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SECTION = (A)

SUBJECT = STRUCTURAL ANALYSIS-II

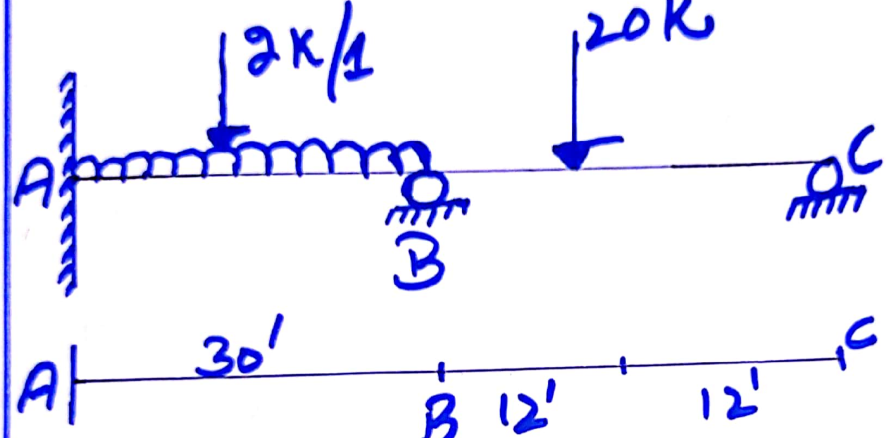
DATE = 21/08/2020

TEACHER = Engr- Sir Adeel.

01

Q (No#01)

Analyze the Given Beam in (FIG#01)

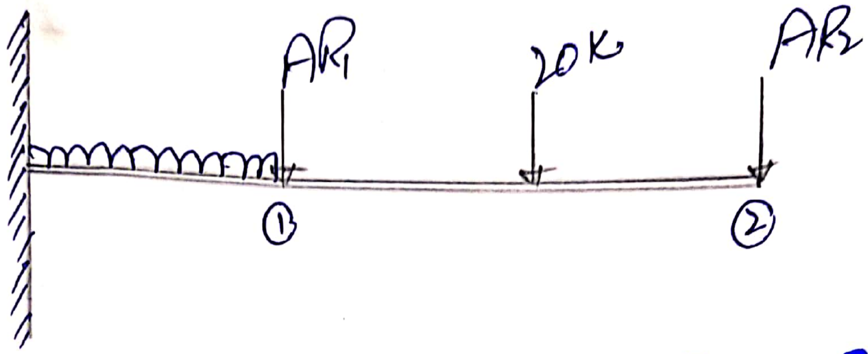


FIG#01

by Flexibility METHOD. EI is Constant.?

