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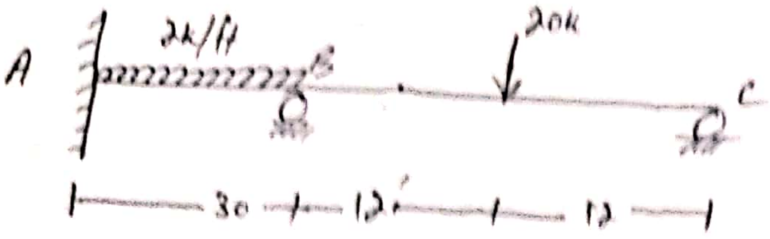
Section	A
Subject	Structure II

Q1

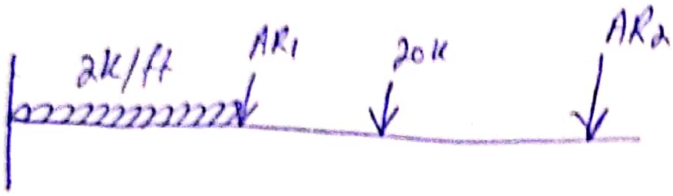


EI = constant.

Solution.

Structural indeterminancy = 2°

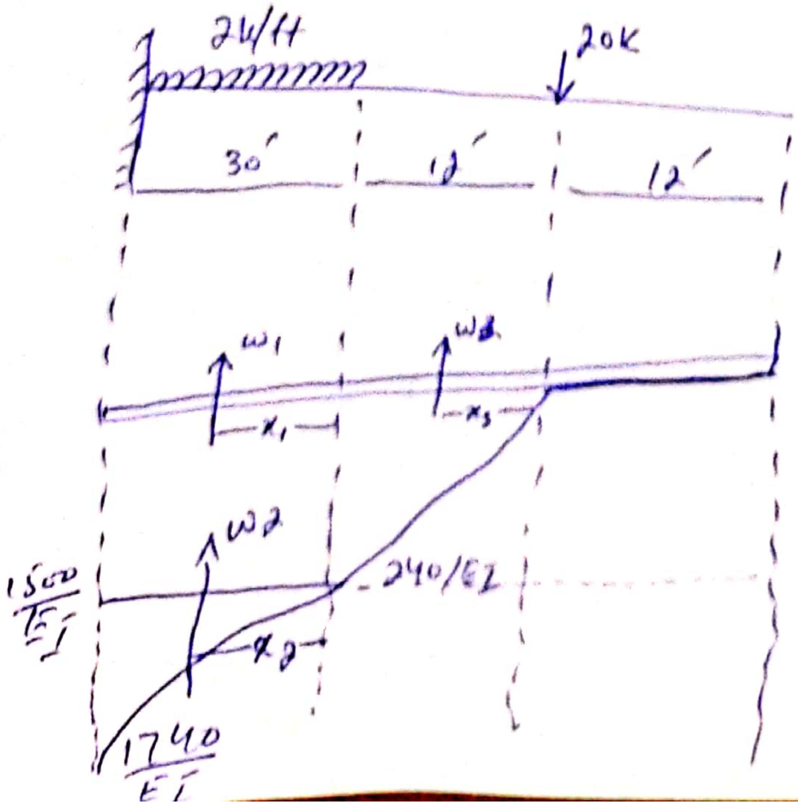
Step #1 Select Redundant Actions.



$$\begin{bmatrix} DRS_1 \\ DRS_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

$$[DRs] = (DRL] + [F] \times [AR]$$

Step #2 Compute the Value of (DRL)



