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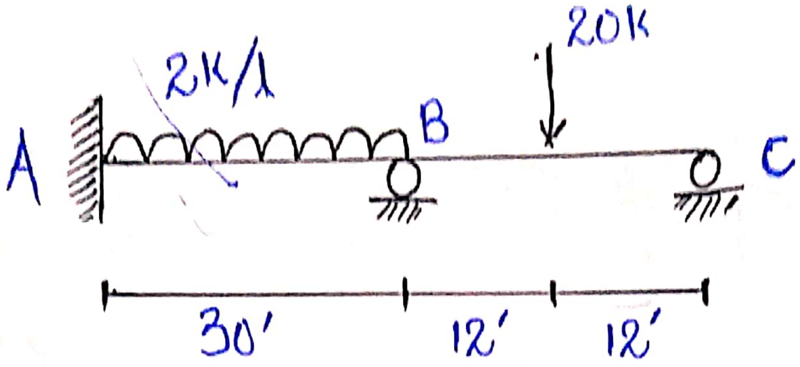
SECTION ः B

SUBJECT ः STRUCTURAL ANALSIS II

SUBMITTED TO ः "Engr; ADEED"

DATE ः 21/08/2020

Ans; 01 Given Beam



EI = Constant

"Flexibility method;"

"Solution;"

"1"; Degree of Static Indeterminacy;

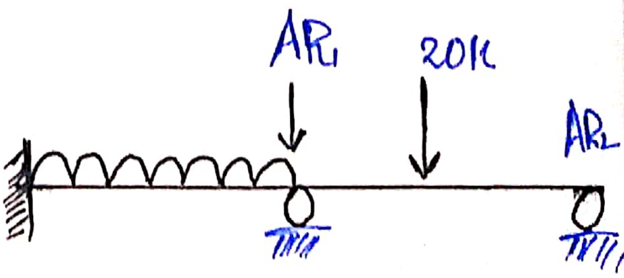
$$D_{si} = R-3 = 5-3 \boxed{= 2}$$

"2"; Flexure rigidity;

EI = constant.

"3"; Redundant Actions;

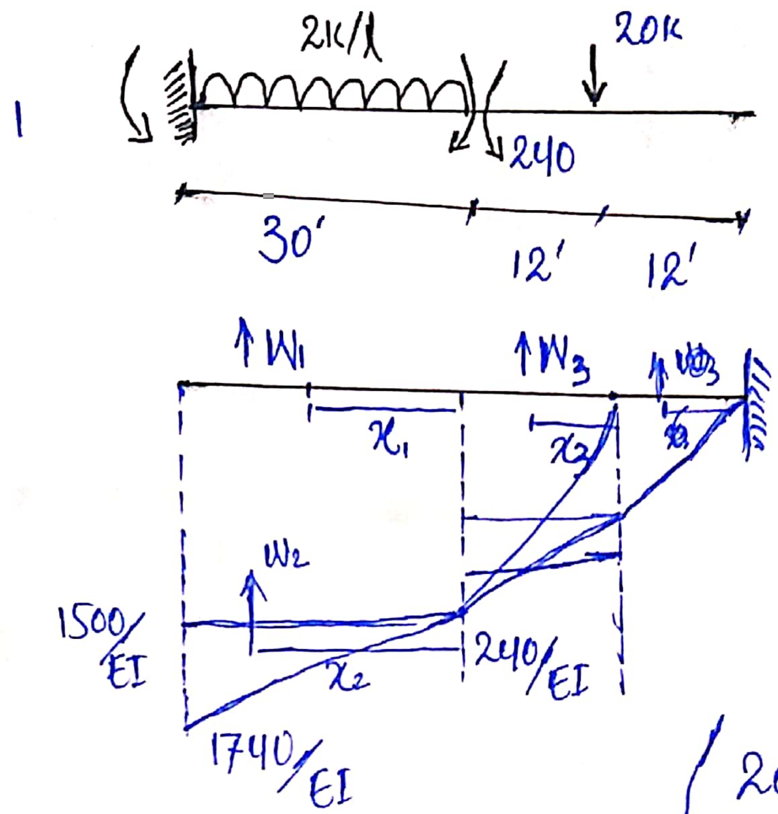
$$\begin{bmatrix} D_{RS1} \\ D_{RS2} \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \quad \begin{bmatrix} A_{R1} \\ A_{R2} \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$



$$[D_{RS}] = [D_{RL}] + [F][A_R]$$

"2"

"4"; Compute values of [DRL].



