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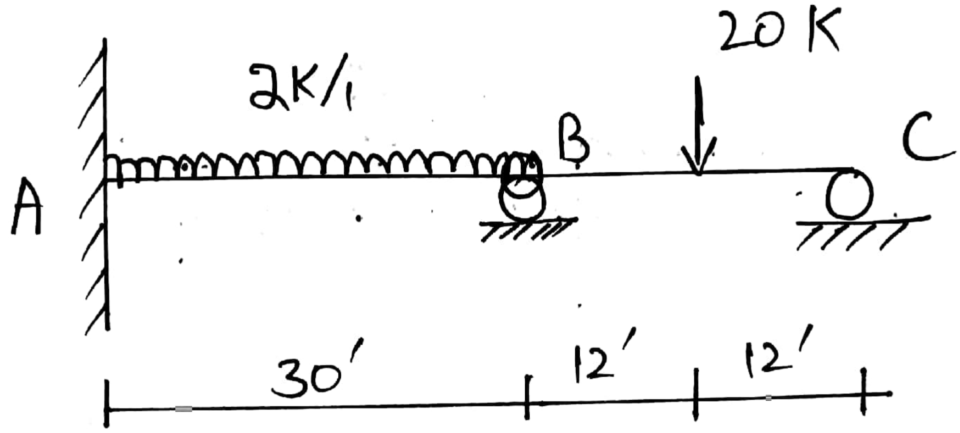
Sec	C
Exam Type	improvement for GPA (Summer 2020)
Paper	Structural Analysis (II)
Submitted to	Engr. Adeed Khan
Department	BS Civil

INU Peshawar

Q: NO 1



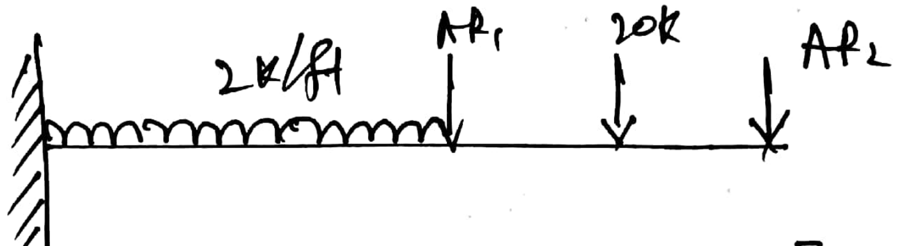
Required:

Analyze the given beam by flexibibility method. EI is constant

Solution:

Structural Indeterminancy = 2°

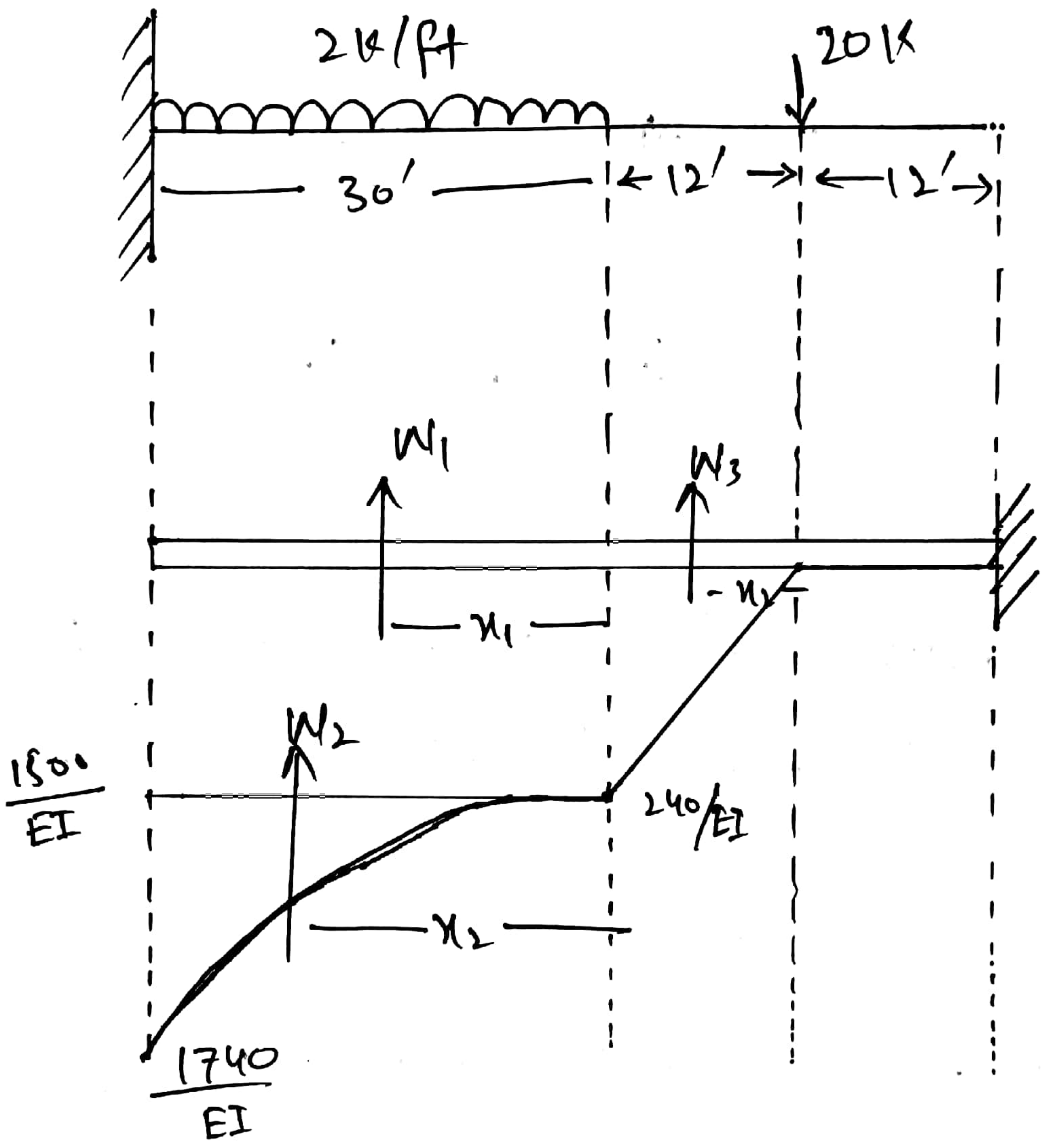
Step # 1 Select Redundant Actions



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

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

Step # 02 Compute the Values of [DRL]



$W_1 = 1500 \times 30 = 45000$

$20 \times 12 = 240$

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

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

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

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

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

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

Now Finding DRL

$$DRL_2 = W_1 \times (x_1 + 24) + W_2 \times (x_2 + 24) + W_3 \times (x_3 + 12)$$

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

$$= 1755000 + 111600 + 28800$$

$$DRL_2 = 1895400 / EI$$

$$DRL_1 = W_1(x_1) + W_2(x_2)$$

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

$$= 675000 + 54000$$

$$= 729000$$

So

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

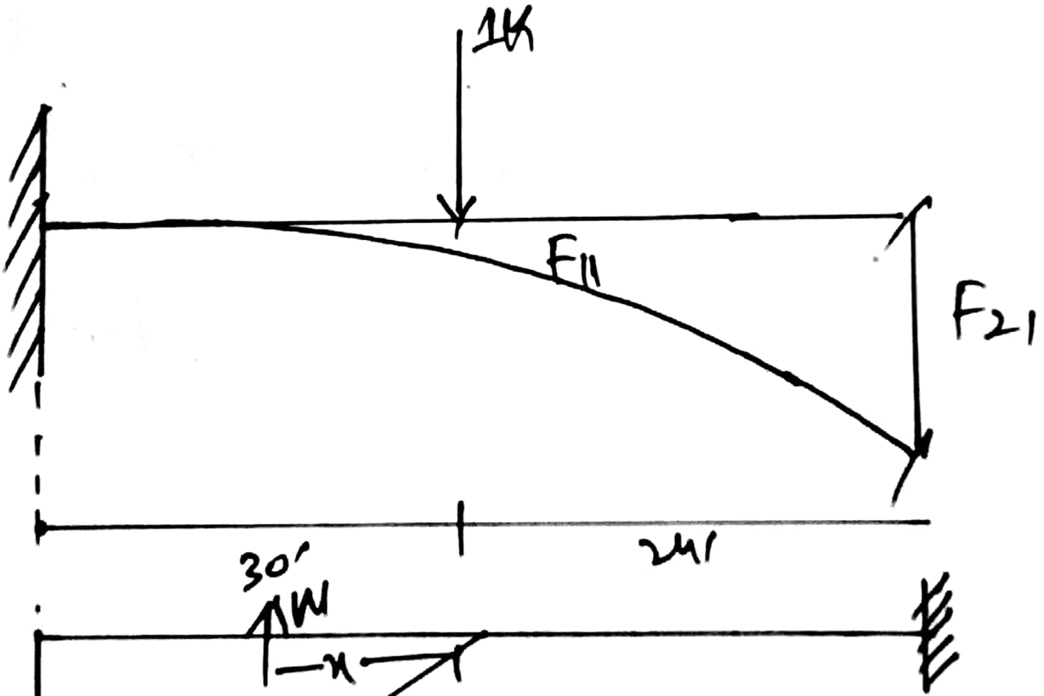
(5)