$W_1 = 1500 \times 30 = 4500$

$W_2 = \frac{1}{3} \times 30 \times 240 = 2400$

$W_3 = \frac{1}{2} \times 12 \times 240 = 1440$

$20 \times 12 = 240$

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

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

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

$x_3 = 2/3 \times L = 2/3 \times \overset{4}{12} = 8'$

Now finding DRL

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

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

$= 1755000 + 111600 + 28800$

$DRL_2 = 1895400 / EI$

$DRL_2 = w_1 (x_1) + w_2 (x_2)$

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

$= 675000 + 54000$

$= 729000$

So

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

Step #3 Flexibility matrix

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

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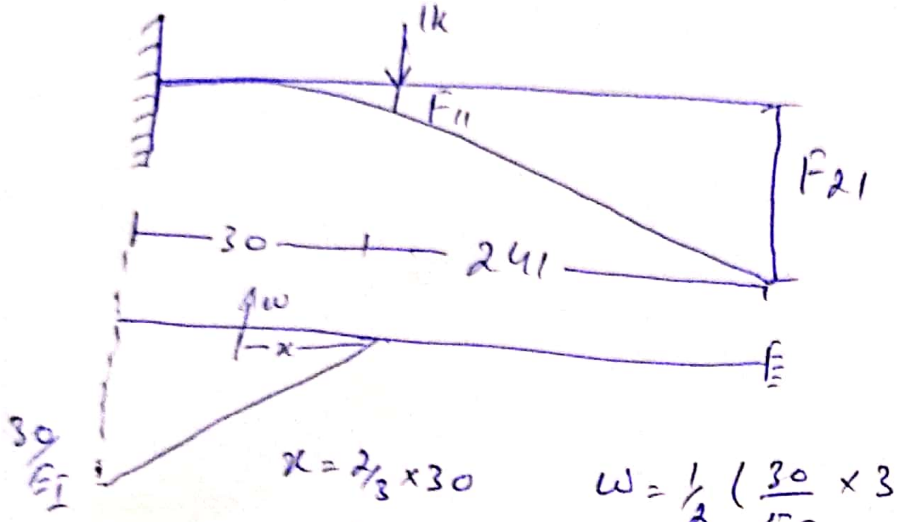
a) Applying unit load on AR1



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

$= 20$

$w = \frac{1}{2}\left(\frac{30}{EI} \times 3\right.$

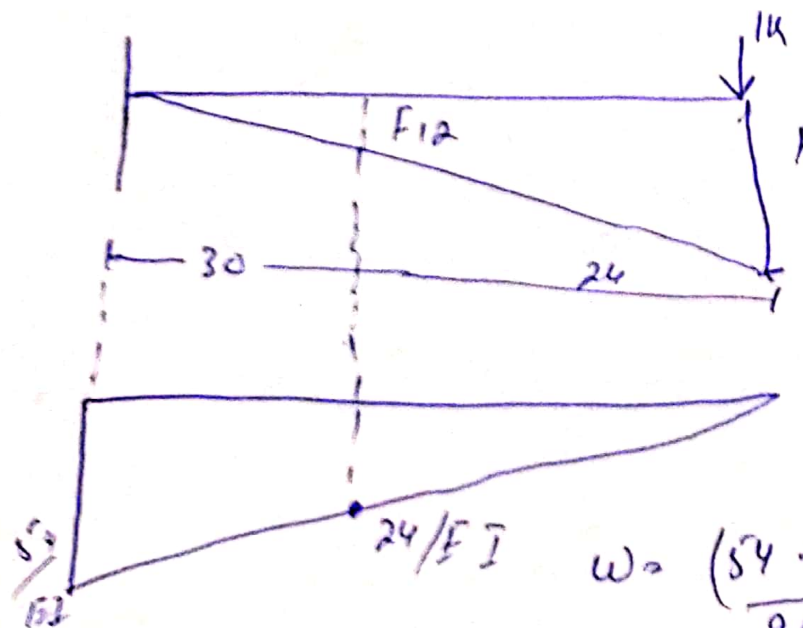
$= 450/EI$

So

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

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

Now Apply unit load on AR2



$w = \frac{(54 + 24)}{2EI} \times 30$

$= 1170/EI$

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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

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

Step 4 compute the value of AR

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

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

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

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$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 19706.4 \\ 19800 & 4787.4 \end{bmatrix}$$

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

$$(430887600 - 391968720)$$

$$\Rightarrow |F| = 3891880$$

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880}$$

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

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

Q2 page!

Differentiate between force method and displacement method and Suggest which method is more suitable for structure analysis of matrix approach.

