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Semester : Batch - 14

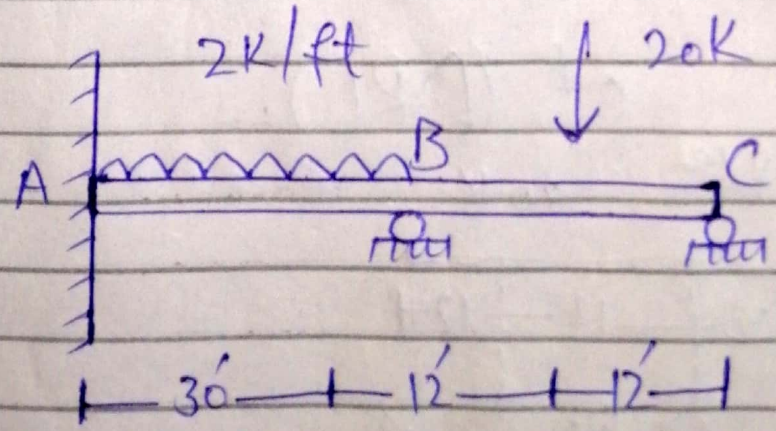
Paper : Structural Analysis - II

Submitted To : Engr. Adeed

x ——— x ——— x ——— x ———

QNO. 1.

Analyze the given beam shown in Fig-1 by flexibility method. EI is constant.

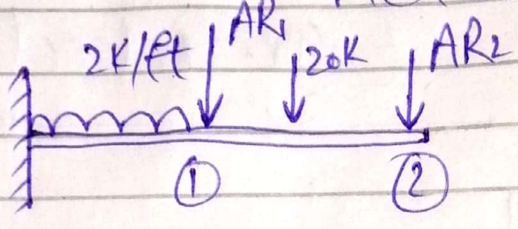


Sol:-

Structural Indeterminacy

= 2°

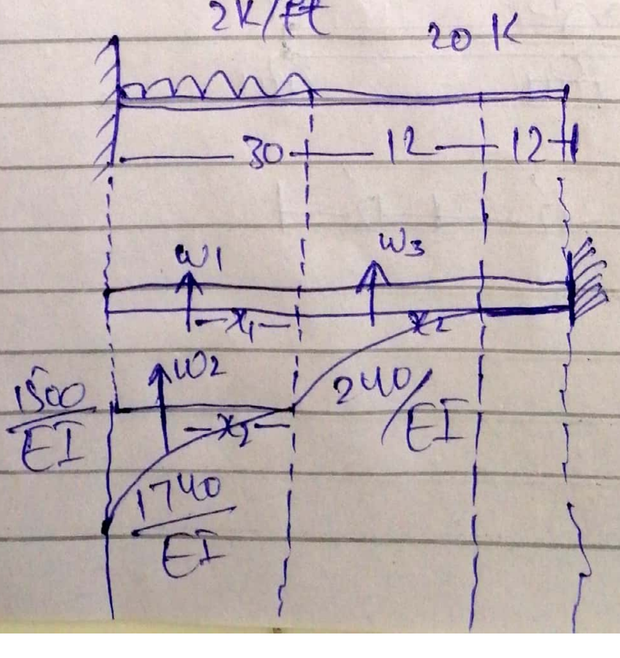
Step 1:- select Redundant Action.



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

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

Step 2:- compute The values of (DRL).



$w_1 = 1500 \times 30 = 45000$

$w_2 = 1/3 \times 30 \times 240 = 2400$

$w_3 = 1/2 \times 12 \times 240 = 1440$

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

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

$x_3 = 2/3 \times L = 2/3 \times 12 = 8'$

Now Finding DRL.

