Submitted To : Engr. ADEED

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Subject : Structure Analysis . II

ID-NO : 7755

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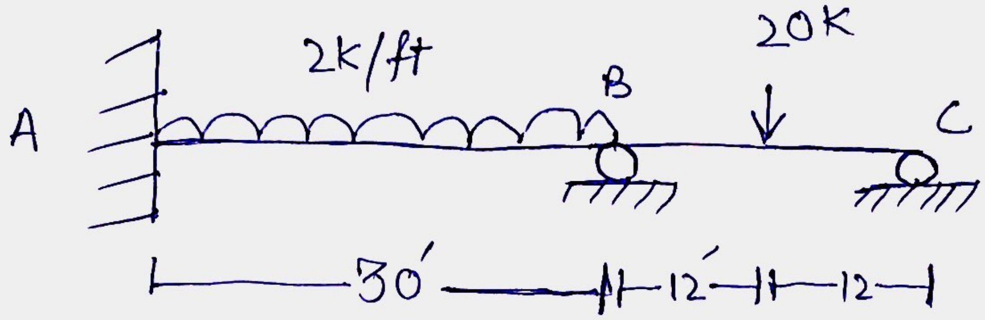
Question No # 01



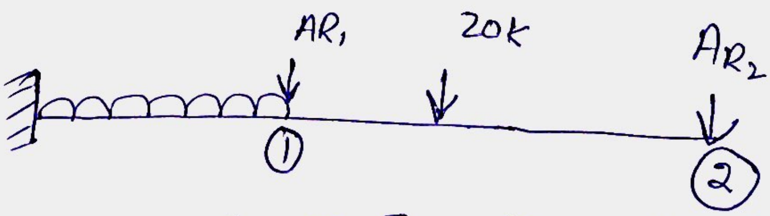
EI = Constant

Solution:

Structural Indeterminacy = ?

Step #01

Select Redundant Actions



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

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

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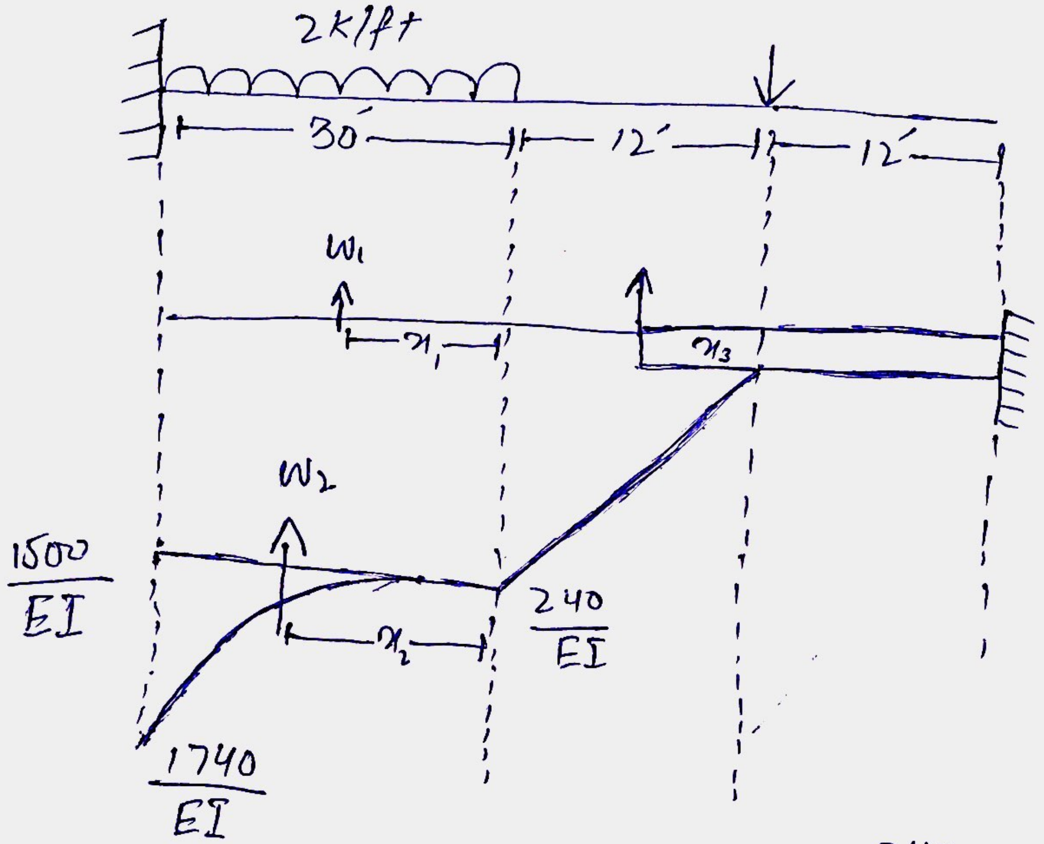
Step # 02

