Midterm Paper (Summer)

Name = M. IKhlas Khan

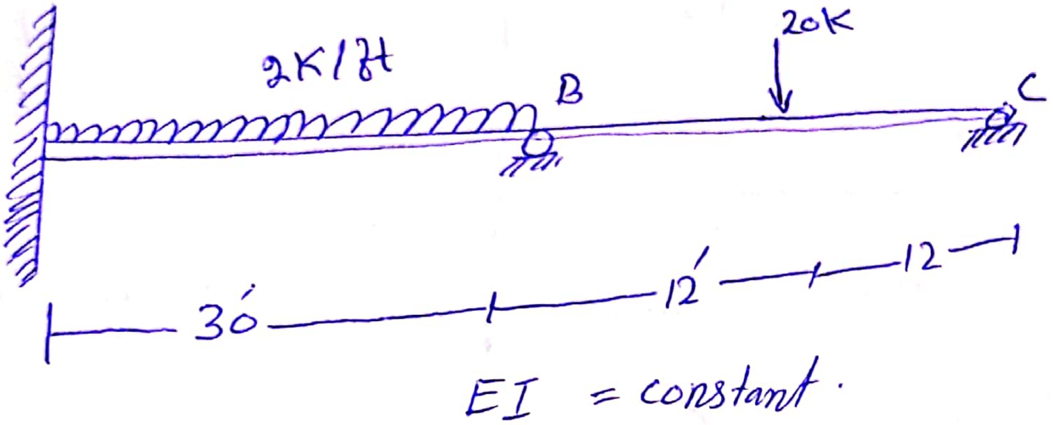
ID = 7768

Section # B

Subject # Structure 2

teacher Name # Engr- Adeed Khan

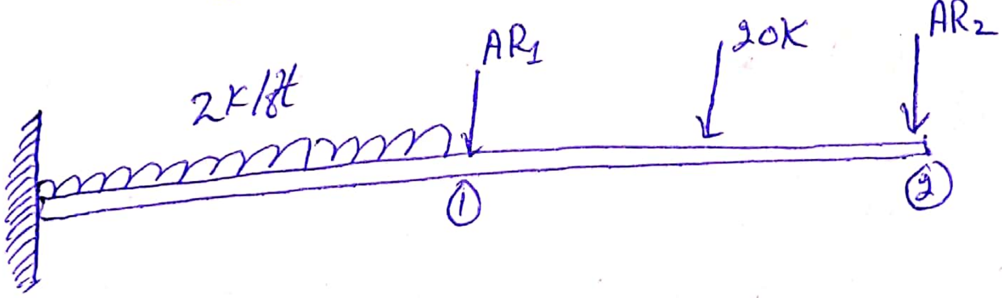
Q No 01



Solution

Structural Indeterminancy = 2^0

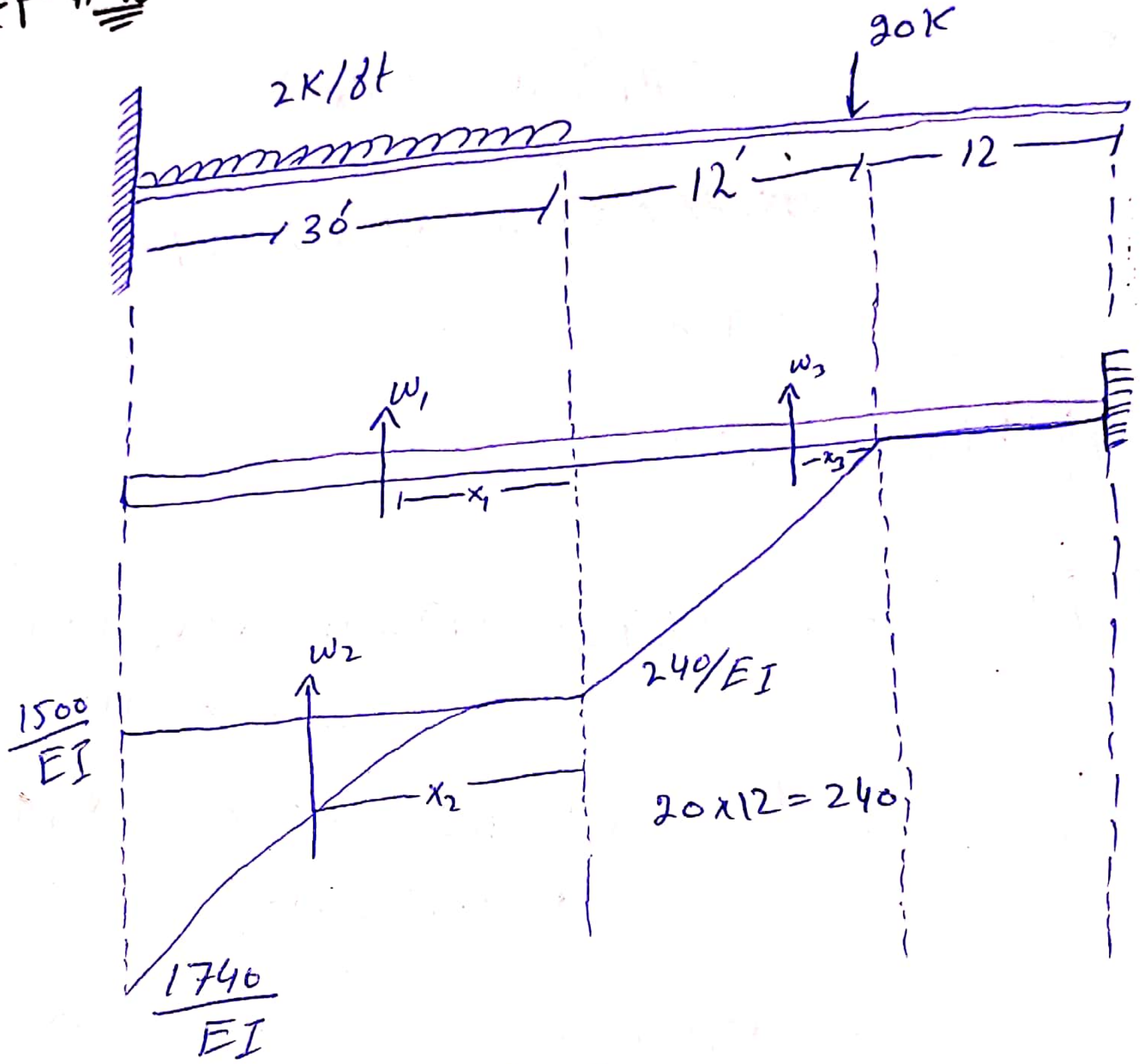
Step # 1 Select Redundant Actions



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

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

Step # 2



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

$W_1 = 1500 \times 30 = 45000$

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

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

$X_1 = b/2 = 30/2 = 15'$

$x_2 = 3/(n+2) = 3/(2+2) \times 30 = 22.5'$

$X_3 = 2/3 \times L = 2/3 \times \cancel{12}^{4} = 8'$

Now Finding DRL

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

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