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

$+ w_3 \times (x_3 + 12)$

$= 45000(15+24) + 2400(22.5+24) +$

$1440 \quad (8+12)$

$= 1755000 + 111600 + 28800$

$DRL_2 = 1895400 / EI$

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

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

$= 675000 + 54000$

$= 729000$

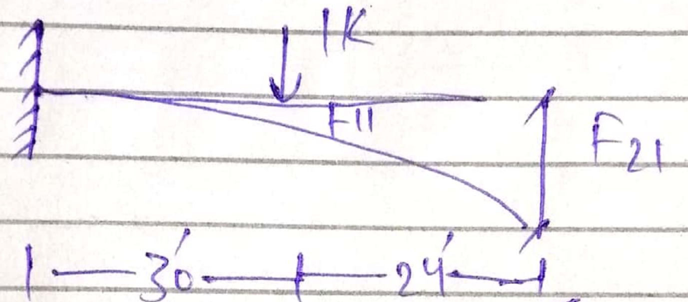
So,

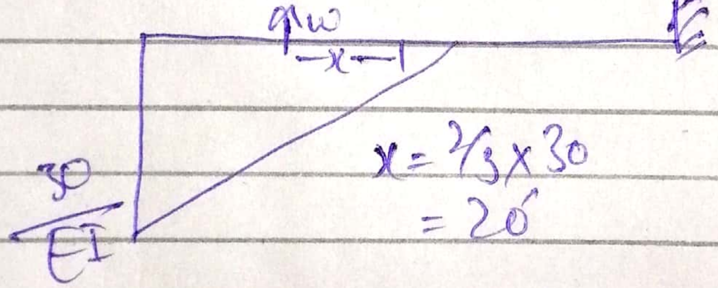
$$DRL = \frac{1}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

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



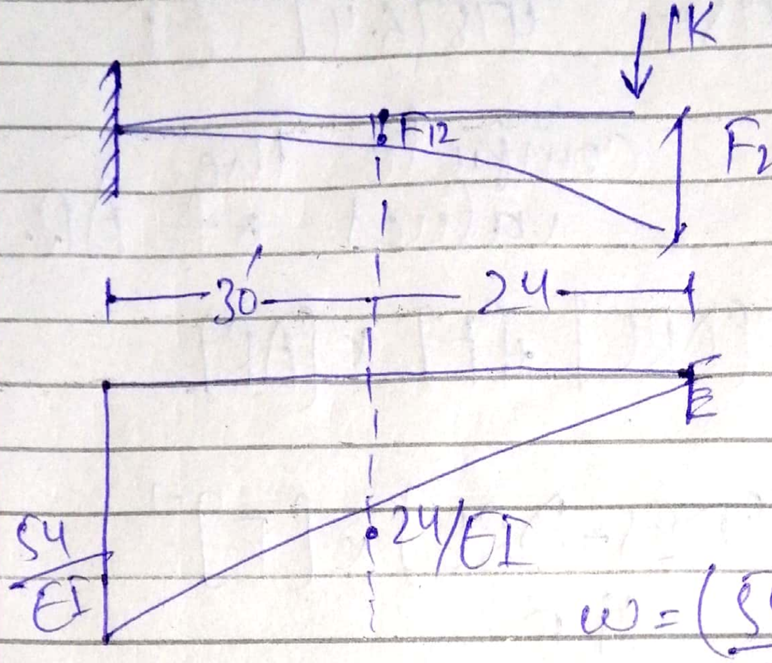


So,

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

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

Now Apply unit load on AR_2.



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

$= 1170/EI$

Now the distance.

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

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

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

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

Hence:

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

Step 4:- compute the values of AR.

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

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

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

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

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

$$(430887600 - 391968720)$$

$$\Rightarrow |F| = 38918880$$

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

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

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{\begin{bmatrix} 47876.4 & -197964 \\ -19800 & 9000 \end{bmatrix}}{38918880}$$

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

Q No. 2

Differentiate b/w force method and displacement method as suggest which method is more suitable for structure analysis of matrix approach.

Ans:- ⇒ **Force Method of Analysis :-**

In force method of Analysis Primary unknown are forces in this Method compatibility equation are written for displacement and rotations (which are calculated by force displacement equations) solving these equations, redundant force are calculated. once the redundant force are calculated, the remaining reactions are evaluated by equations of equilibrium.

=> Displacement method of analysis:-

In displacement method of Analysis, the Primary unknowns are the displacements. In this method, first force - displacement relations are computed and subsequently equations are written satisfying The equilibrium condition of The structure. After determining The unkown displacements, The other forces are calculated satisfying The compatibility conditions are force displacement, The other forces are calculated satisfying The compability and displacement relations.

Difference b/w Force & Displacement Methods.