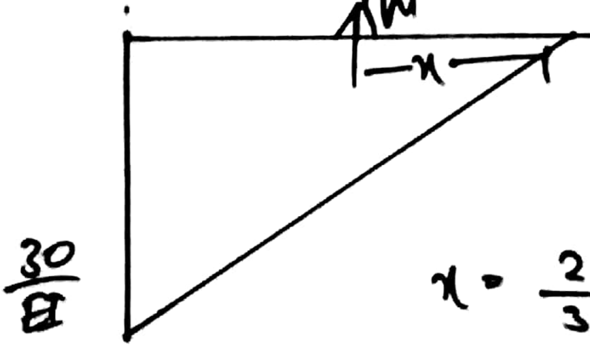
Step# 03

Flexibility Matrix

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

a) Applying unit load on AR_1





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

$$x = 20'$$

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

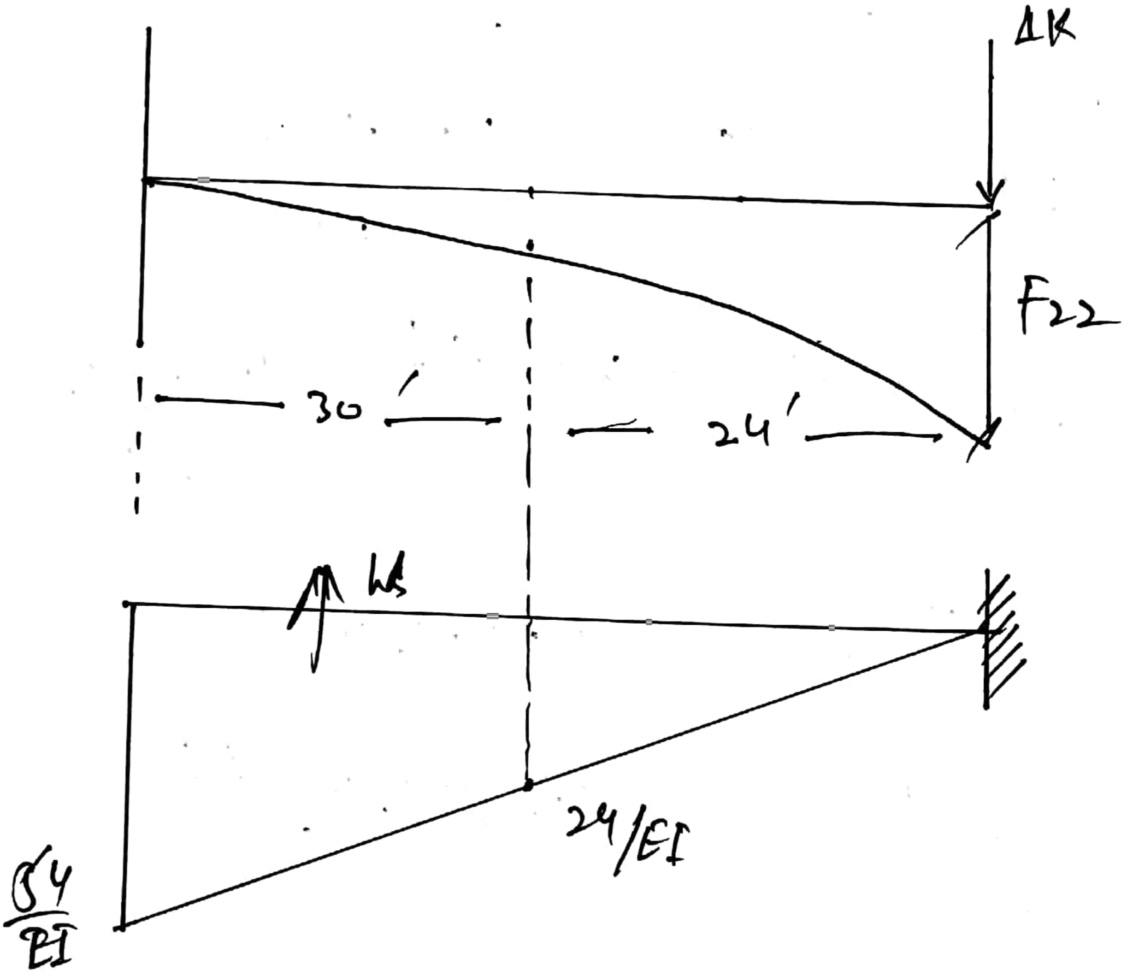
$$= 450/EI$$

So

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

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

Now Apply unit Load on AR2



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

$$= 1170/EI$$

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 values of AR

$$[DRS] = [DR.L] + [F] \times [AR]$$

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

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

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

$$|F| = (9000 \times 47876.4 - 19796.4 \times 19800)$$
$$= (430887600 - 391968720)$$

$$\Rightarrow |F| = 38918880$$

$$\Rightarrow \cancel{\mathrm{Adj}\,A = \begin{bmatrix} 0 & -729000 \\ 0 & -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880}}$$

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

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

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

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

The End.

(10)

Q.NO:2