Compute the values of [DRL]



$20 \times 12 = 240$

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

$$w_1 = 1500 \times 30 = 45000$$

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

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

$$x_1 = \frac{b}{2} = \frac{30}{2} = 15'$$

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

$$x_3 = \frac{2}{3} \times L = \frac{2}{3} \times 12 = 8'$$

Now Finding DRL

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

$$DRL_1 = 45000(15) + (2400)(22.5)$$

$$\boxed{DRL_1 = 729000\ EI}$$

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

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

$$= 1755000 + 111600 + 28800$$

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

So

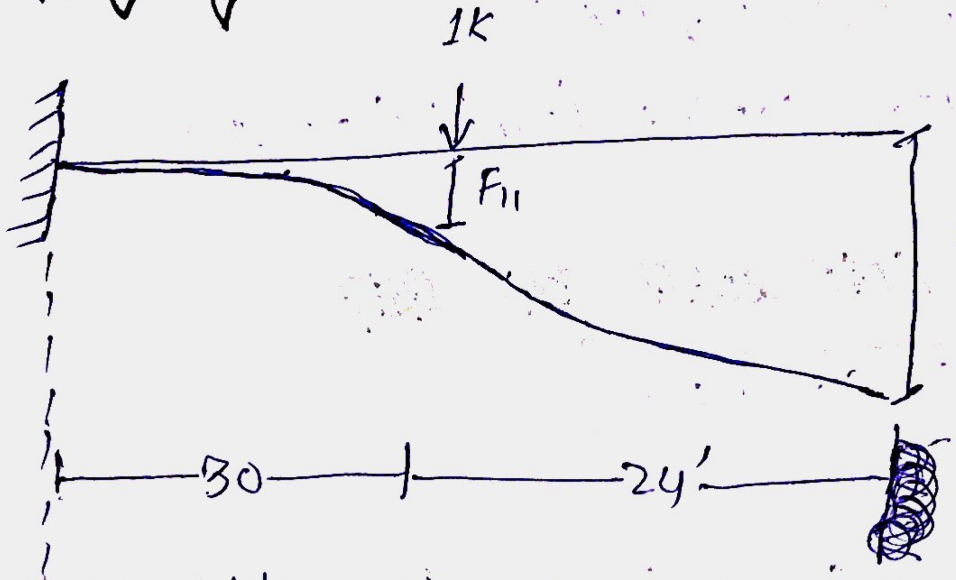
$$DRL = \frac{I}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

