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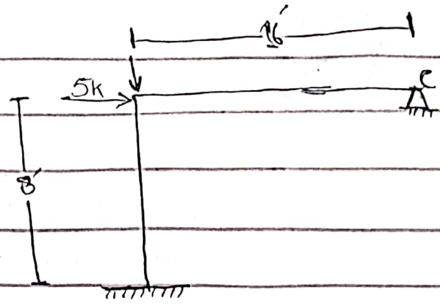
ID # 7770

SUBJECT ⇒ Structural Analysis II

SUBMITTED TO ⇒ Engr. Adeed Khan

DATE = 21/08/2020

Pb # 03



$E = \text{Cos}^n\text{tant}$

$I_C = I$

$I_B = 2I$

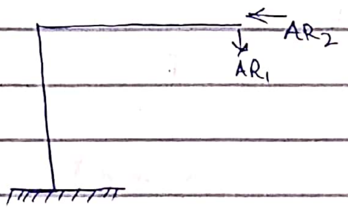
Solution:-

Total statical indeterminacy

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

Step # 01:

Identify Redundant Actions



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

Step # 2: Compute value of [DRL]

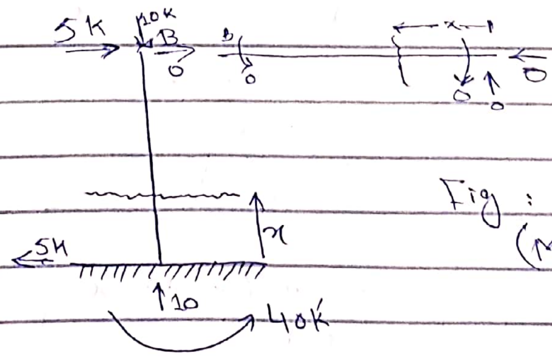


Fig: AML values (M- values)

Step # 03 [F] or [AMR]

a)

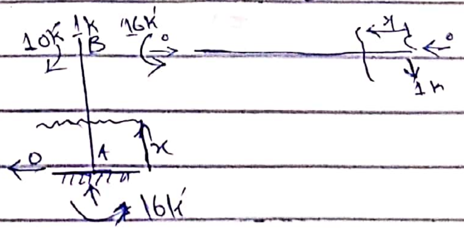


Fig: AMR- values (M1 values)

②

b)

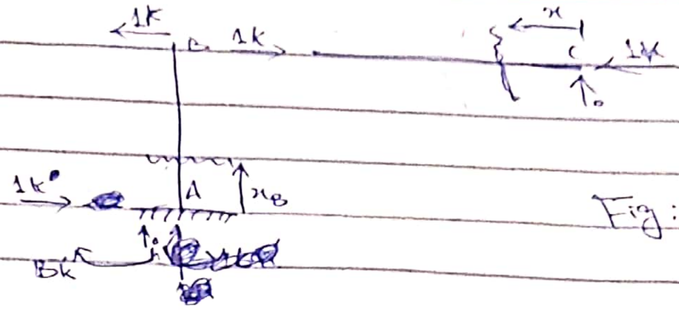


Fig: (AMR - values / M_1 values)

Selected origin should be selected the support

Take x section from origin AML fig and Find moment

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

Take x section on M_1 fig from the origin

For Finding ~~moment~~ values of DRL:-

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot M_{1(AB)}}{EI} + \int_0^{16} \frac{M_{BC} \cdot M_2 (BC)}{EI}$$

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

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

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

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

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

③

$\Rightarrow$ Compute Flexibility Matrix :-

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

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

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

$$F_{12} = F_{21} = \int_0^8 m_1 (AB) \cdot M_2 (AB) + \int_0^{16} m_1 (BC) \cdot m_2 (BC)$$

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

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

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

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

$$F_{22} = 170.67$$

As we know ~~the~~ that

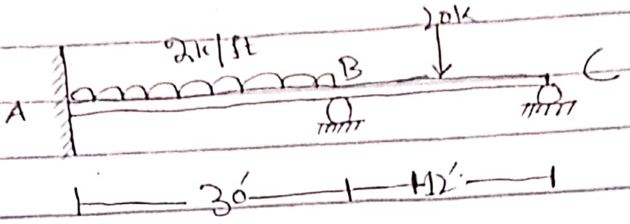
$$\Rightarrow [DRS] = [DRL] + [AR] \times [F]$$

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

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

$$\boxed{\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.0005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}}$$

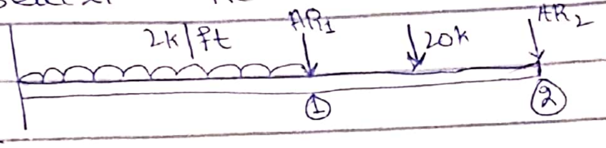
Q#01



Solution:

Structural Indenterminacy Actions

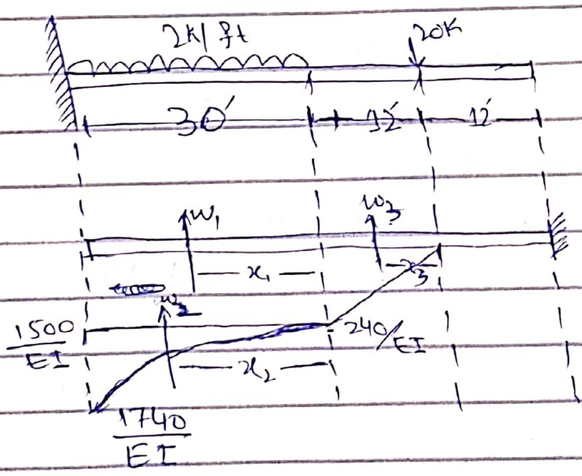
Step# 01 Select Redundant Actions



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

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

Step # 2 Compute the values of $[DRL]$



$20 \times 12 = 40$

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

$W_1 = 1500 \times 30 = 45000$

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

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

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

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

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

Now Finding DRL:

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

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

$= 1755000 + 1116000 + 28800$

$DRL_2 = 1895400/EI$

$DRL_1 = w_1(x_1) + w_2(x_2) \cancel{+ w_3(x_3)}$

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

$= 675000 + 54000$

$= 729000$

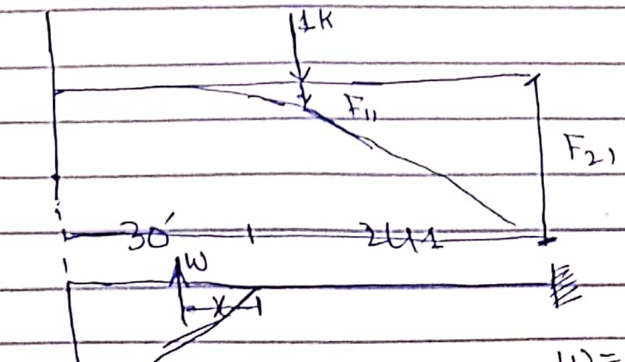
So,

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

Step # 3: Flexibility Matrix

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

a) Applying unit load on AR1



$\frac{30}{EI}$

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

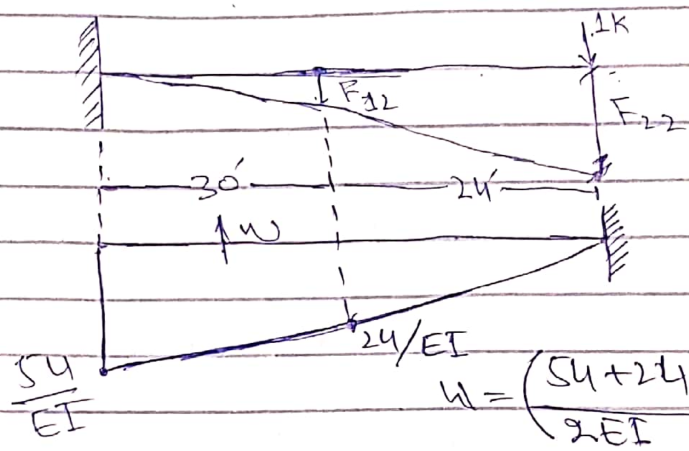
$w = \frac{1}{2}\left(\frac{30}{EI} \times 30\right) = 450/EI$

So,

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

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

Now applying unit load on AR_2



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

$$= 1170/EI$$

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

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

Step # 4: Compute the values of AR

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

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

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

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

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

$$(430887600 - 391968720)$$

$$\Rightarrow |F| = 38918880$$

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

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

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

Q2 Ans: There are two main methods of structural analysis using the matrix approach.

i) Force Method
ii) Displacement Method

Force Method	Displacement Method.
* $D_S < D_K$	* $D_S > D_K$
* Forces are redundant or unknowns	* Preferable when structure have less kinematics Indeterminacy
* Starts with ~~equilibr~~ ~~equilibri~~ equillibrium of forces	* Starts with compatible Deformation
* Knows flexibility	* No of ~~redund~~ redundants $= D_K$ Known as stiffness method
* Knowns flexibility	e.g. slope displacement method.
* Methods of determination Forces found by Compability eqs of displacement	* Displacement found by equillibrium of forces.

Part "2"

SUITABLE

(I): In force method, we assume forces and moments as unknown and solve for them we calculate displacement and relations from forces and moments.
This is better then displacement method if and only if static indeterminacy is less than Kinametic indeterminacy.

Scanned with CamScanner

2: Stiffness method also called displacement method ~~is~~ and is more suitable for structure analysis, matrix approach, 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 requir to carry out analysis.