"Mid Paper Summer 2020"

ID :- 7493

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Subject :. Structure Analysis - II

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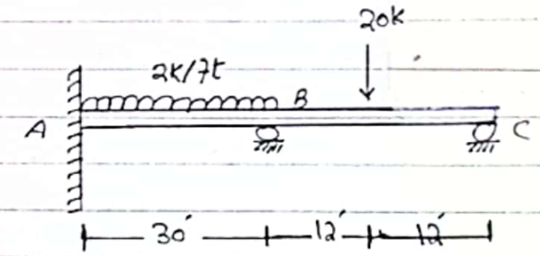
Question #01

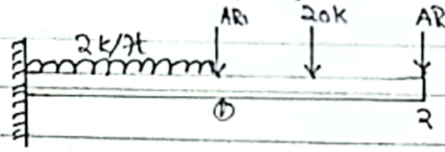


EI = Constant

Solution :-

Structural Indeterminancy = 2°

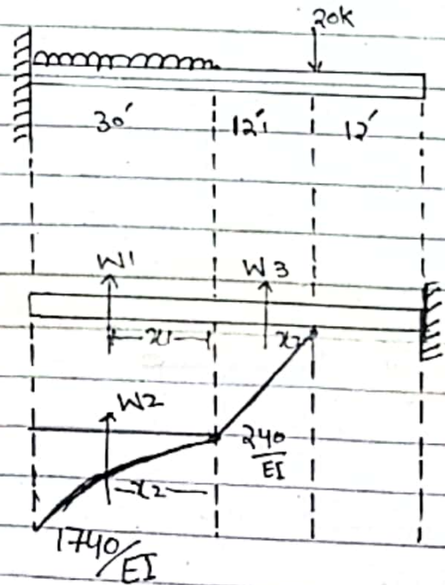
Step#1 Select Redundant Actions



$$\begin{bmatrix} DRS1 \\ DRS2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} AR1 \\ AR2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

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

Step#2 Compute the value of [DRL]