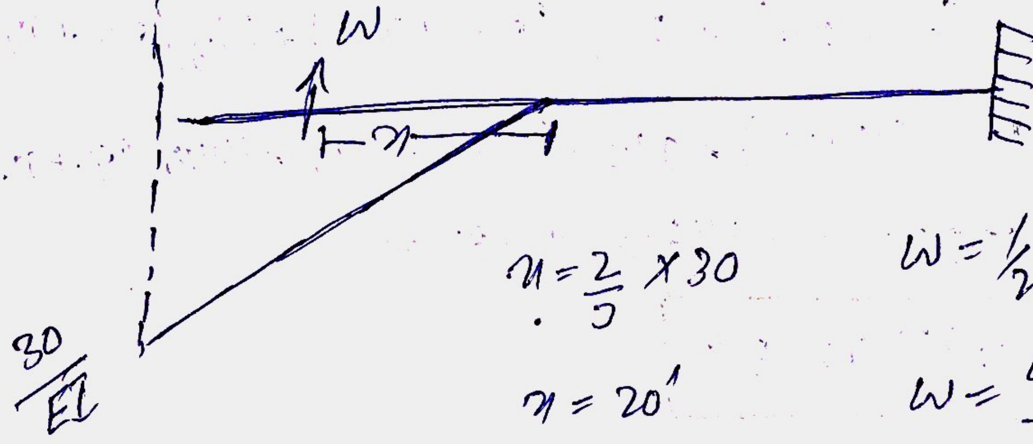
Step # 03

Flexibility matrix

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

a) Applying unit load on AR_1





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

$x = 20'$

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

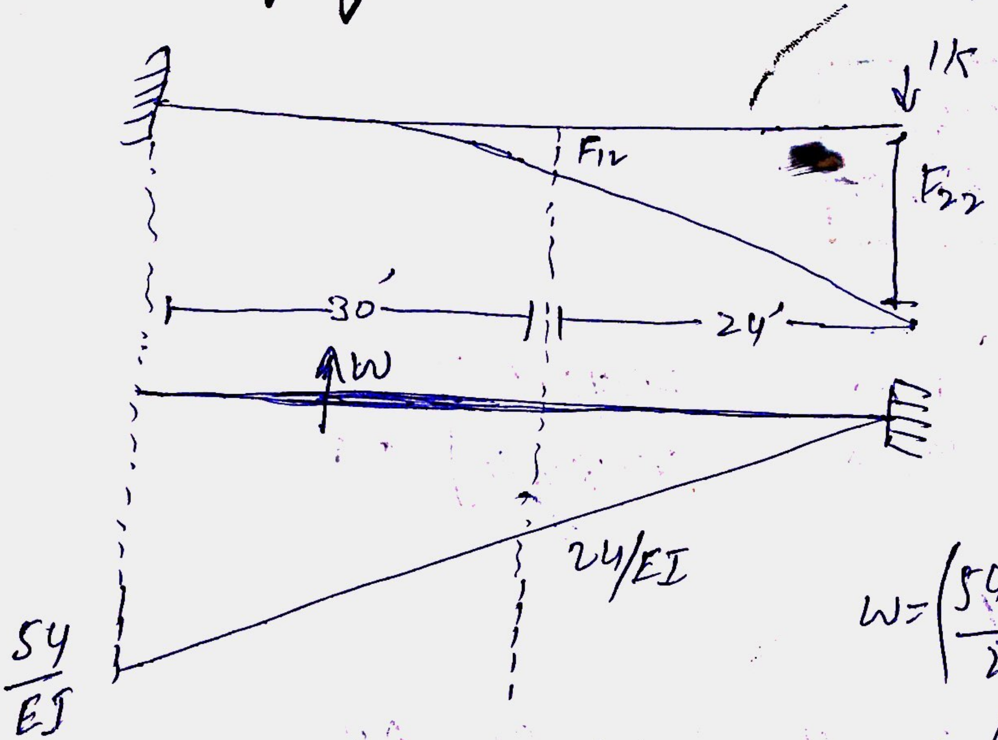
$W = \frac{450}{EI}$

So,

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

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

(B) Applying Unit load on AR_2



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

Now the distance

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

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

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

$$\boxed{F_{12} = \frac{19796.4}{EI}}$$

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

$$\boxed{F_{22} = \frac{47876.4}{EI}}$$

Hence

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

Step # 04

Compute the value of AR

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

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

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

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47896.4 \end{vmatrix}} \times \text{Adj} \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

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

$$|F| = (430887600 - 391968720)$$

$$|F| = 38918880$$

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880} \begin{bmatrix} 47876.4 & -19796 \\ -198000 & 900 \end{bmatrix}$$

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

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

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QNO # 02

FORCE Method	Displacement Method
* It is also known as flexibility matrix method or Compatibility method	* It is also called as equilibrium method or Stifness method matrix.
* In force method the unknown are taken as force or reaction	* In displacement method the unknown are taken as joint displacement (θ, Δ)
* In this the number of redundant = D_s	* In this the number of Redundant = D_K
* In this the ~~number~~ forces are found by compatibility equations of displacement.	* In this the displacement are found by equilibrium equations of forces
* In this the type of Indeterminacy is static Indeterminacy	* In this the type of Indetermimny is kinematic Indetermenny
* It is suitable when $D_s < D_K$	* It is suitable when $D_s > D_K$.

