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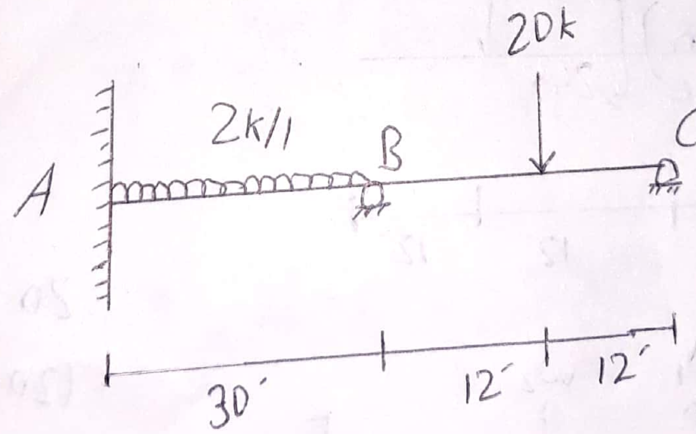
Section: A

Subject: Structure Analysis - II

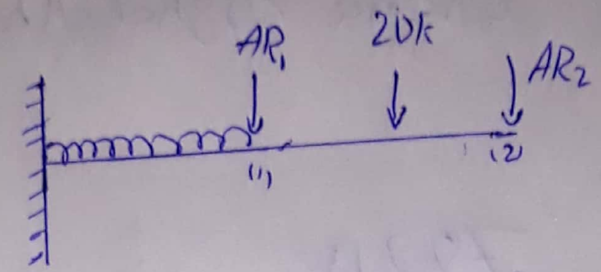
Question No. 1:



Solution:

$S.I = 2^{\circ}$

Step #01: Select redundant actions

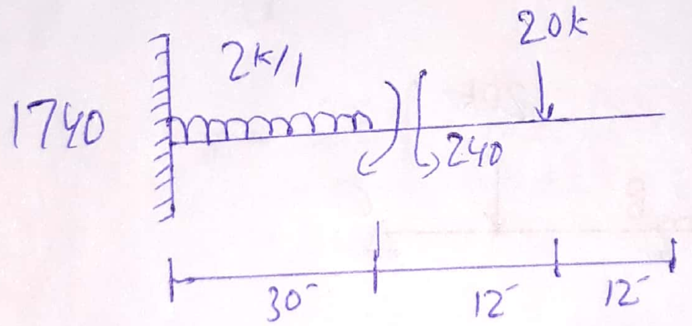


$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \quad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

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

Step #02:

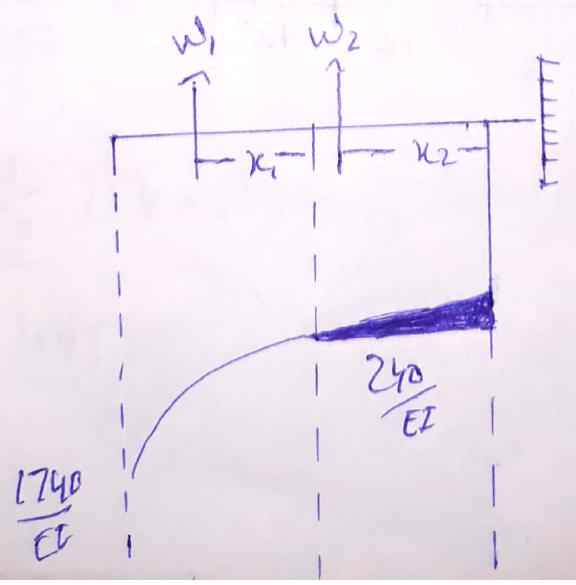
Compute the Values of [DRL]



$20 \times 12 = 240$

$(20 \times 42) + 2 \times 30 \times \frac{30}{2}$

$= \cancel{840}\ 1740$



$$W_1 = \left(\frac{240+0}{2EI}\right) \times 12 = 1440/EI$$

$$W_2 = \frac{1}{n+1} \times (b \times h) = \frac{1}{2+1}\left(\frac{1100}{EI}\right) \times 30 = 1100/EI$$