Ans:- in the force method of analysis primary unknown are force in this method compatibility equations written for displacement and rotations which are calculated by force displacement equations in the displacement method of analysis the primar unknows are the displacement.

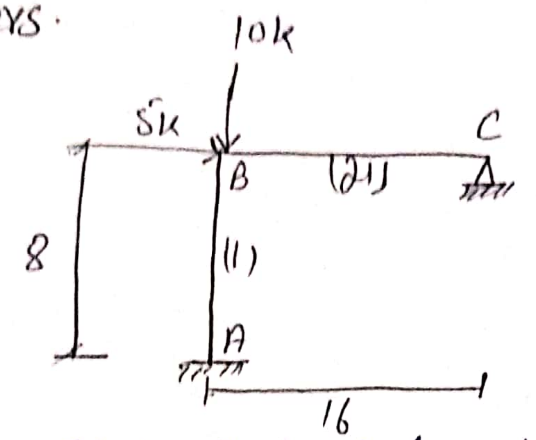
Force methoDs	Displacement methoDs
1) method of consistent deformation	1) Slope deflection method
2) Theorem of least work	2) moment distribution method
3) Column analogy method	3) kani's method
4) Flexibility matrix method	4) Stiffness matrix method
→ Type of indeterminacy static indeterminacy	→ Types of ~~inte~~ indeterminacy kinematic indeterminacy.
→ ~~Governing~~ Governing equation compatibility equations	→ Governing equation equilibrium equation
→ force displacement relations Flexibility matrix	→ force displacement relation Stiffness matrix
→ Assumed force as unknown	→ Assumed Displacement as unknown.
→ preferable when Structure has less Static indeterminacy	→ Preferable when Structure has less kinematic ~~inte~~ indeterminacy.
→ known as Flexibilibility method eg consistent method of Deformations.	→ known as Stiffness method e.g Slope Displacement method and moment Distribution method.

-> Displacement method of analysis the displacement method works by satisfying the equillibrium equation for the Structure to do this the unknown displacements are written in terms of the loads by using the load displacement relations then these equations are solved the displacement.

-> The force method of analysis also known as The method of consistent deformation uses equillibrium equations and compatibility conditions to determine the unknowns in Statically indeteminate Structures this means that there is one reaction force that can removed without jeopardizing the stability of the Structure.

->

Q3 Analyze the rigid joint frame shown in Fig 2 by flexibility method. Assume EI is constant for all members.

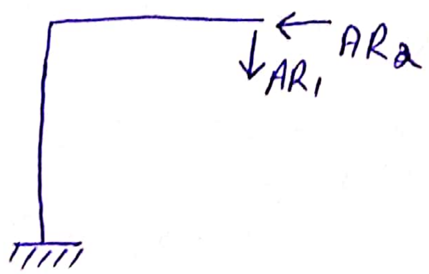


Sol:-

Total Statical indeterming

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

Step#01 Identify Redundant Actions.



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

Step #2: Compute value of [DRL]

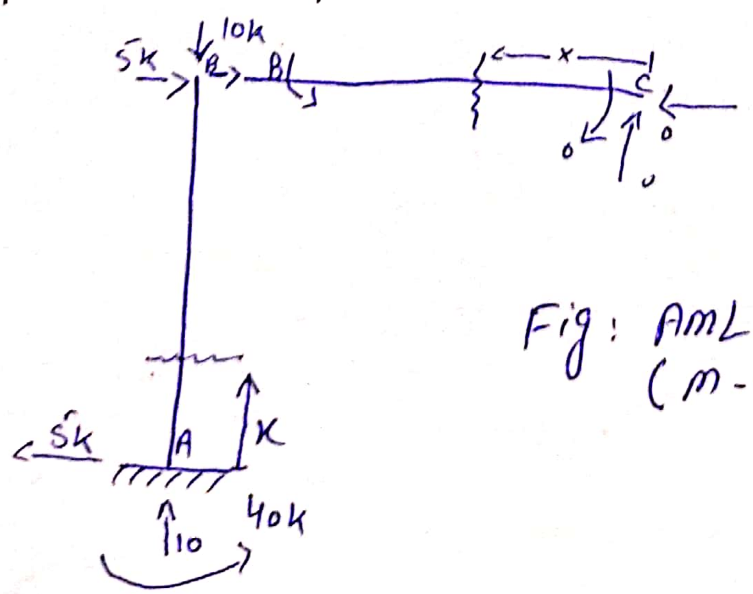


Fig: AML value (m-values)