Suitable Method

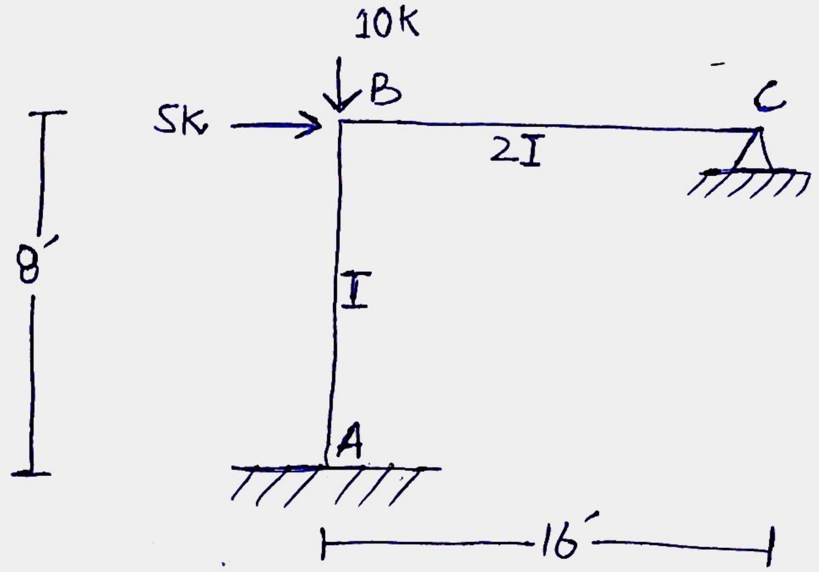
⇒ For analysis of structure of matrix approach both the force method or displacement method can be used depend upon situation

★ When the degree of Static Indeterminacy (D_s) is less than the degree of Kinematic Indeterminacy (D_K) i-e $D_s < D_K$ than It is suggested to use force method of analysis.

★ When the degree of Static Indeterminacy (D_s) is more than the degree of Kinematic Indeterminacy (D_K), $D_K < D_s$

than It is suggested to use "Displacement method of Analysis".

Question # 03



E = Constant

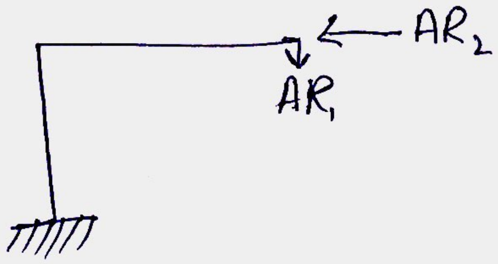
Solution :-

Total Statical Indeterminacy

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

Step # 01

Identifying Redundant actions



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

Step # 02

Compute value of [DRL]

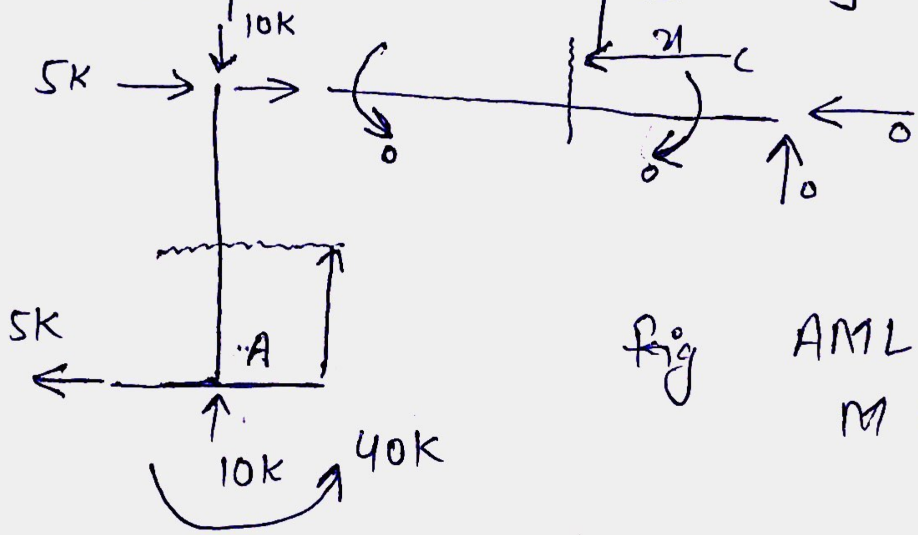


Fig AML value
M value

Step # 03

[F] or [AMR]

(a)

