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|---|---|
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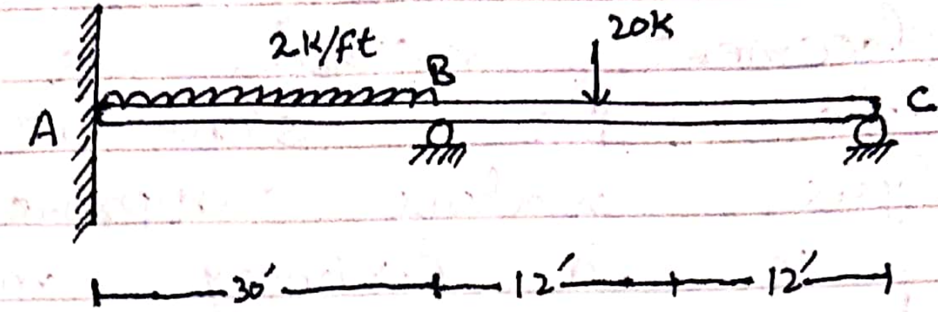
| Sec | A |
| Subject | Structure II |
| Date | 21/8/2020 |

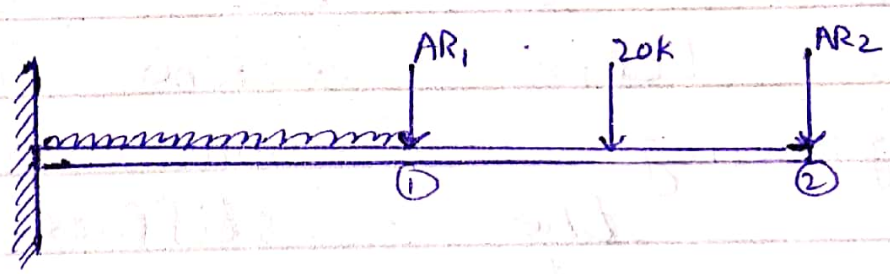
Q1.




Solution:-

Structure Indeterminey = 2°

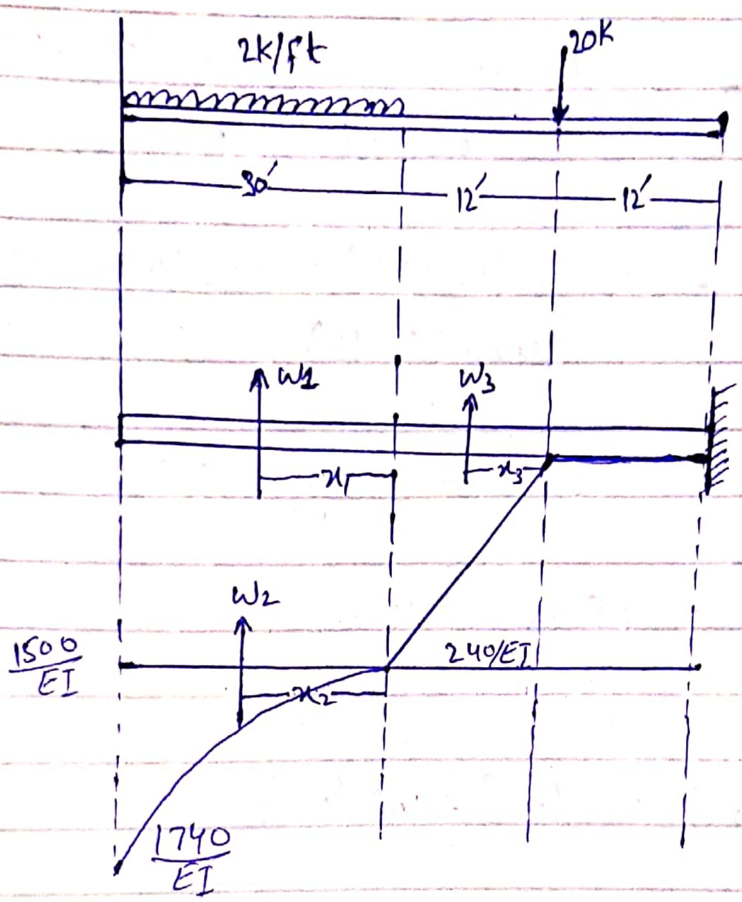
Step # 1. Select Redundant Action




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

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

Step#2 Compute the values of [DRL]




