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Subject :- Structure Analysis II

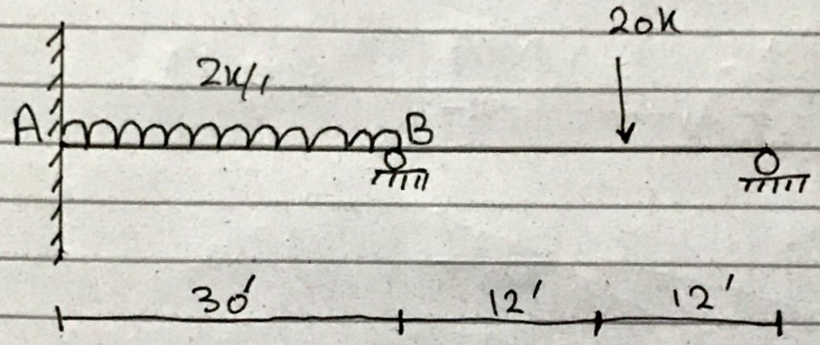
Semester :- 12th Batch 2014

Submitted to :- Engr. Adeed khan.

Mid term Exam

Q no 1:-

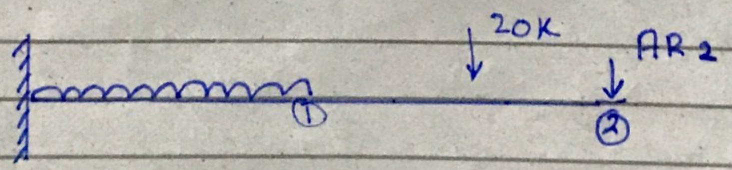
Analyze the given beam shown in fig 1 by ~~com~~ Flexibility method. EI is constant



EI Constant
S.I

Sol:-

Step 1:- Select redudant actions

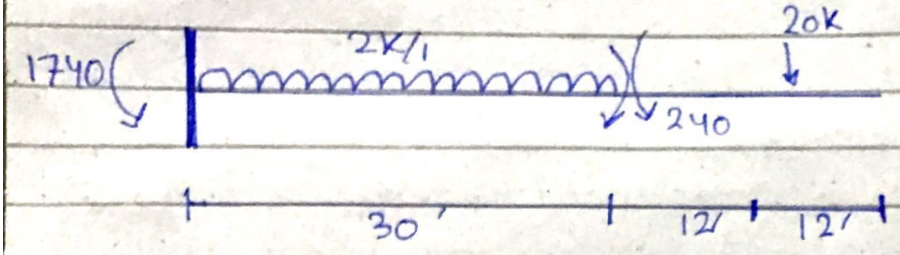


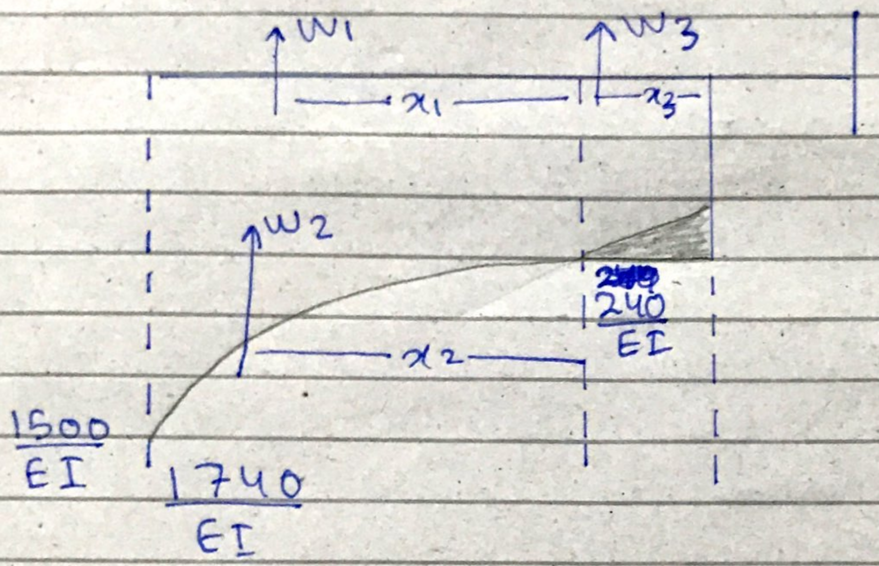
$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

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

Step 2:-

Compute the values of [DRL]