Force Methods	Displacement Methods
-> Method of consistent deformation.	-> Slope deflection Method.
-> Theorem of least work.	-> Moment distribution Method.
-> Column analogy method.	-> Kani's method.
-> Flexibility matrix Method.	-> stiffness matrix Method.
-> Types of Indeterminacy - static indeterminacy.	-> Types of indeterminacy Kinematic indeterminacy.
-> Governing equation compatibility equation	-> Governing equation - equilibrium equation.
-> Force displacement relations - flexibility matrix.	-> Force displacement relation - stiffness matrix.

→ Ds < DK	→ Ds > DK
→ Force are reduntant or unknown.	→ Displacement are redundant or unknown.
→ starts with equilibrium of force.	→ starts with compatable deformation.
→ number of reduntant Ds	→ Number of redudants DK
→ Forces found by compatibility of displacement	→ Displacement found by equilibrium equation of force.

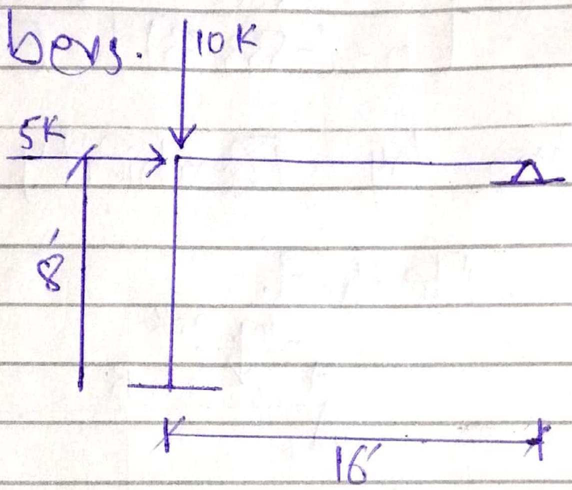
"Best Suitable Method for structure Analysis of Matrix Approach"

Stiffness method also called displacement method is more suitable for structure analysis matrix Approach, as it is a

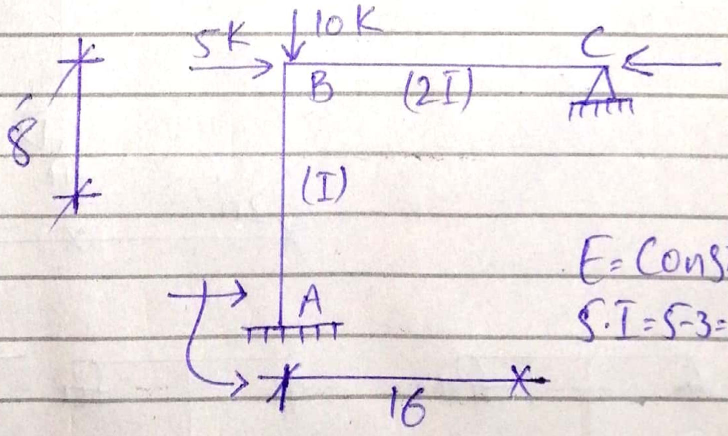
Primary method used in matrix analysis. The main advantage of This method over flexibility method is That it is conductive to computer Programming. once The analytical model of The structure has been defined, No further engineering decisions are reqJuired in The stiffness method in order to carry out The analysis.

Q No. 3

Analyze The Rigid-Joint Frame Shown in Fig-2 by flexibility method. Assume EI is constant for all members.

