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ID # : 7870

SECTION : B

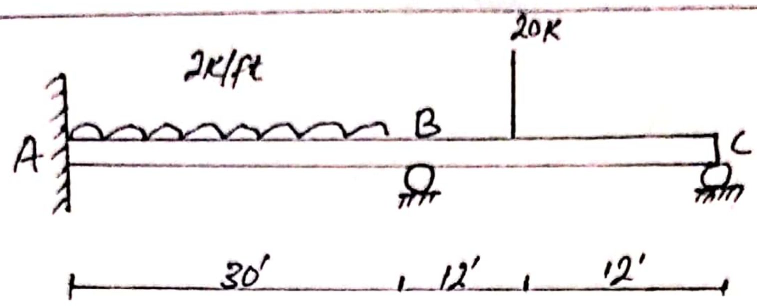
SUBMITTED TO : ENGR. ADEED KHAN

MODULE : 6th

MID-TERM EXAM

(STRUCTURAL ANALYSIS II)

Q#01

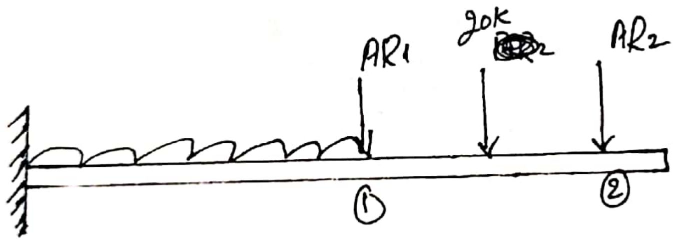


Solution:-

Structural Determinacy = 2°

Step # 01

Slect Redundent Actions



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

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

Now Finding DRL :-

$DRL_2 = w_1 \times (x_1 + 24) + 2400(22.5+24) +$

$1440(8+12)$

$= 1755000 + 111600 + 28800$

$DRL_2 = 1895400/EI$

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

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

$= 675000 + \cancel{2400(22.5)}\ 54000$

$= 729000$

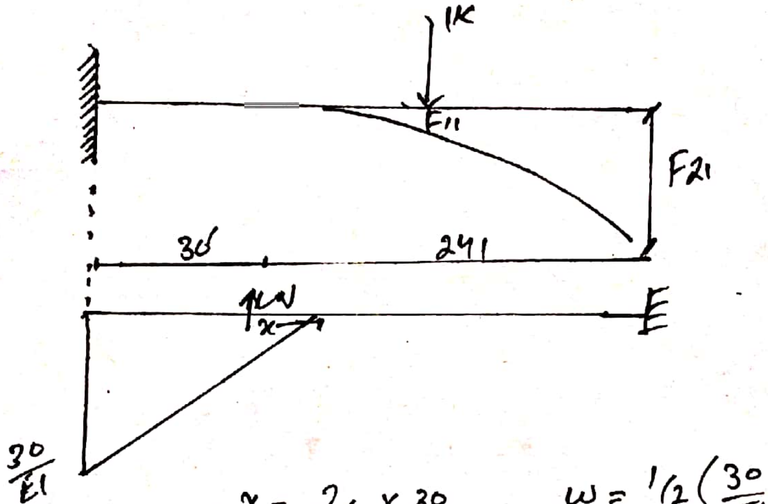
So, $DRL_1 = \frac{1}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$

Step #03 Flexibility Matrix

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

Scanned with CamScanner

a) Applying unit load on AR1



$x = 2/3 \times 30 = 20'$

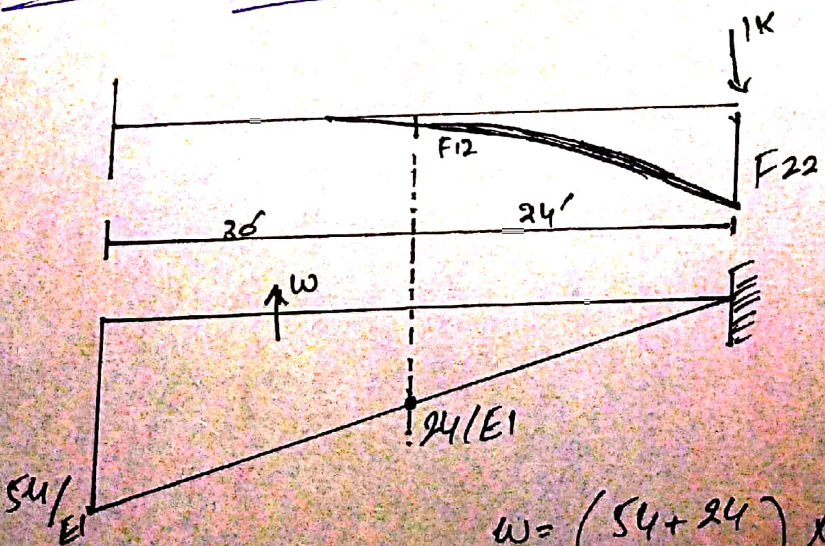
$w = 1/2\left(\frac{30}{EI} \times 30\right) = 450/EI$

