Day. M T W T F S (1) Date:__/__/__

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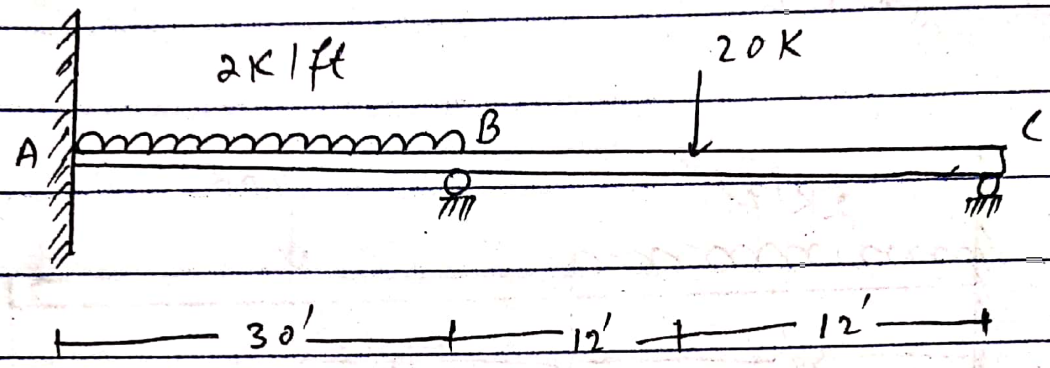
Subject : structure Analysis II

Instructor : Engr. Adeel Khan

Department : Civil Engineering

Date : 21 August 2020

Q NO 1.

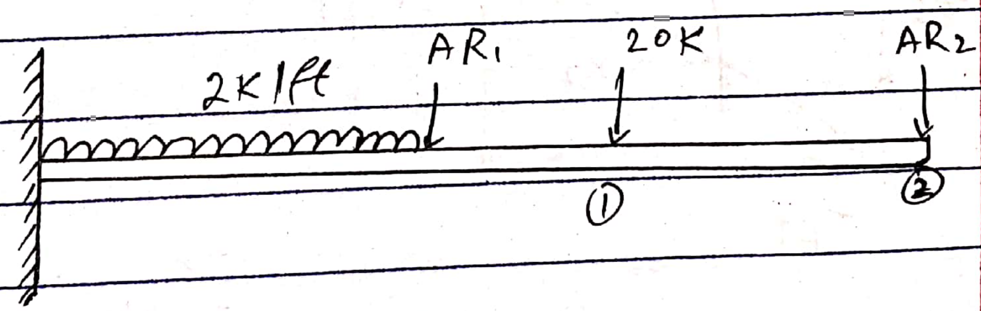


Sol:-

Structural Indeterminancy = 2°

step # 1:

select Redundant actions

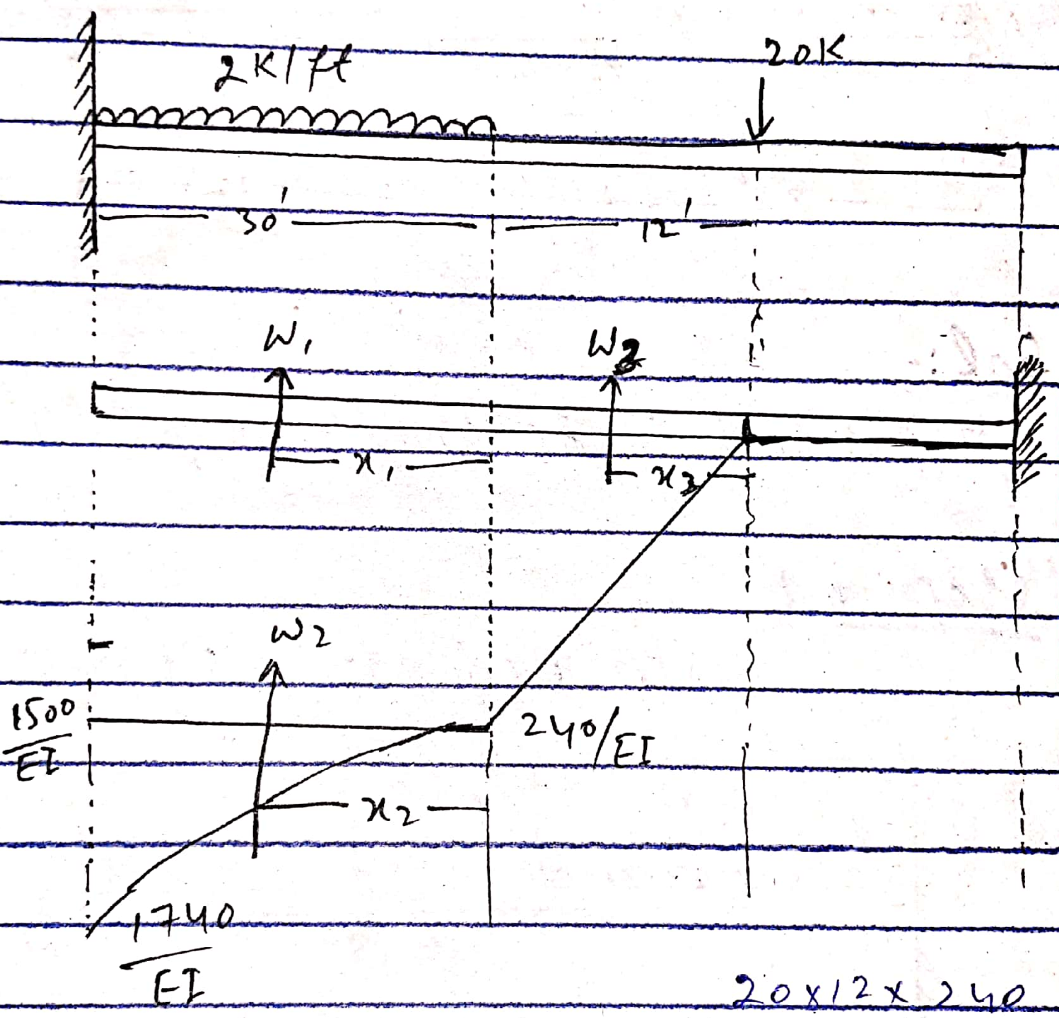


$$\begin{bmatrix} DRS_1 \\ DRS_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

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

Step 2:

Compute the value of [DRL]



$20 \times 12 \times 240$

$20 \times (12 + 30 + 2 \times 3 \times 15$

$= 1740$

$w_1 = 1500 \times 30 = 45000$

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

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

Day. MTWTFS ~~Q~~ 4. (4) Date: __/__/__

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

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

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

Now finding DRL.

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

$\Rightarrow 45000(15) + 2400(22.5)$

$\Rightarrow 675000 + 54000$

$\Rightarrow 729000$

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

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

$\Rightarrow 1755000 + 111600 + 28800$

$DRL_2 = 1895400/ET$

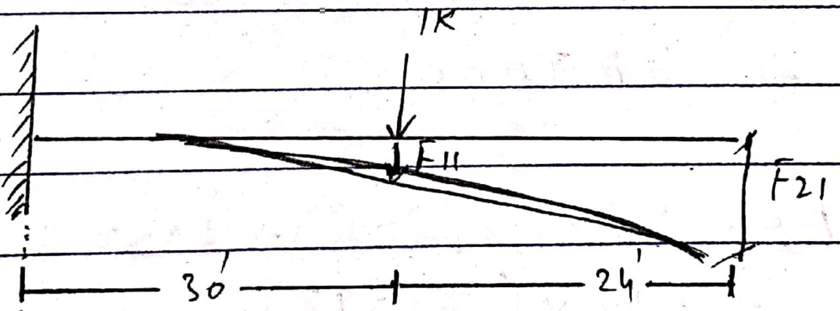
So $DRL = \frac{1}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$

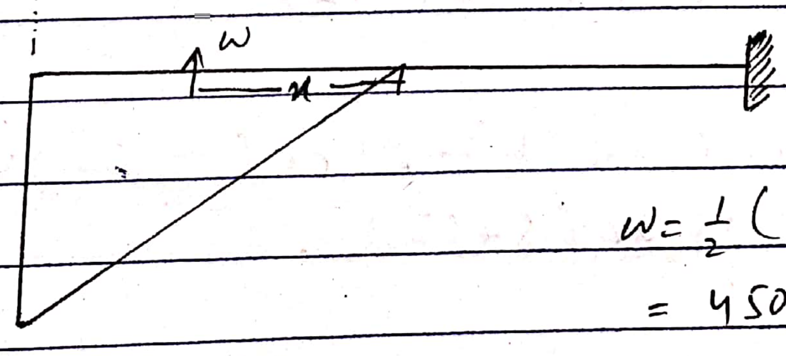
Step # 3:

Flexibility Matrix.

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

a) Applying Unit load on AR_1.





