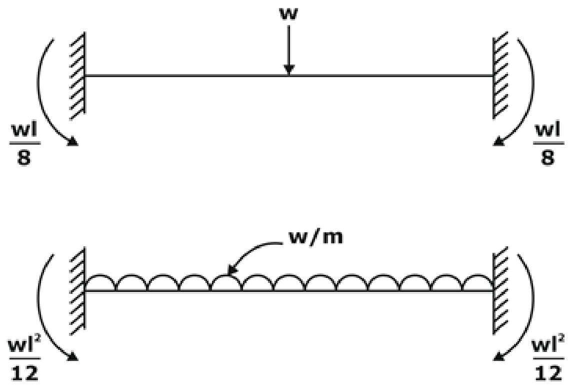
1. If a point load is acting at mid span of a fixed beam of uniform section produces fixed end moments of 120 kN.m, then the same load spread uniformly over the entire span will produce fixed end moments equal to

A. 40 kN.m B. 60 kN.m

C. 80 kN.m D. 90 kN.m

Ans. C

Sol.



Fixed end moment for point load, $M_{point} = \frac{Wl}{8} = 120$

$W = \frac{120x8}{l}$

Here the total load 'W' is equal to product of length of beam and uniform load.

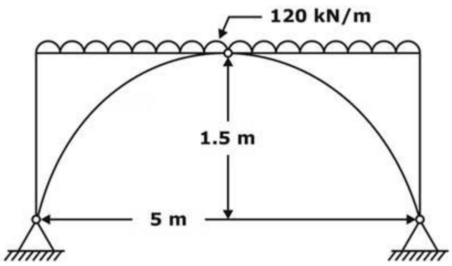
$\therefore wl = W$

Fixed end moment due to uniform load, $M_{UDL} = \frac{wl^2}{12} = 120$

$M_{UDL} = \frac{Wl}{12} = \frac{\frac{120x8}{l}l}{12}$

$M_{UDL} = 80\ kN.m$

2. A three hinged arch of span 5 m and rise 1.5 m carries a uniform distributed load of 120 kN/m over the whole span. The horizontal thrust on each support is



A. 125 kN B. 250 kN

C. 375 kN D. 500 kN

Ans. B

Sol. Here UDL over whole span, w = 120 kN/m

Length of span, L = 5 m

Rise, h = 1.5 m

Vertical reaction at each support = $\frac{wl}{2}$

Let the horizontal thrust at each support be H

The bending moment at crown hinge is zero.

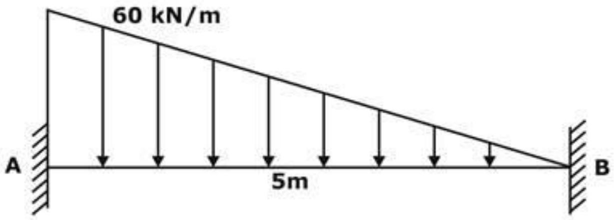
Hence taking moment about C, of the forces on the left hand side of C, we have

$$\frac{wl}{2}.\frac{l}{2} = H.h + \frac{wl}{2}.\frac{l}{4}$$

$$H = \frac{wl^2}{8h}$$

$$H = \frac{120x5^2}{8x1.5} = 250\ kN$$

3. In a fixed beam a variable load is applied as shown in figure of intensity 60 kN over whole span of length 5 m. The fixed moment at support A will be



A. 25 kN.m

B. 50 kN.m

C. 75 kN.m

D. 100 kN.m

Ans. C

Sol. Length of beam, L = 5 m

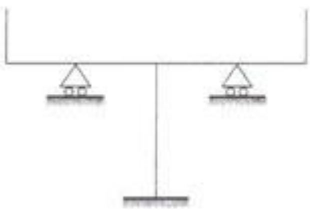
Intensity of UVL, w = 60 kN

Fixed end moment at end A, $M_{FAB} = -\frac{wL^2}{20}$

Fixed end moment at end B, $M_{FBA} = +\frac{wL^2}{30}$

$$M_{FA} = \frac{60x5^2}{20} = -75\ kN.m$$

4. What is the degree of static indeterminacy of the frame shown in the figure given below?



A. 4

B. 3

C. 2

D. zero

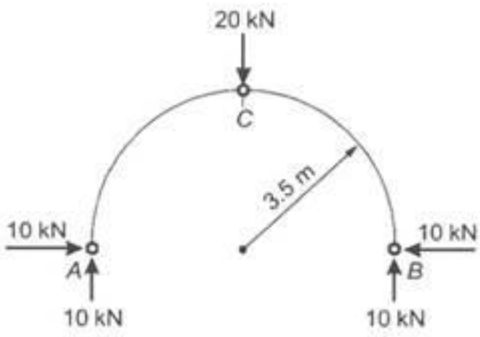
Ans. C

Sol. $D_s=3m+r_e-r_r-3(j)$

$M=7$; $r_e=3+1+1=5$: $r_r=0$; $j=8$

$\therefore D_s = 3 \times 7 + 5 - 3 \times 8 = 2$

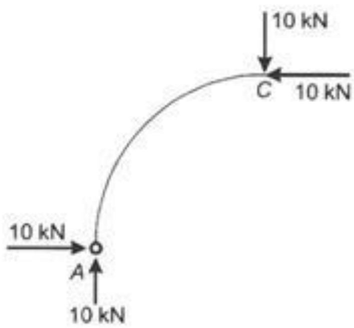
5. A three – hingedloaded semicircular arch ABCD is shown in the figure given below. What is the shearing force at the hinge C?



A. 20 KN
B. $20\sqrt{2}KN$
C. 10 KN
D. $10\sqrt{2}KN$

Ans. C

Sol. The free body diagram of part AC is



So shearing force at C is 10 KN.

6. A suspension bridge with a two- hinged stiffening grider is

A. statically determinate
B. indeterminate of one degree
C. indeterminate two degrees
D. a mechanism

Ans. B

Sol. A suspension bridge with a two- hinged stiffening girder is indeterminate of one degree.

7. A propped cantilever beam AB of span L is subjected to a moment M at the prop end B. The moment at fixed end A is

A. 2 M
B. M/2
C. M
D. 3M/2

Ans. B

Sol.

Applying compatibility condition at B

$$\frac{Rl^3}{3EI} = \frac{Ml^3}{2EI}$$

$$\Rightarrow \qquad R = \frac{3}{2}\frac{M}{l}$$

At A

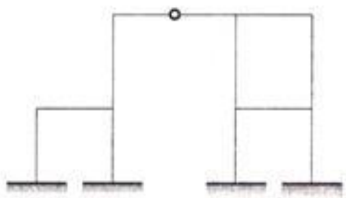
$$\sum M = 0$$

$$M_A + M - Rl = 0$$

$$\Rightarrow M_A = \frac{3}{2}\frac{M}{l}l - M$$

$$M_A = \frac{M}{2}$$

8. What is the statical indeterminacy for the shown below?



A. 12 B. 15

C. 11 D. 14

Ans. C

Sol. Where m= total members = 12

r_e = total external reactions = 12

J = total number of rigid joints = 11

J′ = total number of hybrid joints = 1

r_r = total number of released reactions

$$\sum(m_j - 1) = 2 - 1 = 1$$

$$\therefore D_s = (3\times 12) + 12 - 1 - 3(11+1)$$

$$= 36 + 11 - 36 = 11$$

9. Consider the following statements:

1) Even though a three-hinged parabolic arch is subjected only to vertical loads, its generates horizontal reaction and axial forces.

2) A cables uniformly loaded along the horizontal span assumes the shape of a parabola, whereas a cable uniformly loaded along its length takes the shapes of a catenary.

3) Cables loaded uniformly along the horizontal span are structures in practice.

Which of these ststements is/are correct?

A. only 1 | B. Only 2 and 3

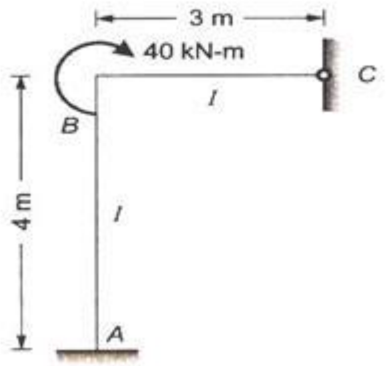
C. only 1 and 2 | D. 1, 2 and 3

Ans. D

Sol. A three-hinged parabolic arch develops horizontal thrust and vertical reactions. Due to these reaction components the arch is subjected to axial force (normal thrust) at every point.

Cables from an important structural component in suspension bridges and they are subjected to uniformly distributed loading throughout their horizontal span. Thus type loaded cables are most widely used.

10. For the rigid frame shown below, what is the moment reaction at A in kN-m?



A. 5

B. 10

C. 12.33

D. 15

Ans. B

Sol. Distribution factor of,

$$BA = \frac{I/4}{\frac{3}{4}\times\frac{I}{3}+(I/4)} = 0.5$$

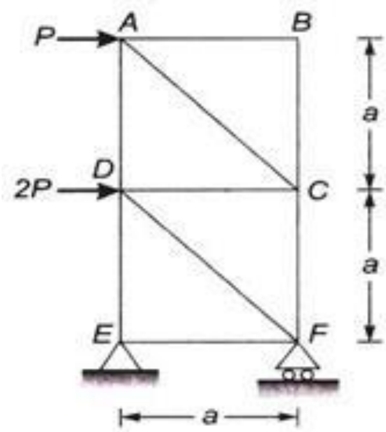
$$\therefore M_{BA} = 40\times 0.5 = 20KN-m$$

$$M_{BC} = 40\times 0.5 = 20KN-m$$

$$M_{AB} = carry\,over\,moment$$

$$= \frac{M_{BA}}{2} = \frac{20}{2} = 10\,KN-m$$

11. The force in the member CD is



A. P/2 Tensile B. P Compressive

C. 2PTensile D. P Tensile

Ans. D

Sol. Since no external force at joint B

$\therefore \quad P_{AB} = P_{BC} = 0$

@$Joint\ A$:

$$P = -P_{AC}\sin(45^0) = -\frac{P_{AC}}{\sqrt{2}}$$

$$\Rightarrow P_{AC} = -P\sqrt{2}$$

@$Joint\ C$:

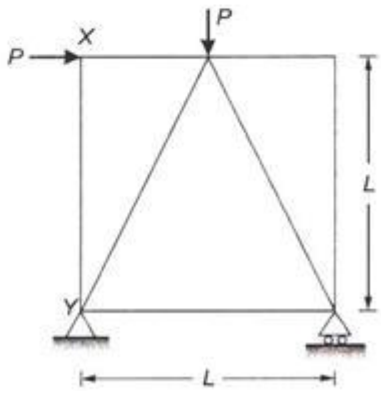
$$P_{AC}\cos(45^0) = -P_{DC}$$

$$\Rightarrow P_{DC} = -P_{AC}\,cos(45^0)$$

$$= -(-P\sqrt{2})cos(45^0)$$

$$= P \quad (Tensile)$$

12. The truss is shown in figure. The cross-sectional area of each member is 'A' and the modulus of elasticity of the material is uniformly E. The strain energy in the member XY is given by



A. $\frac{P^2L}{6AE}$

B. $\frac{P^2L}{3AE}$

C. Zero

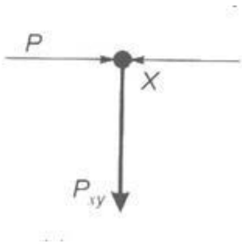
D. $\frac{P^2L}{2AE}$

Ans. C

Sol. Strain energy in any member of a truss

$$=\frac{P^2L}{2AE}$$

Applying method of joints at joint X of truss.



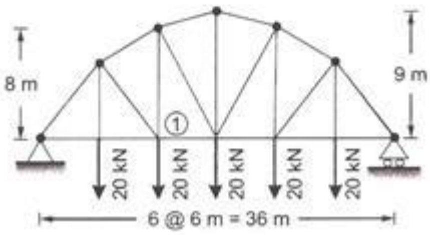
$$\sum V=0$$

$$\Rightarrow \quad P_{xy}=0$$

[∵ No External force in vertical direction at X]

∴ Strain energy = 0

13. What is the force in member 1 for the structure shown in the figure below?



A. 30KN

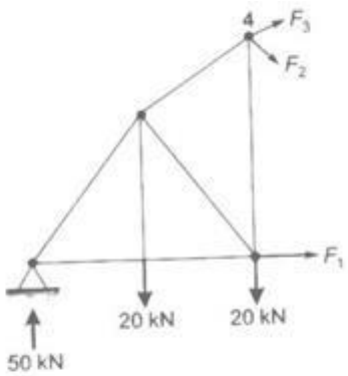
B. 60KN

C. 75KN

D. 80KN

Ans. B

Sol. Cutting a section through the structure as shown below and considering the left hand portion.



