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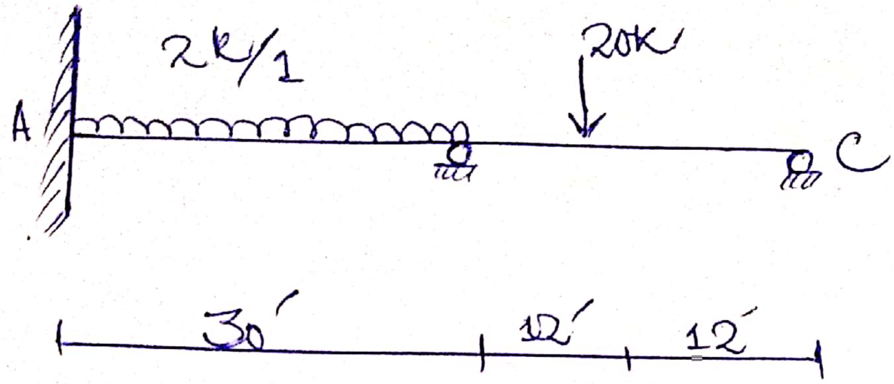
SUBJ: STRUCTURAL ANALYSIS II

INSTRUCTOR:
ENGR ADEED

MAJOR MID ASSIGNMENT:

Question No 1:



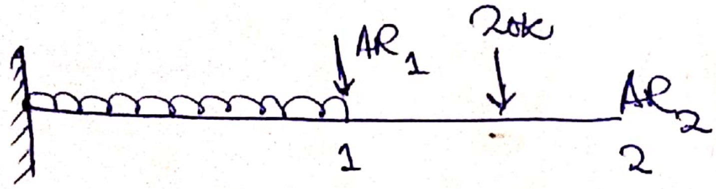
Sol:

EI constant

S.I = 2°

Step 1

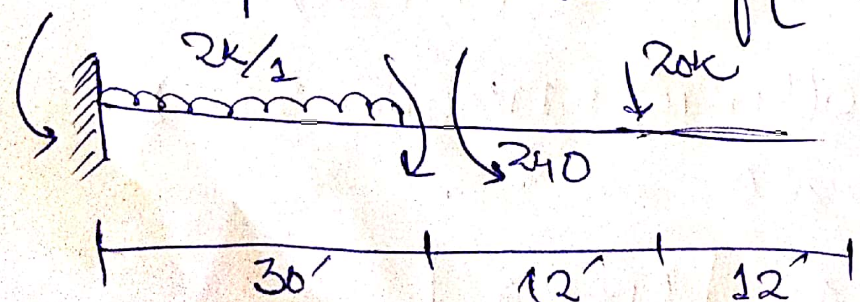
Select redundant actions



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

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

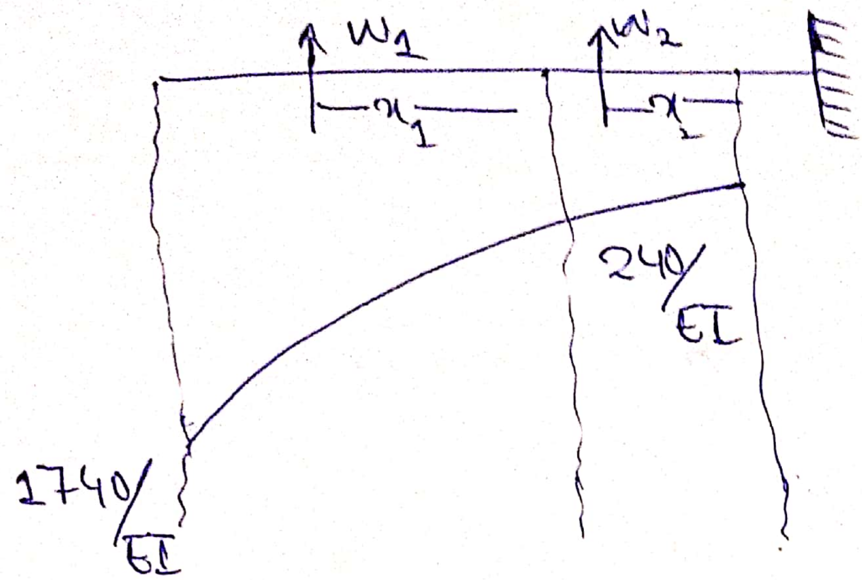
Step 2: Compute the values of [DRL]