Answer:→ Structural Indeterminancy = 2°

⇒ **STEP#(01):⇒** Select Redundant Action

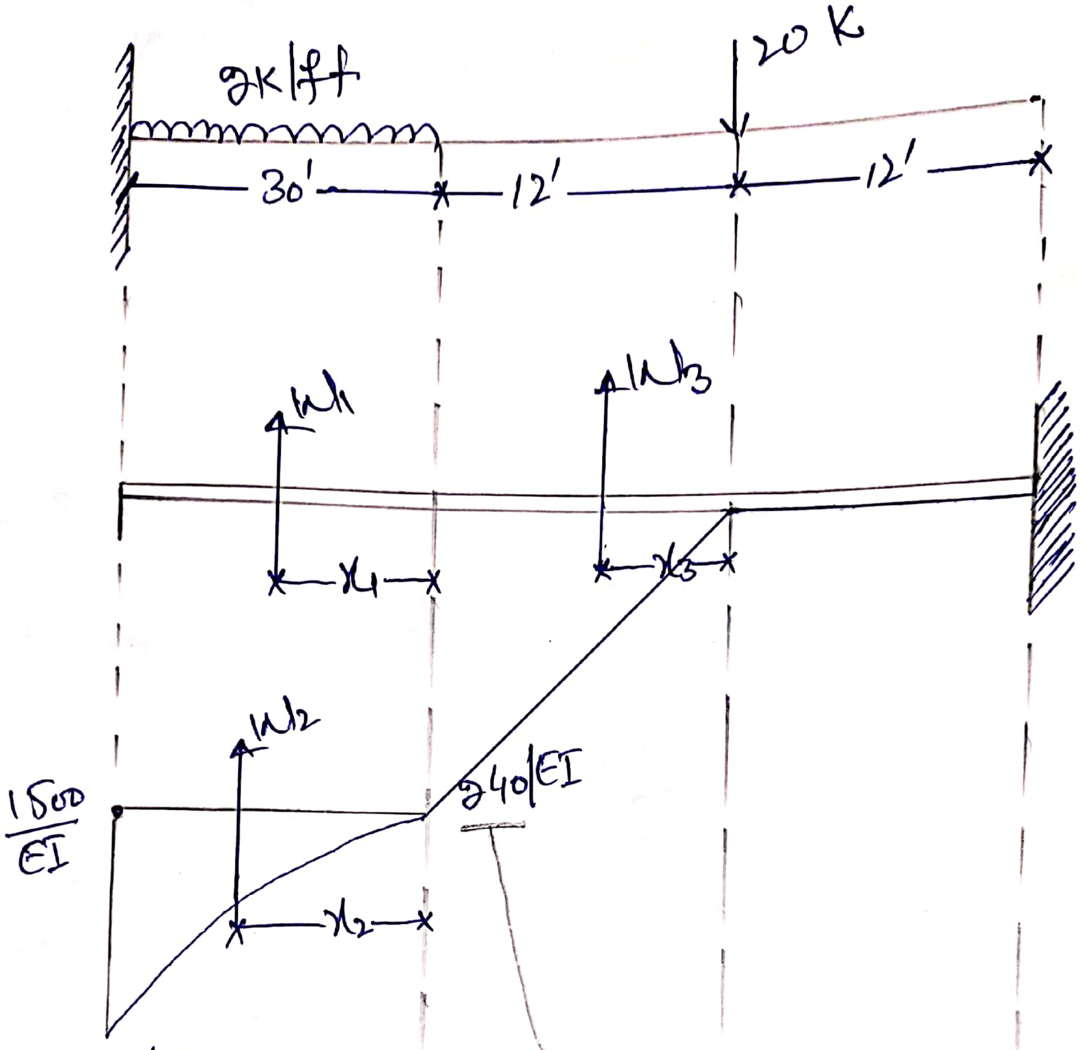


$$\Rightarrow \begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

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

⇒ **Step#(02):⇒** Compute the Values of (DRL).

03



$\frac{1740}{EI} \rightarrow 20\times(12+30)+2\times30\times15$ $\rightarrow 20\times12 = \boxed{240}$

