Horraira h Kabir

7758

Section B

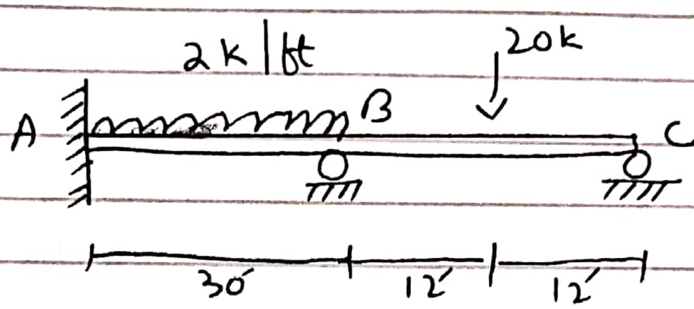
Structure Analysis - II

Sir Adeed

21-Aug-2020

Mid Summar 2020

# Question No 1



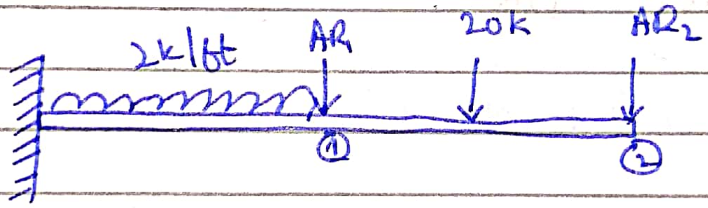

EI = const

## Solution:-

Structural Indeterminancy = 2°

## Step # 1

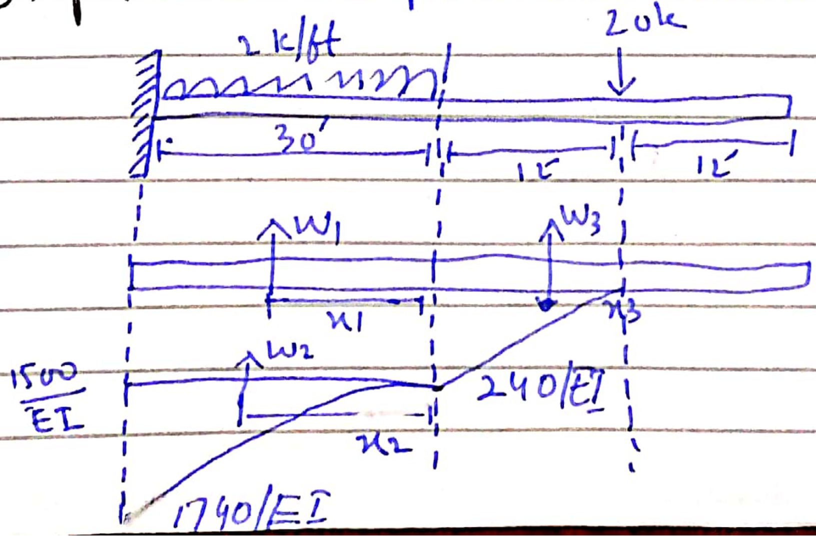
Select Redundant Actions




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

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

## Step # 02 Compute the values of [DRL]



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

$w_1 = 1500 \times 30 = 45000$

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

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

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

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

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

Now Finding DRL :-

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

$= 45000(15) + 2400(22.5)$
$= 675000 + 54000$
$= 729000$

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

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

$= 1755000 + 111600 + 28800$

$DRL_2 = 1895400/EI$

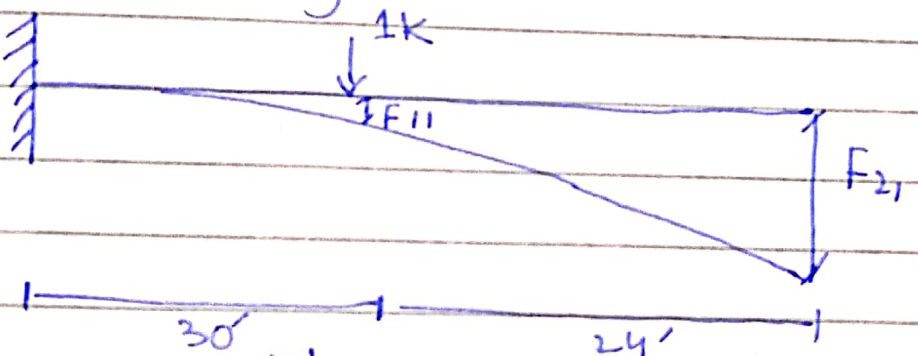
So,

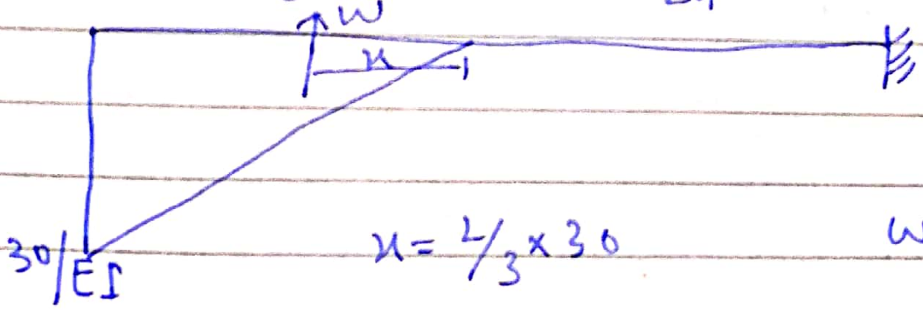
$$DRL = \frac{1}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

## Step # 3 Flexibility Matrix

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

a) Applying unit load on $AR_1$




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

$= 20'$

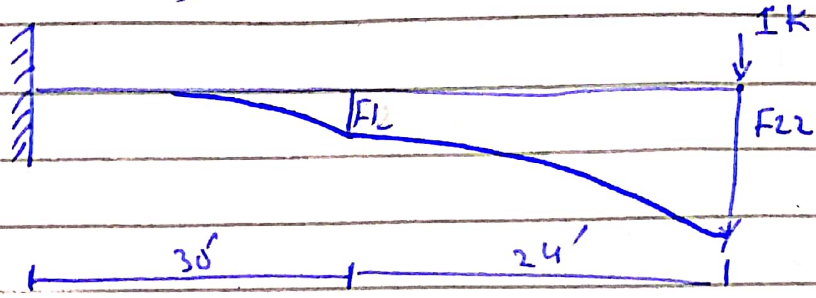
$w = \frac{1}{2}\left(\frac{30 \times 30}{EI}\right)$