Taking moment about 4, we get

$$F_1 \times 8 + 20 \times 6 - 50 \times 12 = 0$$

$$\Rightarrow \qquad F_1 = \frac{480}{8}$$

$$\Rightarrow \qquad F_1 = 60KN$$

14. What does the Williot-Mohr diagram yield?

A. Forces in members of a truss

B. Moments in a fixed beam

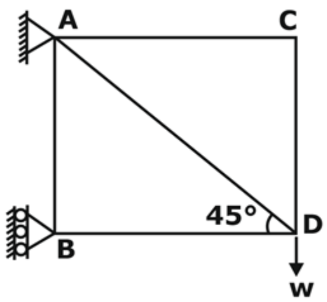
C. Reactions at the supports

D. Joint displacement of a pin jointed plane frame

Ans. D

Sol. The Williot-Mohr diagram yields Joint displacement of a pin jointed plane frame.

15. Find the strain Energy stored in member AB of the truss shown below:



A. $2\frac{P^2L}{AE}$

B. $\frac{P^2L}{2AE}$

C. $\frac{P^2L}{AE}$

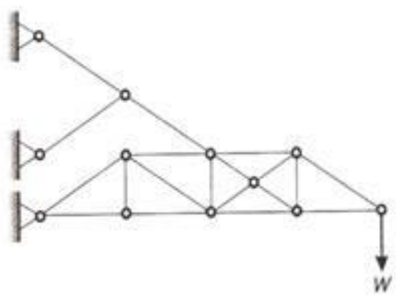
D. zero

Ans. D

Sol. since, it is clearly seen that at joint B, there is a roller, so there cannot be any **vertical reaction** at B. Thus Force in member AB = 0.

$$U_{AB} = \frac{P^2L}{2AE} = 0$$

16. The total (both external and internal) degree of indeterminacy of the pin-joined structure dhown in figure is



A. 4

B. 3

C. 2

D. 1

Ans. D

Sol. External degree of indeterminacy = No of externa reaction – No. of equilibrium reactions.

D_{s_e} = 6 – 3 = 3

Internal degree of indeterminacy,

D_{s_i} = m – (2j – 3)

= 19 – (2 $\times$ 12 – 3) = - 2

$\therefore$ Total degree of indeterminacy,

$D_s = D_{s_e} + D_{S_i}$

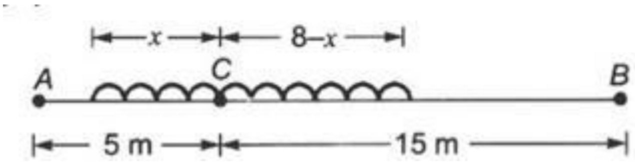
= 3 – 2 = 1

17. A uniformly distributed load of length 8 m croses a simply supported grider of span 20 m. The maximum bending moment at the left quarter-span point occurs when the distance between the point of CG of the total load and mid- span is

A. 0
B. 2 m
C. 3 m
D. 4 m

Ans. C

Sol.



The maximum bending moment at C will occur when the section divides the load in the same ratio as at divides the span

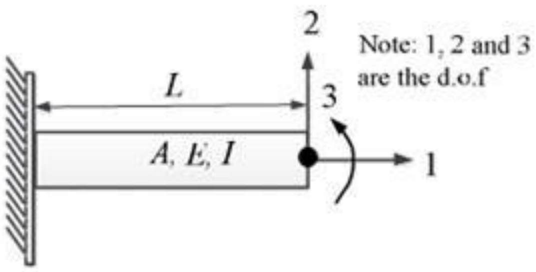
$\therefore \frac{x}{5} = \frac{8-x}{15}$

⇒ 3x = 8 – x

⇒ x = 2 m

Hence distance between point of CG of the total load and mid- span = 10-(5+2) = 3 m.

18. For the beam shown below, the stiffness coefficient K_{22} can be written as



A. $\frac{6EI}{L^2}$

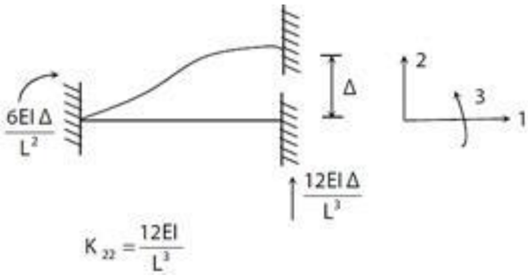
B. $\frac{12EI}{L^3}$

C. $\frac{3EI}{L}$

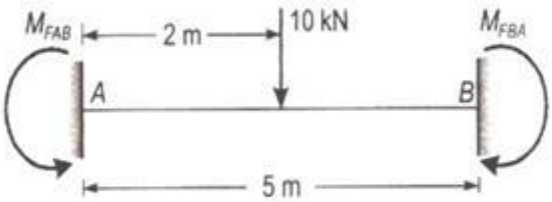
D. $\frac{EI}{6L^2}$

Ans. B

Sol. The ratio of the force acting on a linear mechanical system, such as a spring, to its displacement from equilibrium.



19. A fixed beam AB, of constant EI, shown in the figure below, supports a concentrated load 10 kN. What is the fixed end-moment M_{AB} at support A?



A. 4.8 kN-m

B. 6.0 kN-m

C. 7.2 kN-m

D. 9.5 kN-m

Ans. C

Sol.

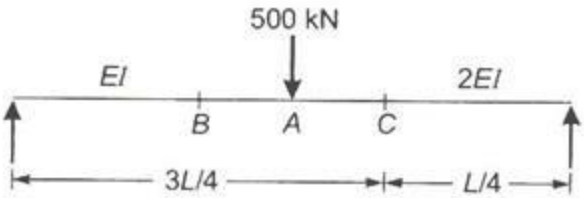
$$M_{FAB} = \frac{Pab^2}{L^2}$$

Here P = 10 KN, a = 2 m.

b = 3 m, L = 5 m

$$\therefore \; M_{FAB} = \frac{10 \times 2 \times 3^2}{5^2} = 7.2\,KN - m$$

20. A load 500KN applied at point A as shown in the figure elow. Produces a vertical deflection at B and C of the beam as Δ_B = 10 mm and Δ_C = 15 mm, respectively.



What is the deflection at A when loads of 100 KN and 300 KN are applied at B and C, respectively?

A. 6 mm
B. 8 mmm
C. 11 mm
D. 12.5 mm

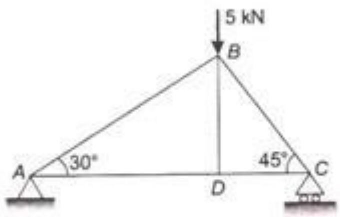
Ans. C

Sol. Using Maxwell-Betti's theorem

$$500\Delta_A = 100\Delta_B + 300\Delta_C$$

$$\therefore \Delta_A = \frac{\Delta_B}{5} + \frac{3}{5}\Delta_C = \frac{10}{5} + \frac{15\times 3}{5} = 11mm$$

21. What is the magnitude of the force in the membe BD in the figure given below?

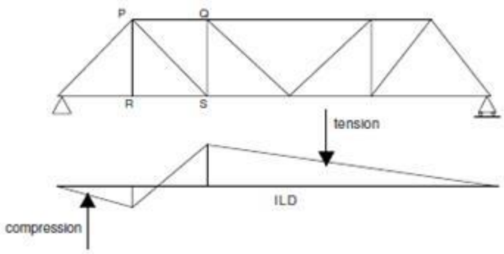


A. 5 KN
B. 7KN (approx)
C. $4\sqrt{2}KN$
D. Zero

Ans. D

Sol. If three members meet at a joint which carries no load then one member will carry zero forces which is not collinear.

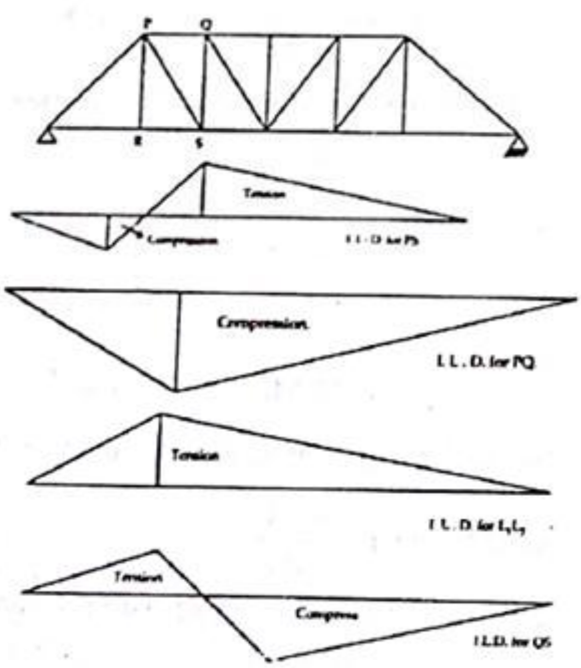
22. The influence line diagram (ILD) shown is for the member



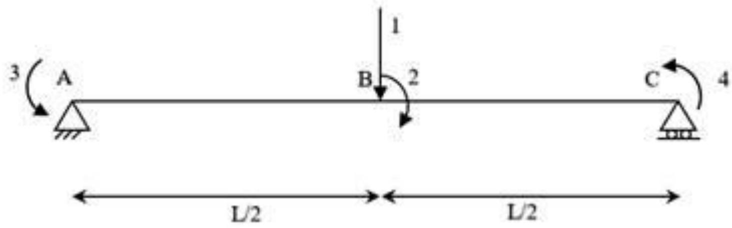
A. PS
B. RS
C. PQ
D. QS

Ans. A

Sol.



23. Which of the following statements are correct?



1) The flexibility matrix will be having 16 terms.

2) The number of zeroes in the flexibility matrix is 4

3) The number of negative terms in the flexibility matrix is 4

4) The number of unequal terms in the flexibility matrix is 7

A. 1, 2 and 3
B. 1, 3 and 4
C. 2, 3 and 4
D. 1, 2 and 4

Ans. B

Sol. Unit force in along 1,

$$F_{11} = \frac{L^3}{48EI}$$

$$F_{21} = 0$$

$$F_{31} = \frac{-L^2}{16EI}$$

$$F_{41} = \frac{L^2}{16EI}$$

Unit force in direction 2,

$$F_{22} = \frac{L}{12EI}$$

$$F_{32} = \frac{L}{24EI}$$

$$F_{42} = \frac{L}{24EI}$$

Unit force in direction 3,

$$F_{33} = \frac{L}{3EI}$$

$$F_{43} = \frac{-L}{6EI}$$

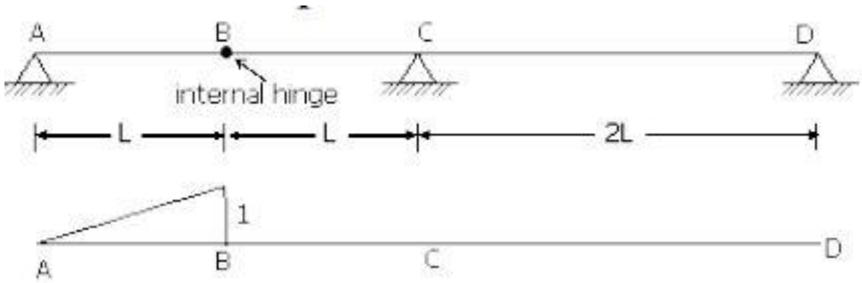
Unit force in direction 4,

$$F_{44} = \frac{L}{3EI}$$

$$F = \begin{bmatrix} \frac{L^3}{48EI} & 0 & \frac{-L^2}{16EI} & \frac{L^2}{16EI} \\ 0 & \frac{L}{12EI} & \frac{L}{24EI} & \frac{L}{24EI} \\ \frac{-L^2}{16EI} & \frac{L}{24EI} & \frac{L}{3EI} & \frac{-L}{6EI} \\ \frac{L^2}{16EI} & \frac{L}{24EI} & \frac{-L}{6EI} & \frac{L}{3EI} \end{bmatrix}$$

Thus, number of zeroes is 2. Statement 2 is incorrect.

24. Consider the beam ABCD and the influence line as Shown below. The influence line pertains to



A. reaction at A, R_A

B. shear force at B, V_B

C. shear force on the left of C, V_C

D. shear force on the right of C, V_C^+

Ans. B

Sol. In engineering, an influence line graphs the variation of a function (such as the shear felt in a structure member) at a specific point on a beam or truss caused by a unit load placed at any point along the structure. Some of the common functions studied with influence lines include reactions (the forces that the structure's supports must apply in order for the structure to remain static),shear, moment, and deflection. Influence lines are important in designing beams and trusses used in bridges, crane rails, conveyor belts, floor girders, and other structures where loads will move along their span. The influence lines show where a load will create the maximum effect for any of the functions studied. Given influence line diagram shows when unit load move from A to B, VB change from 0 to 1.