$= \boxed{1740}$

$W_1 = 1500 \times 30 = 45000$

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

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

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

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

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

$(x_1, x_2, x_3) \Rightarrow (15'), (22.5'), (8')$

Now Finding DRL:→

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

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

$$\Rightarrow 1755000 + 111600 + 28800$$

$$\boxed{DRL_2 = 189540/EI}$$

$$DRL_1 \Rightarrow w_1(x_1) + w_2(x_2)$$

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

$$\Rightarrow 675000 + 54000$$

$$DRL_1 = 729000$$

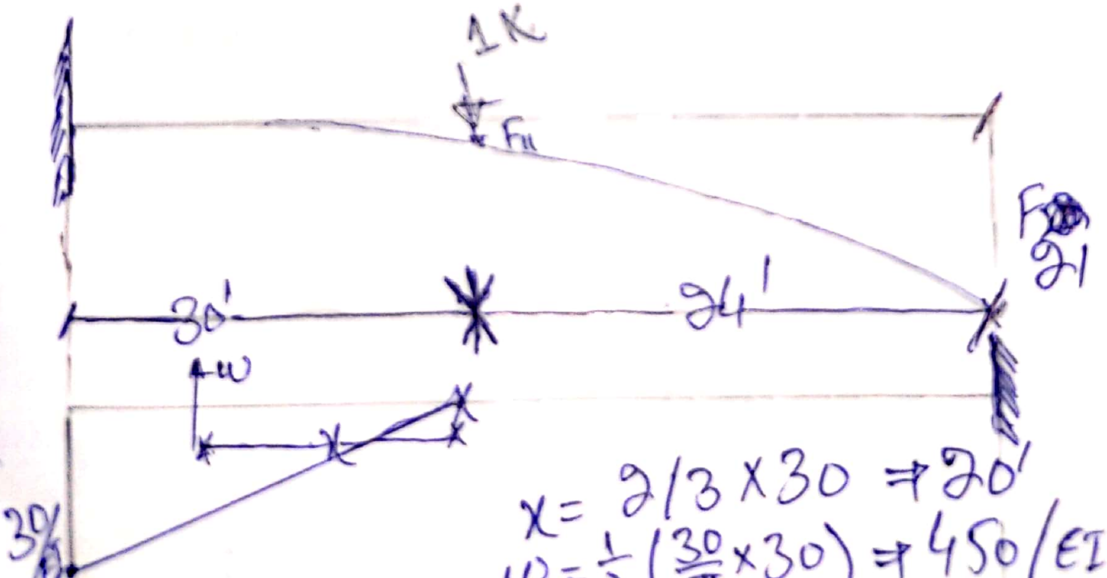
SOL:

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

STEP#03: FLEXIBILITY MATRIX:

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

(a) APPLYING UNIT LOAD ON (AP_1):



$x = 2/3 \times 30 = 20'$

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

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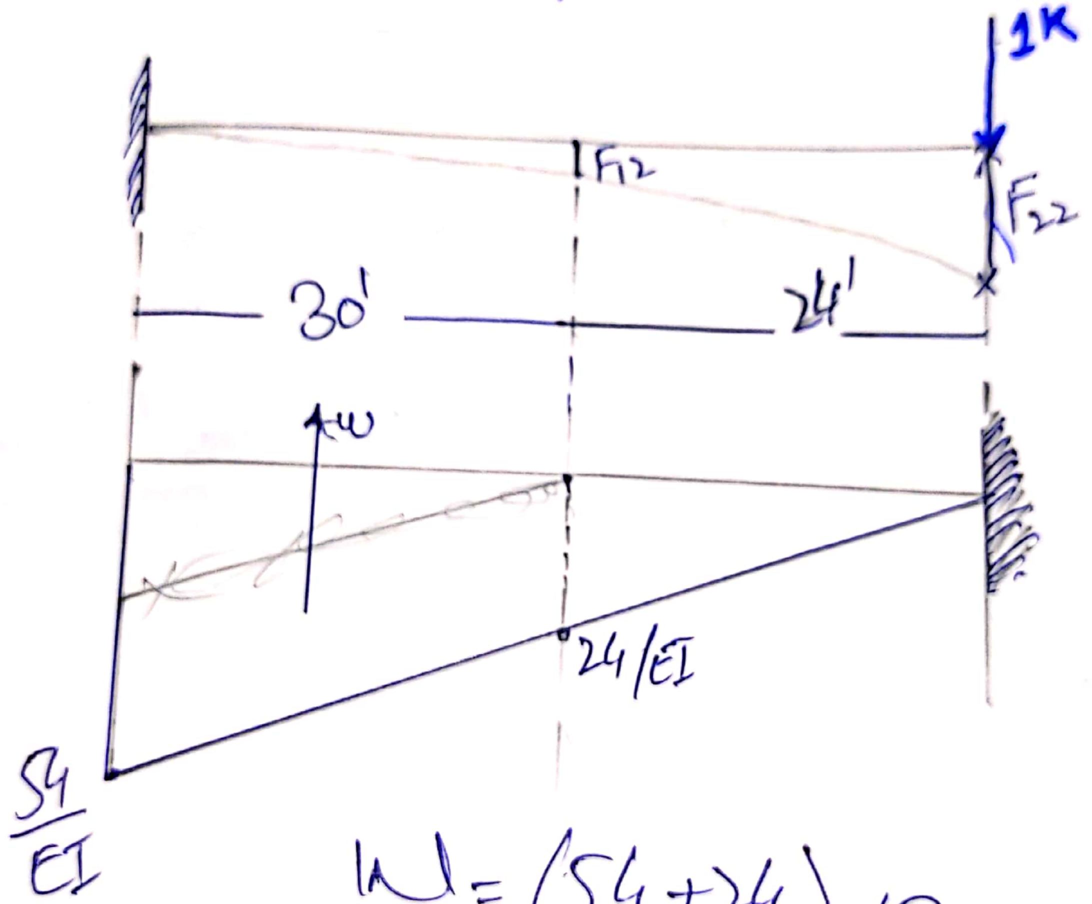
.186