$$= 675000 + 54000$$

$$\boxed{DRL_1 = 729000}$$

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

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

$$= 1755000 + 111600 + 28800$$

$$\boxed{DRL_2 = 1895400/EI}$$

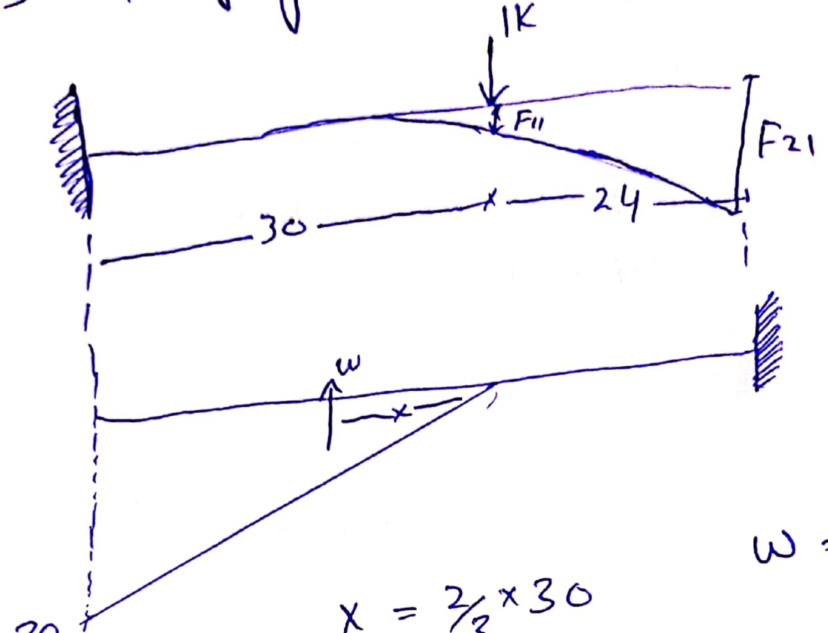
So

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

Step # 3 Flexibility matrix

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

a) Applying unit load on AR_1



$\frac{30}{EI}$

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

$x = 20'$

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

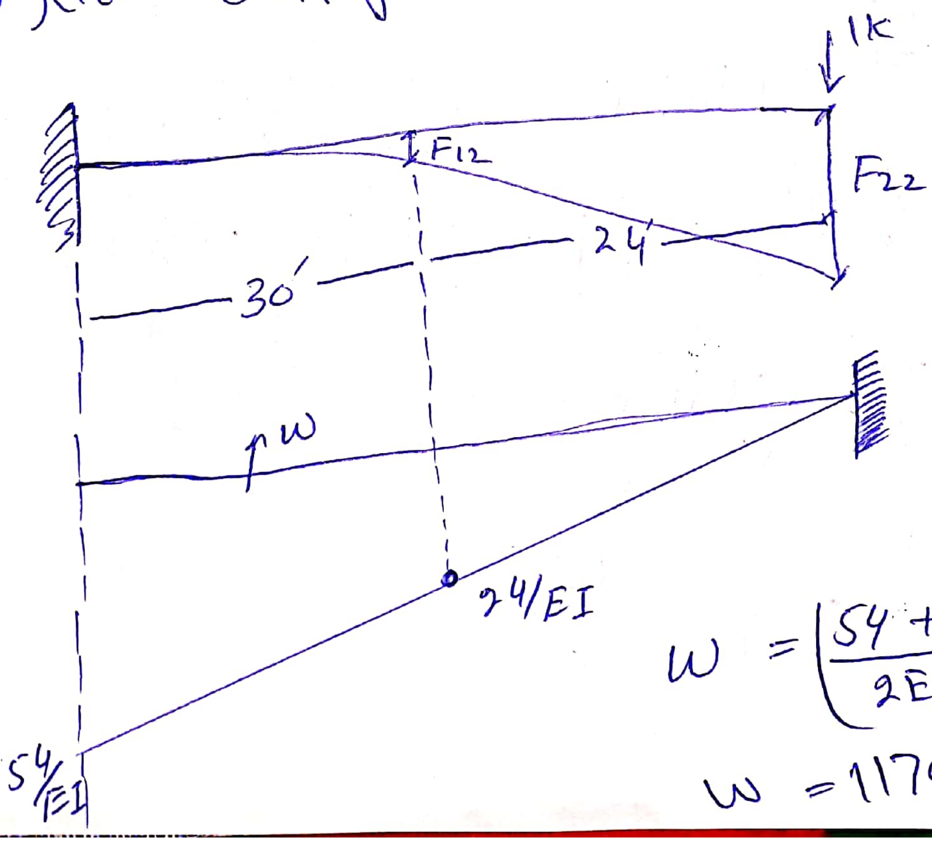
$w = 450/EI$

So

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

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

b) Now Apply unit load on AR_2



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

$w = 1170/EI$

Now the distance

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

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

$$\boxed{x = 16.92'}$$

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

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

Hence

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

Step #4

compute the value of AR

$$[DR_s] = [DR_L] + [F] \times [AR]$$

$$[AR] = [DR_s - DR_L] \times [F]^{-1}$$

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

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$$[F] = \frac{1}{\begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}} \times \text{Adj}\begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

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

$$= (430887600 - 391968720)$$

$$\Rightarrow \boxed{[F] = 38918880}, \quad \text{Adj } A = \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