$20 \times 20 = 240$
$20(12 \times 30) + 2 \times 30 \times 15$
$= 1740$

$W_1 = 1500 \times 30 = 48000$

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

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

Now;

$X_1 = b/2 = 30/2 = 15'$

$X_2 = \frac{3}{n+2} \times L = \frac{3}{2+2} \times 30 = 22.5'$

$X_3 = \frac{2}{3} \times L = \frac{2}{3} \times 12 = 8'$

Now DRL = ?

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

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

$= 675000 + 54000$

$= 729000$

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Now;

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

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

$$= 1755000 + 111600 + 28800$$

$$= 1895400/EI$$

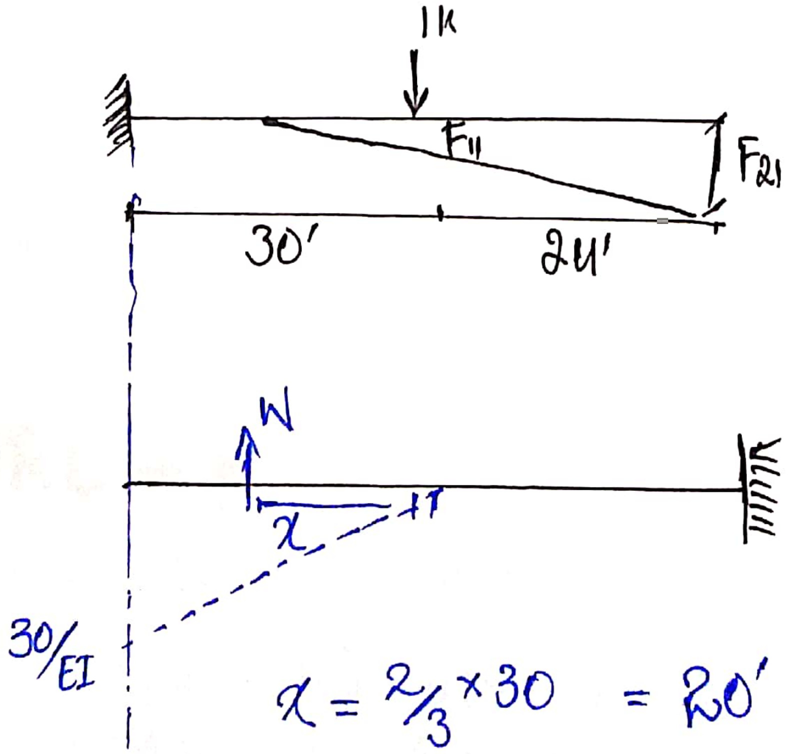
So;

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

"5"; Flexibility Matrix.

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

"a"; Applying unit load on AR_1



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

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

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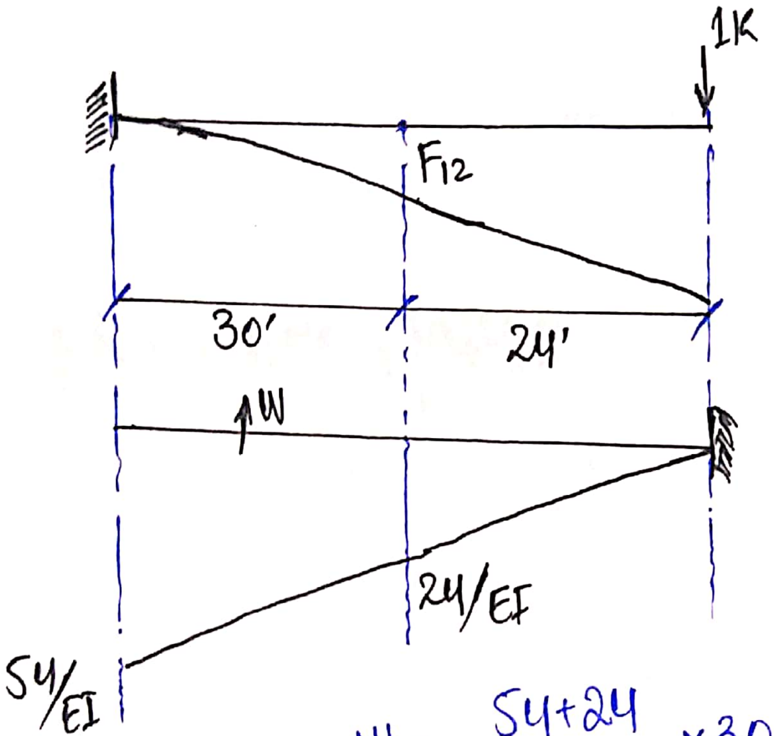
So;

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

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

Now Apply unit load on [AR_2].



$$W = \frac{54+24}{2EI} \times 30 = 1170/EI$$

"Now the distance";

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

$$F_{12} = \frac{1170}{EI}(16.92) = 19796.4/EI$$

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

Hence;

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

"6"; Compute Values of AR.