$2 \times 12 = 240$

$(20 \times 42) + 2 \times 3 \times 15$

$= 1740$



$$W_1 = \left(\frac{240+0}{2EI}\right) \times 12 = 1440/EI$$

$$W_2 = \frac{1}{n+1} \times (b \times h) = \frac{1}{2+1}\left(\frac{1100}{EI}\right) \times 30 = 11000/EI$$

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

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

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

$$DRL_1 = W_1(x_1+30) = 1440(4+30) = 48960$$

$$DRL_2 = W_1(x_1+40) + W_2(x_2+12)$$

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

$$DRL_2 = 442860$$

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

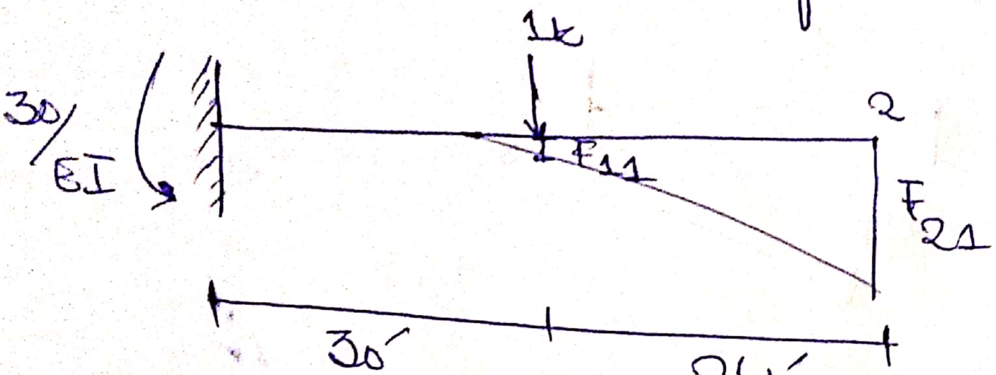
Scanned with CamScanner

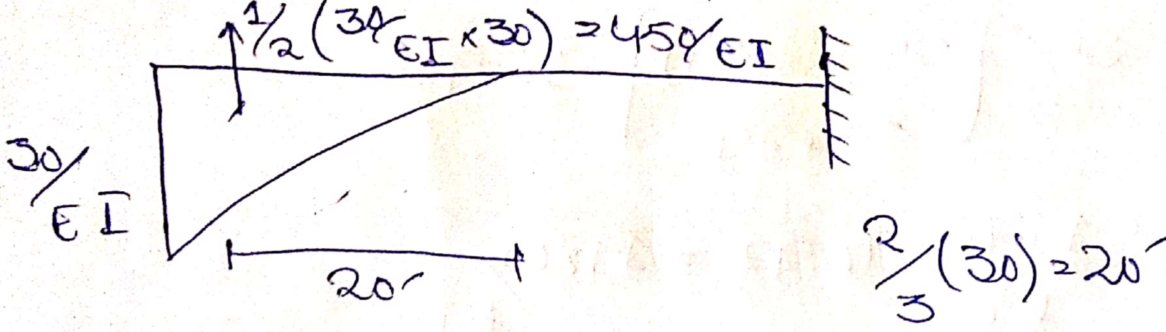
Step 3:

Construct flexibility co-efficient matrix

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

a) Apply a unit value of ΔR_1 at reference point & Compute the value of F_{11} & F_{21}