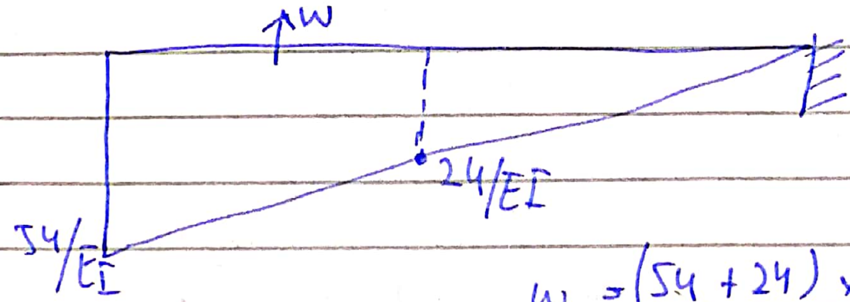
$= 450/EI$

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

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

Now apply unit load on AB.




$$w = \frac{(54+24)\times 30}{2EI}$$

$$= 1170/EI$$

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

$$F_{2\times2} = \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix} \frac{1}{EI}$$

## Step # 4 Compute the values of AR

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

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

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

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

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

$$|F| = 3891880$$

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

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

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

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

# Question No 2

| Force Method | Displacement Method |
|---|---|
| → $D_s \leq D_k$ | → $D_s > D_k$ |
| → Forces are redundant or unknown. | → Displacement are redundant or unknown. |
| → Starts with equilibrium of forces. | → Starts with compatible deformation. |
| → Forces found by compatibility equations of displacement. | → Displacement found by equilibrium equations of forces. |
| → Number of redundants = $D_s$ | → No. of redundants = $D_k$ |
| → Not suitable for compression. | → Not suitable for trusses. |

⇒ Displacement Method is suitable for structure analysis of matrix approach.

