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IQRA NATIONAL UNIVERSITY

Mid Term Paper (Summer Sumester 2020)

Structural Analysis - II

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Section = "A"

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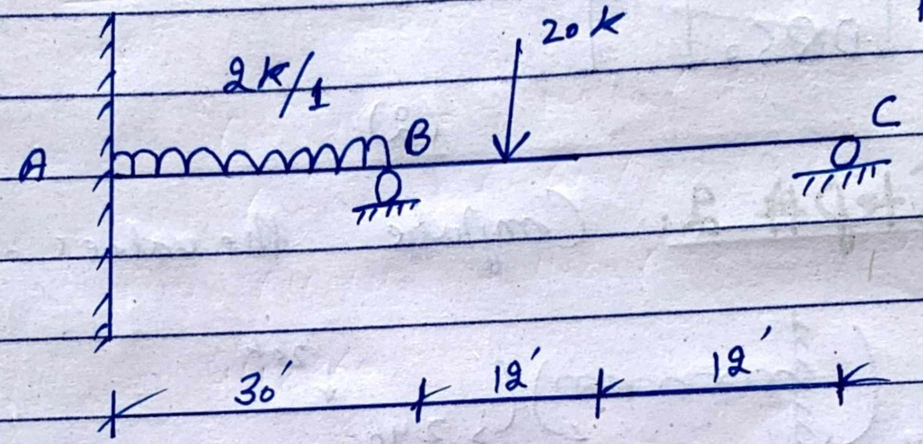
Dated = 21-08-2020

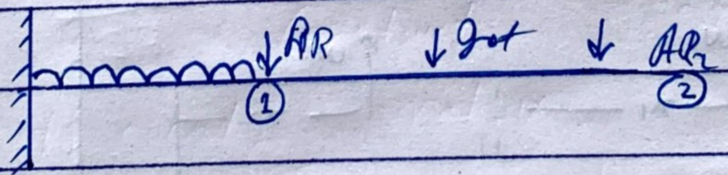
Q 1:- Analyze the given beam shown in FIG-1 by flexibility method. EI is constant.

Fig (1)



Soln:-

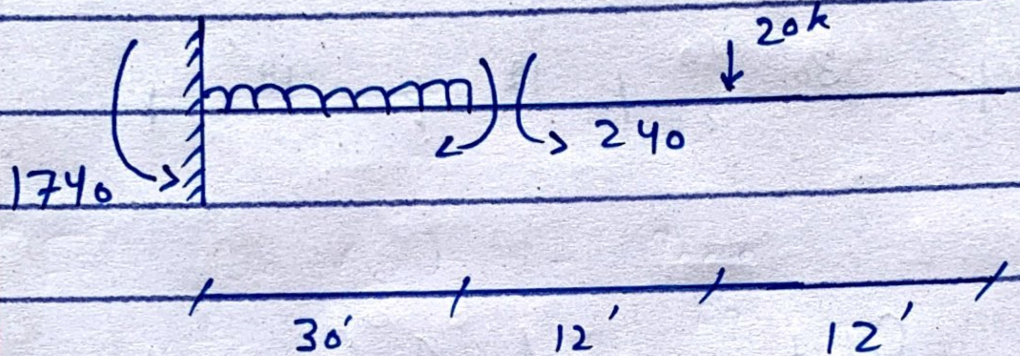
Step#1: Select redundant actions



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

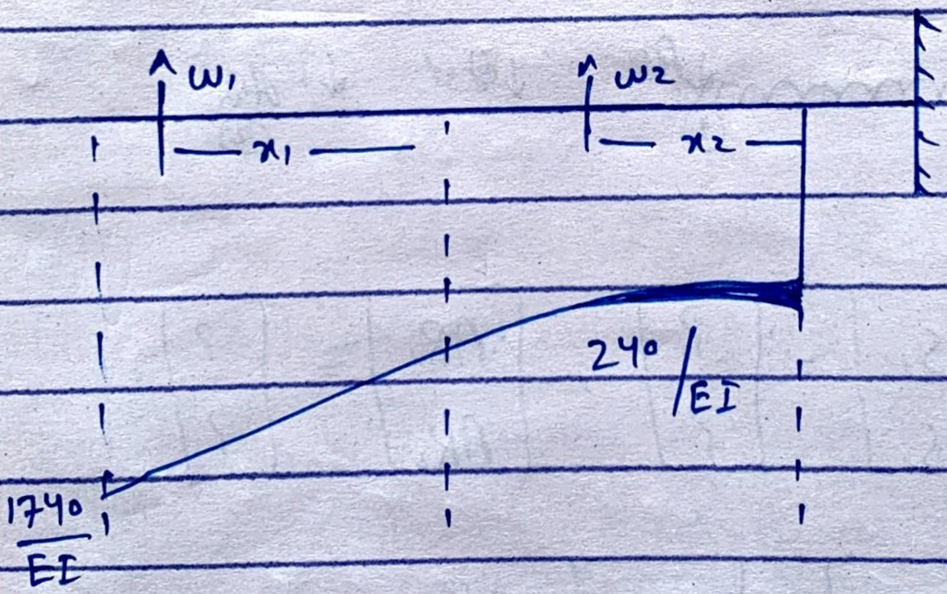
$$[DRS] = [DRL] + F * AR$$

Step# 2: Compute the values of [DBL]