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

$$[AR] = [DRS - DRL][F]^{-1} \qquad \left([F]^{-1} = \frac{1}{|F|} \text{Adj} F\right)$$

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times \text{adj} \begin{pmatrix} 9000 & 19796.4 \\ 19800 & 47879.4 \end{pmatrix}$$

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

$$(430887600 - 391968722)$$

$$[F] = 38918880$$

$$\text{Adj } A = \begin{bmatrix} 47879.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \frac{1}{EI}\begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \times \frac{1}{38918880}\begin{bmatrix} 47879.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

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

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Ans; 02"

Force method	Displacement Method;
$D_s < D_K$	$D_s > D_K$
Assumed Force are unknown.	Assumed Displacement as unknown.
Preferable when structure has less Static Indeterminacy	Preferrable when structure has less Kinematic Indeterminacy
Starts with equilibrium of forces.	Starts with campatible Deformation.
No of redundants = D_s	No of redundants = D_K
Known as Flexibility method e.g consistent method of deformation	Known as Stifness method e.g; Slope Displacement method.
Forces found by compatibility eqns of displacement	Displacement found by equilibrium eqs of forces

"Part; 2"

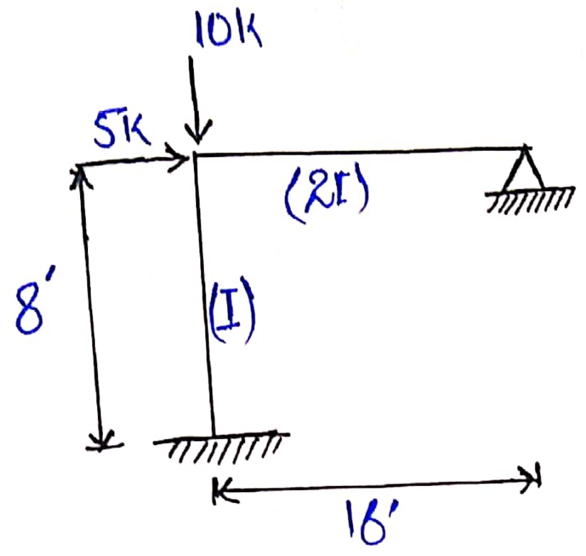
"i"; Force method.
"ii"; Displacement method.

"Suitable"

"1"; In force method, we assume forces and moments as unknown and solve for them the we calculate displacement and rotations from forces, and moments.
This ~~better~~ method is better than displacement method if and only if static indeterminacy is less than kinamatic indeterminacy.

"2"; Stiffness method also called displacement method is more suitable for structure analysis, matrix approach. The main advantage, 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 stiffness method in order to carry out the analysis.

"Ans;03"; "Given Frame";



EI = constant;

"Flexibility Method"

Sol;

"1"; Degree of Static Indeterminacy;

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

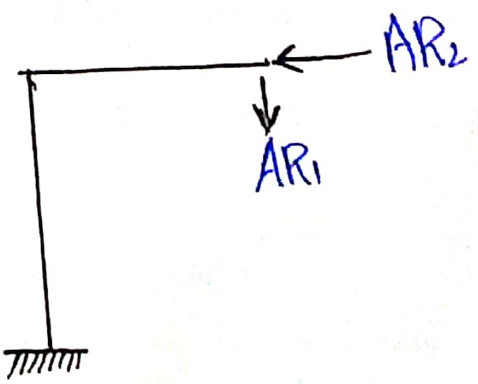
"2"; Flexure rigidity;

$$EI = \text{constant.}$$

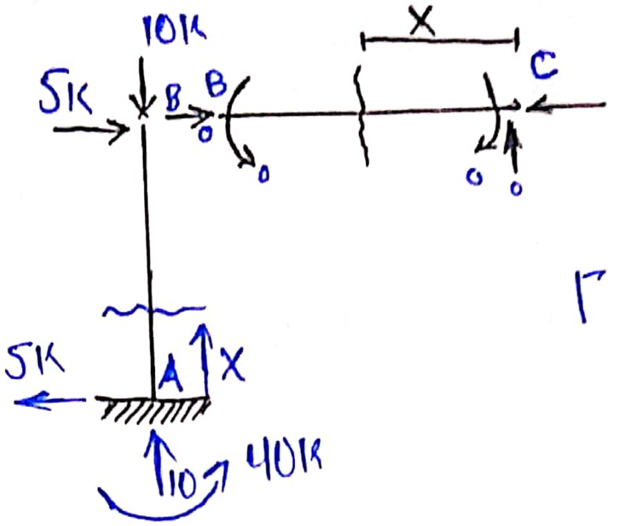
"3"; Redundant Actions;

