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Section :- "B"

Department :- Civil Engineering

Subject :- Structure II

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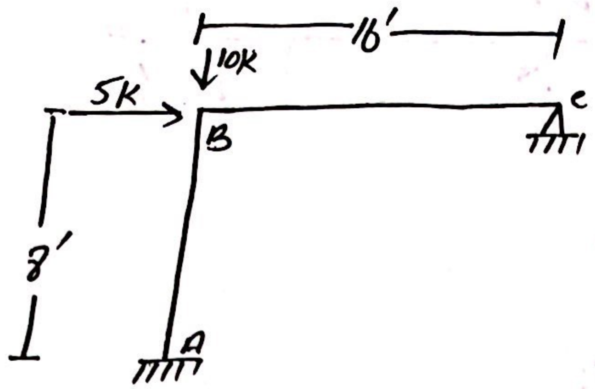
Q No 3



E = Costant

I = I

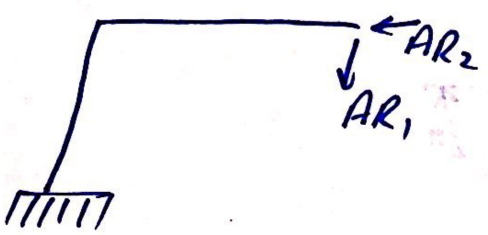
I_B = 2I

Solution:-

Total Statical indeterminacy

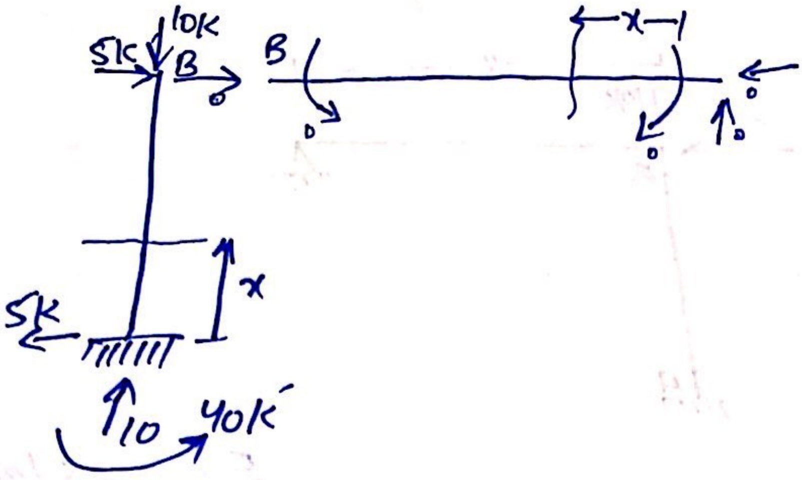
$\Rightarrow R-3 = 5-3 = 2^\circ$

Step # 01 :- Identify Redundant Actions



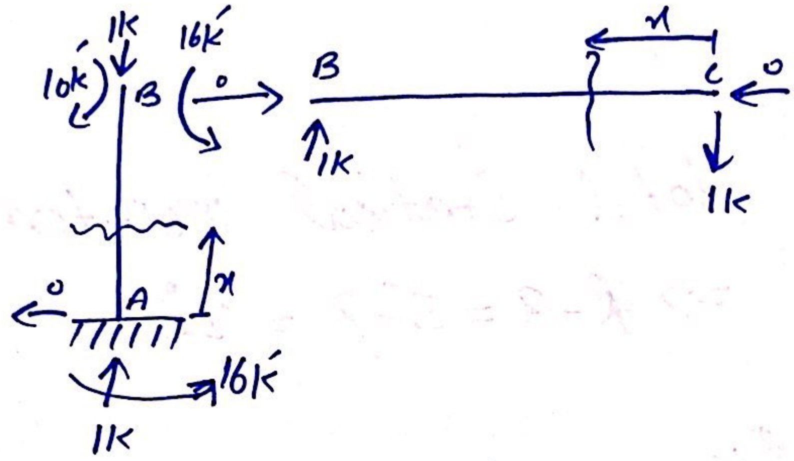
$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} , \quad \begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Step # 2 :- Compute value of [DRL]