So,

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

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

Now apply load on AR2



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

$= 1170/EI$

Now the Distance

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

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

$$= 16.92'$$

$\Rightarrow F_{12} = \frac{1170}{EI} \times 16.92 = \frac{19796.4}{EI}$

$\Rightarrow F_{22} = 1170/EI = (16.92+24) = \frac{47876.4}{EI}$

Hence

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

Step # 04

Compute the value of AR

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

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

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

$$\frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 19796.4 \\ 198000 & 47876.4 \end{bmatrix}$$

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

$$430887600 - 391968720)$$

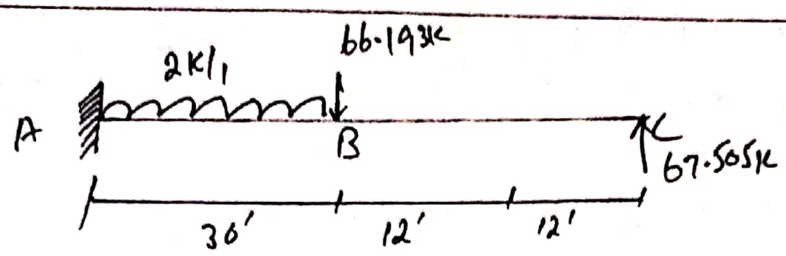
$$\Rightarrow |F| = 38918880$$

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

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

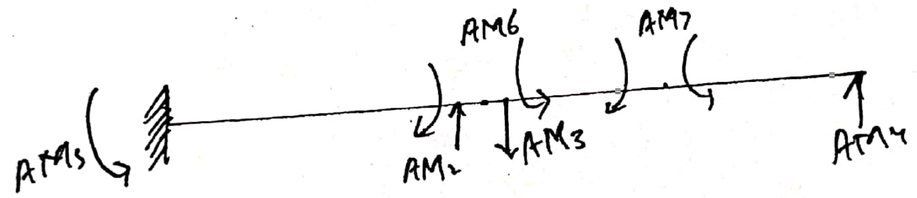
$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{\begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}}{38918880}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -69.505 \end{bmatrix}$$

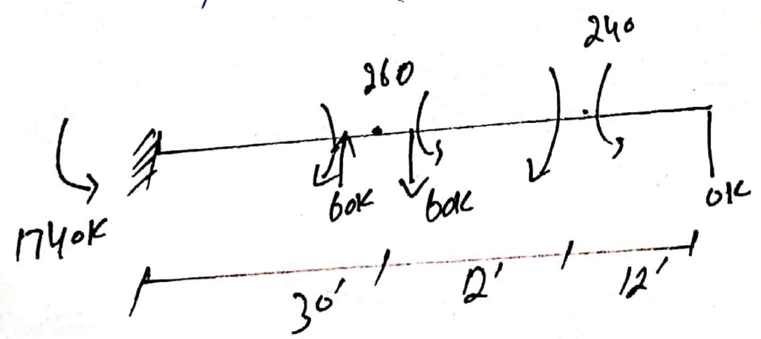


Step # 05 Compute the members end Actions [AM].

$$[AM] = [AML] + [AMR] \times [AR]$$

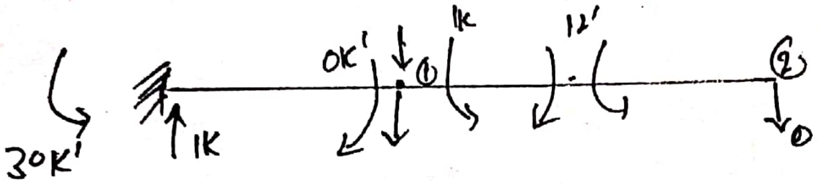


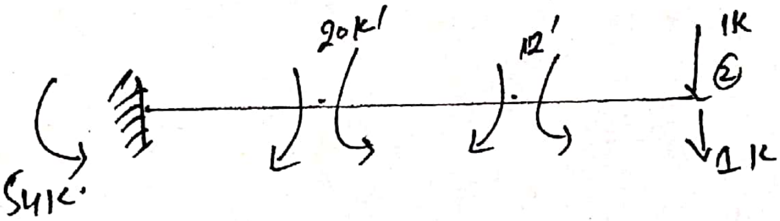
(a) Compute [AML] values



$$\begin{bmatrix} AML_1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} \begin{bmatrix} 80K \\ 60K \\ -60K \\ 0 \\ 1740 \\ 1260 \\ 240 \end{bmatrix}$$