$20 \times 12 = 240$

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

$W_1 = 1500 \times 30 = 45000$

$W_2 = 1/3 \times 30 \times 240 = 2400$

$W_3 = 1/2 \times 12 \times 240 = 1440$

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

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

$x_3 = 2/3 \times L = 2/3 \times \overset{4}{\cancel{12}} = 8'$

Now Finding DRL:-

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

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

$$= 1755000 + 111600 + 28800$$

$$DRL_2 = 1895400/EI$$

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

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

$$= 675000 + 54000$$

$$= 729000$$

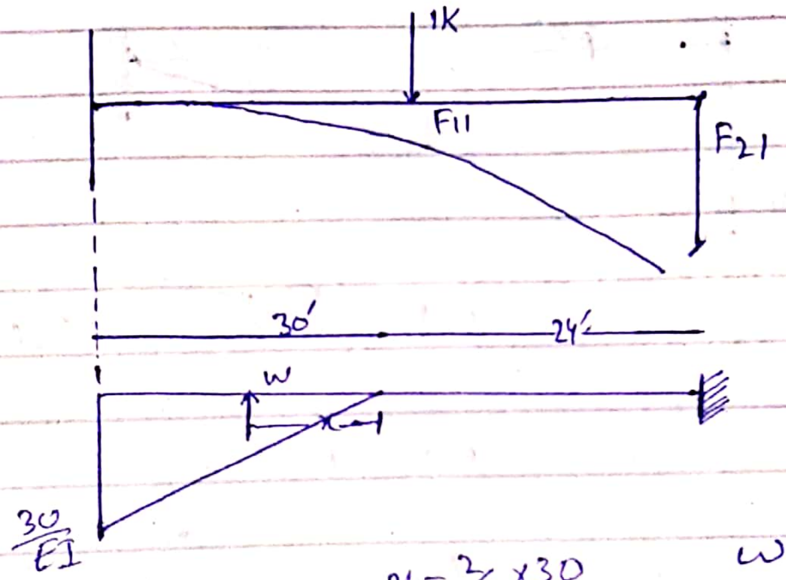
So,

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

Step 3. Flexibility Matrix

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

a) Applying unit load on $AR_1$




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

$x = 20$

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

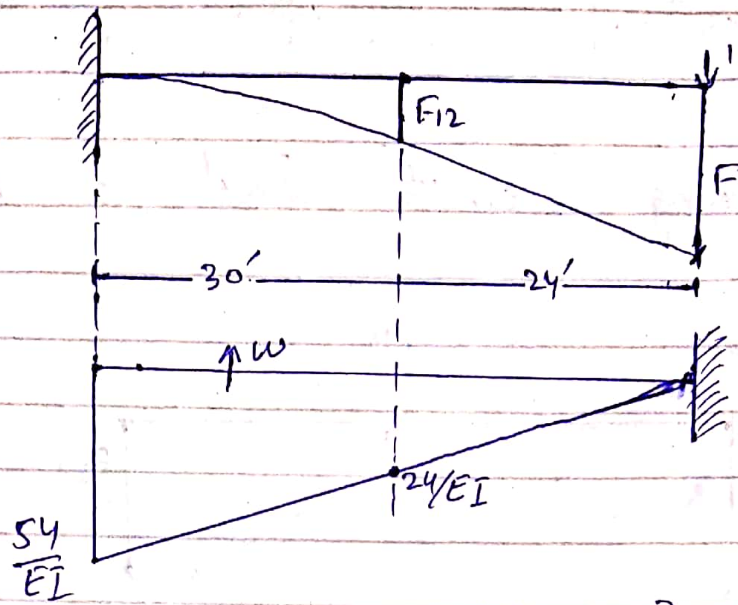
$w = 450/EI$

So,

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

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

Now Apply unit load on $AR_2$.