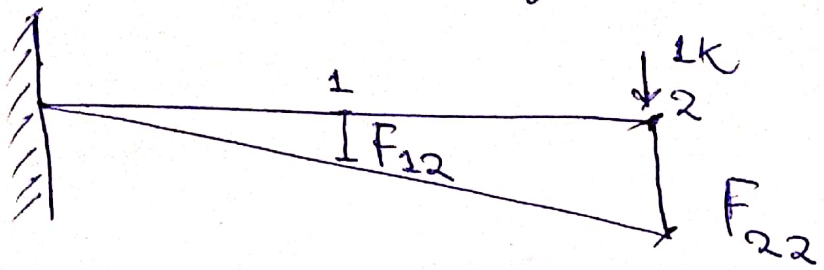


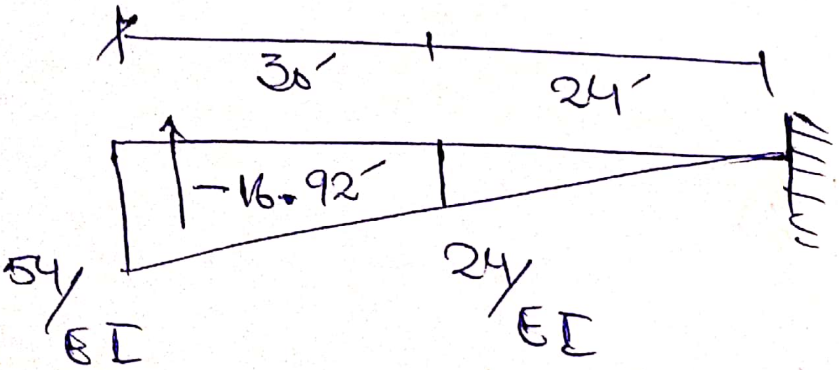


$$F_{11} = \frac{450}{EI}(20) = \frac{9000}{EI}$$

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

(b) Apply a unit of AR_2 at reference point & compute the value of F_{12} & F_{22}





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

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

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

$$F_{22} = 1/2(54 \times 54) \times 1/3(30) + 24 = 49572/EI$$

Step No 4:

Compute the values of

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

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

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

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 474876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

$$|F| = (9000 \times 474876.4 - 19796.4 \times 19800)(430887600 - 391968720)$$

$$|F| = 38918880$$

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

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

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

$$\begin{bmatrix} \Delta R_1 \\ \Delta R_2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}$$

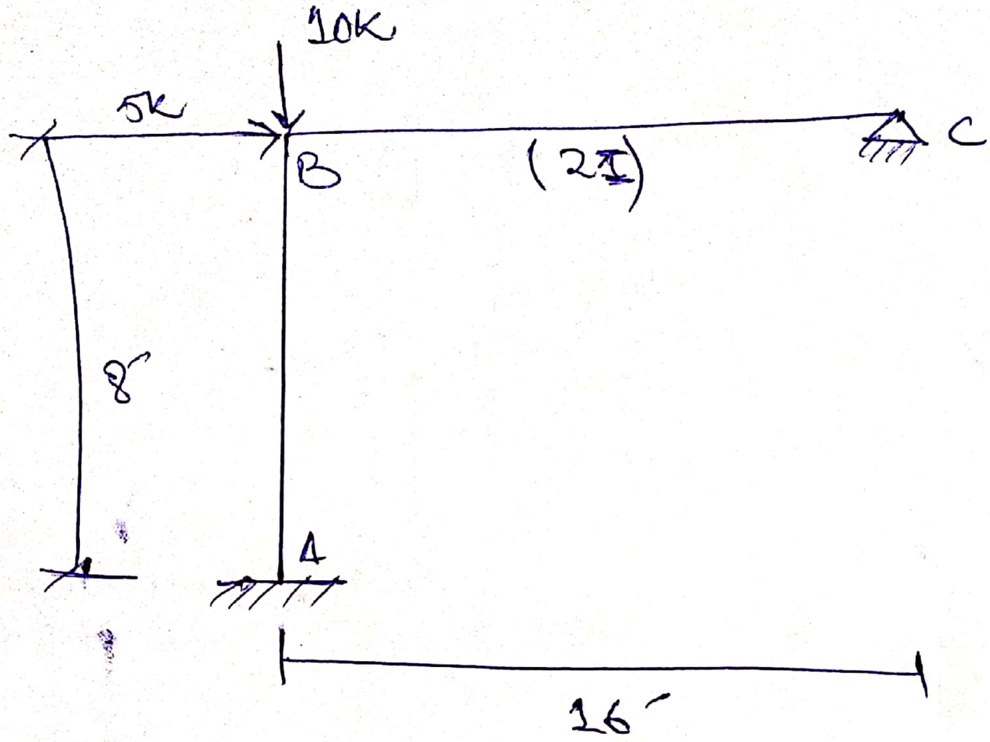
Question No 2:

Ans:

Force Method	Displacement Method:
→ $D_s < D_k$	→ $D_s > D_k$
→ Forces are redumtant or unknown	→ Displacement are redumtant or unknown.
→ Starts with equilibrium of forces	→ Starts with compatible deformation.
→ Forces found by compatibility of displacements.	→ Displacements found by equilibrium equation of forces.
→ No of redumtants = D_s	→ No of redumtants = D_k
→ Not suitable for compression	→ Not suitable for trusses.