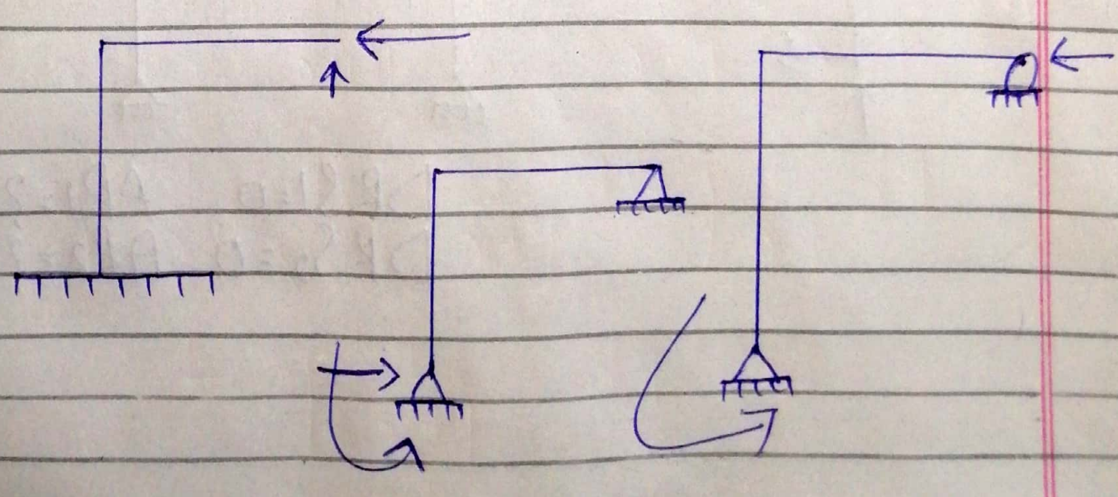


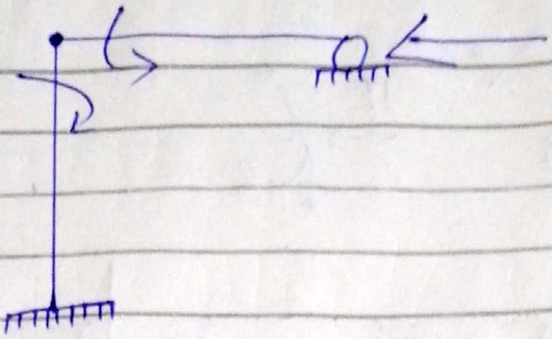
Sol:-

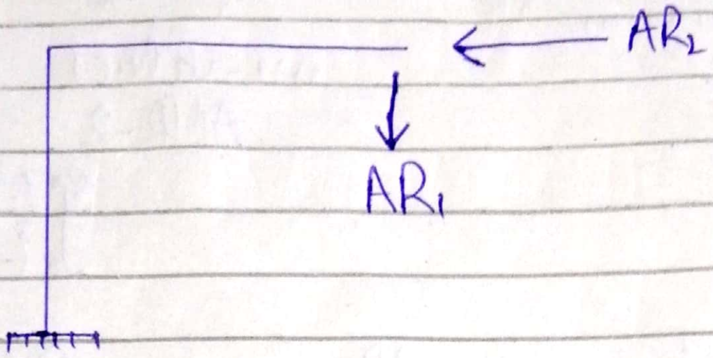


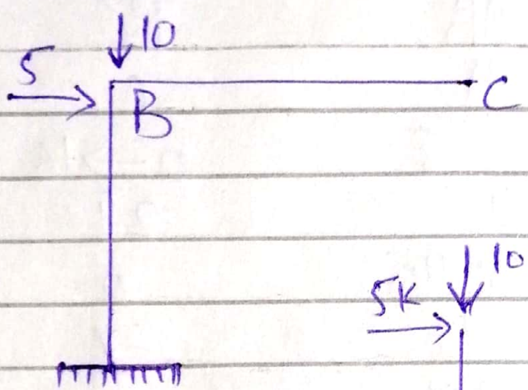
E = Constt

S.I = 5-3 = 2°

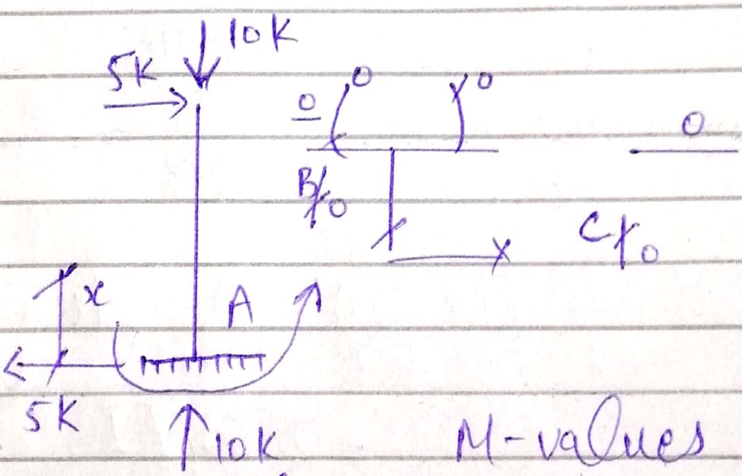




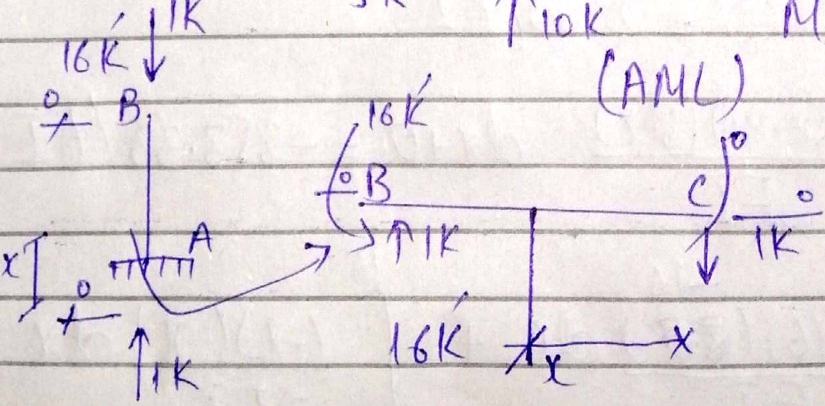




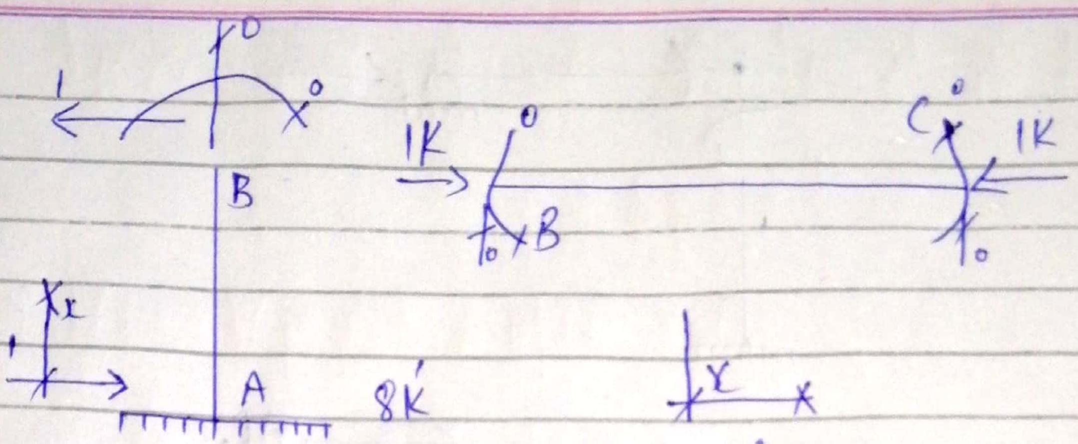
OR



M-values
(AML)



m-values
AMR-1



m2-values

AMR-2