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

$$W = 1170/EI$$

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 values of AR

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

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

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

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

$$|F| = (9000 \times 47876.4 - 19796.4 \times 19800)$$
$$= (430887600 - 391968780)$$

$$\Rightarrow |F| = 38918880$$

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

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

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

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

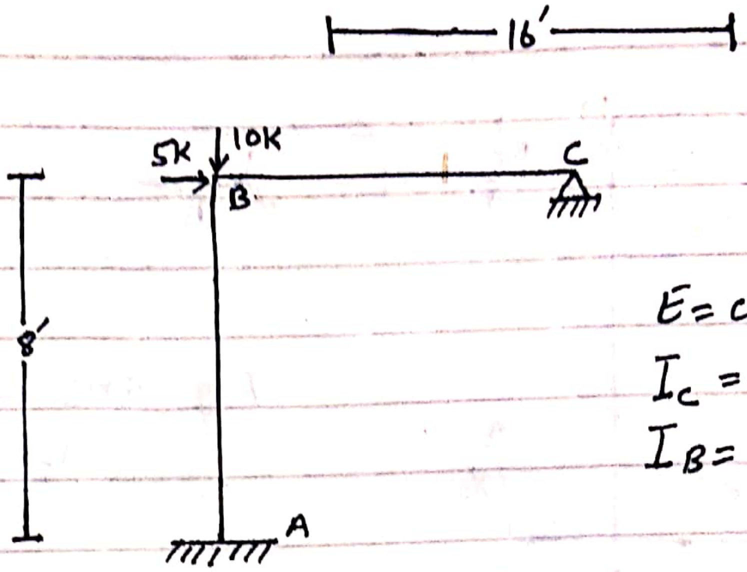
Q.2.

| Force Method | Displacement Method. |
|---|---|
| → $D_s < D_K$ | → $D_s > D_K$ |
| → Force and redondant are unknowns | → Displacement and redondant are unknowns |
| → Starts with equilibrium of forces. | → Starts with compatible deformation |
| → Forces found by compatibility of displacements. | → Displacement found by equilibriom of forces. |
| → no. of redondent = $D_s$ | → no. of redondant = $D_K$ |
| → Not suitable for compatebility. | → Not suitable for tusses. |

## Stiffness Method:-

It is called dissplacement 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 is that it conductive to computer programing. Once the analytical model of the structure has been define, No further engineering decisions are required in the stiffness method in order to carry out the analysis.

# Q3. Problem.



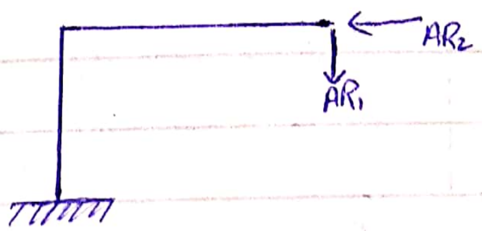

$E$ = constant
$I_C = I$
$I_B = 2I$

Solution:-

Total statical indetermine

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

Step#1. Identify Rebundant action




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

Step #2. Compute value of [DRL]

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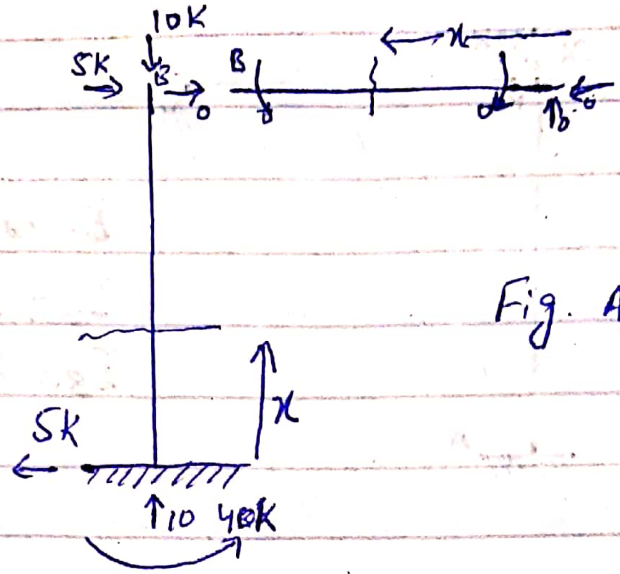