$20 \times 12 = 240$

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

$$W_1 = 1500 \times 30 = 4500$$

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

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

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

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

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

Now finding DRL:-

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

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

$= 1755000 + 1116000 + 28800$

$DRL_2 = 1895400/EI$

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

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

$= 675000 + 54000$

$= 729000$

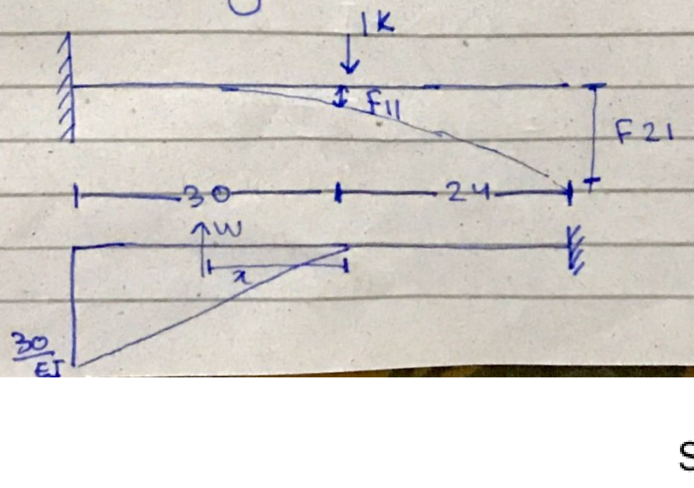
So,

$$DRL = \frac{1}{EI}\begin{bmatrix} 729000 \\ 189400 \end{bmatrix}$$

⇒ Step3:- Flexibility Matrix

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

(a) Applying unit load on AR_1



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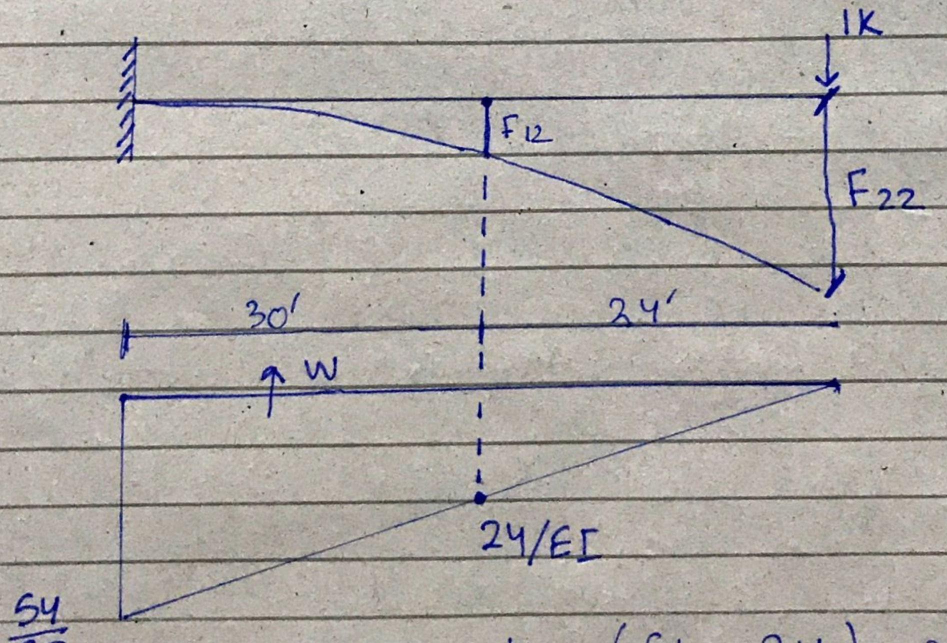
$$x = \frac{2}{3} \times 30 = 20 \qquad W = \frac{1}{2}\left(\frac{30}{EI} \times 30\right) = 450 EI$$

So,

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

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

Now apply unit load on AR_2



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

$$= 1170/EI$$

Now the distance

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

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

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

$$= \frac{19796.4}{EI}$$

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

$$= \frac{47876.4}{EI}$$

Hence

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

Step 4:- Compute the values of AR

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

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

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

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

$$|F| = (9000 \times 47876.4 - 19796.4 \times 19800)$$
$$(430887600 - 391968720)$$
$$|F| = 38918880$$

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

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

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \begin{bmatrix} 47876.4 & -19796.4 \\ -198006 & 9000 \end{bmatrix}$$