So, $F_{11} = 450/EI \times 20 = 900/EI$

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

Now Apply Unit load on R_2



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

$$w = 1170/EI$$

Q

Now the distance:→

$\rightarrow x = \frac{L}{3}\left[\frac{b+2(a)}{a+b}\right] \rightarrow \frac{80}{3}\left[\frac{24+2(54)}{54+24}\right]$

$x \rightarrow 16.92'$

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

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

Hence:→

$$F_{22} = \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix} \frac{1}{EI}$$

Step#04:→ Compute the values of AR:→

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

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

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

$$= \frac{1}{\begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}} \times \text{adj} \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

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

$$= (430887600 - 391968720)$$

$$\boxed{|F| = 38918880}$$

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 & -729000 \\ 0 & -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880} \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \begin{bmatrix} 47876.4 & -19796 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 66.183 \\ -66.505 \end{bmatrix}$$

page #01 To #09

Q no #01

End.

01

(No#02)

Differentiate Between Force METHOD & Displacement. Methods Suggest which Method is More Suitable For Structure Analysis of Matrix Approach?

Answer: There are Two main Method of Structural Analysis using the matrix approach.

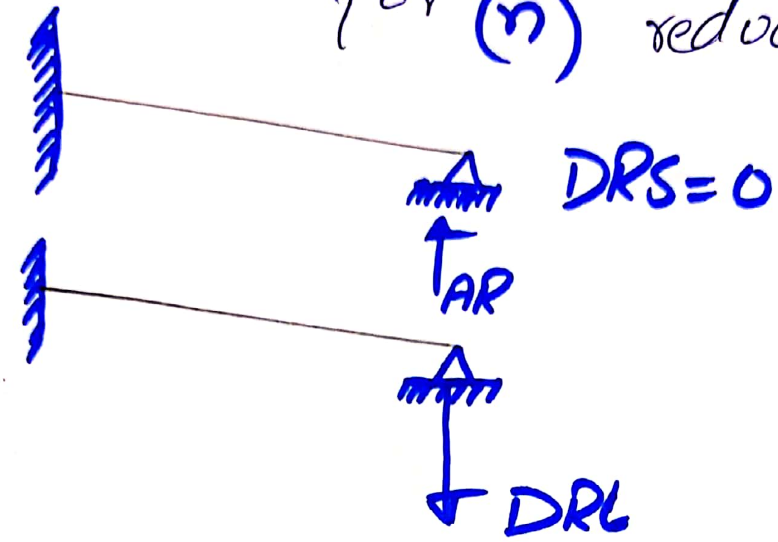
i) **FORCE METHOD:** The Method is also Known as Flexibility or Compatability Method. In Method the degree of Static Indeterminacy of

Q2

If the is determinant & the Cordindants are Identified. A Co-ordinate is Assigned to each redodands. **THUS:-** AR_1, AR_2, AR_3 --- ---, AR_n, are the redodants at Co-ordinate, 1, 2, 3, ... n, If all the redundants are removed the resulting structure known as the released.