$20 \times 12 = 240$

$(20 \times 42) + 2 \times 30 \times 15 = 1140$



$$w_1 = \left(\frac{240+0}{2EI}\right) \times 12 = 1440/EI$$

$$w_2 = \frac{1}{n+1} \times (b \times h) = \frac{1}{2+1}\left(\frac{1100}{EI}\right) \times 30 = 11000$$

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$$x_1 = \frac{L}{3}\left(\frac{a+2b}{a+b}\right)$$

$$x_1 = \frac{12}{3}\left(\frac{240+2(0)}{240+0}\right) = 4'$$

$$x_2 = \frac{3}{n+2} \times b = \frac{3}{2+2}(30) = 22.5'$$

$$DRL_1 = w_1(x_1+30) = 1440(4+30) = 48960$$

$$DRL_2 = w_1(x_1+40) + w_2(x_2+12)$$

$$= 1440(4+40) + 11000(22.5+12)$$

$$DRL_2 = 442860$$

$$[DRL] = \frac{1}{EI}\begin{bmatrix} 48960 \\ 442860 \end{bmatrix}$$

Step # 3: Construct flexibility co-efficient matrix

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

a) Apply a unit value of AR_1 at reference point i- compute the value of F_{11} & F_{21}

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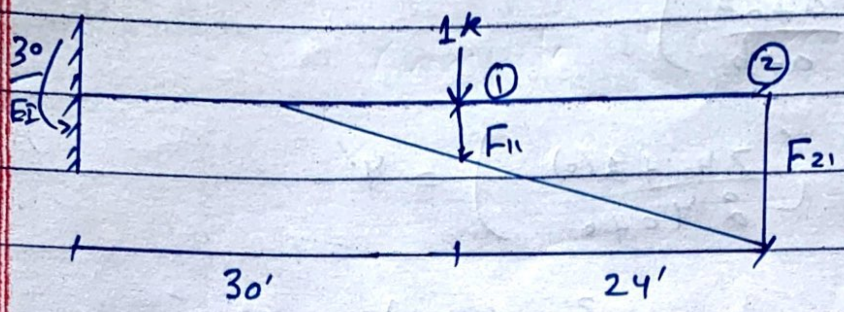
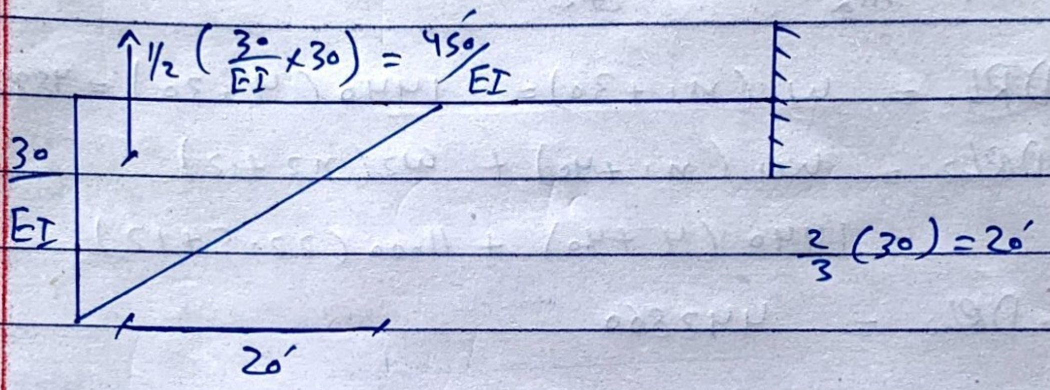
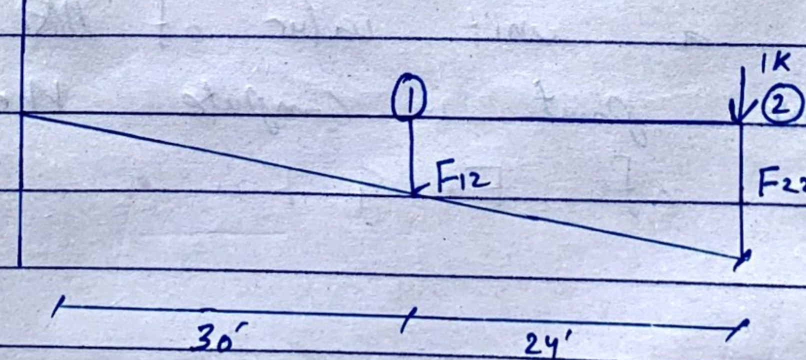




$$F_{11} = \frac{450}{EI}(20) = \frac{9000}{EI}$$

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

(b) Apply a unit of R_2 at reference point (2) ii. Compute the value of F_{12} & F_{22}