25. Stiffness method of structural analysis is based upon

A. force-deformation relations

B. equilibrium condition

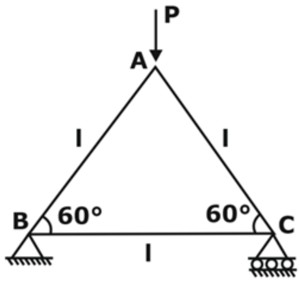
C. compatible deformation

D. equilibrium state of internal stress components

Ans. B

Sol. In the stiffness method, we assume unit deformation and then find the forces developed in the structure due the deformations. Then we use equilibrium conditions to find out the unknowns.

26. The strain Energy stored in member AB of the truss shown below is:



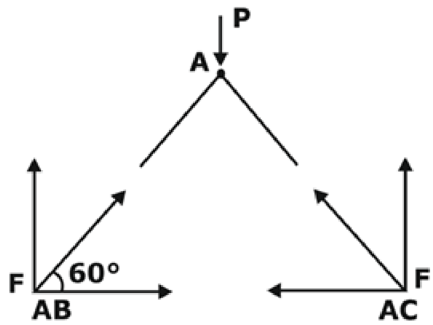
Assume AE as constant for all members.

A. $\frac{P^2 l}{2AE}$ B. $\frac{P^2 l}{3AE}$

C. zero   D. $\frac{P^2 l}{6AE}$

Ans. D

Sol. F_{BD} of joint A ⇒



$\Sigma V = 0 \Rightarrow P = F_{AB} \sin 60° + F_{AC} \sin 60°$

$\Sigma h = 0 \Rightarrow F_{AB} \cos 60° = F_{AC} \cos 60°$

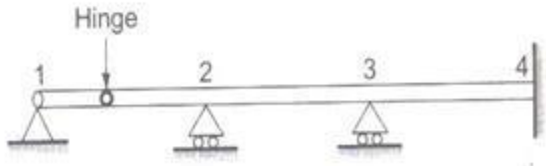
$\Rightarrow F_{AB} = F_{AC} = F$(let)

So, $P = 2F.\frac{\sqrt{3}}{2} \Rightarrow F = \frac{P}{\sqrt{3}}$

So, $F_{AB} = \frac{P}{\sqrt{3}}$

So, $U_{AB} = \frac{F_{AB}^2 l}{2AE} = \frac{P^2 l}{3.2AE} = \frac{P^2 l}{6AE}$

27. The kinematic indeterminacy of the beam is



A. 5
B. 9
C. 14
D. 15

Ans. B

Sol. The kinematic indeterminacy of the beam is

$D_k = 3j - r_E + r_R$

Given,

$j = 5$

$r_E = 7$

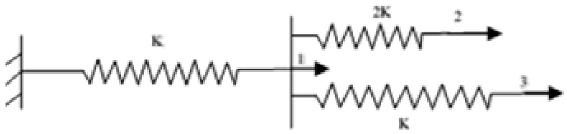
$r_R = \sum(m' - 1)$

$= \sum(2-1) = 1$

$\therefore D_K = 3\times5 - 7 + 1 = 9$

$(\theta_{1,}\theta_{H1}, \theta_{H2}, \Delta_{Hx}, \Delta_{Hy}, \theta_2, \Delta_{2x}, \theta_3, \Delta_{3x})$

28. The degree of freedoms are indicated in the figure below. Find the flexibility matrix.



A. $\frac{1}{K}\begin{bmatrix}1 & 1 & 1\\1 & 1 & 1.5\\1 & 1.5 & 2\end{bmatrix}$

B. $\frac{1}{K}\begin{bmatrix}1 & 1 & 1\\1 & 1.5 & 1\\1 & 1 & 2\end{bmatrix}$

C. $\frac{1}{K}\begin{bmatrix}1 & 1 & 1\\1 & 3 & 0\\1 & 0 & 2\end{bmatrix}$

D. $\frac{1}{K}\begin{bmatrix}1 & 1 & 1\\1 & 1.5 & 1\\1 & 1 & 1\end{bmatrix}$

Ans. B

Sol. Unit force in direction 1,

$$F_{11} = \frac{1}{K_{eq}} = \frac{1}{K}$$

$$F_{21} = \frac{1}{K}$$

$$F_{31} = \frac{1}{K}$$

Unit force in direction 2,

$$F_{22} = \frac{1}{K_{eq}} = \frac{1}{K} + \frac{1}{2K} = \frac{3}{2K}$$

$$F_{32} = \frac{1}{K}$$

Unit force in direction 3,

$$F_{33} = \frac{1}{K_{eq}} = \frac{2}{K}$$

$$F = \frac{1}{K}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1.5 & 1 \\ 1 & 1 & 2 \end{bmatrix}$$

29. A udl of 15 kN/m and length 3m rolls over a simply supported span of 10m length.The maximum bending moment at a section 4m from the right end will be_____kN-m.

A. 70.8

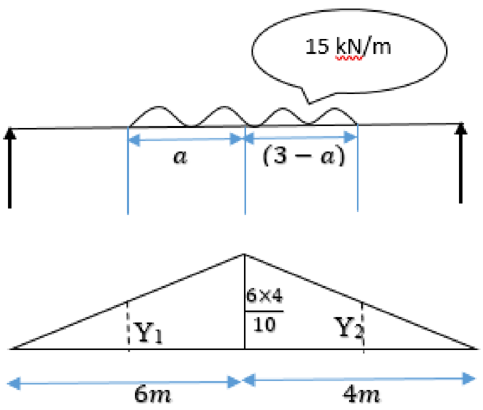
B. 82.2

C. 91.8

D. 100

Ans. C

Sol.



Average load on AC = Average load on CB

$$\frac{wa}{6} = \frac{w\times(3-a)}{4}$$

Or, $a = \frac{9}{5}m$; Y1=1.68=Y2;

Maximum BM at C = Load intensity × area of ILD under load

$$= 15\times\left\{\frac{1}{2}\left(\frac{(2.4+1.68)}{1}\right)*(\frac{9}{5}) + \frac{1}{2}*(2.4+1.68)*(\frac{6}{5})\right\}$$

= 91.8 kN-m

30. For a moving set of wheel loads the absolute maximum value of bending moment is occurred

A. below the centroid of the set of loads

B. below a wheel load adjacent to the centroid of all the loads

C. below the highest wheel load of the set of the loads

D. none of these

Ans. B

Sol. The absolute maximum bending moment is calculated below a load adjacent to the centroid of the set of wheel loads, when the centroid of the wheel load and that load are kept equidistant to the centre of the beam.

31. The number of independent equation to be satisfied for static equilibrium in a space structure is

A. 3 B. 6

C. 4 D. 2

Ans. B

Sol. For static equilibrium in a space structure equations to be satisfied are

$$\sum Fx = 0, \sum F_y = 0 \quad \sum F_z = 0$$
$$\sum M_x = 0, \sum M_y = 0, \sum M_z = 0$$

For plane frame:

$$\sum Fx = 0, \sum F_y = 0, \sum M_x = 0$$

32. The number of unknown to be determined in the stiffness matrix is equal to

A. the static indeterminacy

B. the kinematic indeterminacy

C. the sum of kinematic indeterminacy and static indeterminacy

D. two times the number of supports

Ans. B

Sol. The stiffness or displacement method of analysis is based on kinematic degree of indeterminacy or independent degree of freedom at joint.

33. A uniformly distributed load (w) of length shorter than the span crosses a grider. The bending moment at a section in grider will be maximum when

A. Head of the load at the section

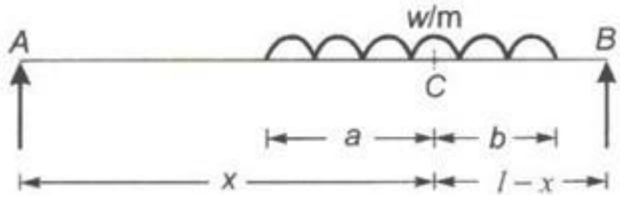
B. Tail of the load is at the section

C. Section divides the load in the same ratio as it divides the span

D. Section divides the load in two equal lengths

Ans. C

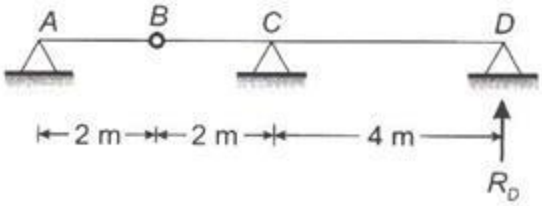
Sol.



For maximum bending moment at section C

$$\frac{a}{b} = \frac{x}{l - x}$$

34. What is the ordinate of influence line at B for reaction R_D in figure below?



A. 0.5

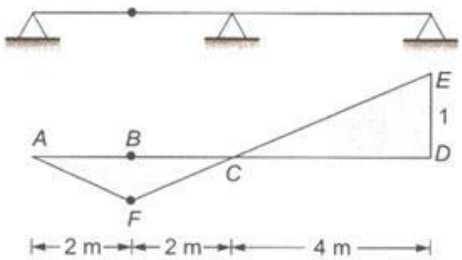
B. 0.4

C. 0.2

D. zero

Ans. A

Sol. Applying Muller Breslau principle, we get ILD for reaction R_D



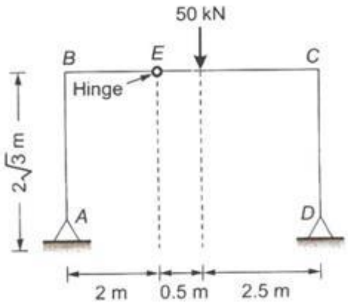
From similar triangular BFC and DEC, we get

$$\frac{BF}{BC} = \frac{DE}{DC}$$

$$\frac{BF}{2} = \frac{1}{4}$$

$$BF = o.5$$

35. What is the inclination of resultant reactions at with the vertical for the frame shown in the figure below?



A. 60^0

B. 40^0

C. 30^0

D. 50^0

Ans. C

Sol. There is no lateral loading on the frame, hence the horizontal reactions at A and D will be equal in magnitude and opposite in nature. Let H be the magnitude of horizontal reaction and it acts from left to right at a. Let vertical reaction at A be V_A upwards.

Taking moments about the hinger at E from left we get

$$V_A \times 2 - H \times 2\sqrt{3} = 0$$

$$\Rightarrow V_A = H\sqrt{3}$$

If the resultant makes an angle θ with the vertical then

$$\tan\theta = \frac{H}{V_A}$$

$$\Rightarrow \theta = \tan^{-1}\left(\frac{H}{\sqrt{3}H}\right)$$

$$\Rightarrow \theta = 30^\circ$$

36. The stiffness co-efficient K_{xy} indicates

A. Force at *x* due to an unit displacement at *y*

B. Deformation at *y* due to an unit displacement at *x*

C. Deformation at *x* due to an unit displacement at *y*

D. Force at *y* due to an unit displacement at *x*

Ans. A

Sol. The stiffness co-efficient K_{ij} indicates Force at *i* due to an unit displacement at *j*.

37. Muller Breslau principle in structural analysis is used for

A. drawing influence line diagram for any force function

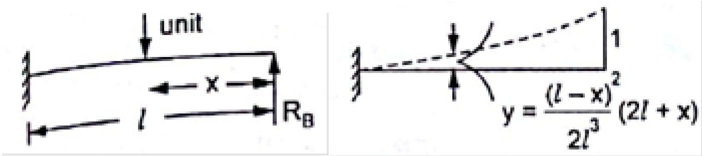
B. writing virtual work equation

C. super–position of load effects

D. none of these

Ans. A

Sol. According to Muller-Breslau principle, the influence line for any stress-function of a structure, such as S.F., B.M. or any reactive force or moment is given by deflected curve of a structure obtained by imposing a unit distortion in the direction of the stress function e.g.



To draw influence line for R_B, a displacement equal to 1 is given in the direction of R_B.

By principle, $R_B \times 1 - 1 \times y = 0$

$\therefore$ $R_B = y$

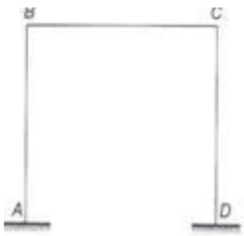
38. If the axial deformation is neglected what is the kinematic inderminacy of a singe bay portal frame fixed at base?

A. 2 B. 3

C. 4 D. 6

Ans. B

Sol. A single bay portal frame fixed at base is shown below.



The kinematic indeterminacy is given by

$$D_k = 3j - r_e - m$$

Here $j = 4; r_e = 6; m = 3$

$\therefore\ D_k = 3 \times 4 - 6 - 3 = 3$

Note Here DOF = 4

$$(\theta_B, \Delta_{BX}, \theta_c, \Delta_{cx})$$

But kinematic indeterminacy is three because $\Delta_{Bx} = \Delta_{cx}$ due to axially rigid member.

