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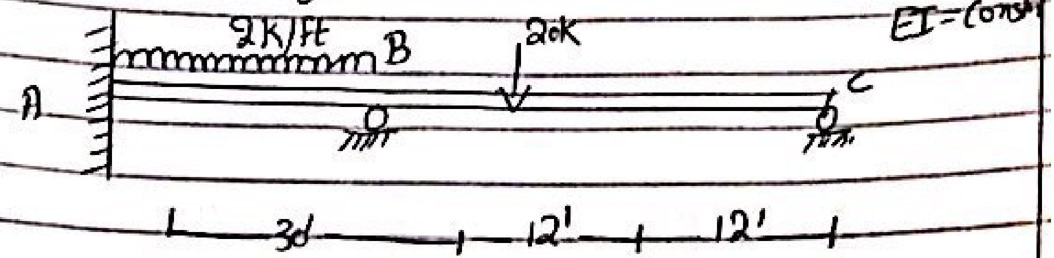
Subject Structure Analysis - II

Submitted to Engr Adeed KHAN

SEC "A"

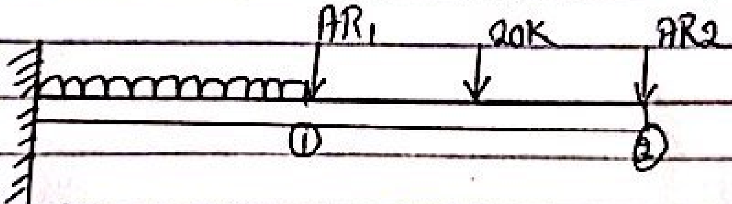
Q1 Analyze the given bean shown in FIG.1 by flexibility method. EI is constant.



Solution

Structural Indeterminarncy = 2°

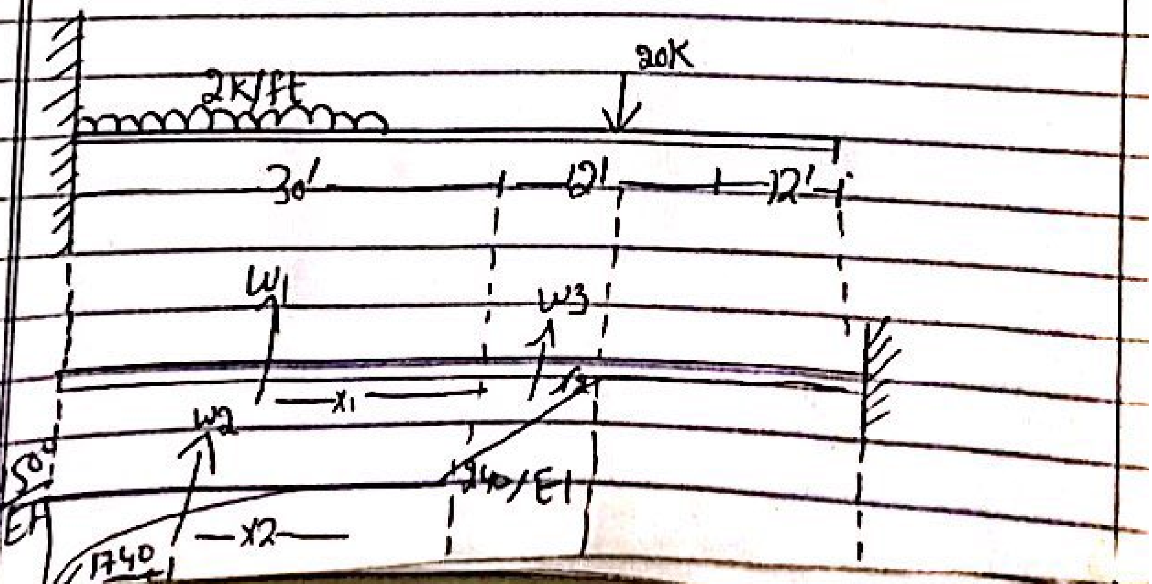
Step no 1 Select Redundant Actions



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

$$DRS = (DRL) + (F) \times (AR)$$

Step no 2 Compute the value of (DRL)