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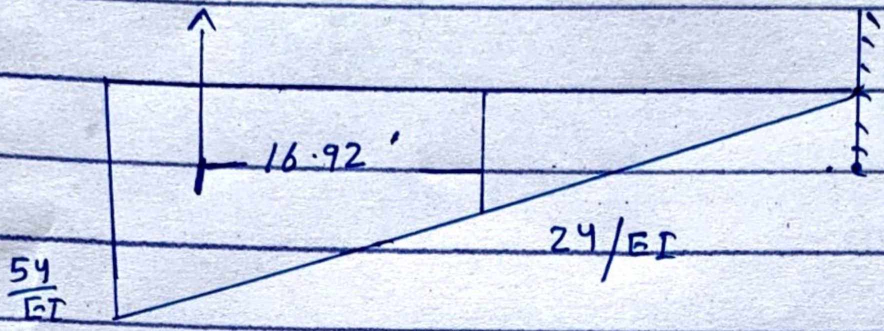
$$W = \left(\frac{54+24}{2EI}\right) \times 30 = \frac{1170}{EI}$$



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

$$F_{12} = \frac{1170}{EI} \times 16.92 = \frac{19800}{EI}$$

$$F_{22} = \frac{1}{2}(54 \times 54) \times \frac{1}{3}(30) + 24$$

$$= \frac{49572}{EI}$$

Q.2:- Differentiate between force method and displacement method and suggest which method is more suitable for structure analysis of matrix approach.

	Force methods	Displacement methods
1.	Flexibility matrix method	Stiffness matrix method
2.	Column analogy method	Kani's method
3.	Theorem of least work	Moment distribution method
4.	Method of consistent deformation	Slope deflection method
5.	This method is also known as flexibility or compatibility method	The displacement method (submersion, or dunking method)

6.	DS < Dk	DS > Dk
7.	No. of redundants = Ds	No. of redundants = Dk
8.	Not suitable for computer	Not suitable for truss.

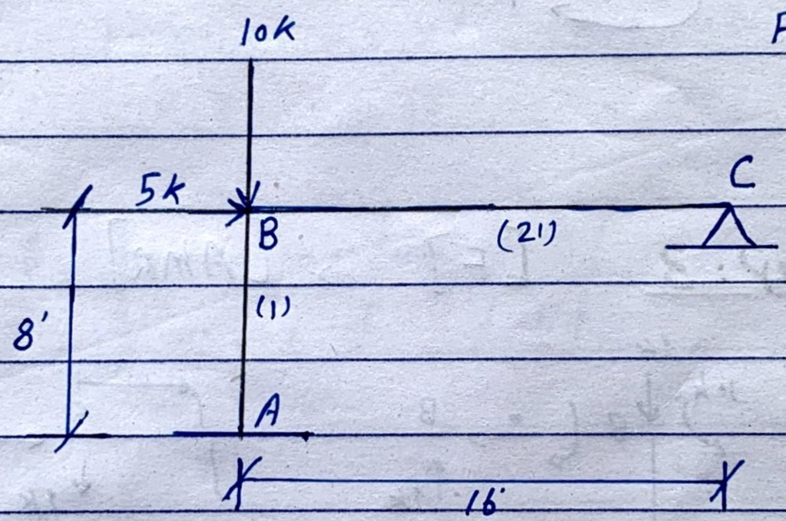
⇒ Displacement method is more suitable for structure analysis of matrix approach.

Indeterminacy = 6 − 3 = 3, while kinematic ~~kinetic~~ Indeterminacy = 0. So, better to start the calculation from moment distribution method.

Globally displacement based analysis of structure is easy and used more.

Q 3:- Analyzie the rigid - joint frame shown in FIG - 2 by flexibility method. Assume EI is constant for all members.

Fig(2)

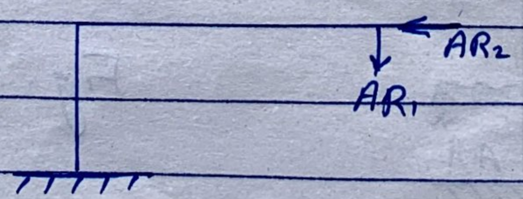


Sol.

