in the member of a Truss by the graphical method, the force diagram is suggested by:**

**[Civil Er. Highway 2067/12/10]**

- A. Mohr
- B. Timoshenko
- C. Maxwell
- D. Betti

**Correct Answer: C**

Explanation:

- ✓ aka Maxwell's diagram or Cremona diagram or Cremona-Maxwell diagram.
- ✓ These diagrams represent the equilibrium of forces acting on the truss, allowing for the graphical determination of internal member forces. The graphical method involves drawing a free-body diagram, selecting a joint or section, and then constructing the

force diagram to visualize and solve for the member forces based on equilibrium principles

---

### 166. Influence line is

[Civil Er. B& Arch 2073/11/2]

- A. The line showing stress function due to unit load
- B. The line showing stress function due to udl
- C. The line showing the variations of stress function due to unit moving load
- D. All of the above

**Correct Answer: C**

#### Explanation:

Influence line diagrams (ILDs) are critical tools in structural engineering for analyzing the effects of moving loads on structures.

1. Purpose: ILDs illustrate how reactions, shear forces, and bending moments or any stress function vary at specific sections of a structure due to the movement of a unit load along its span.

Students commonly confuse ILDs with shear or moment diagrams, which represent static conditions rather than how internal forces at a section change with moving loads.

2. How to generate? : ILDs can be generated using methods like the static equilibrium method or Muller Breslau's principle, with different approaches for determinate and indeterminate structures

3. Critical Load Positions: By analyzing the ILD, engineers can identify the positions of loads that produce maximum stress conditions, ensuring safe and efficient design.

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