$$20 \times 12 = 240$$

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

$W1 = 1500 \times 30 = 4500$

$W2 = \frac{1}{3} \times 30 \times 240 = 2400$

$W3 = \frac{1}{2} \times 12 \times 240 = 1440$

$x1 = b/2 = 30/2 = 15'$

$x2 = \frac{3}{n+2} \times 1 = \frac{3}{2+2} \times 30 = 22.5'$

$x3 = \frac{2}{3} \times L = 8'$

Now finding DRL :-

$DRL2 = W1 \times (x_1 + 24) + W2 \times (x_2 + 24) + W3 \times (x3 + 12)$

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

$= 1755000 + 111600 + 28800$

$DRL_2 = 1895400 / EI$

$DRL1 = W1 (x1) + W2 (x2)$

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

$= 675000 + 54000$

$= 729000$

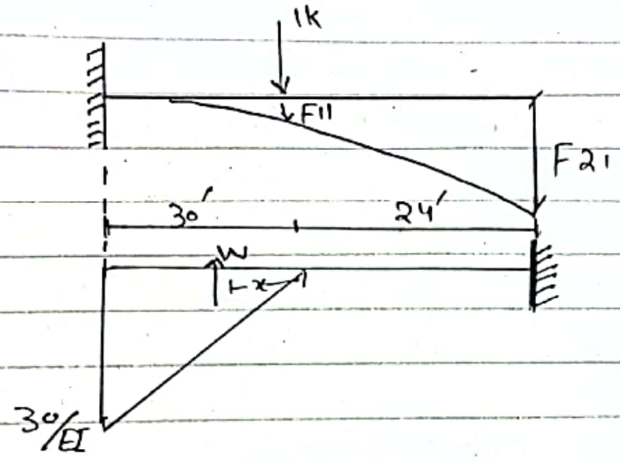
So,

$$DRL1 = \frac{1}{EI} \begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

Step#3 Flexibility Matrix

$$[F]_{2 \times 2} = \begin{bmatrix} F11 & F12 \\ F21 & F22 \end{bmatrix}$$

(a) Applying Unit Load on AR_1



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

$W = 1/2\,(30/EI \times 30)$

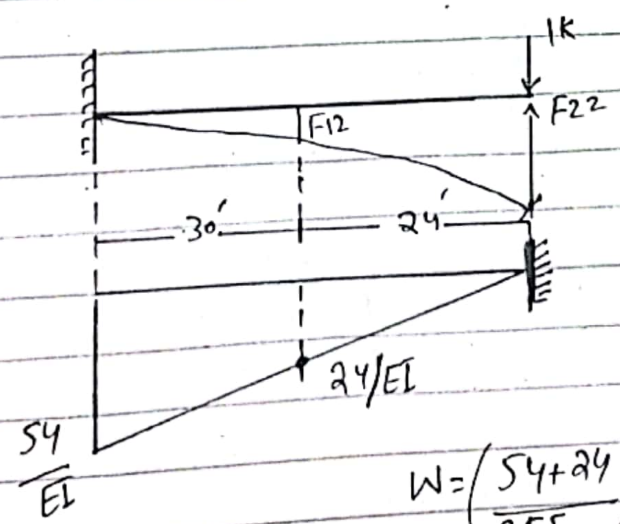
$= 450/EI$

So,

$F11 = \frac{450}{EI}(20) = 9000/EI$

$F21 = \frac{450}{EI}(20+24) = 19800/EI$

Now Apply unit Load on AR_2



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

$= 1170/EI$

Now the distance.

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

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

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

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

Hence

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

Step #4 Compute the value of AR

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

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

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

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 19000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

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

$|F| = 38918880$

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

$\begin{bmatrix} AR1 \\ AR2 \end{bmatrix} = \begin{bmatrix} 0-729000 \\ 0-1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{3891880} \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$

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

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

Answer #2

Force Method	Displacement Method
→ It is also known as flexibility matrix method or compatibility method	→ It is called as equilibrium method or stiffness method matrix
→ In force method the unknown are taken as force or reaction	→ In displacement method the unknown are taken as joint displacement.
→ In this the number of redundant = Ds	→ In this the number of Redundant = Dk
→ In this the forces are found by compatibility equation of displacement	→ In this the displacement are found by equilibrium equation of force.
→ In this the type of Indeterminancy is static Indeterminancy	→ In this the type of indeterminancy is kinematic Indeterminancy.
It is suitable when Ds < Dk	It is suitable when Ds > Dk

Suitable Method::

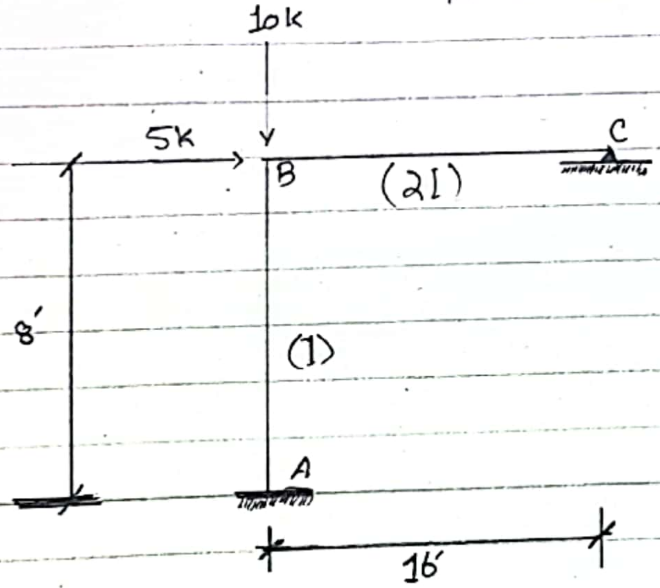
(i) For analysis structure of matrix approach both the force method or displacement method can be used depend upon solution.

(ii) When the degree of static Indeterminancy (DS) is less than the degree of kinematic Indeterminancy (DK) example: Ds < Dk than it is suggested to use force method of analysis.

(iii) When the degree of Static Indeterminancy (DS) is more than the degree of kinematic Indeterminancy (DK), DK < DS. Than it is suggested to use the displacement Method of Analysis