Step # 03 (F3 of (AMR)

a)

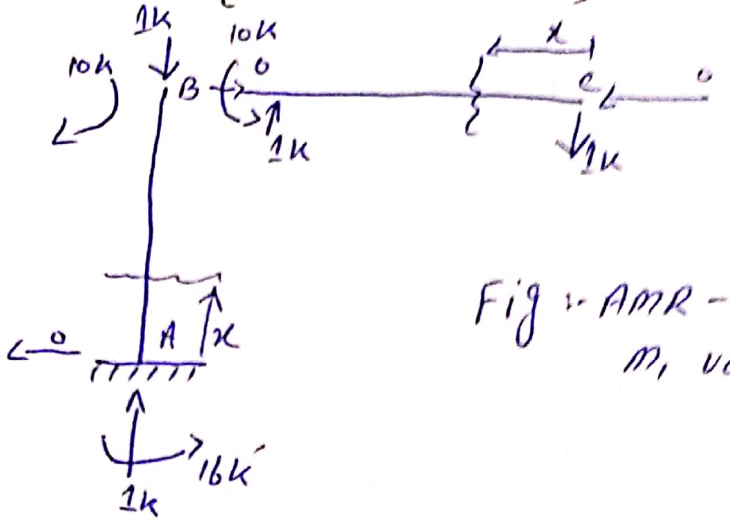


Fig :- AMR-values
m_1 values.

b)

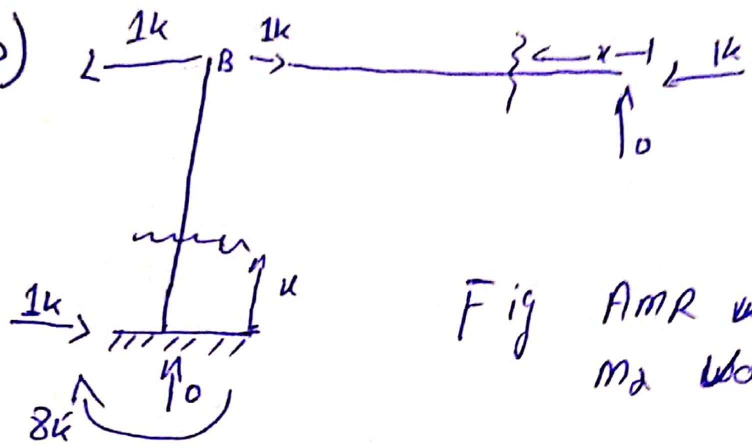


Fig AMR values
m_2 values.

member	AB	BC
origin	A	C
Limits	0-8	0-16
I	I	2I
M1	$5x-40$	0
m_1	-16	x
m_2	$8-x$	0

For Finding value of DRL's :-

$$DRL_1 \int_0^8 \frac{M_{AB}}{EI} m_1 (AB) + \int_0^{16} \frac{M_{BC} \cdot M_2}{EI} (BC)$$

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

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

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

$$\boxed{DRL_2 = \frac{-863.33}{EI}}$$

=> Compute Flexibility matrix

$$F_{2\times2}^{-1} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

$$\Rightarrow F_{11} = \int_0^8 \frac{m_1^2}{EI}AB + \int_0^{16} \frac{m_2^2}{EI}BC = \int_0^8 \frac{(-16)^2}{EI}dx + \int_0^{16} \frac{x^2\,dx}{E(2I)}$$

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

$$F_{12} = F_{21} = \int_0^8 m_1(AB)\, m_2\, AB + \int_0^{16} m_1(BC) \cdot m_2\,(BC)$$

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

$$\boxed{F_{12} = F_{21} \; \frac{-512}{EI}}$$

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

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

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

As we know that

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

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

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

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

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

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