$w_1 = 1500 \times 30 = 45000$

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

$w_2 = \frac{1}{3} \times 30 \times 240 = 2400$

$w_3 = \frac{1}{2} \times 12 \times 240 = 1440$

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

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

$x_3 = 2/3 \times L = 2/3 \times 12' = 8'$

Finding DRL:-

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

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

$= 1755000 + 111600 + 28800.$

$DRL_2 = \frac{1895400}{EI}$

$DRL_1 = w_1(x_1) + w_2(x_2)$

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

$= 675000 + 54000$

$= 729000.$

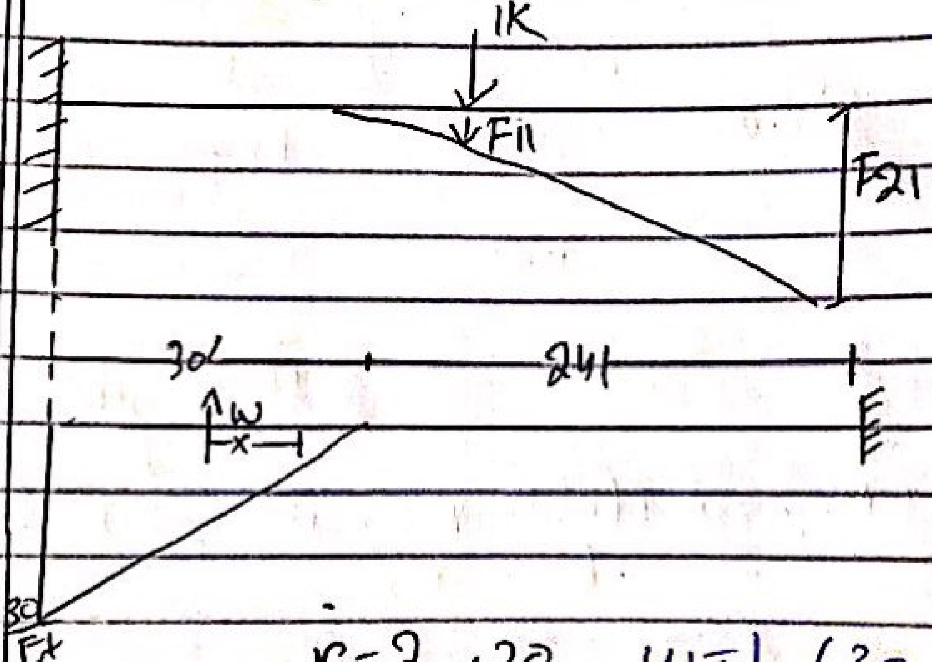
So

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

Step no 3 Flexibility matrix

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

a Applying unit load on AR_1



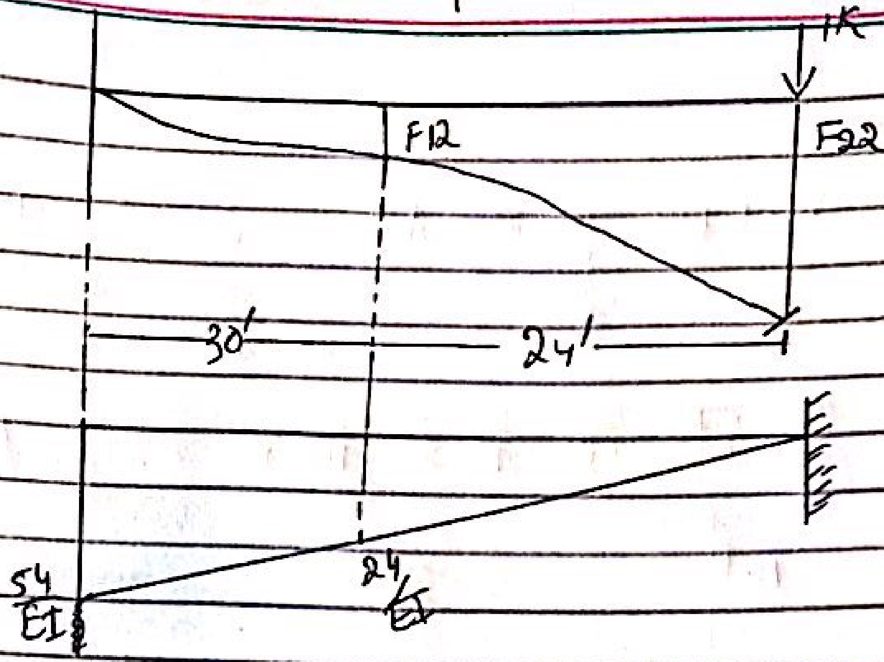
$$\bar{x} = \frac{2}{3} \times 30 = 20 \qquad w = \frac{1}{2}\left(\frac{30}{EI} \times 30\right) = \frac{450}{EI}$$