$$\int_0^8 (-80x+640)\times 8\,(-80x+640)$$

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

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

$$= 2560/EI$$

$$DRL_2 = \int_0^8 \frac{(5x-40)(8-x)}{EI}\,dx + 0 = -853.33/EI$$

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

$$= 2730.67/EI$$

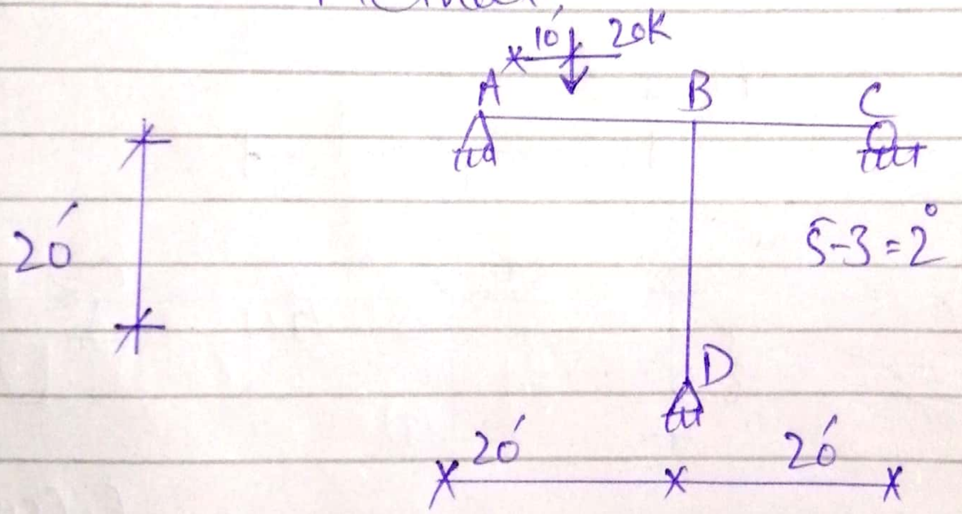
$$F_{21} = \int_0^8 \frac{(-16)(8-x)}{EI} + 0 = -512/EI$$