Question #03

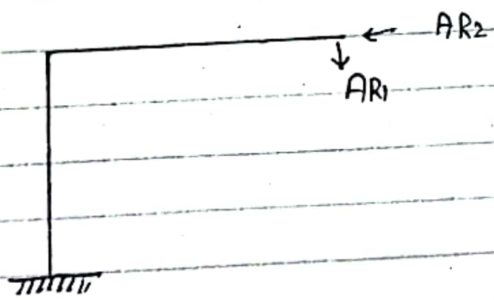
Flexibility Method



Solution :-

Total Statical indeterminacy
=> $R-3 = 5-3 = 2$

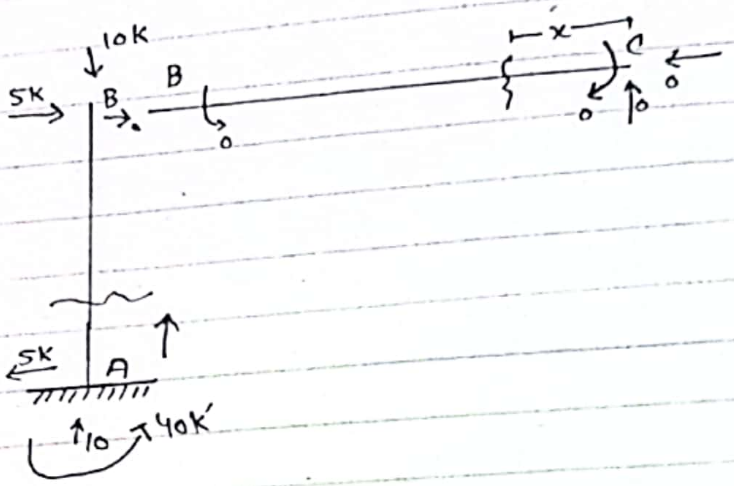
Step#01
Identify Redundant Action



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

Step#02

Compute value of [DRL]



Step#03 [F] or [AMR]

(a)

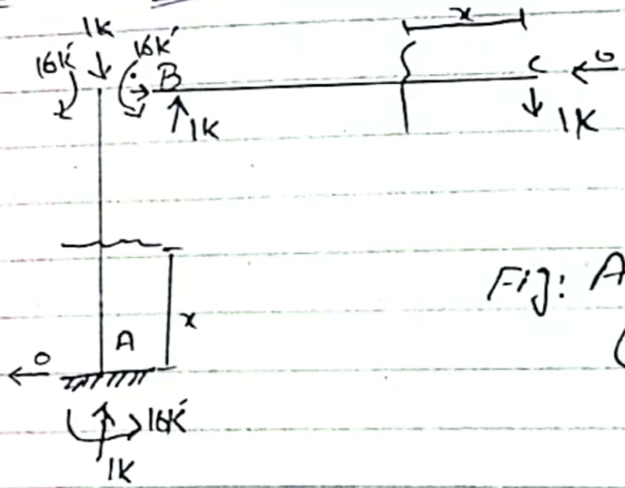


Fig: AMR- values (m1 values)

(b)

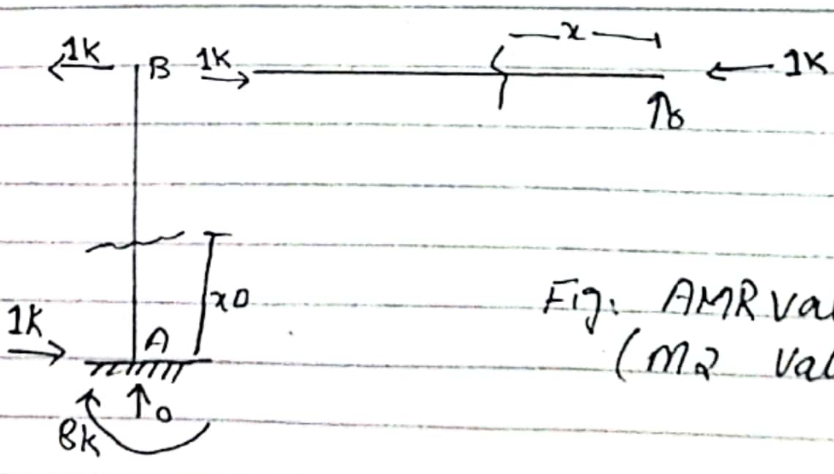


Fig: AMR values (m2 value)

Member	AB	BC
origin	A	C
Limits	0-8	0-16
I	I	2I
M	5x-40	0
m1	-16	x
m2	8-x	0

For Finding value of DRL

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot m_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot m_1(BC)}{EI}$$

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

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

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

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

Compute Flexibility Matrix

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

$$\rightarrow F11 = \int_0^8 \frac{m_1^2 (AB)}{EI} + \int_0^{16} \frac{m_1^2 (BC)}{EI}$$

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

$$F11 = \frac{2730.67}{EI}$$

$$\rightarrow F12 = F21 = \int_0^8 m_1(AB) \cdot m_2(AB) + \int_0^{16} m_1(BC) \cdot m_2(BC)$$

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

$$F12 = F21 = \frac{-512}{EI}$$

$$\rightarrow F22 = \int_0^8 (m_1)^2 AB \, dx + \int_0^{16} (m_2)^2 BC \, dx$$

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

$$F_{22} = 170.67$$

As we know

$$\{DRS\} = \{DRL\} + [AR] * [F]$$

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

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

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.0005 \\ 4.97 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ \hline AR_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$