So

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

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

Now Apply unit Load on AR_2



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

$$= \frac{1170}{EI}$$

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

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

Step 4 Compute the vslue of AR

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

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

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

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

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

$$(430887600 - 391968720)$$

$$|F| = 38918880$$

$$\text{Adj } F = \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{E1} \times \frac{1}{38918880}$$

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{E1} \times \frac{\begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}}{38918880}$$

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

Q#2 Differentiate b/w force method and displacement method and suggest which method is more suitable for structure analysis of matrix approach.

Scanned with CamScanner

Ans:

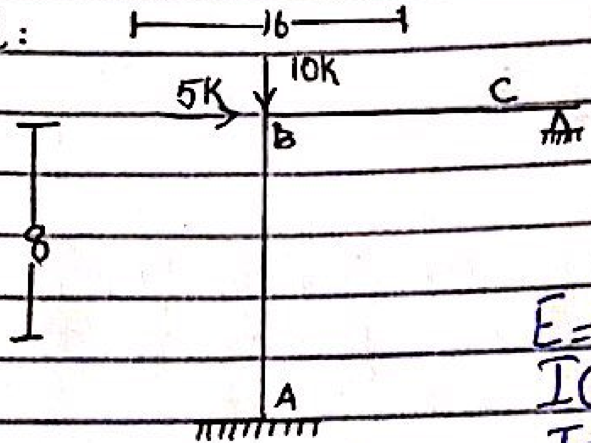
Force Method	Displacement Method
* $D_s < D_k$	* $D_s > D_k$
* Starts with equillibrium of forces	* Starts with Compatible deformation.
* Forces are reductant or unknowns.	* Displacement are reductant or unknown.
* No of reductants = D_s	* No of reductants = D_k
* Forces found by Compatibility of displacements	* Displacement found by equillibrium of forces.
* Not Suitable for Compus	* Not Suitable for trusses

* Stiffness method also Called displacement method 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 ~~es~~ is that it is Conductive to Computer Programming. 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.

Q No 3 Analyze the rigid-joint frame shown in FIG-Q by flexibility method. Assume EI is constant for all members.

Pb No 01:

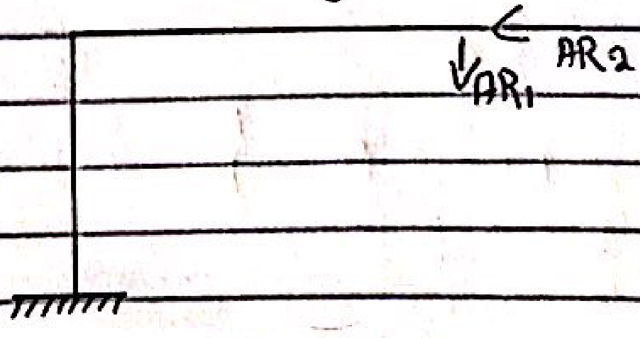


$E = Constant$
$I_C = I$
$I_B = 2I$

Solution

Total statical indeterminacy
$\Rightarrow R - 3 = 5 - 3 = 2^\circ$

Step no 01 Identify Redundant Actions



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

Step no 2:- Compute value of [DRL]