$\frac{30}{EI}$

$$w = \frac{1}{2}\left(\frac{30}{EI} \times 30\right.$$
$$= 450\,EI$$

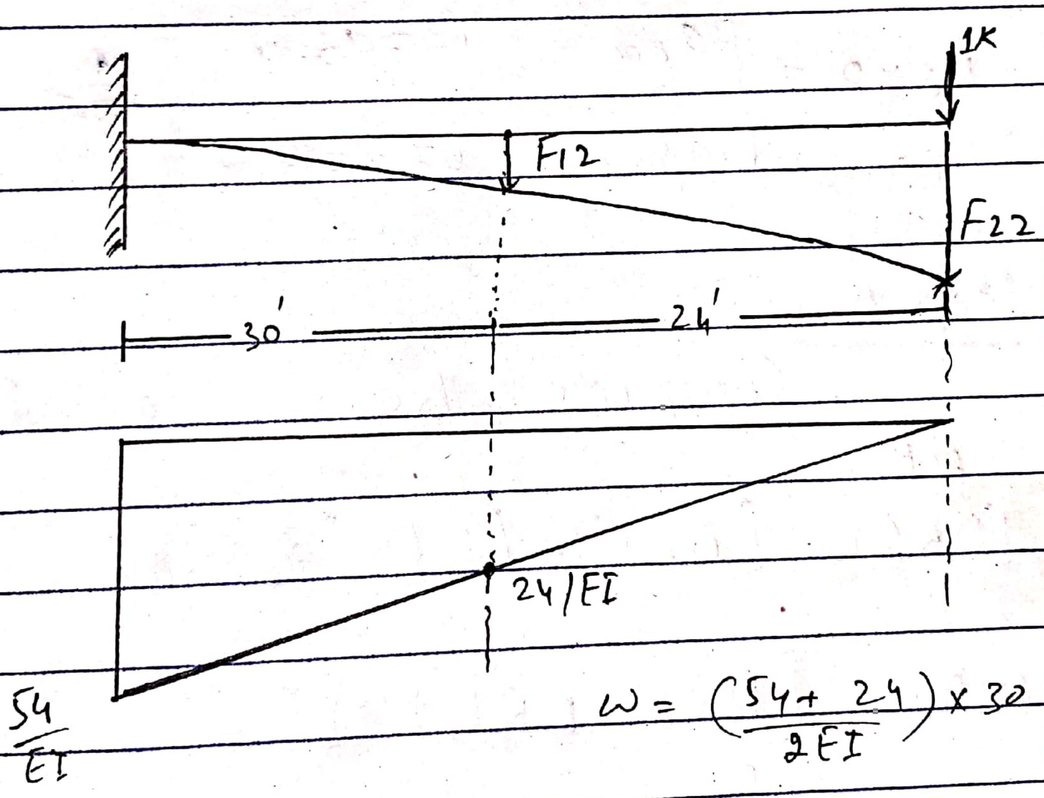
$$x = \frac{2}{3} \times 30$$
$$= 20'$$

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.



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

$$= 1170/EI.$$

Now the distance

$$x = \frac{1}{3}\left[\frac{b+2a}{a+b}\right]$$

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

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

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

Hence

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

Step # 4:

Compute the value of AR.

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

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

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

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

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

$$(430887600 - 391968720)$$

$\Rightarrow [F] = 38918880$

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

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

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

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

Q NO 2.

Difference between Force Method & Displacement Method.

Force Method	Displacement Method.
1) Unknowns are taken redundant forces / reactions	1) Unknowns are taken displacement.
2) To find unknown forces or redundant compatibility equations are written	2) To find unknown displacement joint Equilibrium Condition are written
3) The number of compatibility equations needed is equal to the degree of static indeterminacy	3) The number of equilibrium condition needed is equal to the degree of Kinematic indeterminacy

QNO 2.

Force Method:-

The force method (also called the flexibility method or method of consistant deformation) is used to calculate reactions and internal forces in statically indeterminate structures due to loads and imposed deformations....

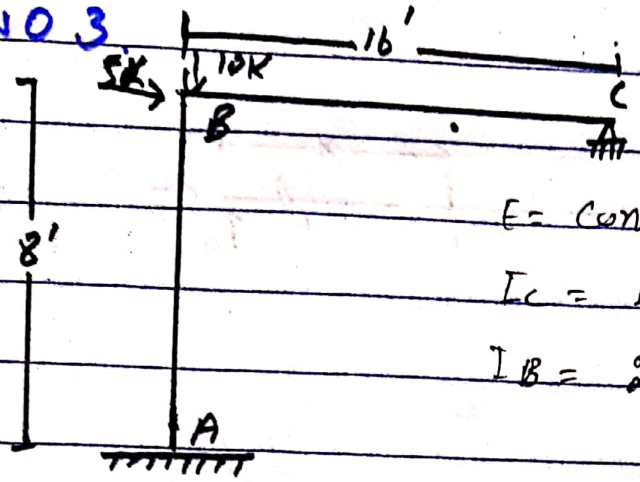
a) Apply the given loading or imposed deformation to the basic determinate structure.