$$x_1 = \frac{L}{3}\left(\frac{a+2b}{a+b}\right)$$

$$x_1 = \frac{12}{3}\left(\frac{240+2(0)}{240+0}\right) = 4'$$

$$x_2 = \frac{3}{n+2} \times b = \frac{3}{2+2}(30)$$

$$= 22.5'$$

$$DRL_1 = W_1(x_1+30) = 1440(4+30)$$

$$= 48960$$

$$DRL_2 = W_1(x_1+40) + W_2(x_2+12)$$

$$= 1440(4+40) + 11000(22.5+12)$$

$$DRL_2 = 442860$$

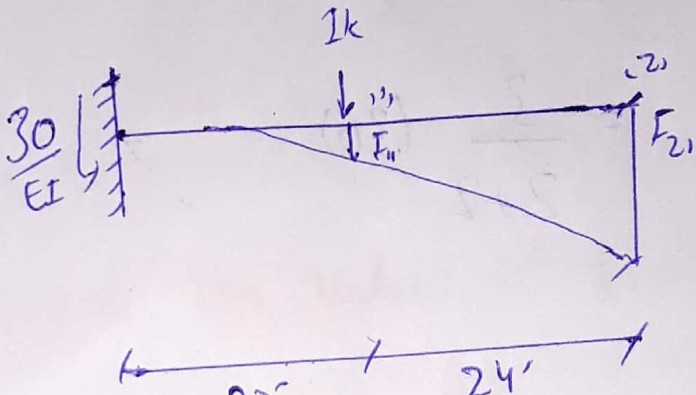
$$(DRL) = \frac{1}{EI}\begin{bmatrix} 48960 \\ 442860 \end{bmatrix}$$

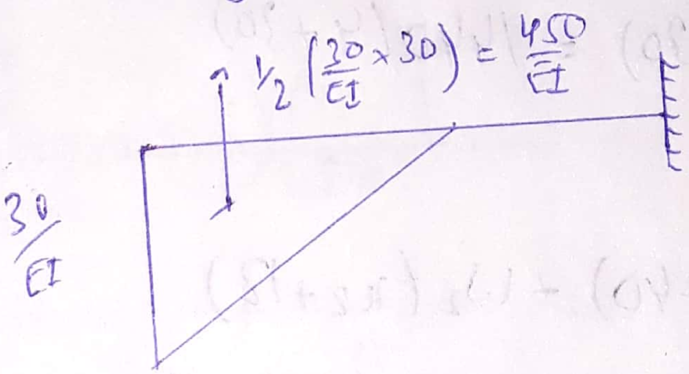
Step # 03 :

Construct flexibility co-efficient matrix

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

(a) Apply a unit value of AR_1 at reference point i- compute the value of F_{11} & F_{21}





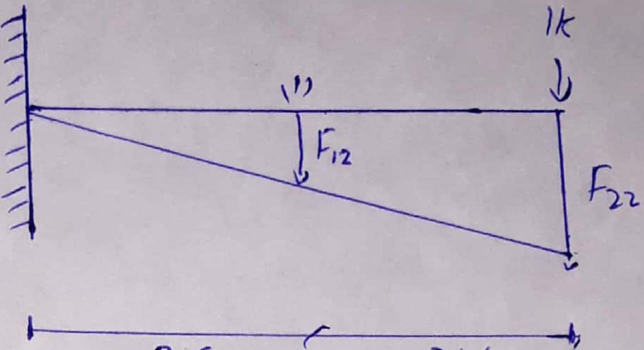
$\frac{2}{3}(30) = 20'$

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

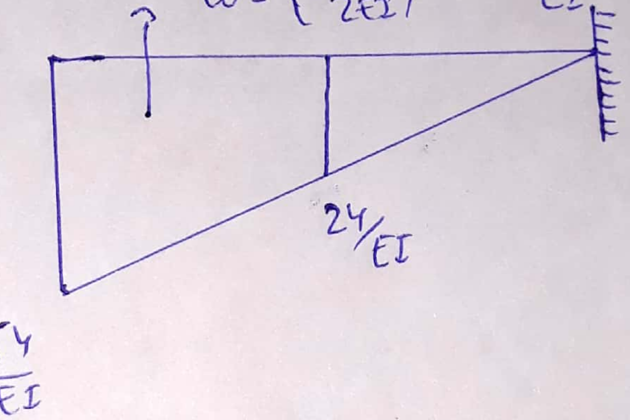
$$F_{21} = \frac{450}{EI}(20+24) = \frac{19800}{EI}$$

b. Apply a unit of AR_2 at reference point (2)