Total statical indetermincy

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

Step # 01: Identify redundant Actions



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

Step #2: Compute value of [DRL]

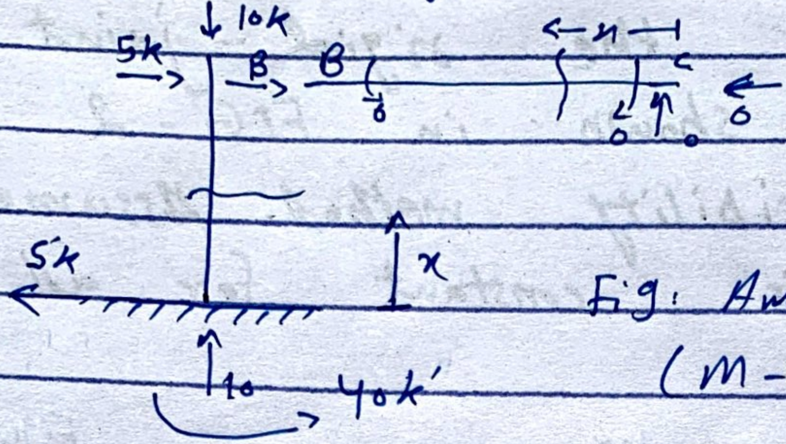


Fig: AmL values
(M-values)

Step: 3 [F] or [AMR]

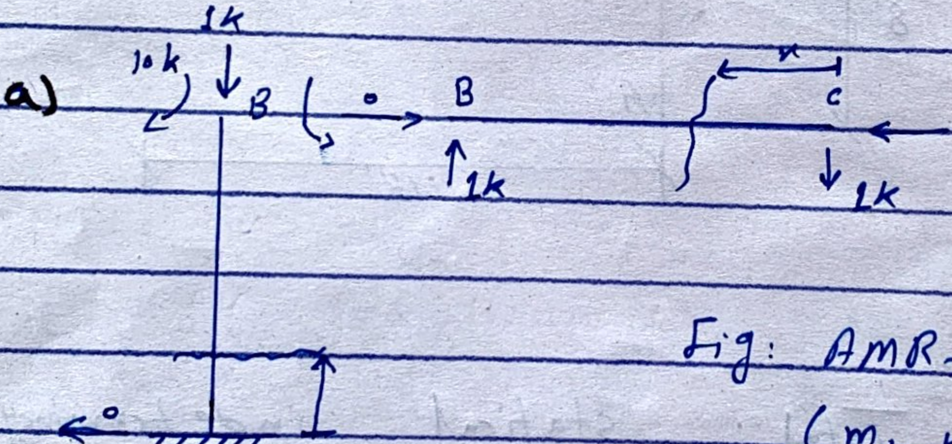


Fig: AMR-values
(m, values)

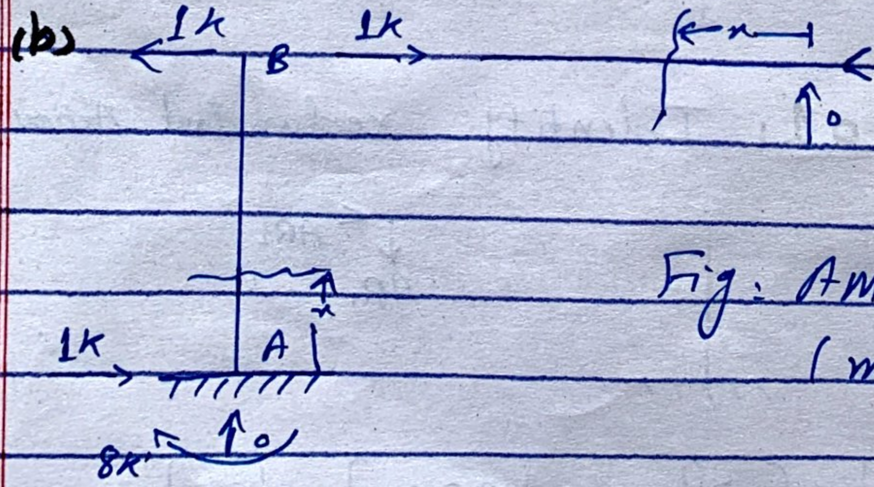


Fig: AMR values
(m2 values.

Member	AB	BC
Origin	A	C
Limit	0 - 8	0 - 16
I	I	2I
M	5x - 40	0 Take x section
m_1	-16	x → on m, Fig from the origin
m_2	8 - x	0

Select origin should be select the support

Take X-section At m, L Fig and Find

=> For Finding values of DRL :-

$$DRL_1 = \int_8^0 \frac{M_{AB} \cdot m_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot m(BC)}{EI}$$

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

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

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

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

=> **Compute Flexibility matrix :-**

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

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

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

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

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

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

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

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

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

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As we know

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

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

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

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

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

END