Stiffness method also called displacement method is more suitable for structure analysis matrix approach, as it is primary method used in matrix analysis. The main advantage of this method over flexibility method is that 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 analyses

Question No 3:



; E = constant

$I_C = I$

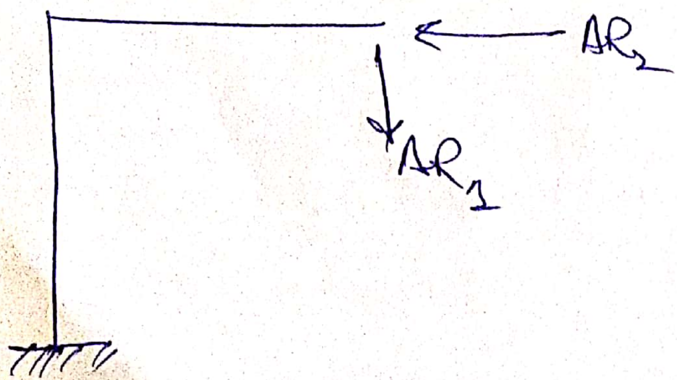
$I_B = 2I$

Solution:

Totatal statical indeterminacy

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

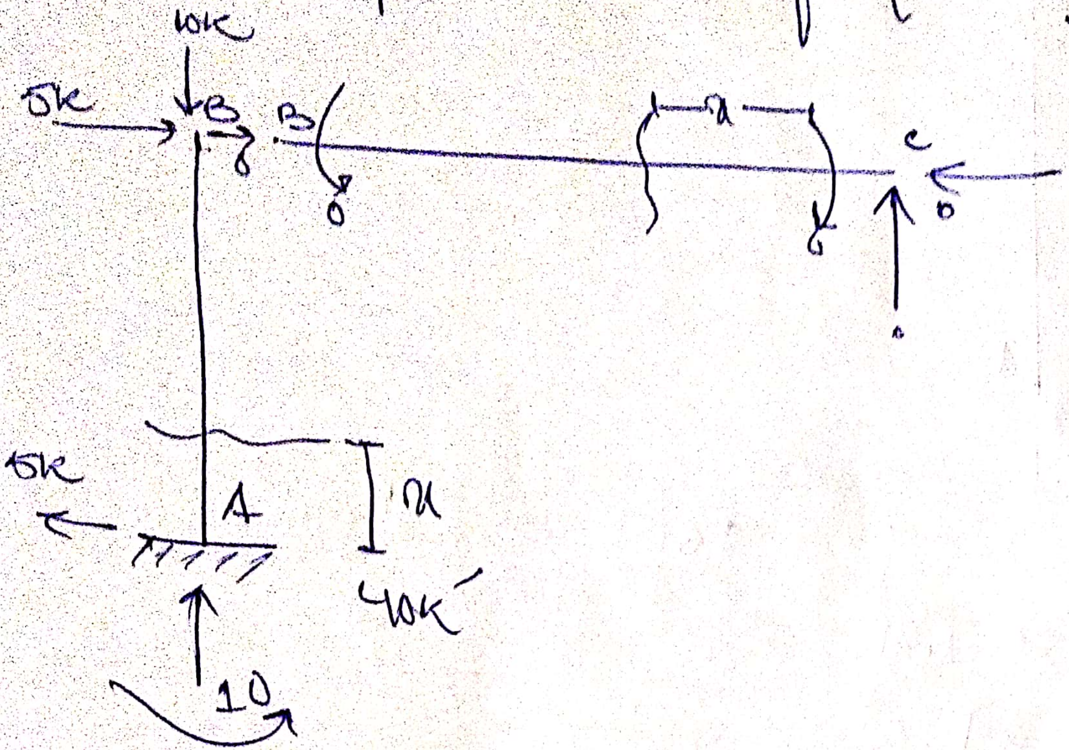
Step 1 Identify Redundant Actions.