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

Q no 2:-

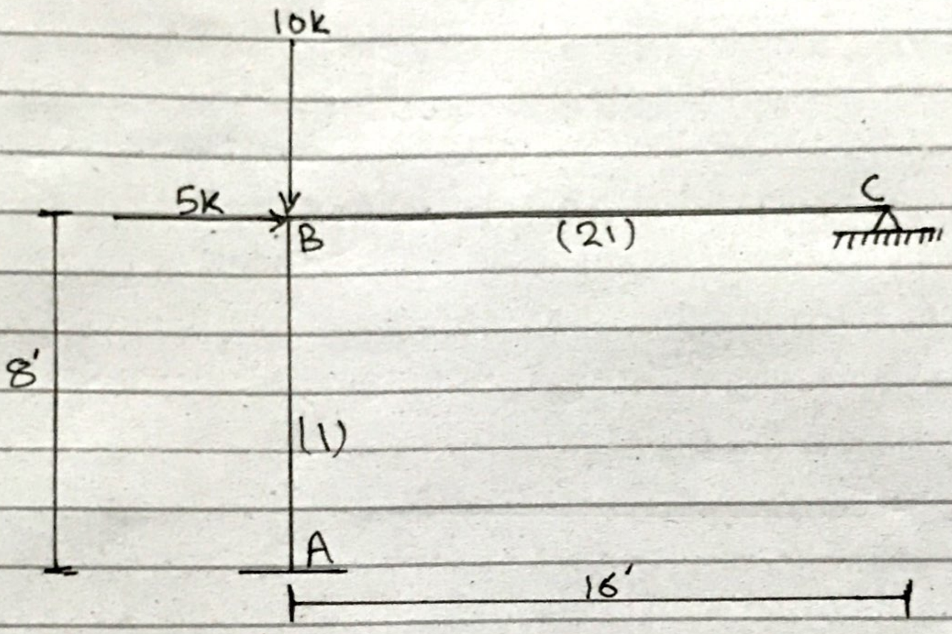
Differentiate between force method and displacement method and suggest which method is more suitable for structures analysis of matrix approach.

Force method	Displacement method
① Forces are redundant or unknown	Displacement are redudent or unknown
② DS is less than DK	DS is greater than DK
③ It starts with Equilibrium of forces	Starts with compatable deformation
④ no of redundants is = DS	No of redundants is = DK
⑤ Forces found by compatibility Eqs of ~~Equilibrium~~ Displacement	Displacements found by Equilibrium Eq. of forces
⑥ Not suitable for computer.	Not suitable for Truses

=> The method which is more suitable for structure analysis of matrix approach is Stifness method also Known as Displacement method it 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 stifness 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.

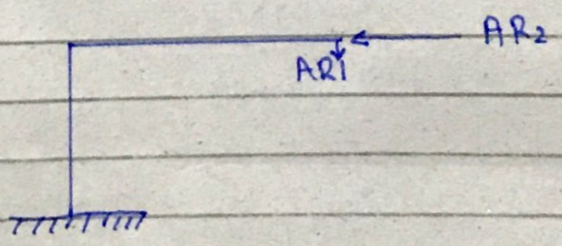


Solution:-

Total Statical indeterminacy

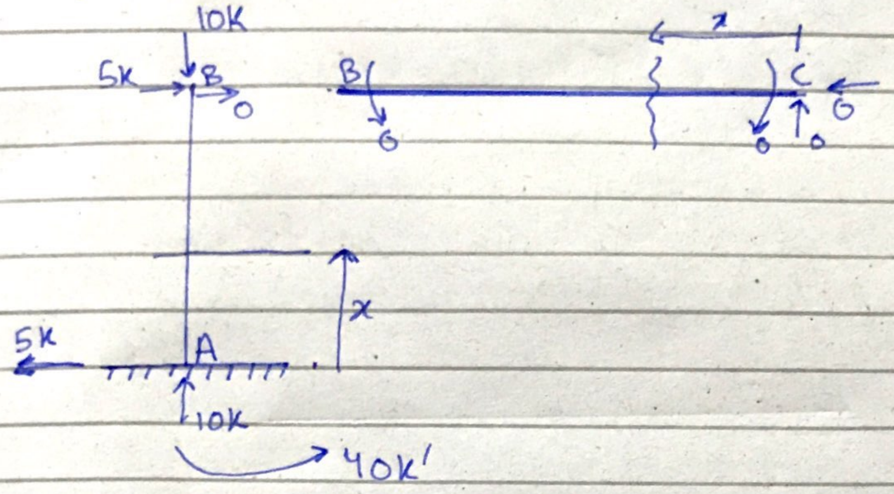
$\Rightarrow R-3 = 5-3 = 2^{\circ}$

Step #1 :- Identify Redundant Action



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

Step#2 Compute value of [DRL]