∴ compute the value of F_{12} & F_{22}.



$$W = \left(\frac{54+24}{2EI}\right)\times 30 = \frac{1170}{EI}$$



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

$$F_{12} = \frac{1170}{EI} \times 16.92 = \frac{19800}{EI}$$

$$F_{22} = \frac{1}{2}(54\times 54)\times \frac{1}{3}(30)+24$$

$$= \frac{49572}{EI}$$

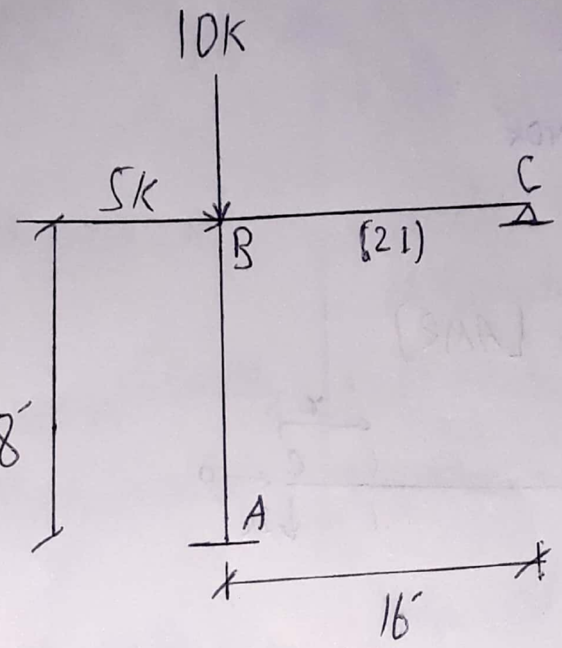
Question No. 2

Answer:

FORCE METHOD:	DISPLACEMENT METHOD
• $D_s < D_k$	• $D_s > D_k$
• Starts with equilibrium of forces	• Starts with compatible deformations
• Forces found by compatibility equations of displacements	• Displacement found by equilibrium equations of forces.
• No. of reductants = D_s	• No. of reductants = D_k
METHODS	METHODS
• Method of consistent deformation	• Slope deflection method
• Column analogy method	• Moment distribution method
• Flexibility matrix method	• Kani's method
	• Stiffness matrix method
• Type of indeterminacy: static indeterminacy	• Type of indeterminacy kinematic indeterminacy

Question No. 3

Analyze the rigid-joint frame shown in figure by flexibility method. Assume EI is constant for all members.

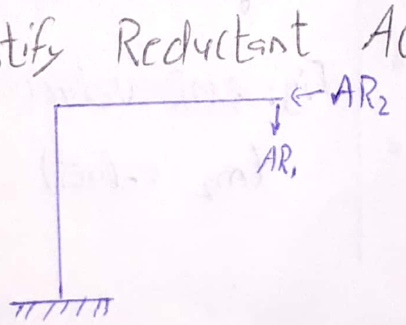


Solution:

Total statical indeterminacy

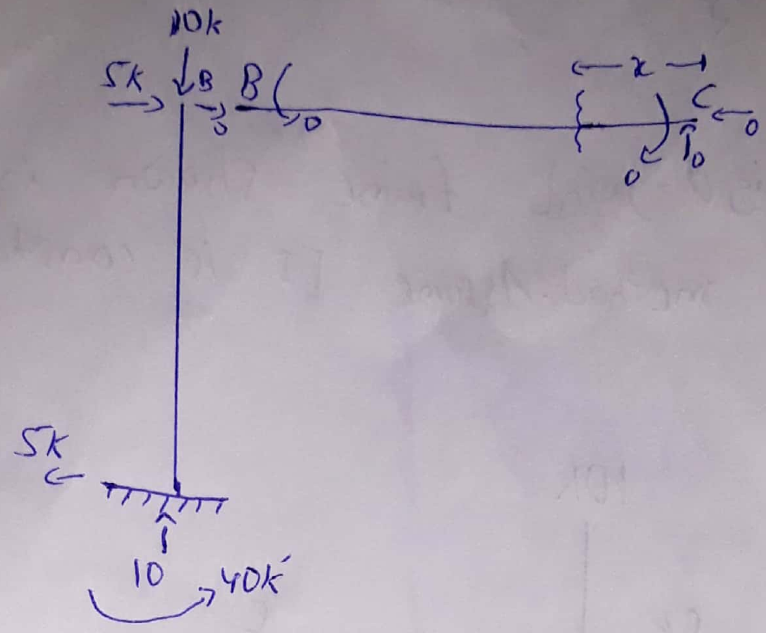
$\Rightarrow R - 3 = 5 - 3 = 2^{\circ}$

Step # 01: Identify Redundant Actions



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

Step#02: Compute Value of (DRL)