Fig. AML values (M-values)

Step #3. [F] or [AMR]

a)

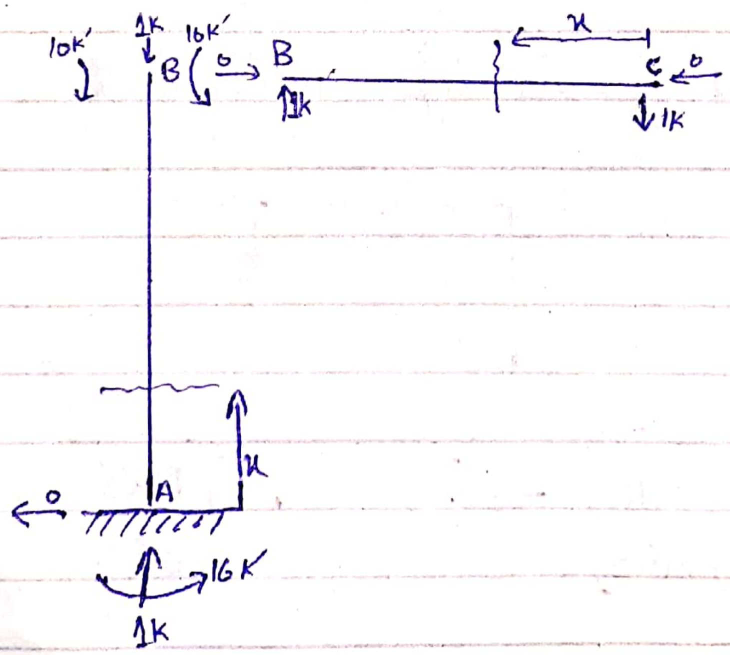


Fig. AMR-value (m, values)

b)

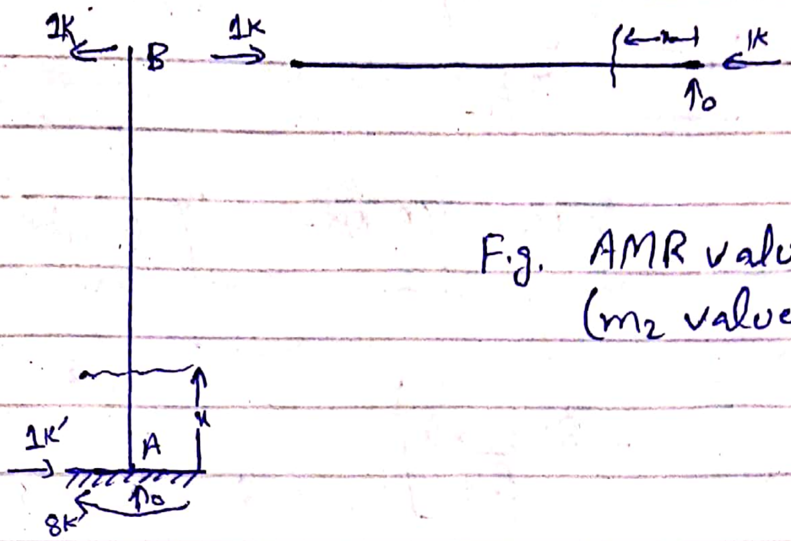


Fig. AMR values
($m_2$ values)

| Member | AB | BC |
|---|---|---|
| select origin (should be selected the support) ← Origin | A | C |
| Limits | 0–8 | 0–16 |
| I | I | I |
| Take x-section from origin AML Fig and Find moment ← M | $5x-40$ | 0 |
| $m_1$ | $-16$ | $x \rightarrow$ Take x-section on $m_1$ Fig from the origon |
| $m_2$ | $8-x$ | 0 |

→ For Finding value of DRL:-

$$DRL_1 = \int_{1}^{8} \frac{M_{AB} \cdot m_{1(AB)}}{EI} + \int_{0}^{16} \frac{M_{BC} \cdot m_{2(BC)}}{EI}$$

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

Scanned with CamScanner

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

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

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

⇒ Compute Flexibility Matrix:-

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

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

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

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

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

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

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

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

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

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

As we know that

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

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

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

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

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