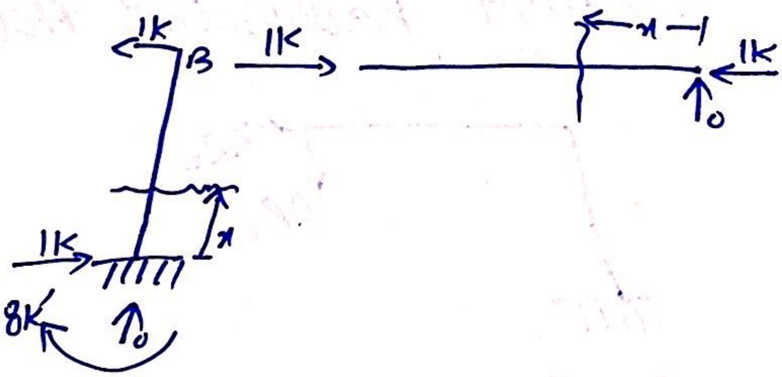


Step #03:- [F] or [AMR]

a)



(b)



Member	AB	BC
Origin	A	C
Limit	0 - 8	0 - 16
I	I	2I
M	5x - 40	0
M_1	-16	x
M_2	8 - x	0

⇒ For finding the value of DRL :-

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot M_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot M_2(BC)}{EI}$$

$$= \int_0^8 \frac{(5x-40)(-16)\,dx}{EI} + \int_0^{16} \frac{0 \cdot x}{E(2I)}\,dx$$

$$\boxed{DRL_1 = \frac{2560}{EI}}$$

$$DRL_2 = \int_0^8 \frac{(5x-40)(8-x)\,dx}{EI} + \int_0^{16} \frac{0 \cdot 0}{E(2I)}\,dx$$

$$\boxed{DRL_2 = \frac{-853.33}{EI}}$$

Compute Flexibility Matrix :-

$$F_{2\times 2} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

$$\Rightarrow F_{11} = \int_0^8 \frac{m_1^2(AB)}{EI} + \int_0^{16} \frac{m_1^2(BC)}{EI} =$$

$$= \int_0^8 \frac{(-16)^2}{EI} dx + \int_0^{16} \frac{x^2}{E(2I)}$$

$$\boxed{F_{11} = \frac{2730.67}{EI}}$$

$$F_{12} = F_{21} = \int_0^8 m_1(AB) \cdot M_2(AB) + \int_0^{16} M_1(BC) \cdot M_2(BC)$$

$$= \int_0^8 \frac{(-16)(8-x)}{EI} dx + \int_0^{16} \frac{(x)(0)}{2EI} dx$$

$$\boxed{F_{12} = \frac{-512}{EI}}$$

$$F_{22} = \int_0^8 (m_2)^2_{AB}\, dx + \int_0^{16} (m_2)^2_{BC}\, dx$$

$$= \int_0^8 \frac{(8-x)^2}{EI}\, dx + \int_0^{16} \frac{0^2}{2EI}\, dx$$

$$\boxed{F_{22} = 170.67}$$

As we Know

$$[DRS] = [DRL] + [AR] * [F]$$

$$\Rightarrow [AR] = \frac{[DRS] - [DRL]}{[F]}$$

2) $[AR] = [F]^{-1} \times [DRS - DRL]$

$$= \begin{bmatrix} 2730.67 & -512 \\ -512 & 170.67 \end{bmatrix}^{-1} \times \begin{bmatrix} 0 - 2560 \\ 0 + 853.33 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.00005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$

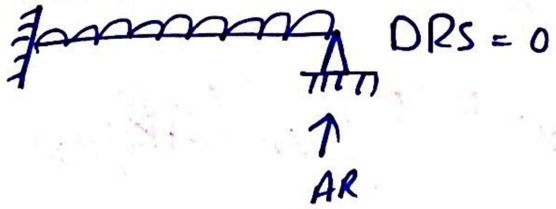
Q No 2

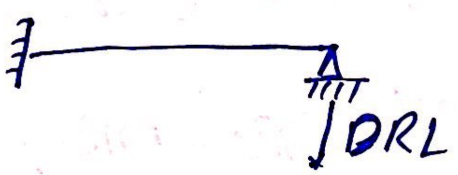
Ans:- There are two main methods of Structural analysis using the matrix approach.

i) Force Method.

ii) Displacement Method.