Step 3:- [F] or [AMR]

(a)

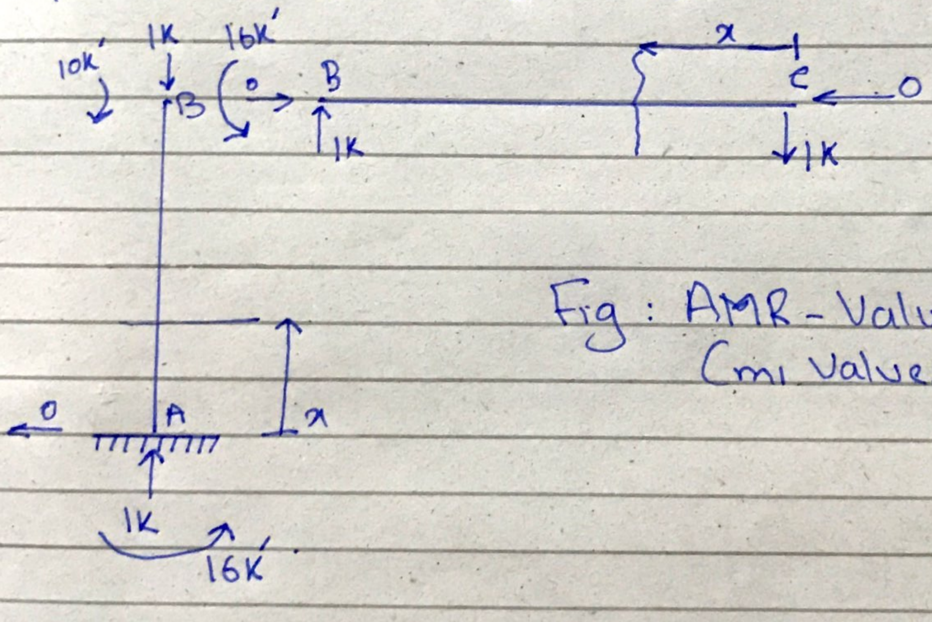


Fig : AMR - Values
(m1 Values)

(b)

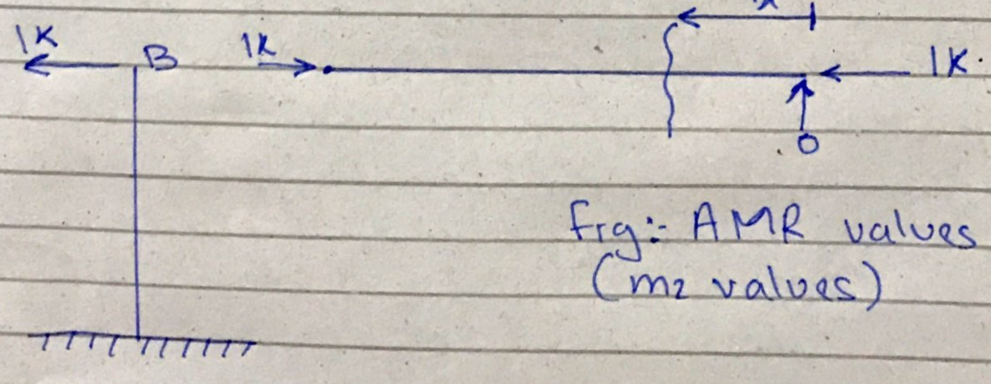


Fig:- AMR values
(m2 values)

Members	AB	BC
Origin ⇒ Select origin	A	C
Limits	0-18	0-16
I	I	2I
M → Take x Section from origin A M I fig and find moment	5x 40	0
M_1	-16	x → Take x section on m I fig from the origin
M_2	8 - x	0

⇒ For finding values of DRL's :-

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

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

$$\boxed{DRL_1 = \frac{2500}{EI}}$$

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

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

⇒ Compute flexibility Matrix

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

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

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

$$F_{12} = F_{21} = \int_0^8 m_1(AB) \cdot m_2(AB) + \int_0^{16} m_1(BC)\ m_2(BC)$$

$$= \int_0^8 \frac{(-16)(8-x)}{EI} dx + \int_0^{16} m_1(BC) \cdot m_2(BC)$$

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

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

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

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

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

As we know

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

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

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

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$