39. What is the shape of influence line diagram for the maximum bending moment in respect of a simply supported beam?

A. Rectangular B. Triangular

C. Parabolic D. Circular

Ans. B

Sol. The maximum bending moment for any position of load occur under the load. So the equation for maximum bending moment is

$$M_{max} = \frac{x(L-x)}{L}$$

Thus the ILD for maximum bending moment is parabolic. This is also called envelop of maximum bending moment.

40. A three- hinged parabolic arch of span ' l' and rise 'h' is subjected to a u. d. i. of intensity 'w' then the horizontal thrust at the support is

A. $\frac{Wt^2}{8h}$ B. $\frac{Wl}{h}$

C. $\frac{Wl}{8h^2}$ D. $\frac{Whl}{8}$

Ans. A

41. Carry-over factor at a support/end is defined as

A. Modulus of Elasticity

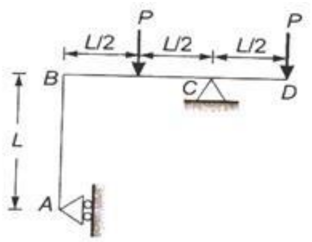
B. The ratio of moment produced at the far end to the applied moment at that support end

C. The value of the moment to be applied to that end to cause a local slope of one radian

D. 2 EK

Ans. B

42. A frame ABCD is supported by a roller at A and is on a hinge at C as shown in the below figure. The reaction at the roller end A is given by

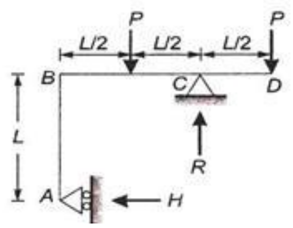


A. P B. 2P

C. p/2 D. Zero

Ans. D

Sol. R=2P

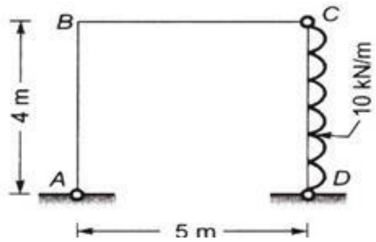


$$\Sigma M_c = 0$$

$$P\frac{L}{2} = P\frac{L}{2} + HL$$

$$\Rightarrow \qquad H = 0$$

43. What is the value of vertical reaction at A for the frame shown in figure below?



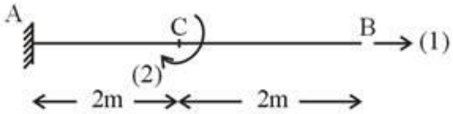
A. 0
B. 10 kN
C. 16 kN
D. 20 kN

Ans. C

Sol. Let the vertical reaction at A be V_A upward , Taking moments about D, we get

$$\sum M_D = 0$$
$$\Rightarrow V_A \times 5 - 10 \times 4 \times 2 = 0$$
$$\Rightarrow V_A = \frac{80}{5}$$
$$\Rightarrow V_A = 16\,KN$$

44. The stiffness matrix of the beam shown in figure is



A. $\begin{bmatrix} \frac{AE}{2} & 0 \\ 0 & \frac{AE}{2} \end{bmatrix}$

B. $\begin{bmatrix} \frac{AE}{4} & 0 \\ 0 & \frac{AE}{4} \end{bmatrix}$

C. $\begin{bmatrix} \frac{1}{AE} & 0 \\ 0 & \frac{2}{AE} \end{bmatrix}$

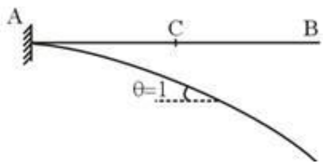
D. $\begin{bmatrix} \frac{AE}{4} & 0 \\ 0 & \frac{EI}{2} \end{bmatrix}$

Ans. D

Sol. **Column 1 :** Apply unit displacement along coordinate 1.

$$K_{11} = \frac{AE}{L} = \frac{AE}{4}$$

$K_{21} = 0$



From symmetry of matrix

$K_{12} = K_{21} = 0$

$$K_{22} = \frac{EI}{L} = \frac{EI}{2}$$

Hence, Stiffness matrix is $\begin{bmatrix} \frac{AE}{4} & 0 \\ 0 & \frac{EI}{2} \end{bmatrix}$

45. For a prismatic beam of length L & moment of inertia 1, the stiffness factor is

A. IE/L B. 2EI/L

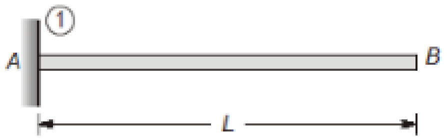
C. 3EI/L D. 4EI/L

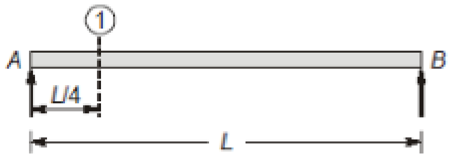
Ans. A

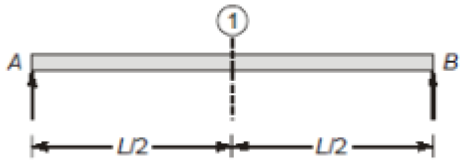
Sol. The stiffness factor (EI/L) of a member is represented as the product of the modulus of elasticity (E) and the second moment of area (I) divided by the length (L) of the member.

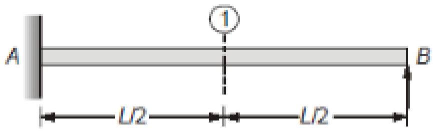
46. Match **List-i** (Beam) with **List-ii** (Influence line for BM) and select the correct answer using the code given below the Lists:

List-I

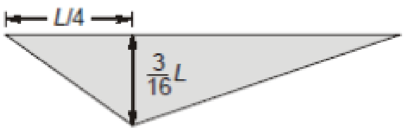
A.


B.


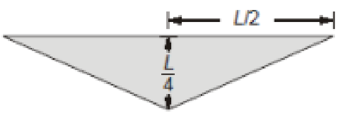
C.


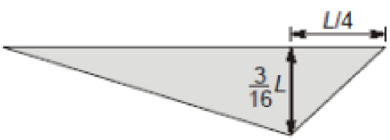
D.


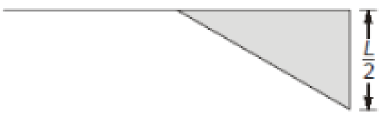
List-II

1).


2).


3).


4).


5).


A. A-2 B-1 C-3 D-5

B. A-3 B-1 C-4 D-5

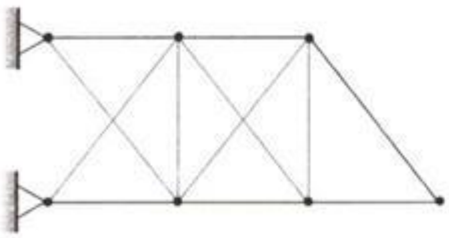
C. A-2 B-5 C-3 D-4

D. A-1 B-3 C-5 D-4

Ans. A

Sol. Bending moment at particular point in the beam is maximum when the load is at maximum distance from that point

47. What is the total degree of satatic indeterminacy (both internal and external) of the cantilever plane truss shown in the figure below?



A. 2

B. 3

C. 4

D. 5

Ans. A

Sol. The total degree of indeterminacy is given by $D_s = m + r_e - 2j$

Where

m= number of members = 12

r_e = number of external reactions = 4

j = number of joints = 9

$\therefore D_s = 12 + 4 - 2x7 = 2$

48. Which one of the following is correct in respect the influence line for the bending moment at one-fourths of the span from left support of a prismatic beam simply supported at ends?

A. It is composed of straight lines only

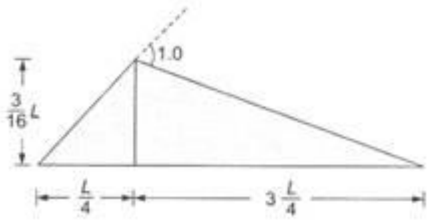
B. It composed of curved lines only

C. It composed of straight and curved lines

D. It is parabolic

Ans. A

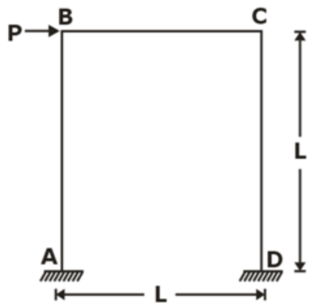
Sol. Introduce a pinned connection at the section and give unit rotation. The ILD for the bending moment will be



The maximum ordinate of the diagram is

$$\frac{L}{4}\times\frac{3L}{4}\times\frac{1}{L}=\frac{3L}{16}units$$

49. What is the shear equation in slope deflection method for the portal frame shown below?



A. $\frac{M_{AB}+M_{BA}}{L}+\frac{M_{CD}+M_{DC}}{L}+P=0$

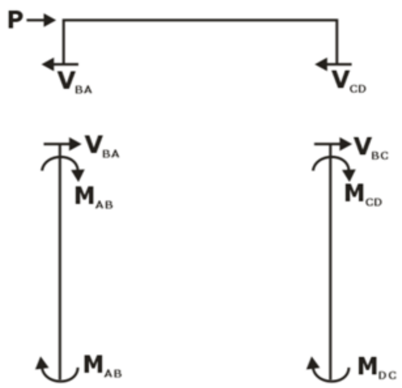
B. $\frac{M_{AB}+M_{BA}}{L}+\frac{M_{BC}+M_{CB}}{L}+P=0$

C. $\frac{M_{BC}+M_{CB}}{L}+\frac{M_{CD}+M_{DC}}{L}+P=0$

D. $\frac{M_{BC}+M_{CB}}{L}+P=0$

Ans. A

Sol.



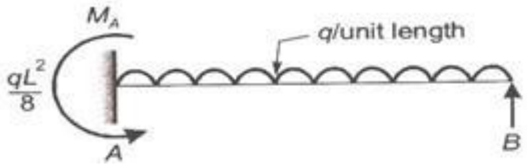
$$V_{BA} = -\left(\frac{M_{BA}+M_{AB}}{L}\right)$$

$$V_{BC} = -\left(\frac{M_{CD}+M_{DC}}{L}\right)$$

$$P - V_{BD} - V_{BC} = 0$$

$$P + \frac{M_{BA}+M_{AB}}{L} + \frac{M_{CD}+M_{DC}}{L} = 0$$

50. The propped cantilever AB carries a uniformly distributed load of q/unit length. In this condition the moment reaction $M_A = \frac{qL^2}{8}$.



What is the clockwise moment required at B to make the slope of the deflection curve equal to zero?

A. $\frac{qL^2}{8}$ B. $\frac{qL^2}{16}$

C. $\frac{qL^2}{12}$ D. $\frac{qL^2}{4}$

Ans. C

51. Which of the following is an incorrect assumption in the analysis of truss?

A. All joints are pinned

B. Loads applied at joints only

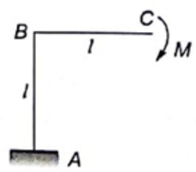
C. All members are straight

D. Weights of members are acting at their centres

Ans. D

Sol. Weights of members are considered to be acting at joints and not at centre.

52. The horizontal deflection at *C* for the frame loaded and supported as shown below is (*EI* is constant)

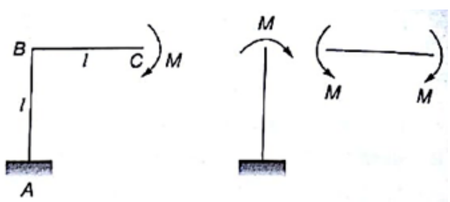


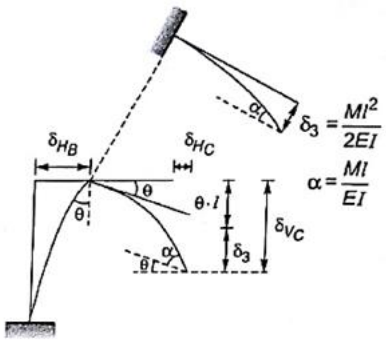
A. $\frac{Ml^2}{(4EI)}$ B. $\frac{Ml^2}{(2EI)}$

C. $\frac{Ml^2}{(3EI)}$ D. $\frac{2Ml^2}{(4EI)}$

Ans. B

Sol.





$$\delta_{H_B} = \frac{Ml^2}{2Ei}; \theta = \frac{Ml}{EI}$$

$$\delta_{H_C} = \delta_{H_B} = \frac{Ml^2}{2EI}$$

$$\delta_{V_C} = \theta \times l + \delta_3$$

$$= \frac{Ml}{EI} \times l + \frac{Ml^2}{2EI} = \frac{3}{2} \cdot \frac{Ml^2}{EI}$$

$$\theta_C = \theta + \alpha$$

$$= \frac{Ml}{EI} + \frac{Ml}{EI} = \frac{2Ml}{EI}$$

53. Two concentrated loads of 50 kN each spaced at 4 meter cross a simply supported girder of span 8 m. The absolute maximum bending moment in the girder is

A. 1125 kN-m at 3 m from support

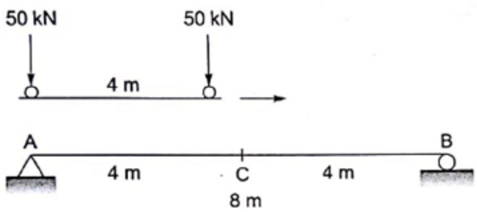
B. 113.5 kN-m at 3 m from support

C. 11.25 kN-m at 3 m from support

D. 93.75 kN-m at 3 m from support

Ans. B

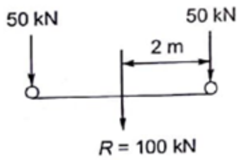
Sol.