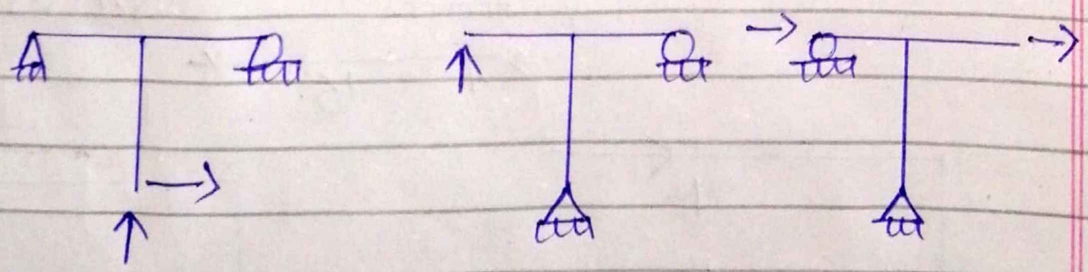
$$F_{22} = \int_0^8 \frac{(8-x)(8-x)}{EI}\,dx + 0 = 170.67/EI$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = EI \begin{bmatrix} 2730.67 & -512 \\ -512 & 170.67 \end{bmatrix}^{-1}$$

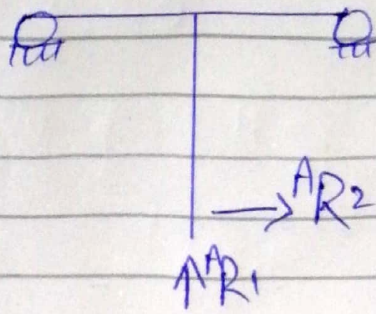
$$\begin{bmatrix} 0 - 2560 \\ 0 - (-853.33) \end{bmatrix} \times \frac{1}{EI}$$

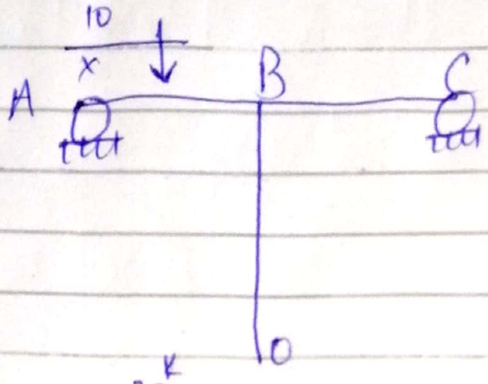
→ Analyze by Flexibility Method.