Structure:- is statically determined From the principle of Super position The net Displacement at any point in a Statically determinate Structure is the Sum of the Displacement in the basic determinate Structure due to applied loads as the redodants Thus Condition Know as Compatability

Condition may be Expressed by the equations for (n) reduced: Actions ردود



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

$$DRS_1 = DRL_1 + F_{11}AR_1 + F_{12}AR_2 + \cdots F_{11}AR_{n0}$$

$$DRS_2 = DRL_2 + F_{21}AR_1 + F_{22}AR_2 + \cdots F_{2n}AR_{n0}$$

$$DRS_n = DRL_n + F_{n1}AR_1 + F_{n2}AR_2 + \cdots F_{nn}AR_{n0}$$

→ Writting These Equation in Matrix Form:→

d1

$$\begin{bmatrix} DRS_1 \\ DRS_2 \\ DRS_n \end{bmatrix}_{n\times1} = \begin{bmatrix} DRL_1 \\ DRL_2 \\ DRL_n \end{bmatrix}_{n\times1} + \begin{bmatrix} F_{11}, & F_{12} & \cdots & F_{1n} \\ F_{12}, & F_{22} & \cdots & F_{2n} \\ F_{n1}, & F_{n2} & \cdots & F_{nn} \end{bmatrix} \begin{bmatrix} AR_1 \\ AR_2 \\ AR_n \end{bmatrix}$$

$$[DRS]_{n\times1} = (DRL)_{n\times1} + (F)_{n\times n}(AR)_{n\times1}$$

$$(F)(AR) = (DRS) - (DRL)$$

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

n = Degree of Indeterminancy

where, DRS = Support Settelement Rotation Corresponding to the redudant action.

DRC = Displacement (Rotation/Translation) Corresponding to the redundant action in a released structure (Basic determinant structure) due to Applied loads.

AR = The redundant actions.

F = Flexibility Coefficient i.e, displacement caused by the unit action.

*1 Diff. B/w F.M & D.M.:-

F.M :-	(D.M)
① DS < DK	① DS > DK
② Force are redundant or unknowns.	② Displacement are redundant or unknowns
③ Starts with equilibrium of force.	③ Starts with Compatible deformation

4) Number of redodants is Ds.

5) Forces is found by compatability of Displacement.

4) Number of redodants = Dk.

5) Displacement found by equilibrium equation of forces.

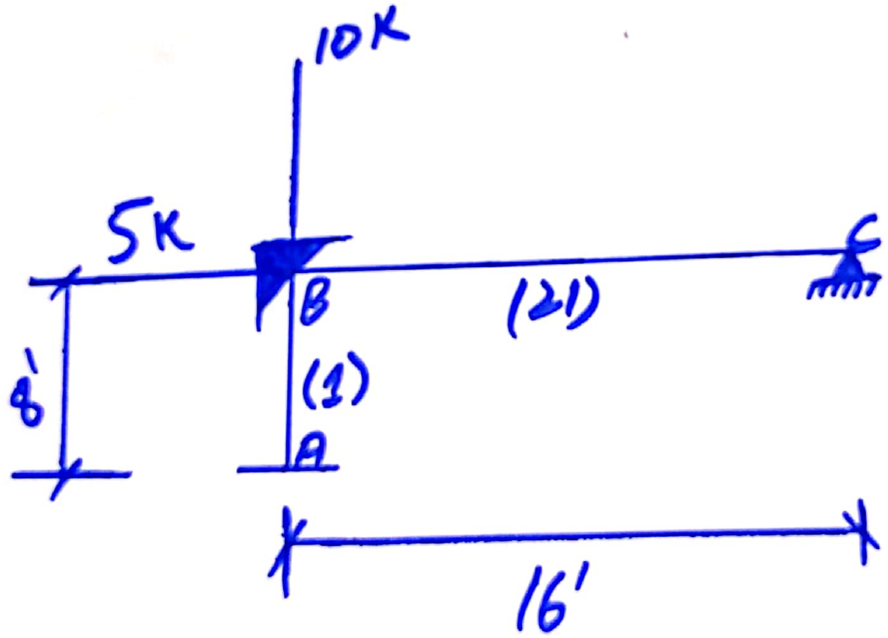
Page #01 to Page #06

End Q#02

01

(No #03)

Analyse the rigid-Joint Frame shown in (Fig #02) by Flexibility Method.