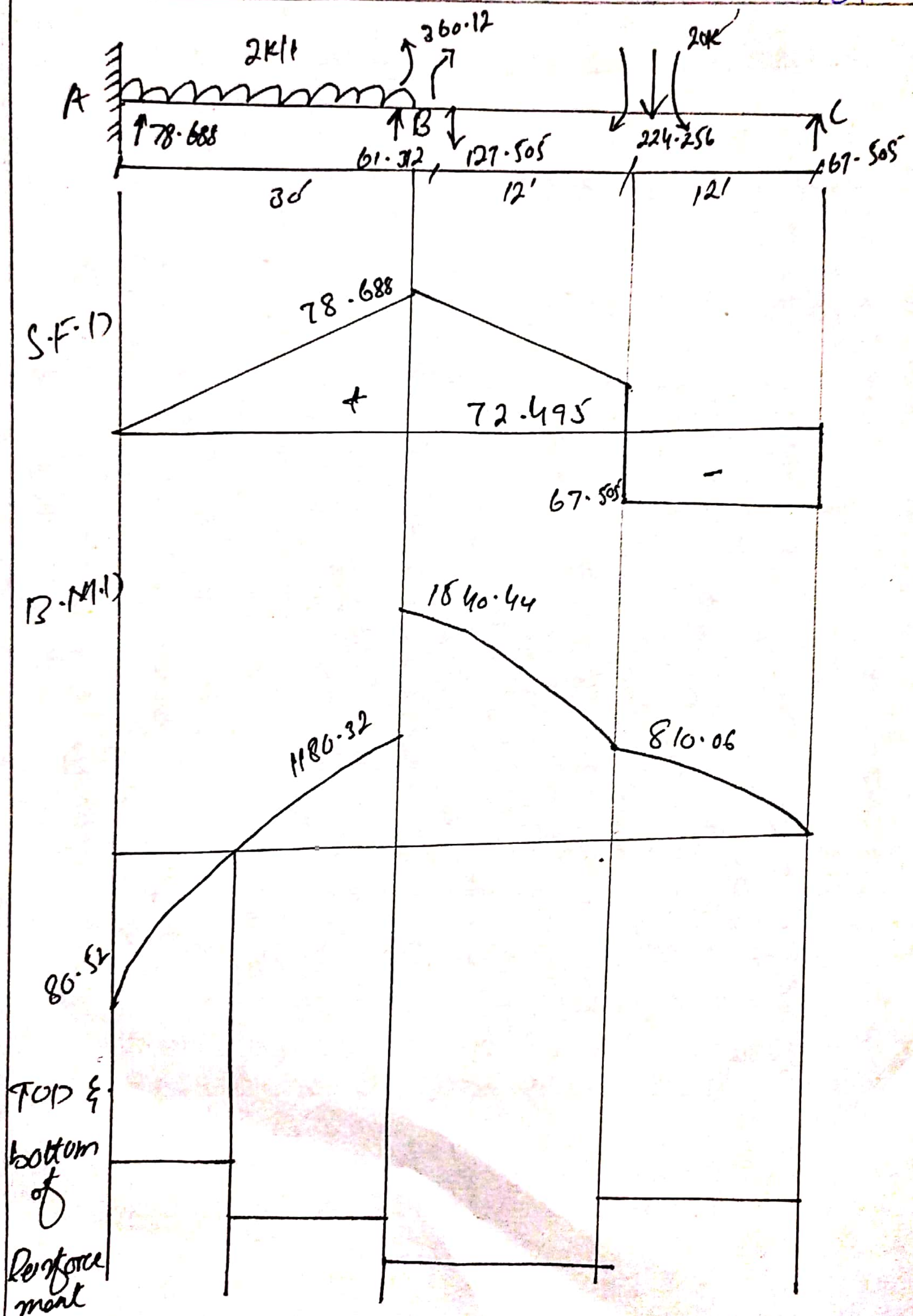
b- Compute [AMR] values. First apply the unit action at reference point ① and Then at reference point ②