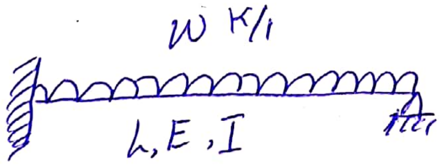
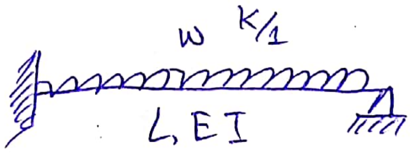
$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0.729000 \\ 0-1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{39918880} \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{\begin{bmatrix} 478764 & -19796.4 \\ -19800 & 9000 \end{bmatrix}}{38918880}$$

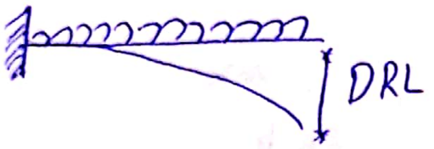
$$\boxed{\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}}$$

Q No 02

Ans

Force Method	Displacement method
☆ $D_s < D_K$	☆ $D_s > D_K$
☆ Forces are redundant or unknowns	☆ Displacement are redundant or unknown.
☆ Force Found by compatibility equations of displacement	☆ Displacement Found by equilibrium equation of force
☆ no of reduntants $= D_s$	☆ no of reduntants $= D_K$
☆ starts with equilibrium of force.	☆ Starts with compatible deformations.
☆ Not suitable for ~~comp~~ computer	☆ Not suitable for truss
☆ 	☆ 
☆ S.I	☆ K.I → displacemt of joint

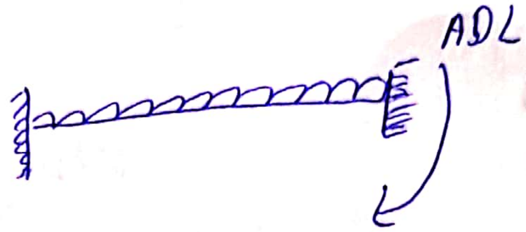
* $DR_S = DR_L + AR * F$

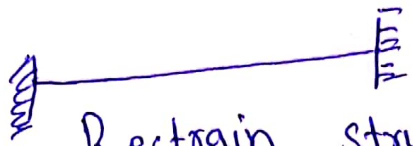
* 

* 

Released structure

* $AD = ADL + S * D$

* 

* 

Restrain structure.

(b) For analysis of structure of matrix approch both the force method or displacement method can be used depends upon situation.

① when the Degree of static Indeterminancy (Ds) is less than the degree of Kinematic Indeterminacy (DK) i.e $D_s < D_K$ than It is suggested to use for method of Analysis

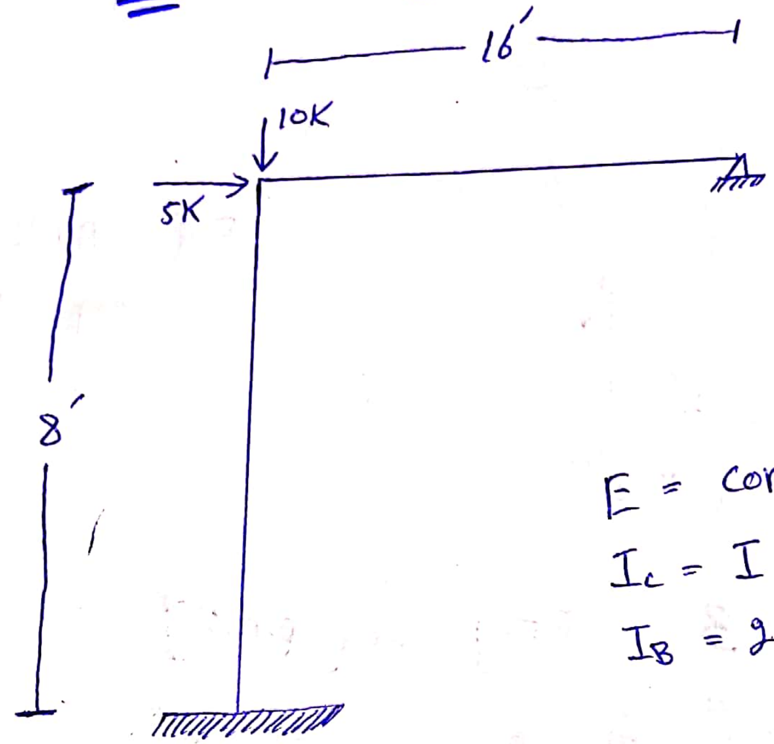
② when the Degree of static Indeterminacy (Ds) is more than the degree of Kinematic Indeterminacy (Dk) i.e $D_K < D_s$ than it is suggested to use displacement method of Analysis.