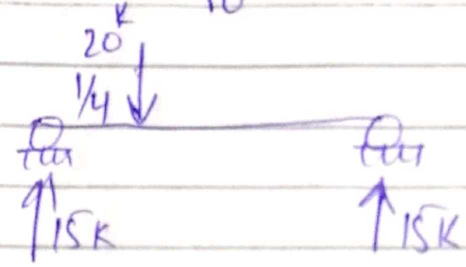


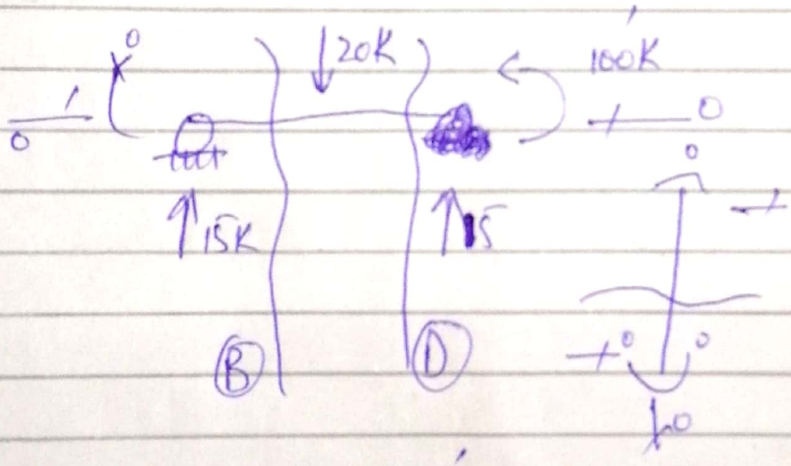


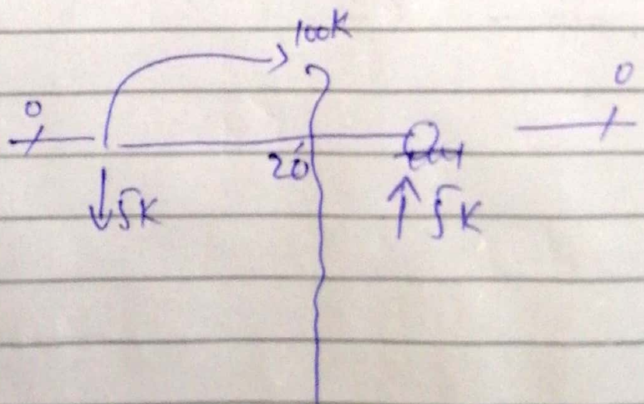
DRS1 = 0 AR1 = ?
$DRS_2 = 0$ AR2 = ?