Displacement Method:-

It is also known as stiffness matrix method. In this method compatibility equations are written for displacement and rotations, which were calculated by force displacement equations.

Displacement method is more suitable for structure analysis matrix approach, as it is a primary method used in matrix analysis. The main advantage of this method over flexibility method is that it is conductive to computer programing. 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.

QNO 3



E = constant

$I_c = I$

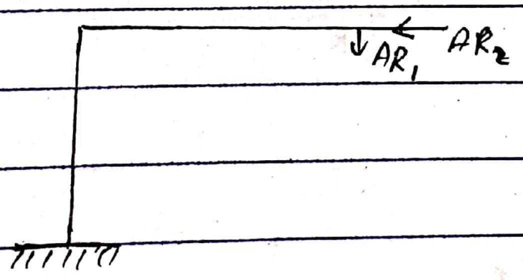
$I_B = 2I$

Sol :-

Total statical indeterminacy

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

Step 1 :- Identify Redundent 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 $[DRL]$

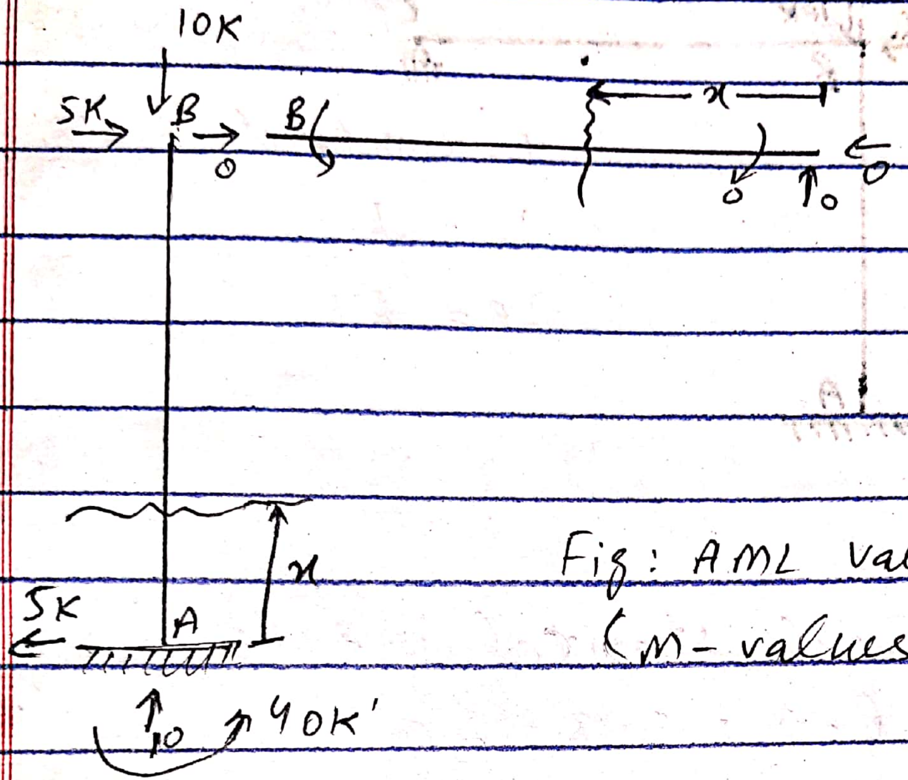


Fig: AML values
(M- values)

Step # 3 :- (F) or [AMR]

a)