Step#03: (F) or (AMR)

(a)

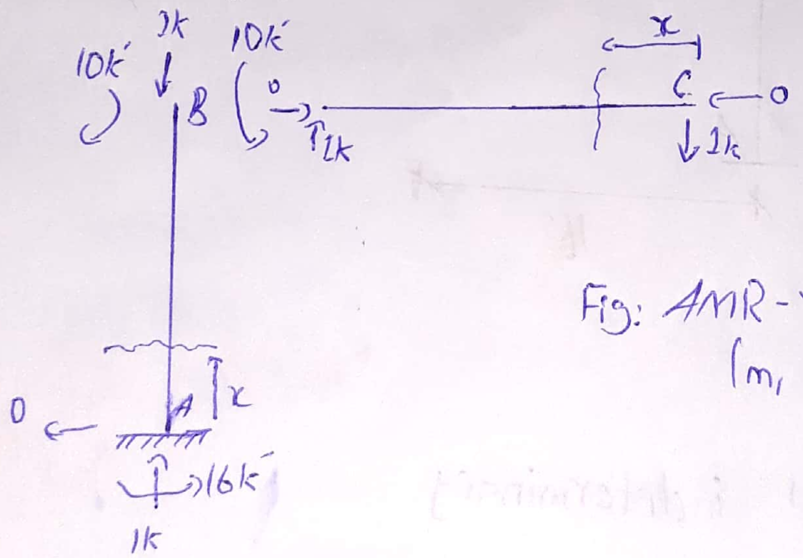


Fig: AMR - Values (m_1 Values)

b)

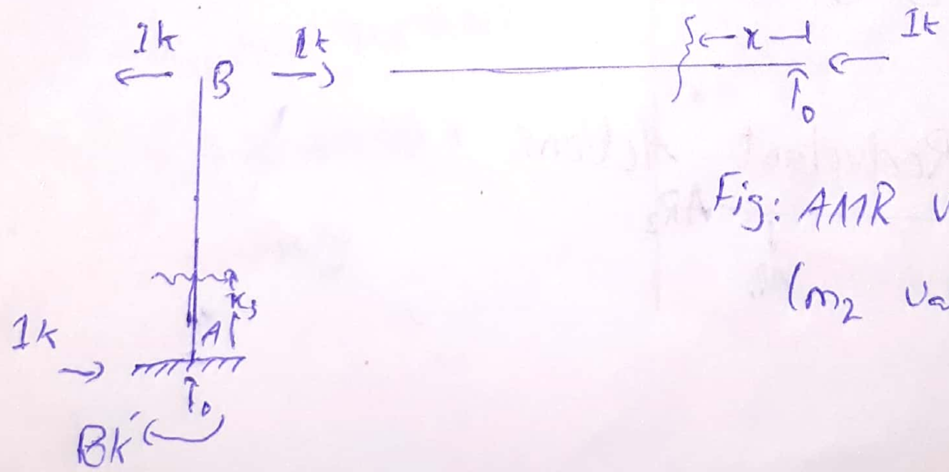


Fig: AMR Values (m_2 Values)

P.T.O

Member	AB	BC
Origin	A	C
Limits	0-8	0-16
I	I	2I
M	5x-40	0
M_1	-16	x
m_2	8-x	0

⇒ Finding Values of DRL's :-

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot M_{1(AB)}}{EI} + \int_0^{16} \frac{M_{BC} \cdot M_{2(BC)}}{EI}$$

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

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

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

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

⇒ Compute Flexibility Matrix:

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

$$\Rightarrow F_{11} = \int_0^8 \frac{M_1^2(AB)}{EI} + \int_0^{16} \frac{M^2(BC)}{EI}$$

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

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

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

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

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

$$F_{22} = \int_0^8 (M_2)^2_{AB}\, dx + \int_0^{16} (M_2)^2_{BC}\, dx$$

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

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

As we know,

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

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

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

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

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