Force Method:- This method is also know as Flexibility or Compatibility method. In this method the degree of Static indertermancy of the is determined and the reedundants are identified. A Co-ordinate is assigned to each reedudants. Thus $AR_1, AR_2, \ldots, AR_n$ are the redudants at co-ordinate 1,2 ..... n. if all the the redundants are removed the resulting Structure know as the as the released strc; is statically determinate from the principle of superposition. The net displacement at any point in a statically determinate strc. is the sum of the displacement in the basic determinate strc due to applied loads and the redudants - Thus condition, know as compalibility condition may be expressed by the equations for "n" redudant actions.





$$DRS = DRL + F \times AR$$

$$DRS_1 = DRL_1 + F_{11} AR_1 + F_{12} AR_2 + \cdots F_{1n} AR_n$$

$$DRS_2 = DRL_2 + F_{21} AR_1 + F_{22} AR_2 + \cdots F_{2n} AR_n$$

$$DRS_n = DRL_n + F_{n1} AR_1 + F_{n2} AR_2 + \cdots F_{nn} AR_n$$

Writing these equation in matrix form

$$\begin{bmatrix} DRS_1 \\ DRS_2 \\ DRS_n \end{bmatrix}_{n \times 1} = \begin{bmatrix} DRL_1 \\ DRL_2 \\ DRL_n \end{bmatrix}_{n \times 1} + \begin{bmatrix} F_{11} & F_{12} \cdots & F_{1n} \\ F_{12} & F_{22} \cdots & F_{2n} \\ F_{n1} & F_{n2} \cdots & F_{nn} \end{bmatrix} \begin{bmatrix} AR_1 \\ AR_2 \\ AR_n \end{bmatrix}$$

$$[DRS]_{n \times 1} = (DRL)_{n \times 1} + (F)_{n \times n} (AR)_{n \times 1}$$

$$(F)(AR) = (DRS) - (DRL)$$

$$AR = (F)^{-1} (DRS - DRL)$$

n = Degree of indeterminancy

where, DRS = Support settlement/Rotation Corresponding to the redudant action

DRL = Displacement (Rotation/translation)

Corresponding to the redudant action in a released Strc (Basic det str) due to applied loads.

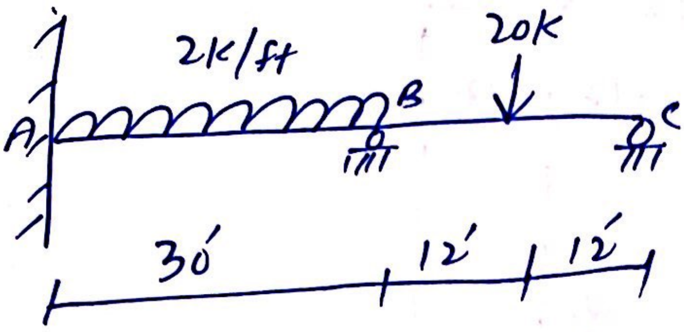
AR = The redudant actions.

F = Flexibility Co-efficient i.e, displacement caused by unit action.

Differentiate between Force And Displacment Method

Force Method	Displacemnt Method.
1) $D_s < D_K$	$D_s > D_K$
2) Force are redudant or unknows	Displacment are redudants or unknows.
3) Starts with equilibrium of Force	Starts with Compatible deformation.
4) Number of redudants = D_s	Number of redudants = D_K
5) Forces found by Compatibility of displacement	Displacement found by equilibrium equation of forces.