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

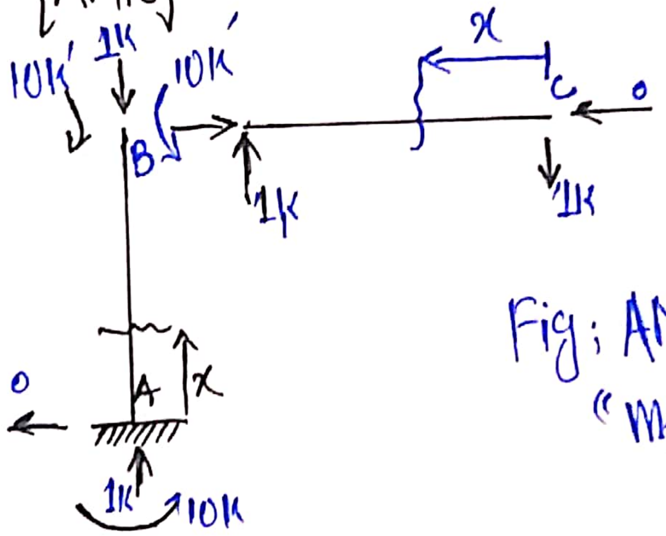


"4"; Compute values of [DRL]



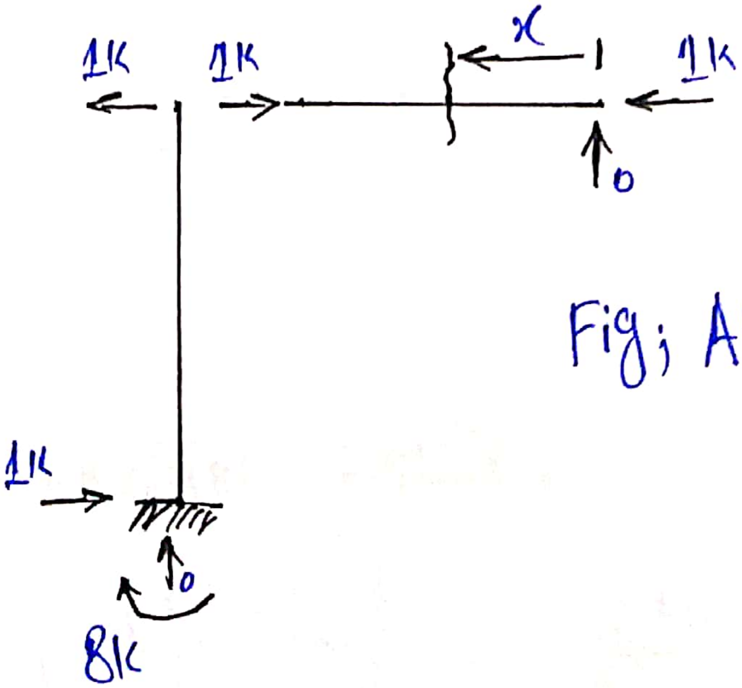
"5"; [F] or [AMR]

"a"



Fig; AMR-values
"m_1-values"

"b";



Fig; AMR-values
"m_2-values"

Member	AB	BC
Origin	A	C
Limits	0-8	0-10
I	I	2I
M	$5x-40$	0
m_1	-16	x
m_2	$8-x$	0

"6"; Finding values of DRL

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

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

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

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

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

"7"; Compute Flexibility Matrix;

$$F_{2\times2} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$ (Because its 2^0)

$$F_{11} = \int_0^8 \frac{m_1^2(AB)}{EI} + \int_0^{16} \frac{m_2^2(BC}{EI} = \int_0^8 \frac{(-16)^2 dx}{EI} + \int_0^{16} \frac{x^2}{E(2I)}$$

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

$$F_{12} = F_{21} = \int_0^8 \frac{m_1(AB)}{EI} dx + \int_0^{16} \frac{m_2(BC)}{E(2I)} dx$$

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

$$\boxed{= \frac{-512}{EI}}$$

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

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

$$\boxed{= 176.67/EI}$$

As we know that;

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

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

$$= \begin{bmatrix} 2730.67 & -512 \\ -512 & 176.67 \end{bmatrix}^{-1} \begin{bmatrix} 0 - 2500 \\ 0 + 853.33 \end{bmatrix}$$

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