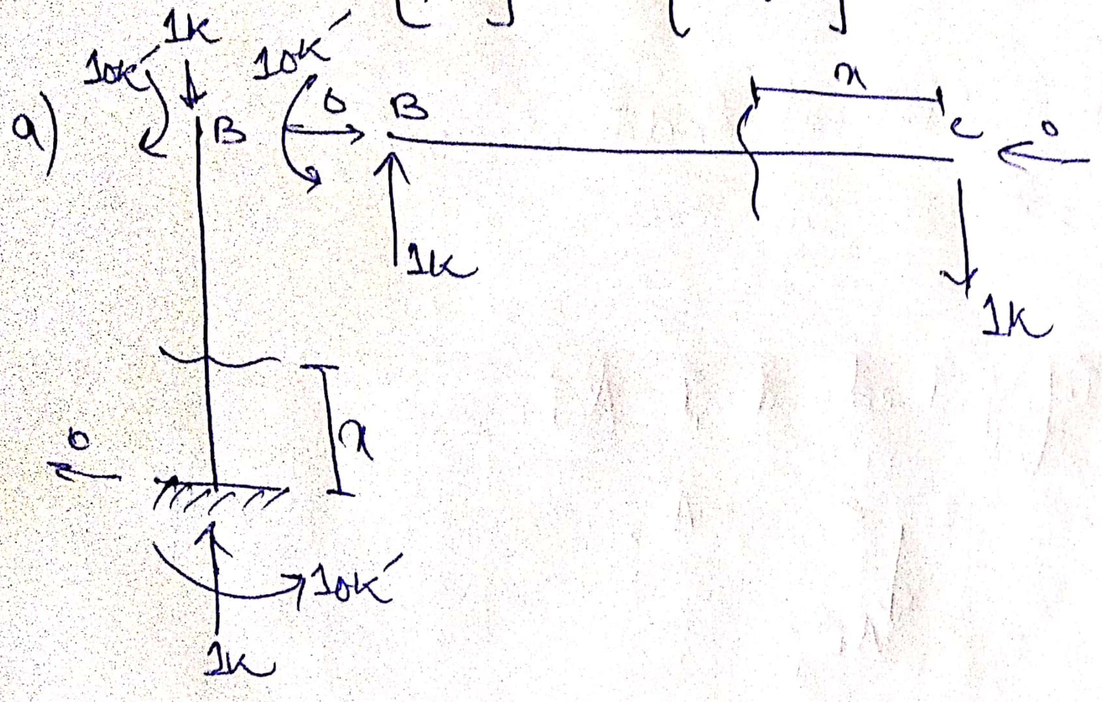
$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} , \begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

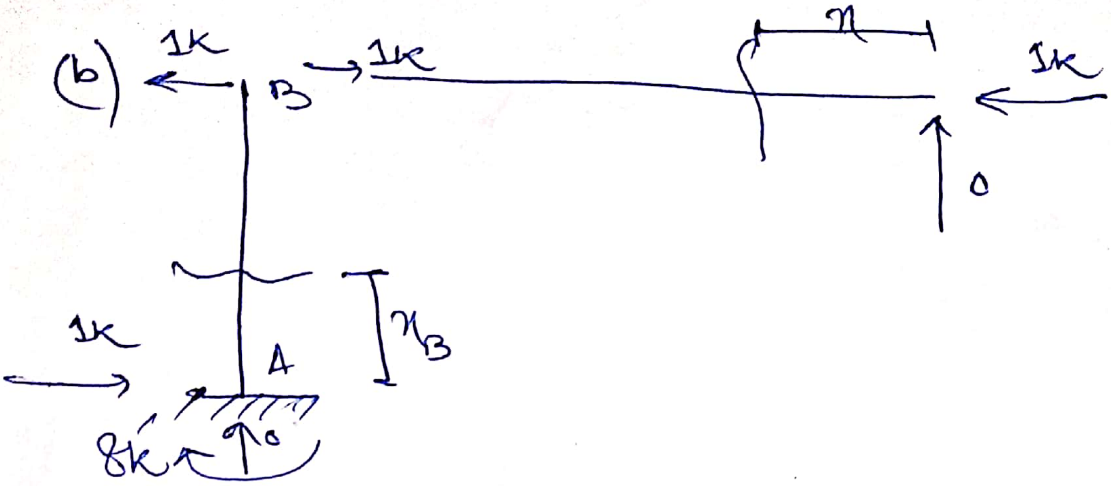
Step #2:

Compute Values of [DRL]



Step #3: [F] or [AMR]





Member	AB	BC
Origin	A	C
Limits	0—8	0—16
I	I	2I
⇐ M	$5x-40$	x
M_1	-16	0
M_2	$8-x$	0

→ For finding values of DRL :

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot M_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot M_2(BC)}{EI}$$

$$= \int_0^8 \frac{(5x-40)(-18)\,dx}{EI} + \int_0^{16} \frac{0 \cdot x}{E(2I)}\,dx$$

$$DRL_1 = 2560/EI$$

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

$$DRL_2 = -853.33/EI$$

→ Compute flexibility Matrix:

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

$$F_{11} = \int_0^8 \frac{M_1^2(AB)}{EI} + \int_0^{16} \frac{m_1^2(BC)}{EI} = \int_0^8 \frac{(-16)^2}{EI} dx + \int_0^{16} \frac{x^2}{E(2I)} dx$$

$$F_{11} = 2730.67/EI$$

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

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

$$F_{12} = F_{21} = -512/EI$$

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

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

$F_{22} = 170.67$

As we know

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

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

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

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

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