Q No 1

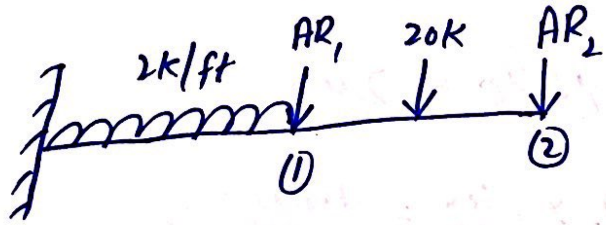


EI = Constant

Solution:-

Structural Indeterminancy = 2°

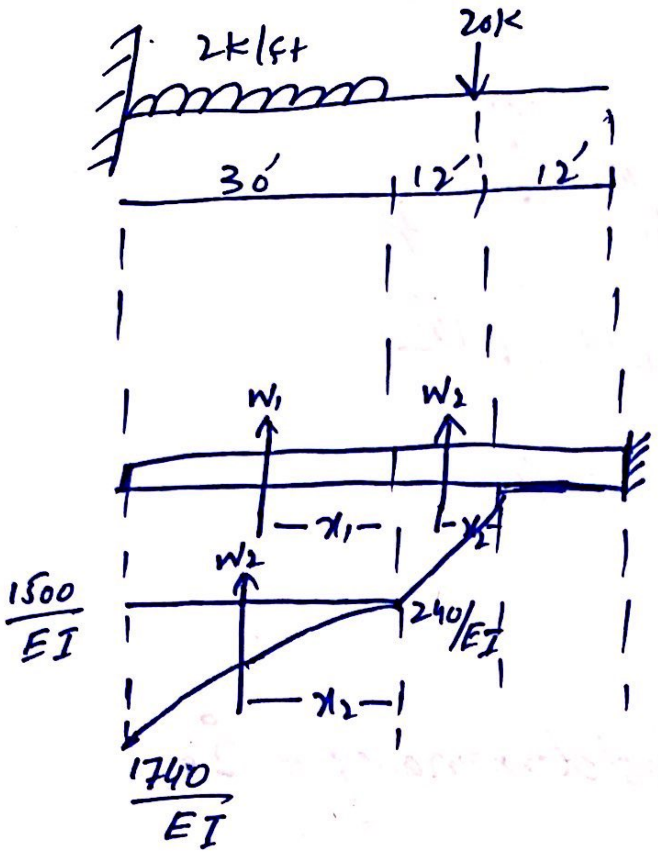
Step # 01:- Select Redundant Actions



$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} , \quad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

$$[DRS] = [DRL] + [F] \times [AR]$$

Step #2:- Compute the value of [DRL]



$20 \times 12 = 240$

$20 \times (12 \times 30 + 2 \times 30 \times 15)$
$= 1740$

$w_1 = 1500 \times 30 = 45000$

$w_2 = \frac{1}{3} \times 30 \times 240 = 2400$

$w_3 = \frac{1}{2} \times 12 \times 240 = 1440$

$x_1 = b/2 = 30/2 = 15'$

$x_2 = \frac{3}{n+2} \times L = \frac{3}{2+2} \times 30 = 22.5'$

$x_3 = \frac{2}{3} \times L = \frac{2}{\cancel{3}} \times \cancel{12}^{4} = 8'$

Now finding DRL:-

$$DRL_2 = w_1 \times (x_1 + 24) + w_2 \times (x_2 + 24) + w_3 \times (x_3 + 12)$$