Stiffness method is also called Displacement method is more suitable for structure analysis matrix apprach as it is a primary method used in matrix analysis. The main advantage of this method 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 stiffness method in order to carry out the analysis.

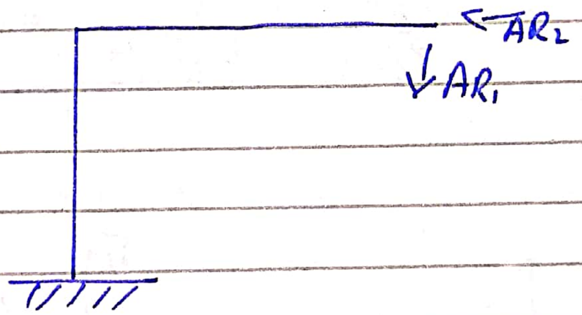
# Question No 3

**Step #1**

Total statical indeterminacy

$\Rightarrow R-3 = 5-3 = 2$

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 #2** Compute value of [DRL]

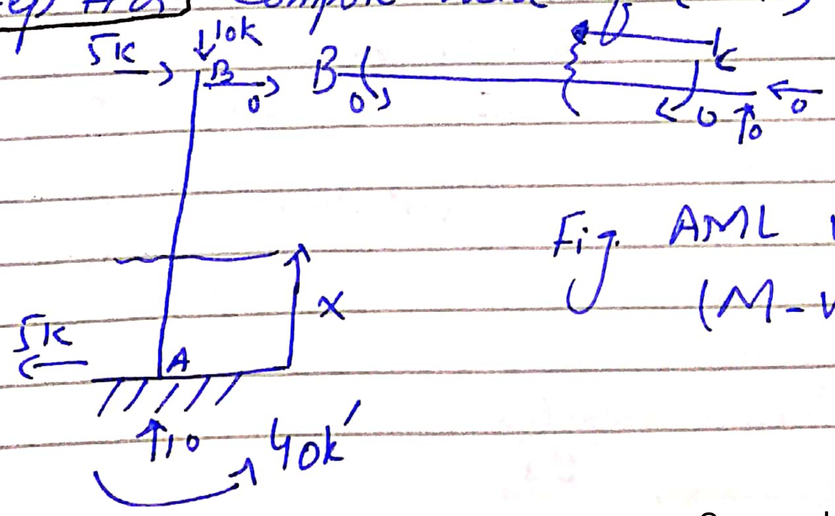



Fig. AML values (M-values)

## Step # 3 (F) or (AMR)

(a)