To find absolute maximum bending moment:

• Generally absolute maximum bending moment will occur below heavier load particularly if it is closer to mid span.

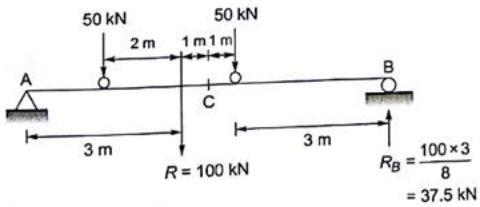
Case 1: Maximum bending moment under leading 50 kN load:



$R = 100$ kN

$\bar{x} = \dfrac{50 \times 0 + 50 \times 4}{100} = 2$ m

We know that, for maximum bending moment below a point load, the pint load should be so placed that the point load and resultant load are equidistant from mid span.

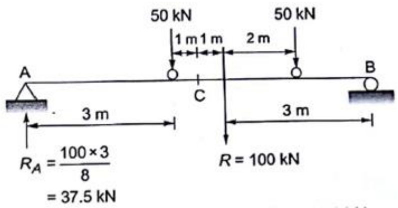


∴ Bending moment under leading 50 kN load

$= R_B \times 3$

$= 37.5 \times 3 = 112.5$ kNm

Case 2: Maximum bending moment under trailing 50 kN load:



∴ Bending moment under trailing 50 kN load

$= R_A \times 3$

$= 37.5 \times 3 = 112.5$ kNm

∴ Absolute maximum bending moment

= Maximum of the above 2-criteria

= 112.5 kNm at 3 m from either support

54. A parabolic arched rib, of span 30 m, is hinged at the springing and crown and is having a central rise of 5 m. If the coefficient of thermal expansion for the arch material is 12 × 10^{-6} per °C, the effect of a temperature rise of 300 °C is

A. to cause thermal stresses

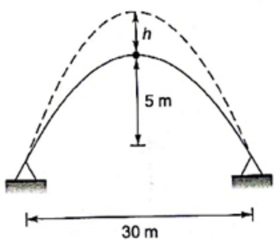
B. to cause thermal stresses as well as a central rise of 18 mm

C. to cause a central rise of 18 mm

D. to cause no effect on the structure

Ans. C

Sol.



$\propto = 12 \times 10^{-6} /°C$

h = central rise = 5 m

$\Delta T = 300°C$

dh = Rise due to temperature change

$$= \left(\frac{l^2 + 4h^2}{4h}\right) \propto T$$

$$= \left[\frac{900 + 4 \times (25)}{4 \times 5}\right] \times 12 \times 10^{-6} \times 300$$

$$= 0.18 \text{ m} = 180 \text{ mm}$$

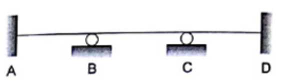
55. A three-span continuous beam is fixed at the ends and supported by unyielding roller supports in between. What is the size of the stiffness matrix?

A. 2 × 2 | B. 3 × 3

C. 1 × 1 | D. 4 × 4

Ans. A

Sol.



No of unknowns = 2(θ_B and θ_C)

D_K = Size of stiffness matrix

56. Which of the following is displacement method?

A. Flexibility method

B. Moment distribution method

C. Kani’s method

D. None of the given answers

Ans. B

Sol. In displacement method, displacements are taken as unknowns. Among the options only moment distribution method is a displacement method.

57. The absolute stiffness of a prismatic member with one end hinged is

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

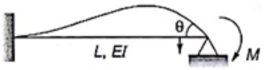
B. $\frac{4EI}{l}$

C. $\frac{3EI}{l}$

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

Ans. B

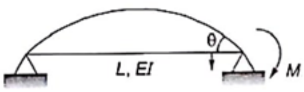
Sol.



$$\text{Stiffness} = \frac{M}{\theta} = K$$

$$\theta = \frac{ML}{4EI}$$

$$\frac{M}{\theta} = K = \frac{4EI}{L}$$



$$\text{Stiffness} = \frac{M}{\theta} = K$$

$$\theta = \frac{ML}{3EI}$$

$$\frac{M}{\theta} = \frac{3EI}{L}$$

58. Sway calculations and non-sway calculations are carried out in a single operation in

A. Kani's method

B. Moment distribution method

C. Unit load method

D. None of the given answers

Ans. A

Sol. Sway calculation and non-sway calculations are carried out in a single operation in Kani's method.

59. The Eddy's theorem is valid for

A. Vertical loads only

B. Horizontal loads only

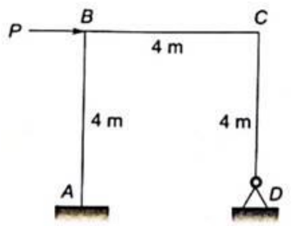
C. Dynamic loads only

D. All loads

Ans. A

Sol. Eddy's theorem for 3-hinged arch states that – The bending moment at any section an arch is proportional to the vertical interrupt between the linear arch (or theoretical arch) and the centre line of actual arch.

60. For the Portal frame shown in figure, the shear equation is

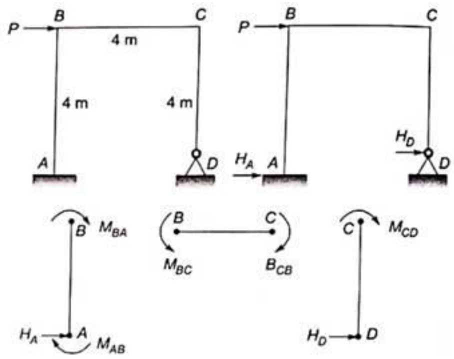


A. $\frac{M_{BA}+M_{AB}}{4}+\frac{M_{CD}}{4}+P=0$ B. $\frac{M_{BC}+M_{CB}}{4}+P=0$

C. $\frac{M_{BA}+M_{AB}}{4}+P=0$ D. $\frac{M_{CD}}{4}+P=0$

Ans. A

Sol.



Shear equation for this portal frame is given as

$$H_A + H_D + P = 0$$

$$\Sigma M_B = 0$$

$$\Rightarrow \quad M_{BA} + M_{AB} = H_A \times 4$$

$$\Rightarrow \quad H_A = \frac{M_{BA}+M_{AB}}{4}$$

$$\Sigma M_B = 0$$

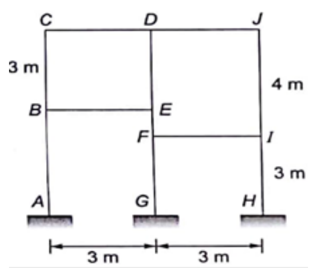
$$\Rightarrow \quad M_{CD} = 4 \times H_D$$

$$\Rightarrow \quad H_D = \frac{M_{CD}}{4}$$

Hence, shear equation becomes

$$\frac{M_{BA}+M_{AB}}{4}+\frac{M_{CD}}{4}+P=0$$

61. Determine the degree of static and kinematic indeterminacy of the frame structure as shown in the figure:

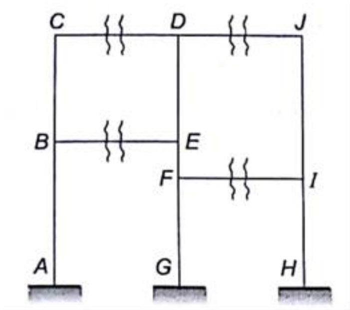


A. 15,8 B. 12,12

C. 12,10 D. 15,9

Ans. C

Sol.



D_s=3C-R'

Where, C=number of cuts to make structure determinate=4

R'=number of restraints required to make all joints rigid

R'=0

D_s=3x4-0=12

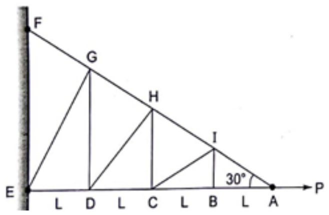
D_k=3 x 7 – 11=10

7= joints

3=Number of independent displacement prevented at each joint

4= number of cuts to make stale cantilever frames

62. A cantilever truss as shown in the figure is subjected to a horizontal load 'P' at joint A . The total number of zero force members in the truss is



A. 6 B. 4

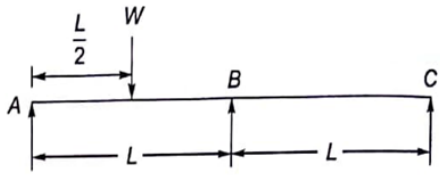
C. 9 D. 10

Ans. A

Sol. Zero force members=BI, IC, CH, HD, DG, GE

Concept used- If 3 members meet at a point and two of them are collinear, force in 3^{rd} member is zero.

63. A continuous beam *ABC* is as shown in the figure. End supports are simple (i.e., *A* and *C*) and span *AB*=span BC=*L*. There is a concentrated load '*W*' at the centre of the span *AB* while no load over the span *BC*.E_j is same for both the spans What is the moment at the continuous support *B*?



A. $-\frac{WL^3}{16}$

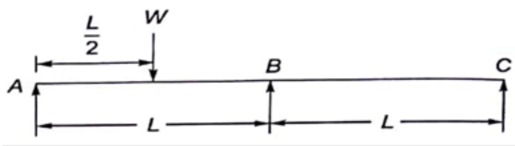
B. $-\frac{WL^2}{32}$

C. $-\frac{3WL^2}{32}$

D. $-\frac{3WL^2}{16}$

Ans. C

Sol.



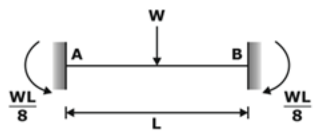
To find moment at support let us find by using M-D (moment distribution) method.

Distribution factor:

Joint	Member	Member stiffness (MS)	Joint stiffness (JS)	D.F = $\frac{MS}{JS}$
B	BA	$\frac{3EI}{L}$	$\frac{6EI}{L}$	$\frac{1}{2}$
	BC	$\frac{3EI}{L}$		$\frac{1}{2}$

Fixed end moment:

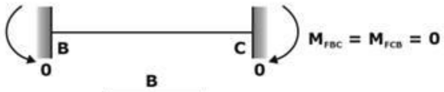
Span AB



$M_{FAB} = -\frac{WL}{8}$

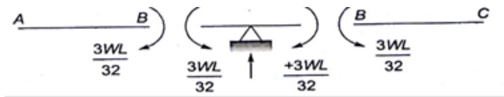
$M_{FBA} = -\frac{WL}{8}$

Span BC



A	B		B	
	$\frac{1}{2}$	$\frac{1}{2}$		
$\frac{-WL}{8}$	$\frac{WL}{8}$	0	0	Initial FEM
$\frac{+WL}{8}$	$\frac{WL}{16}$			
0	$\frac{3WL}{16}$	0	0	New FEM
	$\frac{-3WL}{32}$	$\frac{-3WL}{32}$		Bal
0	$\frac{3WL}{32}$	$\frac{-3WL}{32}$	0	

(FBD)

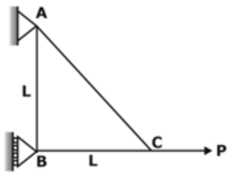


Moment at support B,= $\frac{3WL}{32}(Hogging)$

64. A simple truss *ABC* is supported at *A* and *B* as shown in the figure. If a point load *(P)* along *BC* is applied at joint *C* in horizontal direction, then what will be the vertical deflection at *C* ?

Assume same area and same material

(i.e., A.E, I same for all members).



A. $\frac{PL}{AE}(\uparrow)$

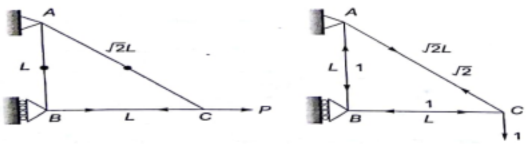
B. $\frac{2PL}{AE}(\downarrow)$

C. $\frac{PL}{AE}(\downarrow)$

D. $\frac{2PL}{3AE}(\downarrow)$

Ans. A

Sol.



$$\delta_c = \frac{\sum PKL}{AE}$$

Where rotations have their usual meaning

$$= 0 + 0 + \frac{P(-1)L}{AE} = -\frac{PL}{AE}$$

-ve sign indicated deflection of the joint is opposite to applied force of 1 kN.