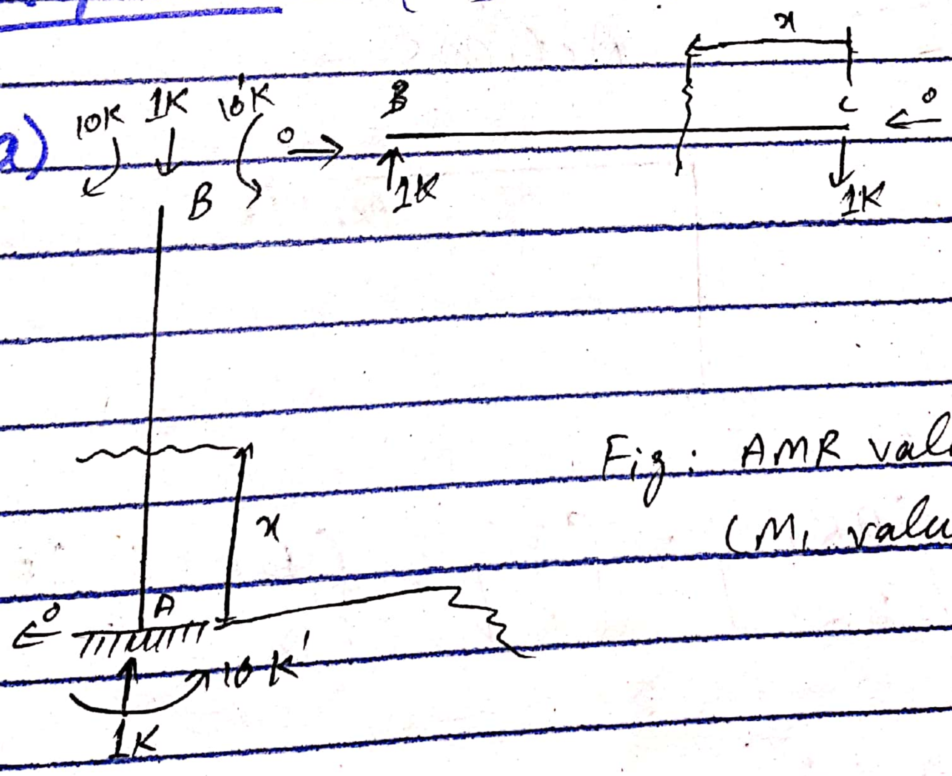


Fig: AMR values
(M_1 values)

b)

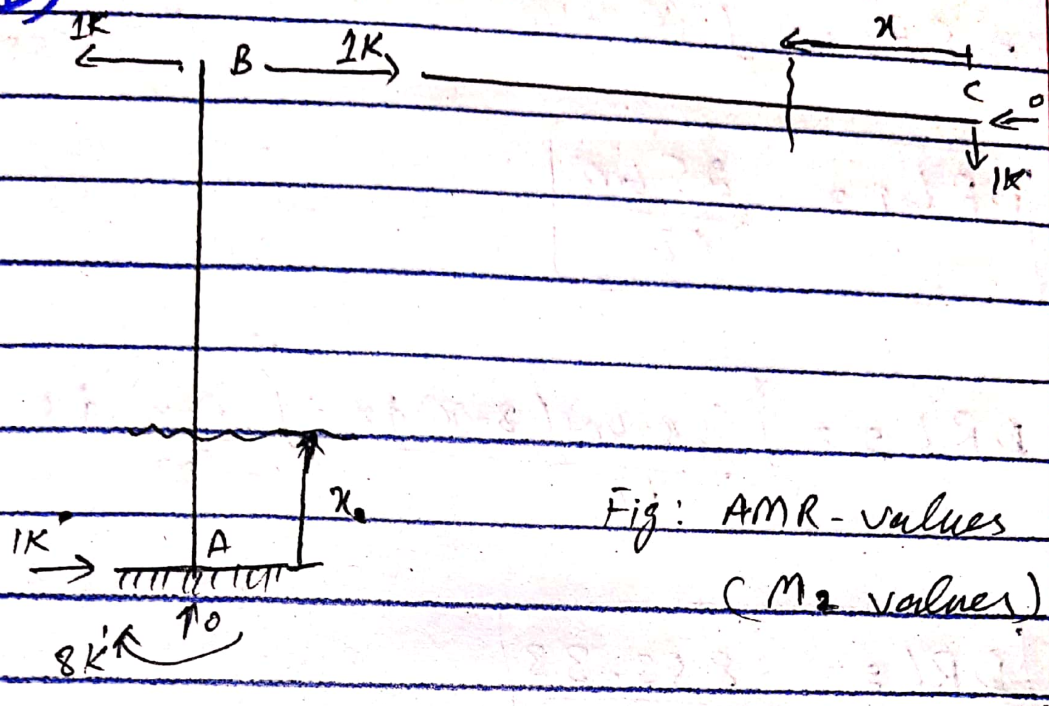


Fig: AMR - values
(M_2 values)

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

⇒ For finding value of DRL :-

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

$$\Rightarrow DRL_1 = \int_0^8 (5x-40)(-16)\,dx + \int_0^{16} \frac{0.x\,dx}{E(2I)}$$

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

$$DRL_2 = \int_0^8 \frac{(5x-40)(8-x)\,dx}{EI} + \int_0^{16} \frac{0.0}{E(2I)}\,dx$$

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

$\Rightarrow$ Compute flexibility Matrix :-

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

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

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

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

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

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

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

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

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

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

As we know

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

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

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

Day: M T W T F S (17) Date: __/__/__

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

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