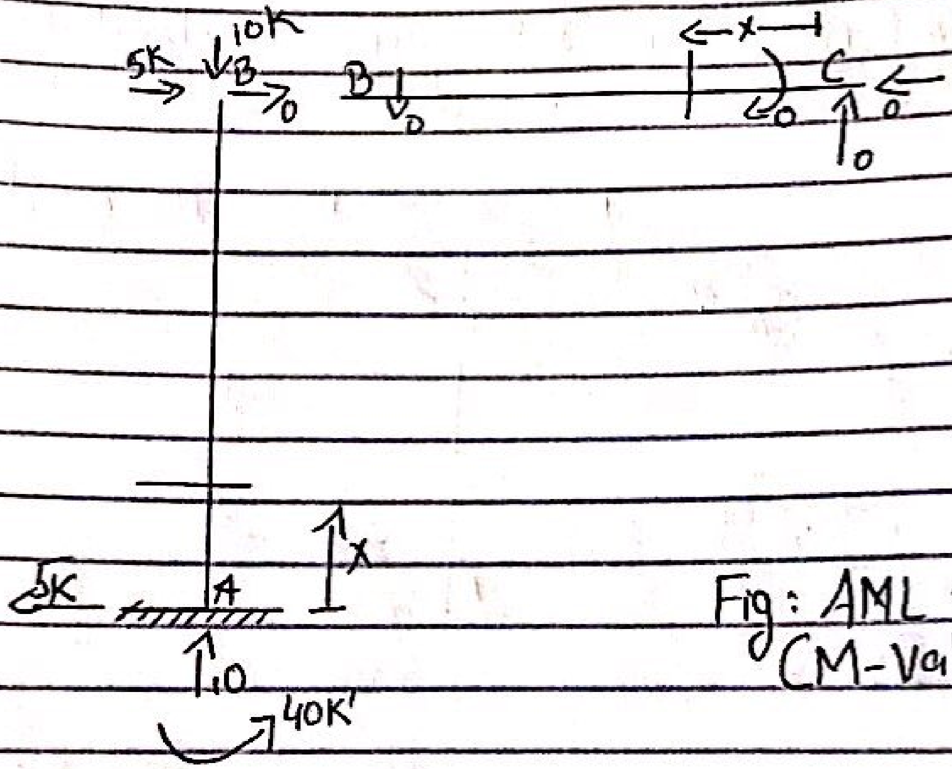


Fig: AML valus
CM-Values

Step no 3: [F] or [AMR]

(a)