(Fig #02)

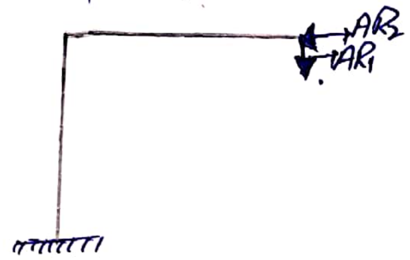
Assume EI is Constant For all Members?

Q2

SOLUTION:→ Total of Statical Indeterminacy

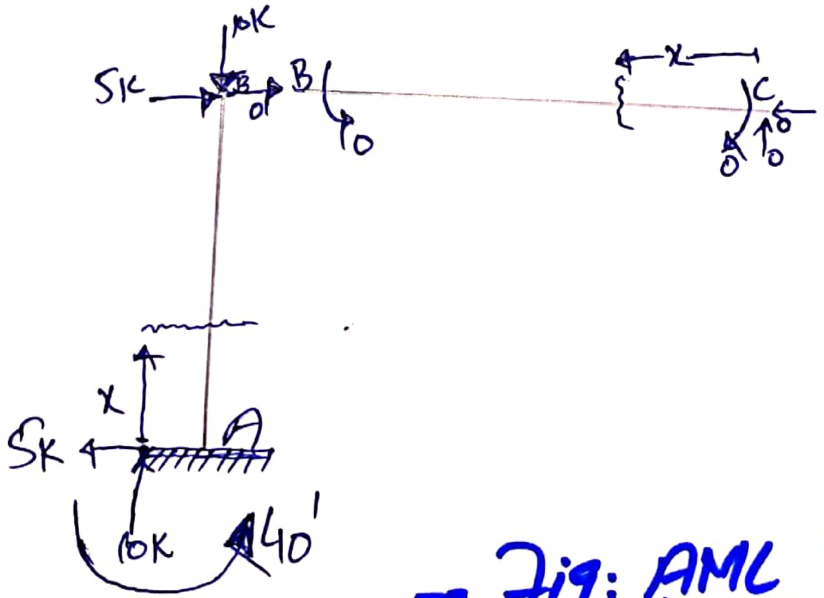
$$\rightarrow R-3 = 5-3 = 2°$$

→ **Step 2:→** Identify Redundant Actions:→



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

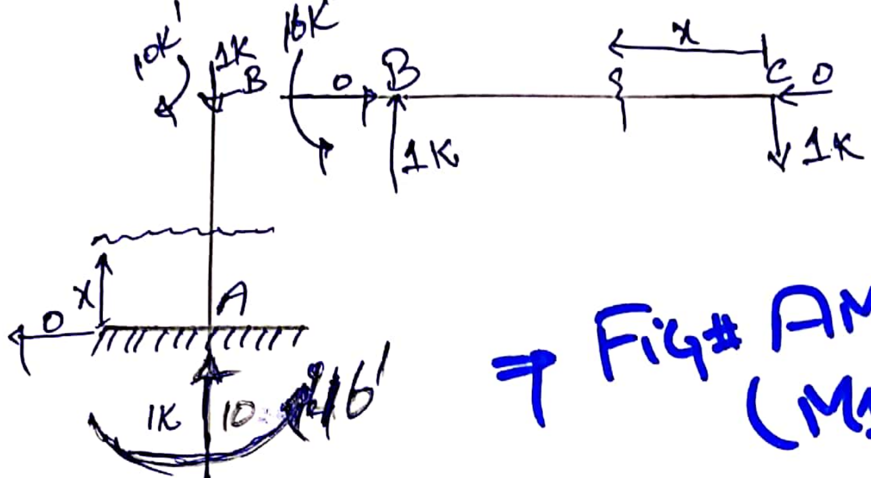
→ **Step 02:→** Compute Value of (DRL).