OR

When comparing the flexibility and stiffness method. it is seen that flexibility method requires the solution of equation of compatbility for unknown force whereas the stifness method require the solution of equbrium for unkown displacent.

Q ON 03

Sol:



E = constant

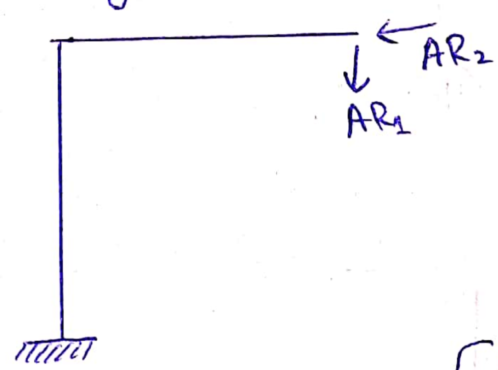
$I_c = I$

$I_B = 2I$

Total statical indeterminacy

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

Step #01 Identify Redundant Actions



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

Step # 02 Compute value of [DRL]

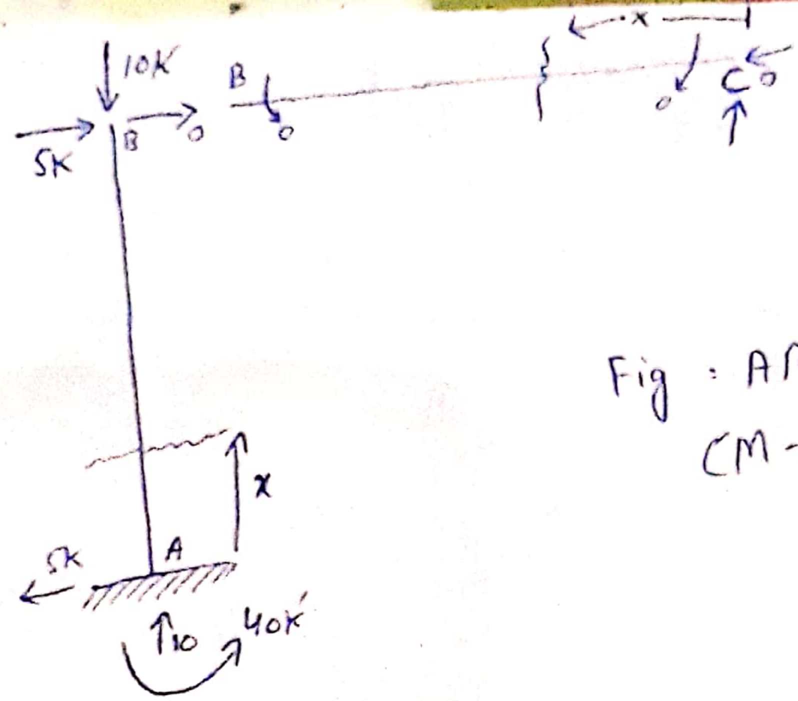


Fig : AML values (M-values)

Step # 3 [F] or [AMR]

a)