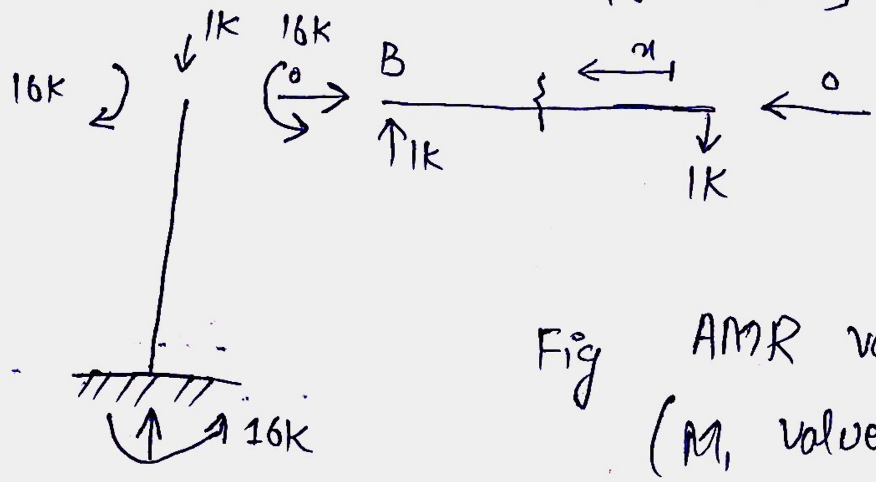


Fig AMR value
(M_1 values)

(b)

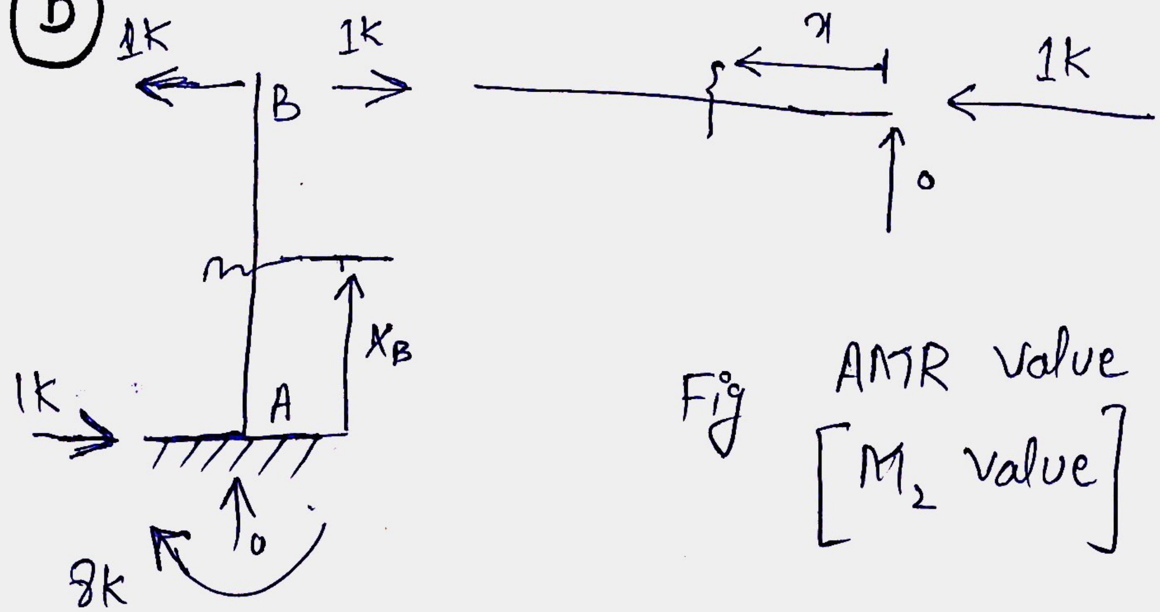


Fig AMR value [M_2 value]

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

→ Finding values of DRL

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

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

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

$$DRL_2 = \int_0^8 \frac{(5x-40)(8-x)\,dx}{EI} + \int_0^{16} \frac{0.0}{E(2I)}\,dx$$

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

→ Compute Flexibility Matrix

12°

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

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

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

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

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

$$= \int_0^8 \frac{(-16)(8-x)\, dx}{EI} + \int_0^{16} \frac{(x)(0)}{E(I2)}\, dx$$

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

$$\Rightarrow F_{22} = \int_0^8 (m_1)^2\, AB\, dx + \int_0^{16} (m_2^2)\, Bc\, dx$$

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

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

As we know that

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

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

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

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.00088 \\ 4.97 \end{bmatrix}$$

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