Differentiate between force Method and displacement method.

Force Method	Displacement Method
$D_s < D_K$	$D_s > D_K$
Forces are redundant or unknowns	Displacements are redundant or unknowns
Starts with equilibrium of forces.	Starts with compatible deformations
Forces found by Compatibility equations of displacements	Displacements found by equilibrium equations of forces
no. of redundants = D_S	no. of redundants = D_K
not Suitable for computer	not Suitable for truss.

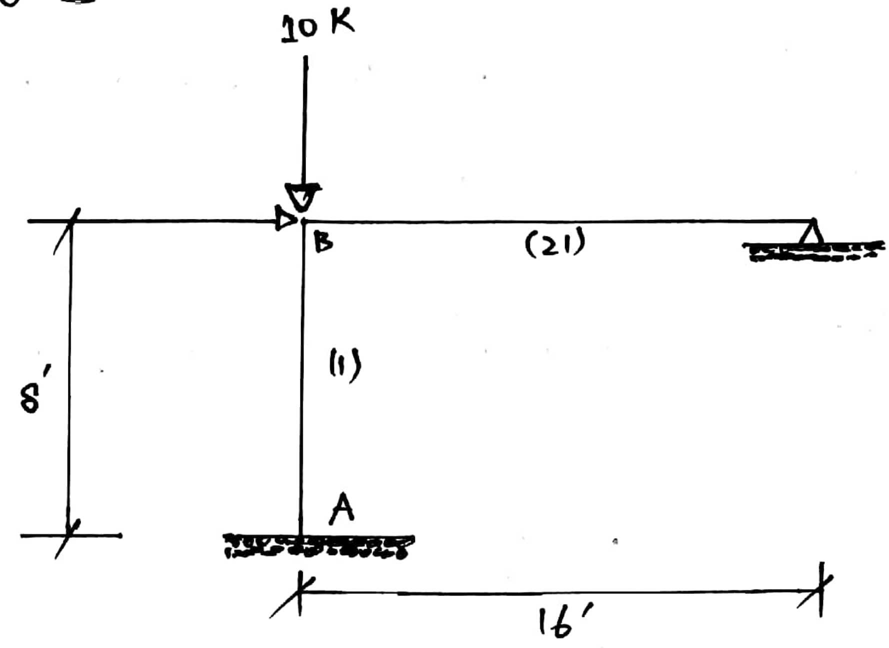
Force Method	Displacement Method
i) Method of consistent deformation	i) Slope deflection method
ii) Theorem of least work	ii) Moment of distribution method
iii) Column analogy method	iii) Kani's method
iv) Flexibility Matrix Method	iv) Stifness matrix method

Q:2 Part (B)

Which method is more Suitable :

Stiffness Method also Called Displacement Method is more Suitable for structure analysis matrix approach, as it is a primary method used in matrix analysis. The main advantages of this method over flexibility method is that it is conductive to computer Programming. Once the analytical model of the structure has been defined, No further engineering decisions are required in the stiffness method in order to carry out the analysis.

Q NO: 3



Required:

Analyse the rigid-joint frame by flexibility Method. Assume EI is constant, for All members.