65. In the moment distribution method, the carry over moment, when the far end is fixed, is equal to

A. double of its corresponding distributed moment and has same sign

B. one-half of its corresponding distributed moment and has same sign

C. one-half of its corresponding distributed moment and has opposite sign

D. None of the above

Ans. B

Sol. The carry over moment in moment distribution method is taken as half of the distributed load with same sign.

$$\frac{ML^2}{2EI} = \frac{RL^3}{3EI}$$

$$R = \frac{3M}{2L}$$

$$M_1 = \frac{3}{2}M - M = \frac{M}{2}$$

$$= \left(\frac{1}{2}\right)xM\left(carryoverfactor = \frac{1}{2}\right)$$

66. A three-hinged semicircular arch of radius R carries a uniformly distributed load W per unit run over the whole span. The horizontal thrust is

A. R

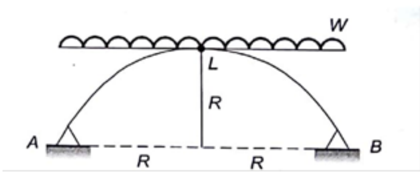
B. $\frac{WR}{2}$

C. $\frac{4}{3\pi}WR$

D. $\frac{2}{3\pi}WR$

Ans. B

Sol.



$R_A = R_B$

$= \frac{W \times 2R}{2} = WR$

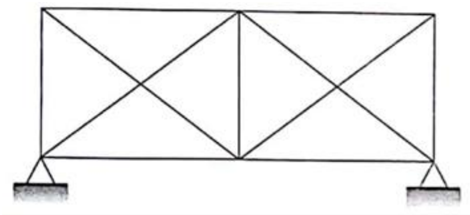
$\sum M_c = 0$

$W \times R \times \frac{R}{2} + H_A \times R = V_A \times R$

$H_A \times R = WR^2 - \frac{WR^2}{2}$

$H_A = \frac{WR}{2}$

67. In the pin-jointed truss shown in the figure, the static degree of indeterminacy is



A. 2
B. 1
C. 3
D. 4

Ans. C

Sol. D_s for truss is given as m+r-2j

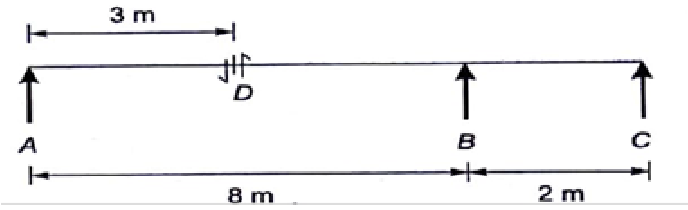
D_s=11+4-2x6=3

68. A beam ABC is simply supported at A and B . BC is overhanging. Span AB=8m, BC=2m. Point 'D' is situated at 3 m from A . Using and influence line diagram or otherwise, find the maximum ordinates at 'D' of the influence line diagram for shear at 'D'

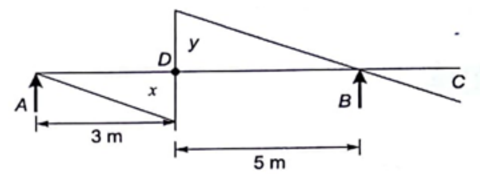
A. -0.375
B. -0.625
C. +0.625
D. +1.875

Ans. C

Sol.



ILD for shear at D



$$x + y = 1$$

$$\frac{x}{3} = \frac{y}{5}$$

$$y = \frac{5}{3}x$$

$$\frac{5}{3}x + x = 1$$

$$x = \frac{3}{8}(-ve)$$

$$y = \frac{5}{8}(+ve)$$

Hence maximum ILD coordinate=+0.625

69. A temperature rise in a two hinged symmetric parabolic arched rib causes

A. a uniform bending moment in the rib

B. no bending moment in the rib

C. a maximum bending moment at the crown of the arch

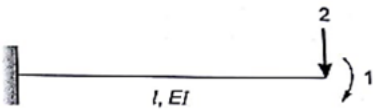
D. a minimum bending moment at the crown of the arch

Ans. C

Sol. Due to temperature change horizontal reaction develops at the support which will induce moment in the arch.

Maximum moment will develop at the crown since it is farthest from the reaction.

70. For the structure shown, the elements of the flexibility matrix are



A. $f_{11} = \frac{l}{(EI)}; f_{21} = \frac{l^2}{(2EI)}; f_{12} = \frac{l^2}{(2EI)}; f_{22} = \frac{l^3}{(3EI)}$

B. $f_{11} = \frac{l^3}{(3EI)}; f_{21} = \frac{l^2}{(2EI)}; f_{12} = \frac{l^2}{(2EI)}; f_{22} = \frac{l}{(EI)}$

C. $f_{11} = \frac{l}{(EI)}; f_{21} = \frac{l^2}{(EI)}; f_{12} = \frac{l^2}{(EI)}; f_{22} = \frac{l^3}{(3EI)}$

D. $f_{11} = \frac{l}{(EI)}; f_{21} = \frac{l^2}{(2EI)}; f_{12} = \frac{l^2}{(2EI)}; f_{22} = \frac{l^3}{(4EI)}$

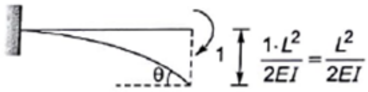
Ans. A

Sol.

Development of flexibility matrix:

f_{ij} = deflection in coordinate direction (i) due to unit load applied at (j)

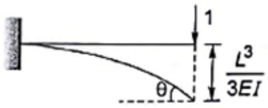
Ist column:



$$\theta = \frac{ML}{EI} = \frac{L}{EI}$$

$$f_{11} = \frac{L}{EI},\ f_{21} = \frac{L^2}{2EI}$$

IInd column:



$$\theta = \frac{L^2}{2EI}$$

$$f_{12} = \frac{L^2}{2EI},\ f_{22} = \frac{L^3}{3EI}$$

$$\therefore \text{Flexibility matrix} = \begin{bmatrix} \frac{L}{EI} & \frac{L^2}{2EI} \\ \frac{L^2}{2EI} & \frac{L^3}{3EI} \end{bmatrix}$$

71. If a truss has two more members surpassing each other, then it is:-

A. Simple

B. Compound

C. Complex

D. None of these

Ans. C

Sol. **Simple Truss**: It is possible to create a simple truss by joining three bars together to form a triangle. We can increase the size of the truss by adding two more members with an additional joint. By repeating this process, we can develop simple trusses with different shapes.

Compound Truss: A compound truss is made up of simple trusses joined together to form a larger truss. It is also possible to have multiple simple trusses joined together to create a larger compound truss. Compound trusses are commonly used to support loads over long spans as in bridges.

Complex Truss: A complex truss uses a general layout of members different from that used in simple and compound trusses. It often incorporates overlapping members.

72. Which of the following statements is not correct?

A. Flexibility matrix is a square matrix.

B. Flexibility matrix is a symmetric matrix

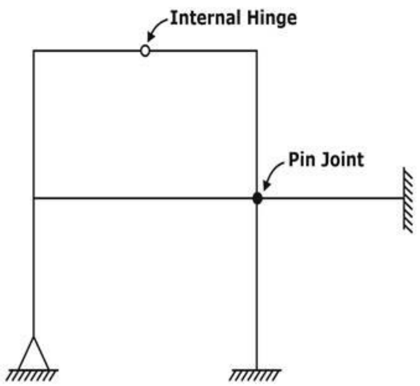
C. All elements of flexibility matrix must be positive

D. Elements of flexibility matrix are displacement and can be computed only for the stable structures.

Ans. C

Sol. Only the diagonal elements would be positive and the non-diagonal elements can be positive or negative.

73. Degree of freedom for the following frame structure having one internal hinge and inextensible members is



A. 11
B. 12
C. 13
D. 14

Ans. B

Sol. Number of inextensible members, m = 8

Number of joints, j = 7

Number of external reactions, r_e = 8

Number of internal hinge, i = 1

Number of member connected to hybrid or pin joint, m' = 4

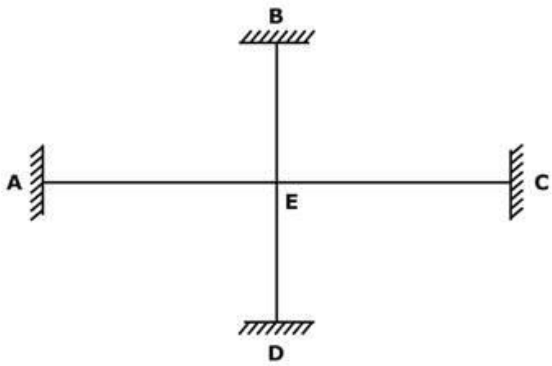
Additional degree of freedom due to hybrid joint and internal hinge, $r_r = 2 \times i + (m' - 1)$

$r_r = 2 \times 1 + (4 - 1) = 7$

Degree of freedom or kinematic indeterminacy, $D_k = 3j - r_e - m + r_r$

$D_k = 3x7 - 8 - 8 + 7 = 12$

74. Four identical beams AE, BE, CE and DE have been rigidly jointed at E as shown in the figure below. The point C slips and rotates along with member firmly fixed at E.



Which of the following is correct?

A. There is no moment on the members

B. Except at C, there is no moment on the members of frame

C. Except at C and E for member EC, no moment will be there on other members

D. All the members are subjected to moment

Ans. D

Sol. Since the members are finally fixed at E and E is a rigid joint at which all the members will have same rotation. So from slope deflection equations, all the members will have the moment.

75. A beam strongest in flexural is one which has

A. Maximum bending moment.

B. Maximum section modulus

C. Maximum area of cross-section

D. Maximum moment of inertia

Ans. B

Sol. i) The section modulus of the cross-sectional shape is of significant importance in designing beams. It is a direct measure of the strength of the beam. A beam that has a larger section modulus than another will be stronger and capable of supporting greater loads.

ii) The elastic section modulus is defined as S = I / y, where I is the second moment of area (or moment of inertia) and y is the distance from the neutral axis to any given fiber. It is often reported using y = c, where c is the distance from the neutral axis to the most extreme fiber.

76. The unit load method used in structural analysis is

A. Applicable only to statically indeterminate structures

B. Another name for stiffness method

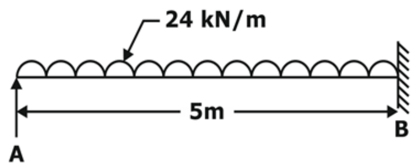
C. An extension of Maxwell's reciprocal theorem

D. Derived from Castigliano's theorem

Ans. D

Sol. Unit load method is derived from the principle of virtual work and unit displacement method from the principle of virtual displacement using Castigliano's theorem. The unit load method is used to calculate displacements of trusses due to external loading.

77. If fixed and moment at A i.e. $M_{FAB} = -50\ kN.m$, then what is the value of slope at A for the beam shown in figure below?



A. $\frac{125}{2EI}$

B. $\frac{250}{EI}$

C. $\frac{125}{EI}$

D. $\frac{250}{3EI}$

Ans. A

Sol. Length of beam, l = 5 m

$$M_{FAB} = -50 \text{ kN.m}$$

UDL at whole span, w = 24 kN/m

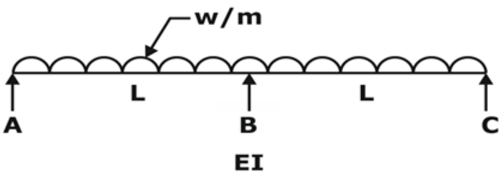
$$M_{AB} = 0$$

$$M_{AB} = M_{FAB} + \frac{2EI}{l}(2\theta_A + \theta_B)$$

$$0 = -50 + \frac{2EI}{5}(2\theta_A)$$

$$\theta_A = \frac{125}{2EI}$$

78. A two span continuous beam having equal spans each of length L is subjected to a uniformly distributed load w per unit length. The beam has constant flexural rigidity. The reaction at middle support is



A. wL

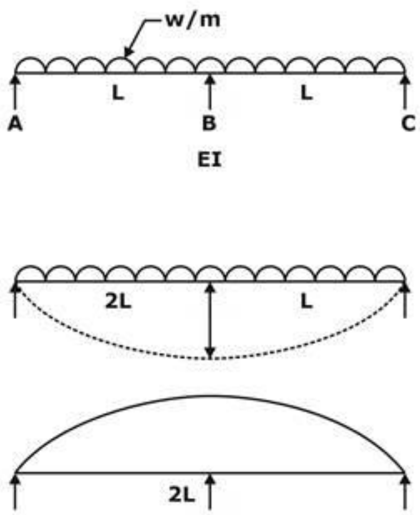
B. $\frac{5wL}{2}$

C. $\frac{5wL}{4}$

D. $\frac{5wL}{8}$

Ans. C

Sol.