→ Fig: AML Values (M-Values).

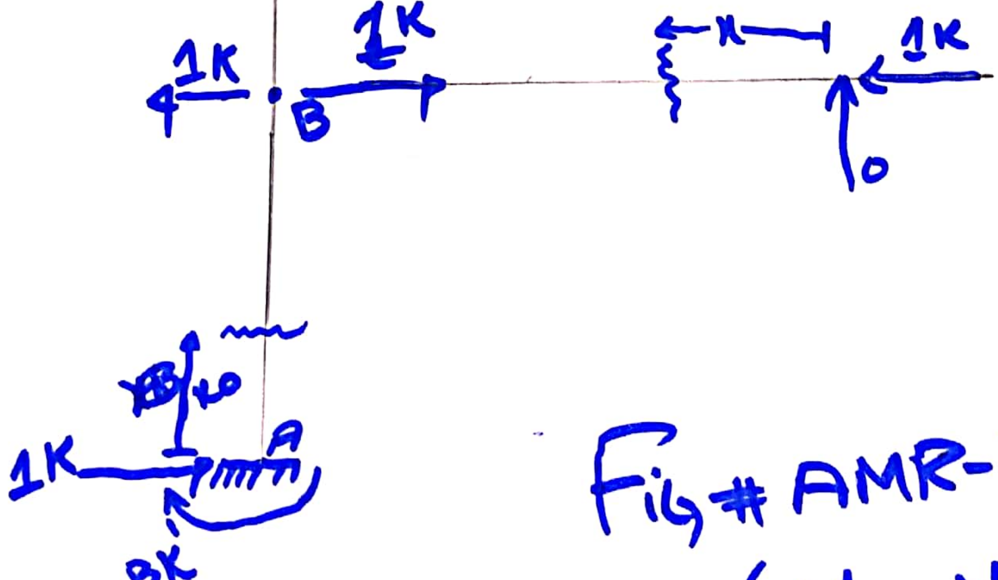
S#Q3:→ (F) OR (AMR)

(a)



→ Fig# AMR-Values (M1-Values)

(b)



Fig# AMR-Values (M2-Values)

MEMBER:→

4

⇒ Origin Limits =(I) Select origin should be select the support.

⇒ (M) = Taue X-Section from Origin

⇒ (AML) . (Fig) & Find moment.

Member	AB	BC
origin	A	C
Limit	0/I 8	0-16
I	5x-40	0
M	I	2I
m_1	(-(-16))	x
m_2	(8-x)	0

→ Take X-Section on m_2 Fig From the origin.

⇒ **FOR FINDING VALUE OF (DRC).**

6

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

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

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

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

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

⇒ Compute Flexibility Matrix:-

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

6

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

$$F_{11} = \int_0^8 \frac{(-16)^2}{EI}\,dx + \int_0^{16} \frac{(x^2)\cdot dx}{E(2I)}$$

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

$$F_{21} = \int_0^8 \frac{M_1(AB)\cdot m_2(AB)}{EI} + \int_0^{16} \frac{m_1(BC)\cdot m_2(BC)}{E(2I)}$$

$$F_{21} = \int_0^8 \frac{(-16)(8-x)}{EI}\,dx + \int_0^{16} \frac{(x)(0)}{2EI}\,dx$$

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

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

$$F_{22} \int_0^8 \frac{(8-x)^2}{EI}\,dx + \int_0^{16} \frac{0^2}{2EI}\,dx$$

7

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

⇒ As We Know That:⇒

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

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

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

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

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

END # Q No#03

Page = (1–7)