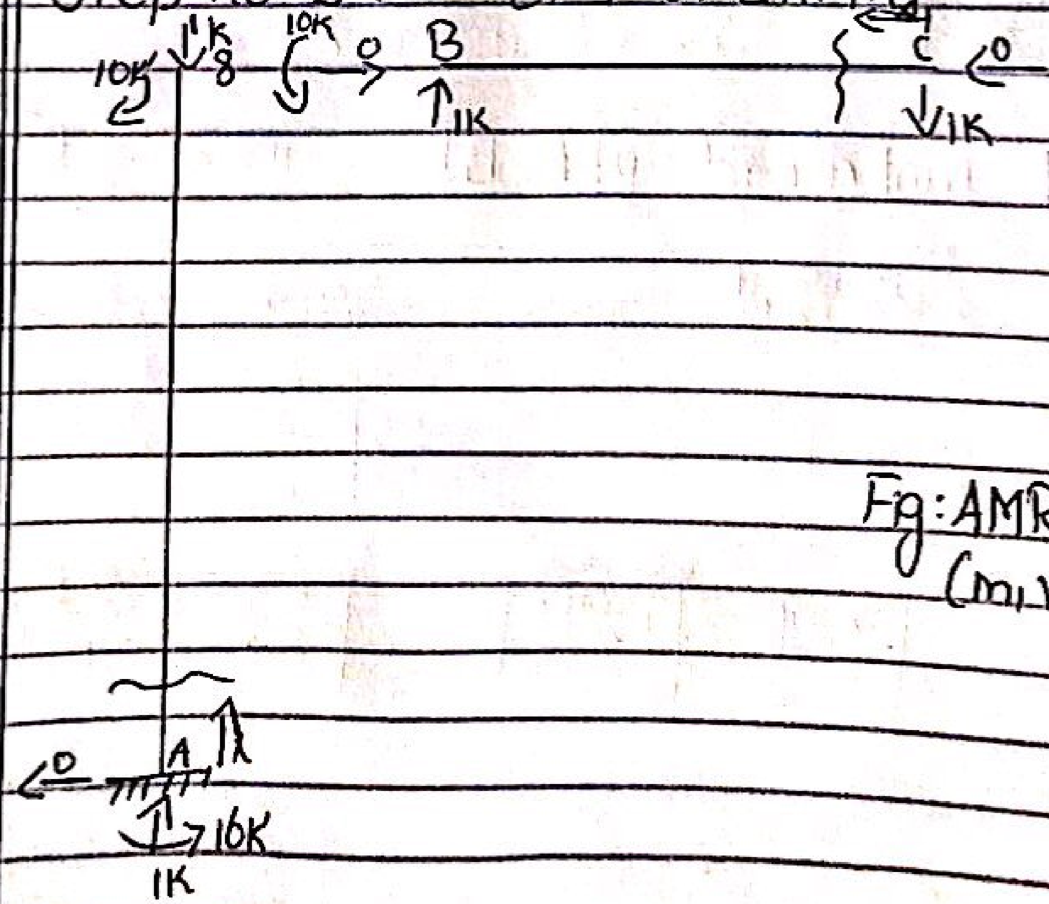


Fig: AMR-value
(mi values)

b)

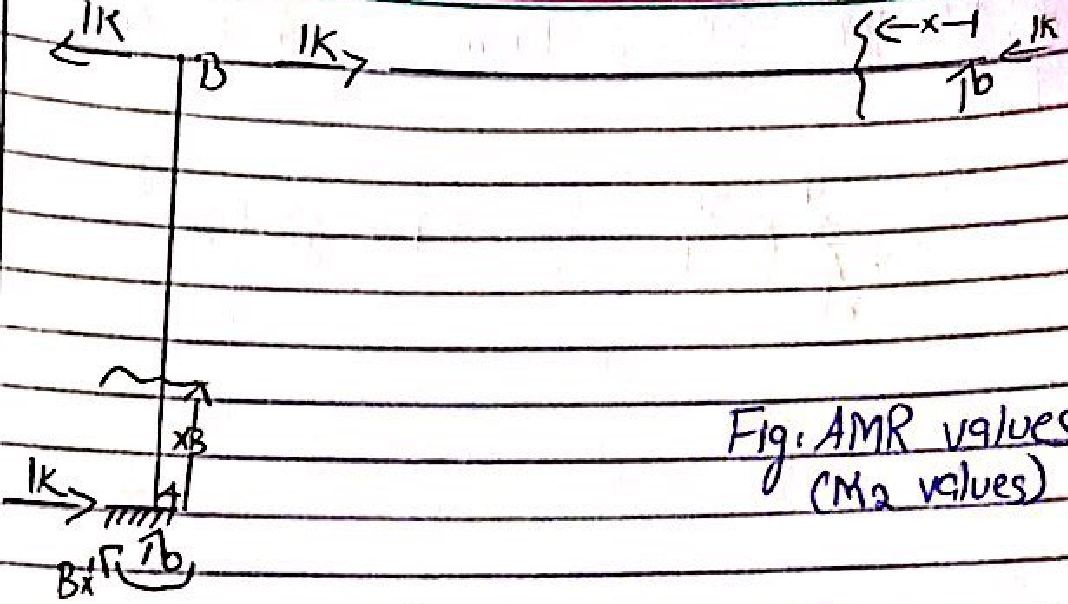


Fig: AMR values (M2 values).

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

select origin should be select the support

Take x-section AML fig & find moment

Take x section on m1 fig from the origin

⇒ For finding value of DRL :-

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

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

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

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

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

⇒ Compute Flexibility Matrix:-

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

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

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

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

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

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

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

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

$$F_{22} = 170.67.$$

As we know

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

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

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

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

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

1 mode → matrix
2 mata (1)
3 select order
4 put value & (risk =
5 Press (on)
6 Shift + 4
7 Press 1 (Dimenien
8 Press 2 (mat B)
9 Select order & put values
10 Press on
11 shift + 45 matA × mate = result.