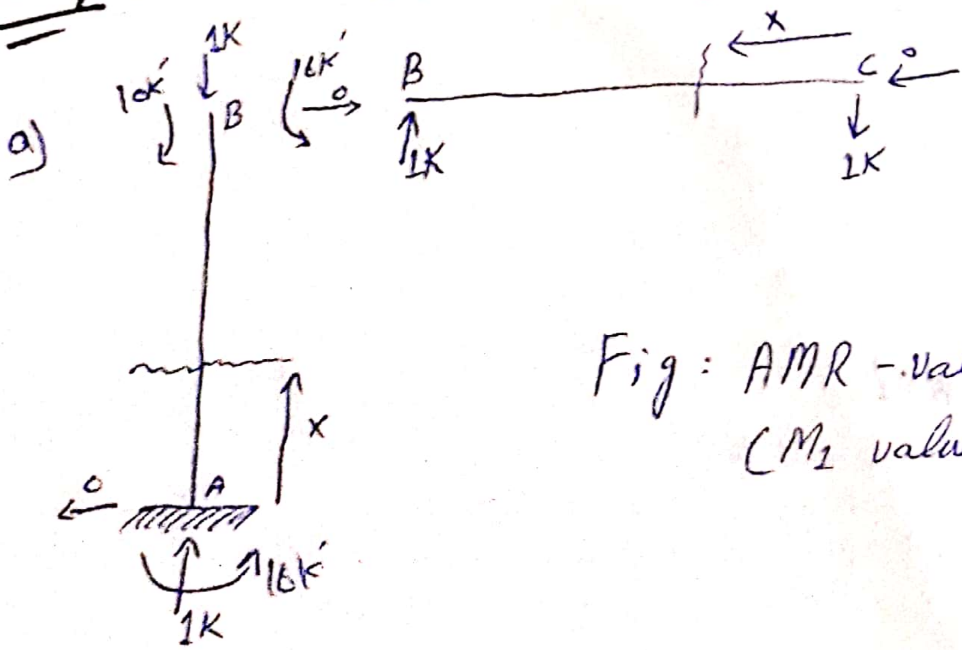


Fig : AMR -values (M_1 values)

(b)

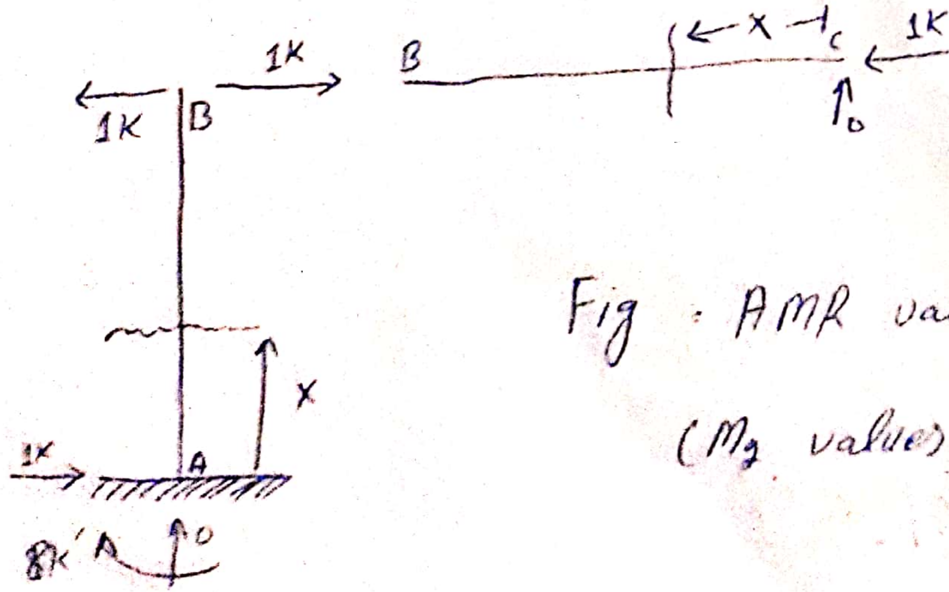


Fig : AMR values (M_2 values)

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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

Take x-section on m_1 Fig from the origin

origin → Select origin should be select the support

- M → Take x-section from origin (AML Fig and Find moment)

⇒ **For Finding value of DRL**

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

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

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

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

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

⇒ Compute Flexibility matrix.

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

$$\Rightarrow F_{11} = \int_0^8 \frac{m_1^2 (AB}{EI} + \int_0^{16} \frac{m_2^2 (BC)}{EI}$$

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

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

$$F_{12} = F_{21} = \int_0^8 \frac{M_1 (AB) \cdot M_2 (AB)}{EI} + \int_0^{16} \frac{m_1 (Bc) \cdot m_2 (Bc)}{2EI}$$

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

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

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

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

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

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As We Know

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

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

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

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

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

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