Remove support B and deflection at B

$$\frac{5w(2L)^4}{384\text{ EI}}(\text{downward}) = \frac{R_B(2L)^3}{48\text{ EI}}(\text{Upward})$$

$$\frac{5w\,(2L)}{384\text{ EI}} = \frac{R_B}{48}$$

$$R_B = \frac{5wL}{4}$$

79. The slope deflection in a structural analysis fall in the category of

A. Force method

B. Flexibility method

C. Consistent deformation method

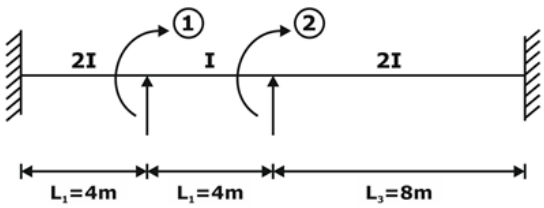
D. Stiffness method

Ans. D

Sol. i) The flexibility method is based upon the solution of equilibrium equations and compatibility equations. There will always be as many compatibility equations as redundant. It is called the flexibility method because flexibilities appear in the equations of compatibility. Force method and consistent deformation method fall in the category of flexibility method.

ii) In the stiffness method, displacements (rather than forces) are taken as the unknown quantities. For this reason, the method is also called the displacement method. So slope deflection method is stiffness method.

80. For the beam shown in figure, find the component of stiffness matrix at co-ordinate 1 due to unit moment at co-ordinate 1.



A. 0.5EI

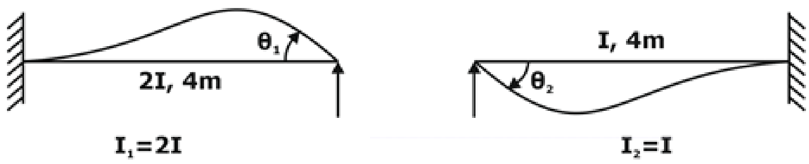
B. EI

C. 2EI

D. 3EI

Ans. D

Sol. For the given beam when unit moment is applied at co-ordinate 1, we can consider the other end at co-ordinate 2 behaves like a fixed support as the far end support is fixed.



Here $I_1 = 2I$, $I_2 = I$ and $I_3 = 2I$

$L_1 = 4m$, $L_2 = 4m$ and $L_3 = 8$ m

$$K_{11} = \frac{4EI_1}{L_1} + \frac{4EI_2}{L_2}$$

$$K_{11} = \frac{4E(2I)}{4} + \frac{4EI}{4}$$

$K_{11} = 3EI$

81. In a fixed beam of span 'L' subjected to a central concentrated load 'W', the fixed end moment and moment at midspan are respectively

A. $\frac{WL}{12}$ and $\frac{WL}{6}$

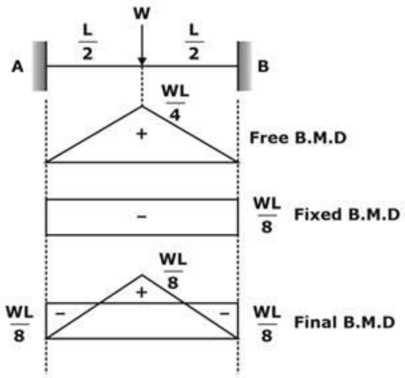
B. $\frac{WL}{8}$ and $\frac{WL}{8}$

C. $\frac{WL}{6}$ and $\frac{WL}{12}$

D. None of the above

Ans. B

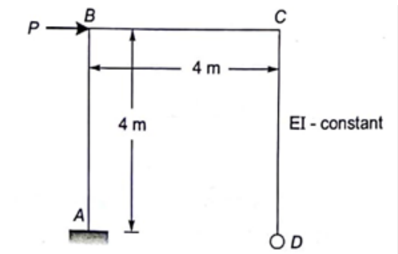
Sol. For a fixed beam subjected to concentrated load W at mid span



Fixed end moment and moment at mid span

$$= \frac{WL}{8} and \frac{WL}{8}$$

82. For the frame shown in the figure, the shear equation is



A. $\frac{M_{BA} + M_{AB}}{4} + \frac{M_{CD}}{4} + P = 0$

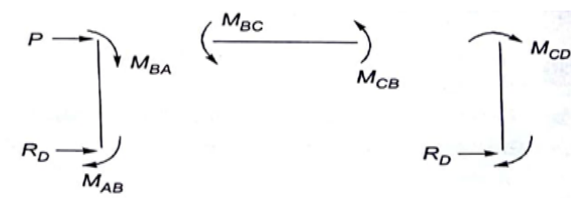
B. $\frac{M_{AB} + M_{BC}}{4} + \frac{M_{DC}}{4} + P = 0$

C. $M_{AB} + M_{BA} + M_{CD} + M_{DC} = 0$

D. $M_{AB} + M_{BA} + M_{CD} + M_{DC} = P$

Ans. A

Sol.



$R_A + R_D + P = 0$ shear equation

$$R_A = \frac{M_{BA} + M_{AB}}{4}$$

$$R_R = \frac{M_{CD}}{4}$$

Shear equation is given as

$$\frac{M_{BA} + M_{AB}}{4} + \frac{M_{CD}}{4} + P = 0$$

83. In the force method of analysis of indeterminate trusses, if the truss is indeterminate to degree one, the change in length of redundant member due to unit force is found by using the formula where A is cross-sectional area

I- Moment of Inertia

n- force in the member due to unit load application

N- force in the member due to actual load

E- Modulus of Elasticity

A. $\Sigma\frac{nNL}{EI}$

B. $n\Sigma\frac{NL}{AE}$

C. $\Sigma\frac{nNL}{AE}$

D. $\Sigma\frac{NL}{AE}$

Ans. A

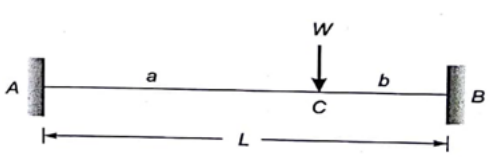
Sol. $\Delta_t = \Sigma\frac{nNL}{AE}$

It is derived from virtual worth (or unit load) method. It says

External virtual load x actual deflection=Virtual stress due to virtual loads x actual internal deflections due to real forces

$$1.\Delta_t = \Sigma(n)x\left(\frac{NL}{AE}\right)$$

84. For both ends of the fixed beam shown in the figure carrying a concentrated load eccentrically placed on the beam, deflection under load is



A. $-\frac{Wa^2b^2}{3EIL^2}$

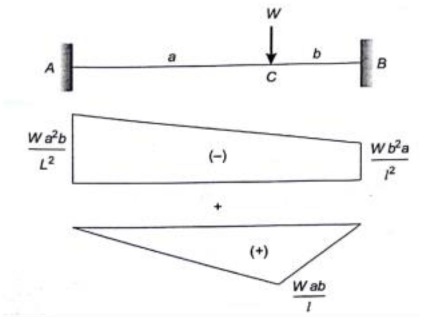
B. $-\frac{Wab^2}{3EIL}$

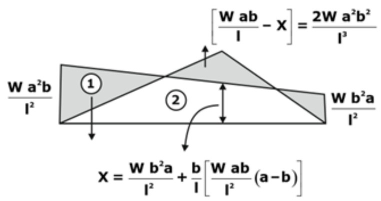
C. $-\frac{Wa^3b^3}{3EIL^3}$

D. $-\frac{Wa^3b^2}{3EIL^2}$

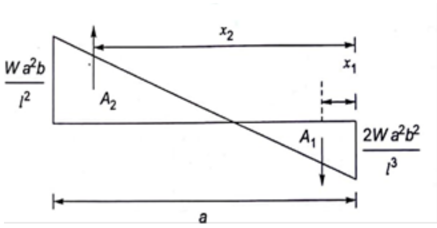
Ans. C

Sol. Use moment area theorem:





$\Delta_A - \Delta_C$ = Moment of area b/w A and C points in BMD about point C we have two triangulate areas generalized as



$$\Delta_A = 0$$

$$-\Delta_c = -\frac{Wa^3b^3}{3EIL^3}$$

85. A continuous beam ABC is simply supported at supports A, B and C . Portion AB ahs span of 6 m and BC 4 m. Portion AB is loaded with a concentrated load of 120 kN downward at 3m from A . The qualitative reactions shall be

A. Reactions at A and B shall be upward and reaction at C shall be zero

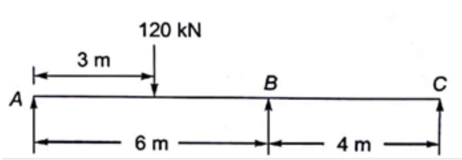
B. Reactions at A and B shall be upward

C. All reactions i.e., at A, B and C shall be upwards

D. None of the above

Ans. B

Sol.

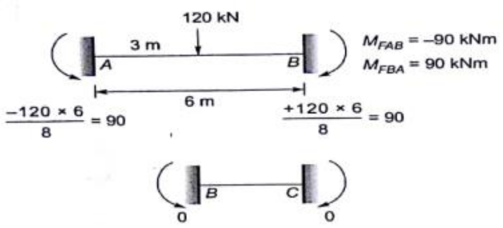


To find the reactions at supports A, B and C. Distribution factor:

Joint	Member	Member stiffness (MS)	Joint stiffness (JS)	D.F = $\frac{MS}{JS}$
B	BA	$\frac{3EI}{6}$	$\frac{5EI}{4}$	$\frac{2}{5}$
	BC	$\frac{3EI}{4}$		$\frac{3}{5}$

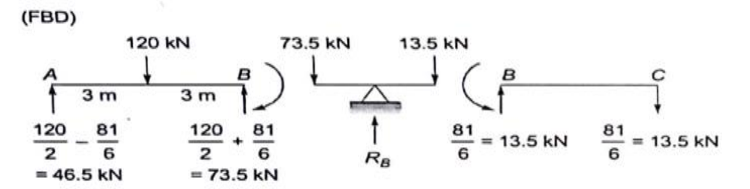
Fixed end moment:

Span AB



$$M_{FBC} = M_{FCB} = 0$$

	B 0.4	B 0.6		
–90	90	0	0	Initial FEM
+90	45			
0	135	0		New FEM
	–54	–81		
0	81	–81	0	



∴ Net reactions at supports B=87 kN

∴ Hence, reaction at A and B will be upward and reaction at C will be downward.

86. A beam AB is simply supported and has flexural rigidity *EI*. The flexural strain energy of the beam having span 6m and carrying a central point load of 10 kN is

A. $\frac{142.38}{EI}$

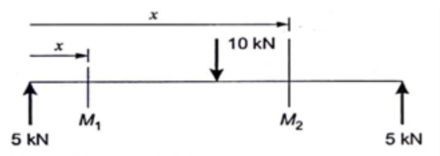
B. $\frac{775}{EI}$

C. $\frac{225}{EI}$

D. None of the above

Ans. C

Sol.



$M_1 = 5x$ [0<x<3]

M_2 =[-10(x-3)]+5x [3<x<6]

=(30-5x)

$$U = \int \frac{M^2 dx}{2EI}$$

$$^3\int_0 \frac{(5x)^2 dx}{2EI} + ^3\int_0 \frac{(30-5x)^2 dx}{2EI} = \frac{225}{EI}$$

87. If the span and dip of a parabolic cable are L and h respectively, then the length of the cable is approximately equal to

A. $L+\frac{3}{8}h$

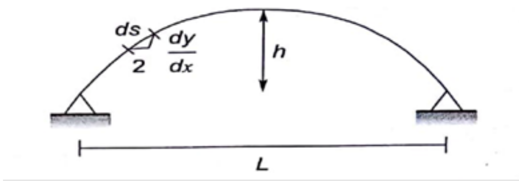
B. $L+\frac{8}{3}h$

C. $L+\frac{3}{8}\frac{h^2}{L}$

D. $L+\frac{8}{3}\frac{h^2}{L}$

Ans. D

Sol.



Equation of parabolic arch

$$y = \frac{4hx}{l^2}(l - x)$$

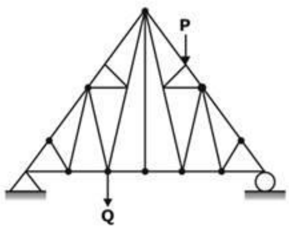
$$\frac{dy}{dx} = \frac{4h}{l^2}(l - 2x)$$

$$ds = \sqrt{1 + \left(\frac{dy}{dx}\right)}^2$$

Total length of cable

$${}^{S}{}_{0}\int ds = {}^{l}{}_{0}\int \sqrt{1 + \left[\frac{4h}{l^2}(l - x)\right]}^2 dx = \left[L + \frac{8}{3}h^2 L\right]$$ -Neglect higher order terms since h<<L.