Solution:

$E = \text{constant}$

$I_c = I$

$I_B = 2I$

Total Statical Indeterminacy

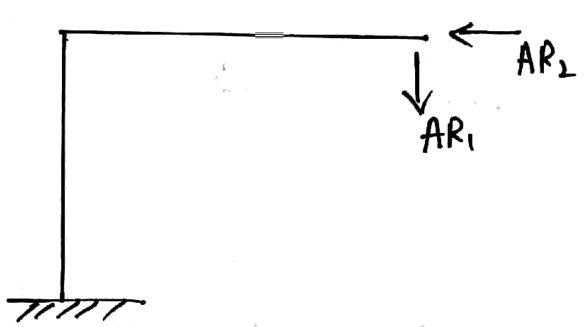
$\Rightarrow R - 3 = 5 - 3 = 2^\circ$

Step # 01

~~Identify~~ Total Statical Indeterminacy

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

Indetify 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 # 02

Compute Value of [DRL]

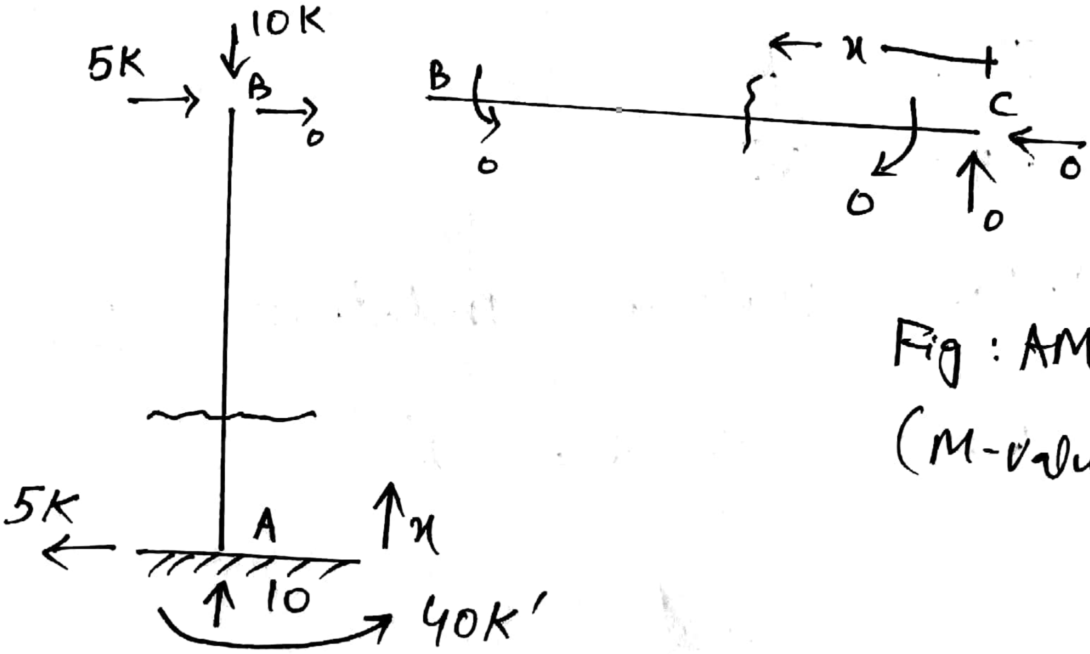


Fig : AML Values (M-values)

Step # 03 [F] or [AMR]

a)