AR2
AR1

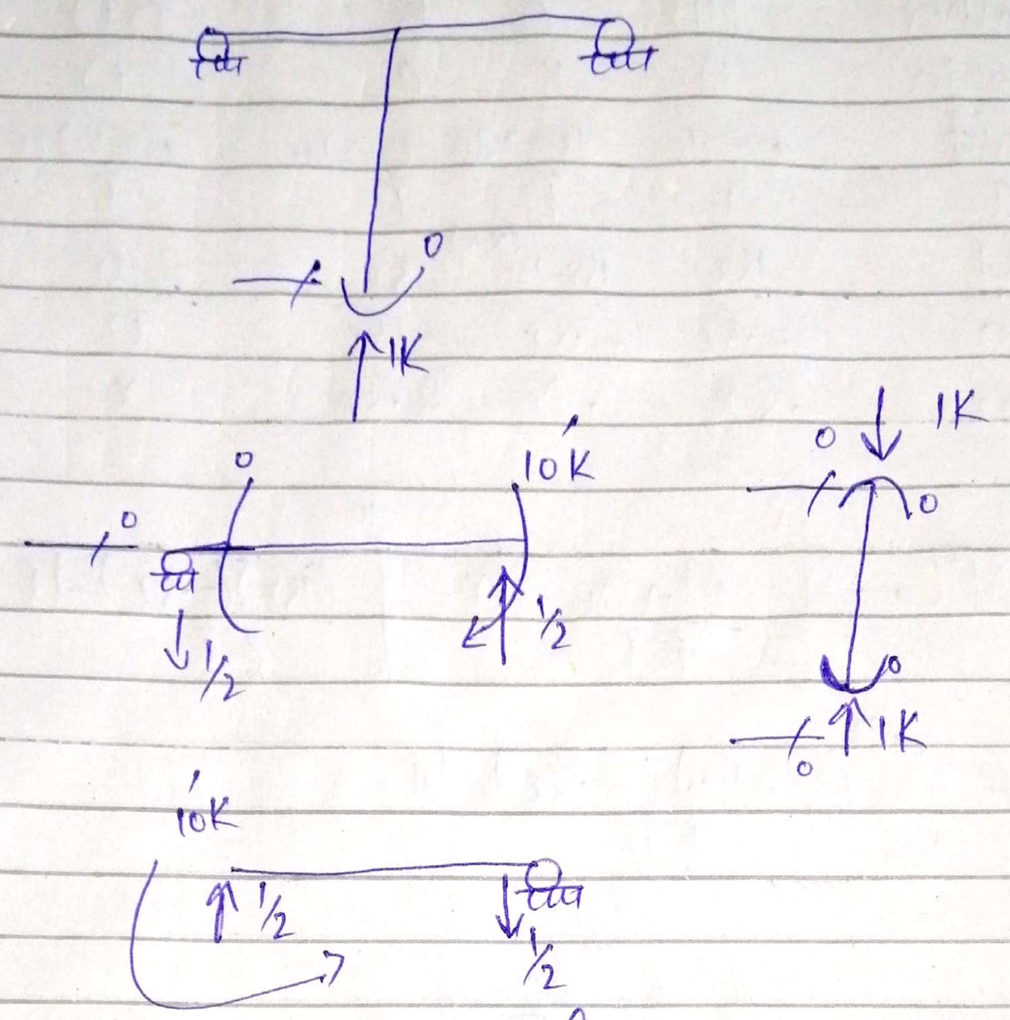

10
x
A
B
C
0


20K
1/4
15K
15K

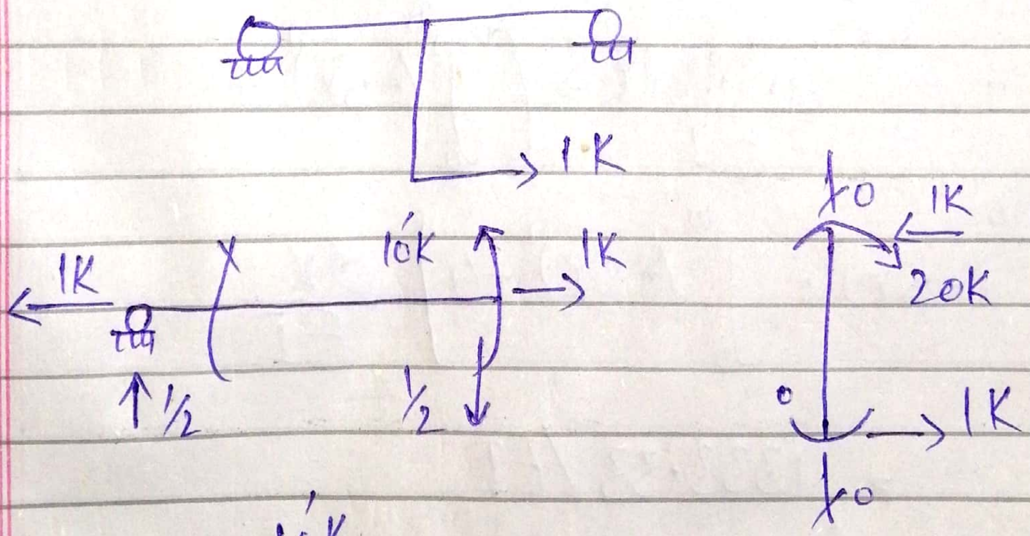

0
1
0
20K
100K
15K
15
B
D

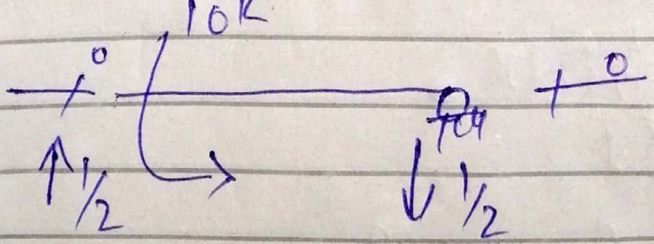

100K
0
20
5K
5K

M-values



m1 values





m2 - values

Member	AB		BC	BD
Origin	A	B	C	D
Limit	0→10	10→20	0→20	0→20
I	I	I	I	I
M	15x	15x−20(x−10)	5x	0
m1	−.5x	−.5x	−.5x	0
m2	.5x	.5x	−.5x	x

$$DRL_1 = \int_0^5 \frac{M \cdot m_1}{EI} dx = \int_0^{10} \frac{(15x)(-.5x)}{EI} dx$$

$$+ \int_0^{20} \frac{(5x+200)(-.5x)}{EI} dx$$

$$DRL_2 = 5000/EI$$

$$F_{11} = \int_0^c \frac{m_1^2 \cdot dx}{EI} = \left[\int_0^{10} (-.5x)^2 + \right.$$

$$\left. \int_0^{20} (-.5x)^2 + \int_0^{10} (-5x)^2 + 0 \right] \frac{dx}{EI}$$

$$= 1333.33/EI$$

$$F_{22} = \int_0^c \frac{m_2^2 \, dx}{EI}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 13.75K \\ -1.25K \end{bmatrix}$$