88. For the plane truss shown in the figure, the number of zero force members for the given loading is



A. 4

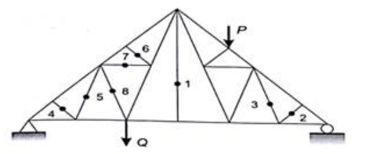
B. 8

C. 11

D. 13

Ans. B

Sol. Zero force number; concept if 3 members meet at a point and two of them are collinear, then force in 3rd member is 0.



Identification sequence of zero force members in figure hence, 8 zero fore members.

89. A structure is said to be statically indeterminate when

A. the number of unknown reaction component exceeds the number of equilibrium conditions.

B. the number of equilibrium conditions exceeds the number of unknown reaction components

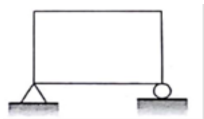
C. the number of equilibrium conditions equal to the number of unknown reaction components

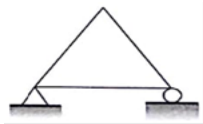
D. None of the above

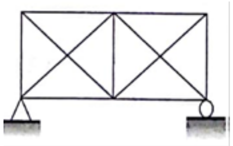
Ans. A

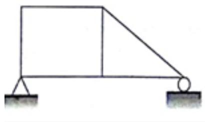
Sol. In indeterminate structures no of equilibrium equations are less than unknown reaction component hence it is not possible to analyze the structure using only equilibrium equations.

90. Which truss is the perfect truss out of the following

A. 

B. 

C. 

D. 

Ans. B

Sol. A perfect truss is one in which the following equation is satisfied m=(2j-3)

1. m=4 > 2j-3=8-3=5 No

2. m=3 = 2j-3=6-3=3 Yes

3. m=11 > 2j-3=12-3=9 No

4. m=6 < 2j-3=10-3=7 No

91. In a fixed beam of span 'L' subjected to a central concentrated load 'W', the fixed end moment and moment at midspan are respectively

A. $\frac{WL}{12}\ and\ \frac{WL}{6}$

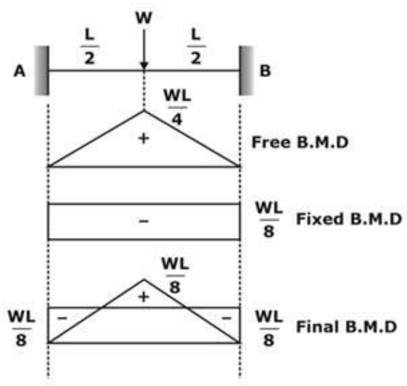
B. $\frac{WL}{8}\ and\ \frac{WL}{8}$

C. $\frac{WL}{6}\ and\ \frac{WL}{12}$

D. None of the above

Ans. B

Sol. For a fixed beam subjected to concentrated load W at mid span



Fixed end moment and moment at mid span

$$= \frac{WL}{8}\ and\ \frac{WL}{8}$$

92. In the force method of analysis of indeterminate trusses, if the truss is indeterminate to degree one, the change in length of redundant member due to unit force is found by using the formula where A is cross-sectional area

I- Moment of Inertia

n- force in the member due to unit load application

N- force in the member due to actual load

E- Modulus of Elasticity

A. $\Sigma \frac{nNL}{EI}$ B. $n\Sigma \frac{NL}{AE}$

C. $\Sigma \frac{nNL}{AE}$ D. $\Sigma \frac{NL}{AE}$

Ans. A

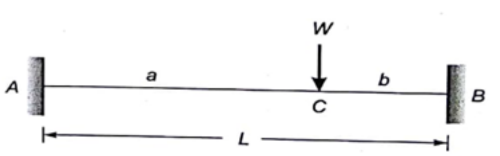
Sol. $\Delta_t = \Sigma \frac{nNL}{AE}$

It is derived from virtual worth (or unit load) method. It says

External virtual load x actual deflection=Virtual stress due to virtual loads x actual internal deflections due to real forces

$$1.\Delta_t = \Sigma(n)x\left(\frac{NL}{AE}\right)$$

93. For both ends of the fixed beam shown in the figure carrying a concentrated load eccentrically placed on the beam, deflection under load is

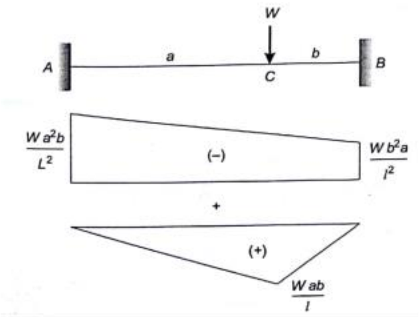


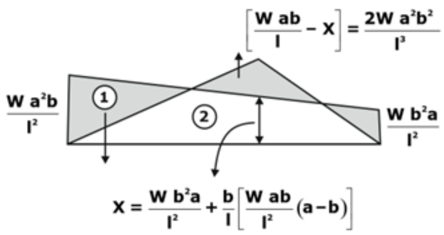
A. $-\frac{Wa^2b^2}{3EIL^2}$ B. $-\frac{Wab^2}{3EIL}$

C. $-\frac{Wa^3b^3}{3EIL^3}$ D. $-\frac{Wa^3b^2}{3EIL^2}$

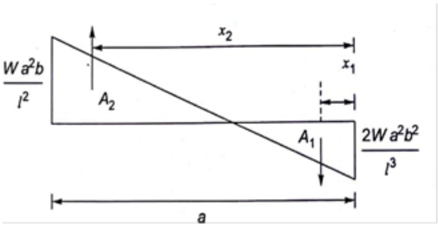
Ans. C

Sol. Use moment area theorem:





Δ_A – Δ_C =Moment of area b/w A and C points in BMD about point C we have two triangulate areas generalized as



$$\Delta_A = 0$$

$$-\Delta_c = -\frac{Wa^3b^3}{3EIL^3}$$

94. A continuous beam ABC is simply supported at supports A, B and C . Portion AB ahs span of 6 m and BC 4 m. Portion AB is loaded with a concentrated load of 120 kN downward at 3m from A . The qualitative reactions shall be

A. Reactions at A and B shall be upward and reaction at C shall be zero

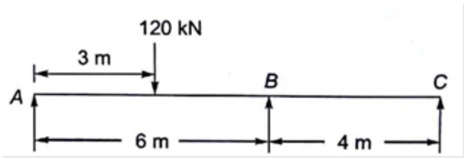
B. Reactions at A and B shall be upward

C. All reactions i.e., at A, B and C shall be upwards

D. None of the above

Ans. B

Sol.

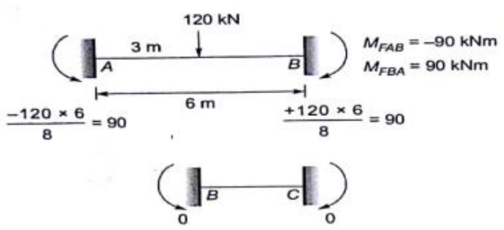


To find the reactions at supports A, B and C. Distribution factor:

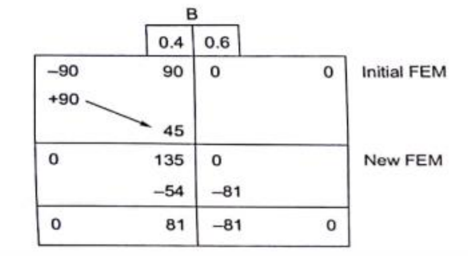
Joint	Member	Member stiffness (MS)	Joint stiffness (JS)	D.F = $\frac{MS}{JS}$
B	BA	$\frac{3EI}{6}$	$\frac{5EI}{4}$	$\frac{2}{5}$
	BC	$\frac{3EI}{4}$		$\frac{3}{5}$

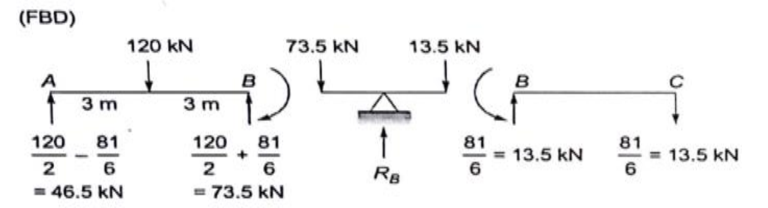
Fixed end moment:

Span AB



$$M_{FBC} = M_{FCB} = 0$$





∴ Net reactions at supports B=87 kN

∴ Hence, reaction at A and B will be upward and reaction at C will be downward.

95. A beam AB is simply supported and has flexural rigidity *EI*. The flexural strain energy of the beam having span 6m and carrying a central point load of 10 kN is

A. $\frac{142.38}{EI}$

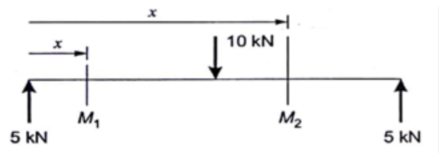
B. $\frac{775}{EI}$

C. $\frac{225}{EI}$

D. None of the above

Ans. C

Sol.



$M_1 = 5x$ [0<x<3]

M_2 =[-10(x-3)]+5x [3<x<6]

=(30-5x)

$$U = \int \frac{M^2 dx}{2EI}$$

$$^3\int_0 \frac{(5x)^2 dx}{2EI} + ^3\int_0 \frac{(30-5x)^2 dx}{2EI} = \frac{225}{EI}$$

96. If the span and dip of a parabolic cable are *L* and *h* respectively, then the length of the cable is approximately equal to

A. $L + \frac{3}{8}h$

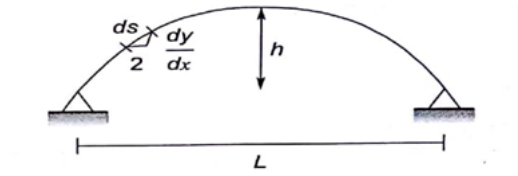
B. $L + \frac{8}{3}h$

C. $L + \frac{3}{8}\frac{h^2}{L}$

D. $L + \frac{8}{3}\frac{h^2}{L}$

Ans. D

Sol.



Equation of parabolic arch

$$y = \frac{4hx}{l^2}(l-x)$$

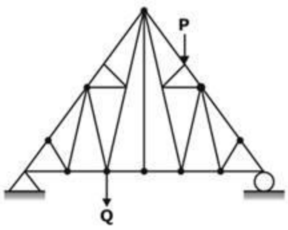
$$\frac{dy}{dx} = \frac{4h}{l^2}(l-2x)$$

$$ds = \sqrt{1+\left(\frac{dy}{dx}\right)^2}$$

Total length of cable

$$^s{}_0\int ds = ^l{}_0\int \sqrt{1+\left[\frac{4h}{l^2}(l-x)\right]^2}\, dx = \left[L + \frac{8}{3}h^2 L\right]$$ -Neglect higher order terms since h<<L.

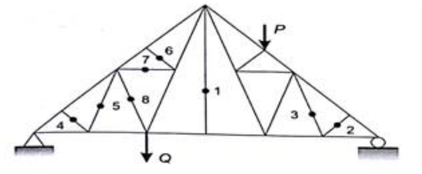
97. For the plane truss shown in the figure, the number of zero force members for the given loading is



A. 4
B. 8
C. 11
D. 13

Ans. B

Sol. Zero force number; concept if 3 members meet at a point and two of them are collinear, then force in 3rd member is 0.



Identification sequence of zero force members in figure hence, 8 zero fore members.

98. A structure is said to be statically indeterminate when

A. the number of unknown reaction component exceeds the number of equilibrium conditions.

B. the number of equilibrium conditions exceeds the number of unknown reaction components

C. the number of equilibrium conditions equal to the number of unknown reaction components

D. None of the above

Ans. A

Sol. In indeterminate structures no of equilibrium equations are less than unknown reaction component hence it is not possible to analyze the structure using only equilibrium equations.

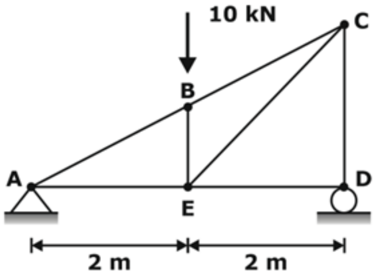
99. The flexibility method is also known as the

A. Energy method
B. Equilibrium method
C. Displacement method
D. Force method

Ans. D

Sol. Flexibility method is also known as force method as in this case forces in the members are taken as redundant stiffness method is also known as displacement method as in this case displacements are taken as redundant.

100. The figure given below shows a pin-jointed frame



What are the forces in members BE, CD and ED ?

A. 10kN, 5kN and 5 kN

B. 10kN, 5kN and Zero

C. 5kN, 10kN and Zero

D. 5kN, 5kN and Zero

Ans. B

Sol. Taking moment about A

$\sum M_A=0$

$R_D \times 4= 10 \times 2$

$R_D= 5$ kN

At joint D

$\sum F_V = 0$

$F_{CD} = R_D = 5$ kN (Compressive)

$\sum F_H = 0$

$F_{ED}=0$

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