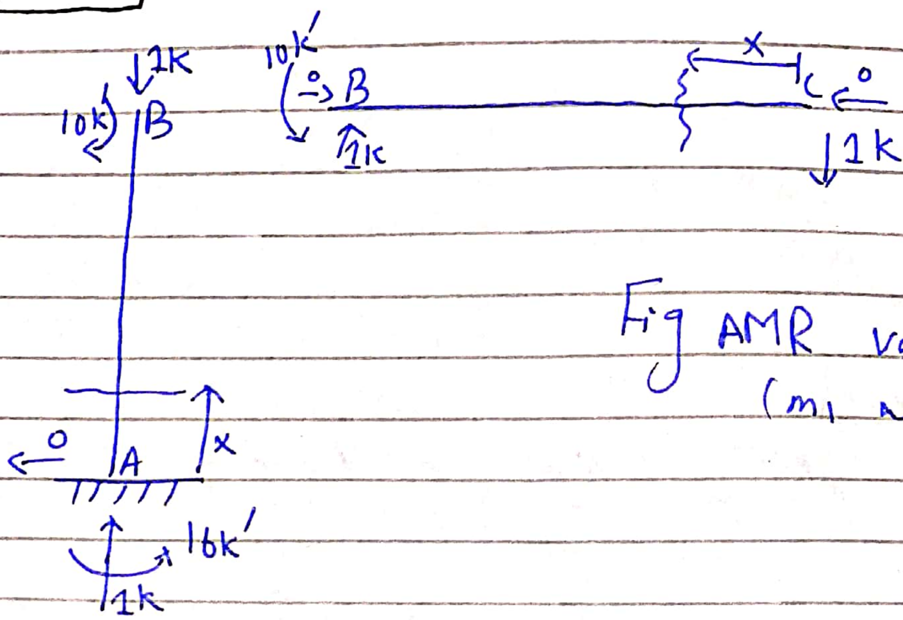



Fig AMR values ($m_1$ values).

(b)

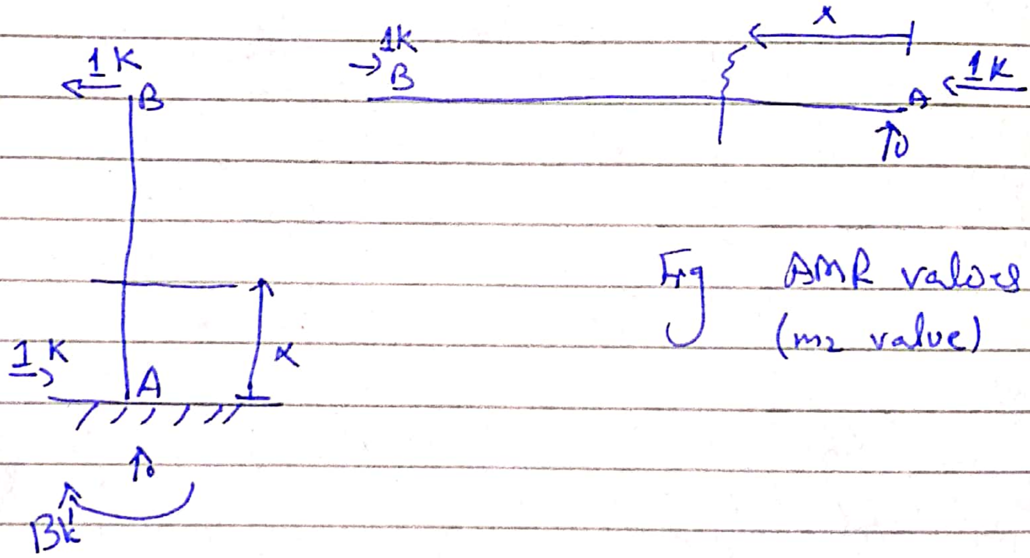



Fig AMR values ($m_2$ value)

⇒ For finding values of DRL's :-

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

$$= \int_0^{8} \frac{(5x-40)(-11)dx}{EI} + \int_0^{16} \frac{0 \cdot x\,dx}{EI}$$

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

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

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

⇒ Compute Flexibility Matrix:-

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

$$\Rightarrow F_{11} = \int_0^8 \frac{m_1^2(AB)}{EI} + \int_0^{16} \frac{m_2^2(BC)}{EI}$$

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

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

$$F_{12} - F_{21} = \int_0^8 m_1(AB) \cdot M_2(AB) + \int_0^{16} m_1\left(BC\right) \cdot m_2(BC)$$

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

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

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

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

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

As we know

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

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

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

$$= \begin{bmatrix} 273.67 & -512 \\ -512 & 170.67 \end{bmatrix}^{-1} \times \begin{bmatrix} 0 & -2560 \\ 0 & +853.33 \end{bmatrix}$$

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