$$= 45000(15+24) + 2400(22.5+24) + 1440(8+12$$

$$= 1755000 + 111600 + 28800$$

$$DRL_2 = 1895400/EI$$

$$DRL_1 = w_1(x_1) + w_2(x_2)$$

$$= 45000(15) + 2400(22.5)$$

$$= 675000 + 54000$$

$$DRL_1 = 729000$$

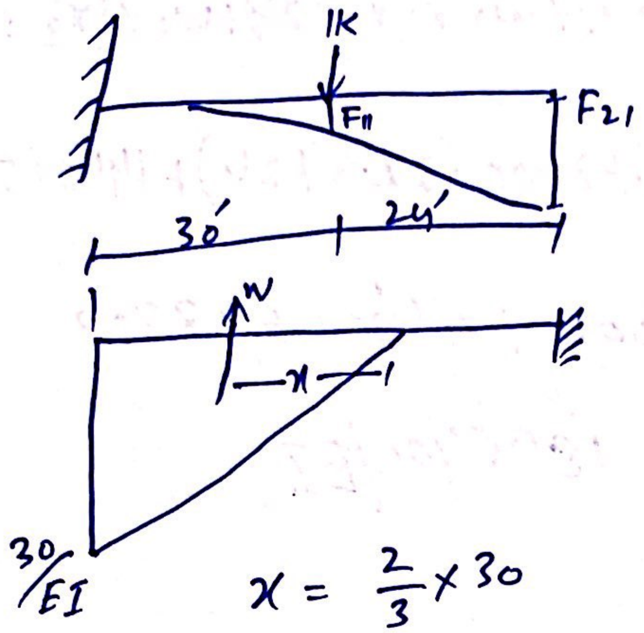
So

$$DRL = \frac{1}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

Step#3:- Flexibility Matrix:

$$[F]_{2\times2} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

(9) Applying unit load on AR_1



$$x = \frac{2}{3} \times 30$$

$$x = 20'$$

$$w = \frac{1}{2}\left(\frac{30}{EI} \times 30\right)$$

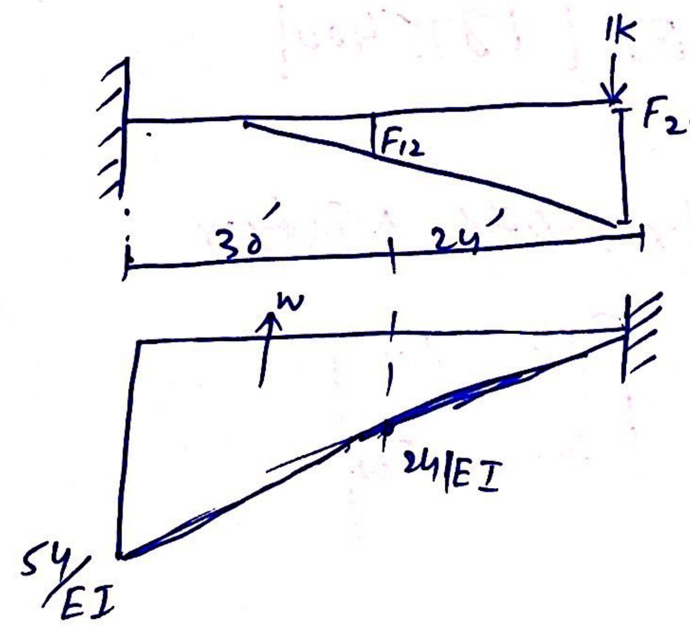
$$w = 450/EI$$

So,

$$F_{11} = \frac{450}{EI}(20) = 9000/EI$$

$$F_{21} = \frac{450}{EI}(20+24) = 19800/EI$$

Now Apply unit Load on AR_2:-



$$W = \left(\frac{54+24}{2EI}\right) \times 30$$

$$W = 1170/EI$$

Now the distance.

$$x = \frac{L}{3}\left[\frac{b + 2(a)}{a+b}\right]$$

$$= \frac{30}{3}\left[\frac{24 + 2(54)}{54+24}\right] = 16.92'$$

$$\Rightarrow F_{12} = \frac{1170}{EI} \times 16.92 = \frac{19796.4}{EI}$$

$$\Rightarrow F_{22} = \frac{1170}{EI} \times (16.92 + 24) = \frac{47876.4}{EI}$$

Hence

$$F_{2\times2} = \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix} \frac{1}{EI}$$

Step#4:- Compute the value of AR

$$[DRS] = [DRL] + [F] \times [AR]$$

$$[AR] = [DRS - DRL] \times [F]^{-1}$$

$$[F]^{-1} = \frac{1}{|F|} \times Adj\,F$$

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

$$|F| = (9000 \times 47876.4 - 19796.4 \times 19800)$$

$$= (430887600 - 391968720)$$

$$|F| = 38918880$$

$$\Rightarrow Adj\ A = \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880} \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{\begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}}{38918880}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}$$