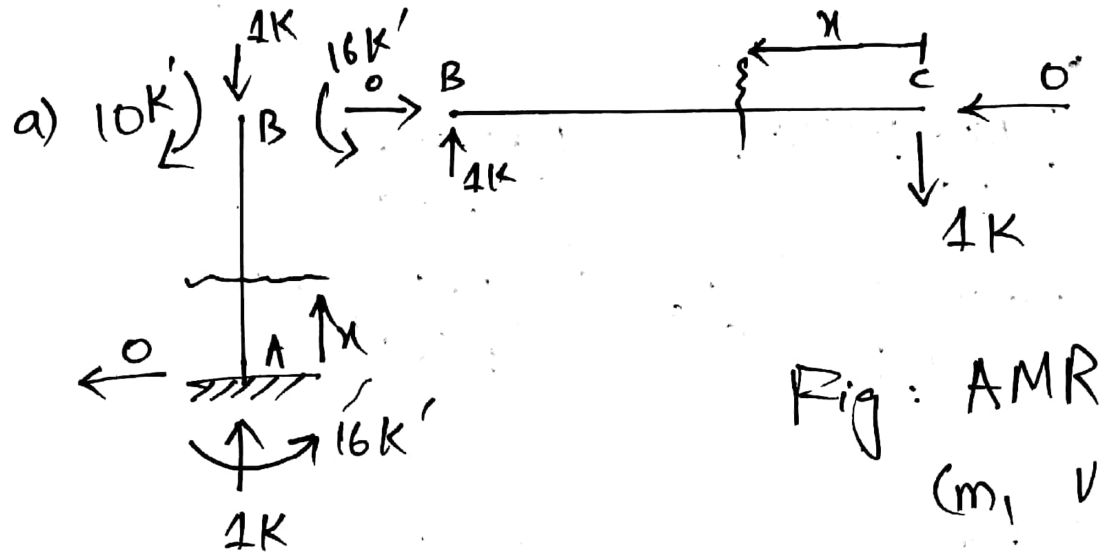


Fig: AMR-Values
(m_1 Values)

∴

b)

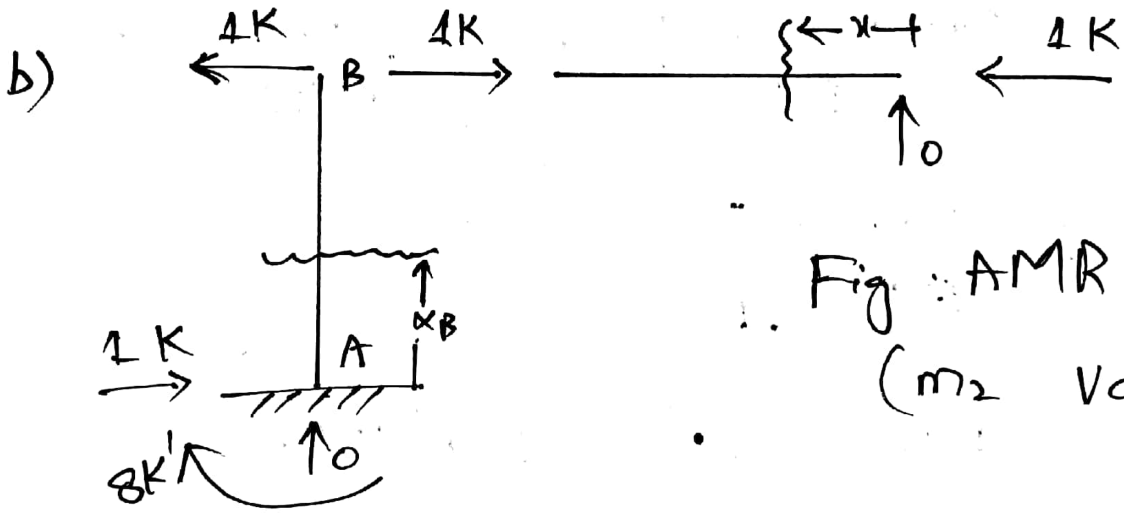


Fig: AMR values
(m_2 Values)

Member	AB	BC
Origin	A	C
Limits	0-8	0-16
I	I	2I
M	$5x-40$	0
m_1	-16	x
m_2	$8-x$	0

Select origin (should be select the support) ← Origin

Take x-section from origin AML Fig and Find moment ← M

x → Take X section on m_1 Fig from the origin

⇒ For Finding Values of DRL:

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

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

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

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

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

⇒ Compute Flexibility Matrix:

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

$$\Rightarrow F_{11} = \int_0^8 \frac{m_{1(AB)}^2}{EI} + \int_0^{16} \frac{m^2_{(BC)}}{EI} = \int_0^8 \frac{(-16)^2}{EI}\,dx + \int_0^{16} \frac{x^2}{E(2I)}$$

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

$$F_{12} = F_{21} = \int_0^8 m_{1(AB)} \cdot m_{2(AB)} + \int_0^{16} m_{1(BC)} \cdot m_{2(BC)}$$

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

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

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

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

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

As we know that

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

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

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

$$= \begin{bmatrix} 2730.67 & -515 \\ -512 & 170.67 \end{bmatrix}^{-1} \times \begin{bmatrix} 0 & -2560 \\ 0 & +853.33 \end{bmatrix}$$

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

The End

Asim Ali
(For Improvement)