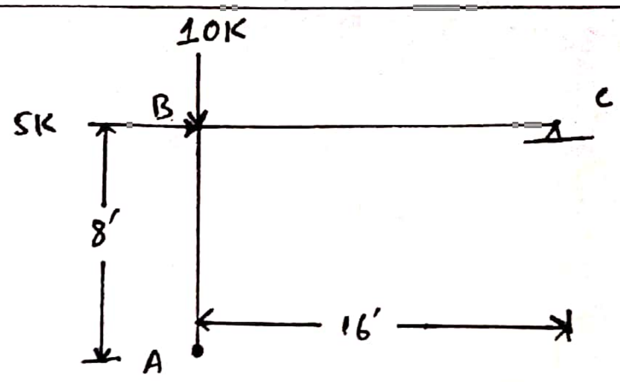


$$AMR = \begin{bmatrix} AMR_{11} & AMR_{12} \\ AMR_{21} & AMR_{22} \\ AMR_{31} & AMR_{32} \\ AMR_{41} & AMR_{42} \\ AMR_{51} & AMR_{52} \\ AMR_{61} & AMR_{62} \\ AMR_{71} & AMR_{72} \end{bmatrix} \begin{bmatrix} 1 & 1 \\ -1 & -1 \\ 0 & 1 \\ 0 & -1 \\ 30 & 54 \\ 0 & 24 \\ 12 & 12 \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} \begin{bmatrix} 80 \\ 60 \\ -60 \\ 0 \\ 1740 \\ 1260 \\ 240 \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ -1 & -1 \\ 0 & 1 \\ 0 & -1 \\ 30 & 54 \\ 0 & 24 \\ 12 & 12 \end{bmatrix} \times \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix} \begin{bmatrix} 78.688 \\ 61.312 \\ -127.505 \\ 67.505 \\ 80.52' \\ -360.12' \\ 224.256' \end{bmatrix}$$


260.12
2K/1
20K
A
B
C
78.688
61.312
127.505
224.256
67.505
30'
12'
12'
S.F.D
78.688
+
72.495
67.505
-
B.M.D
1840.44
1180.32
810.06
86.52
Top & bottom of Reinforcement

Q#03



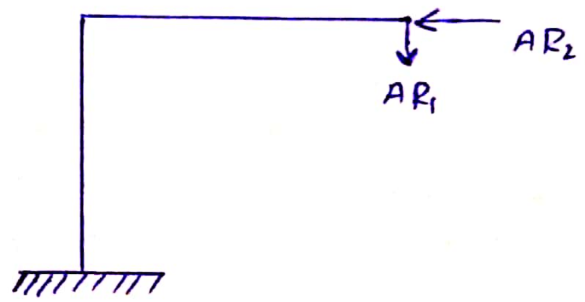
Solution:

Total statical indeterminacy

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

Step#01

Identify Redundent 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#02 :-

Compute value of [DRL]

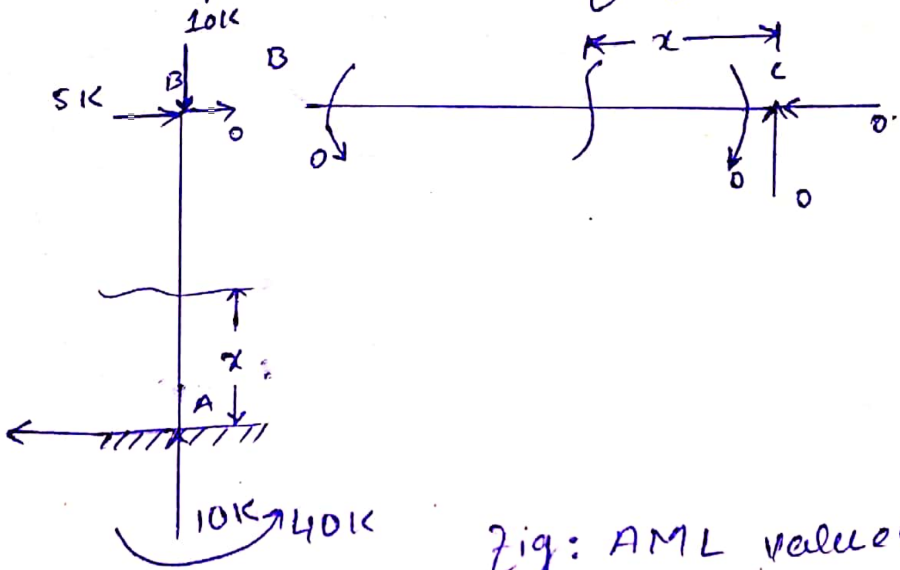


Fig: AML values
(M- values)

Step#03 :-

[F] OR [AMR]

a)

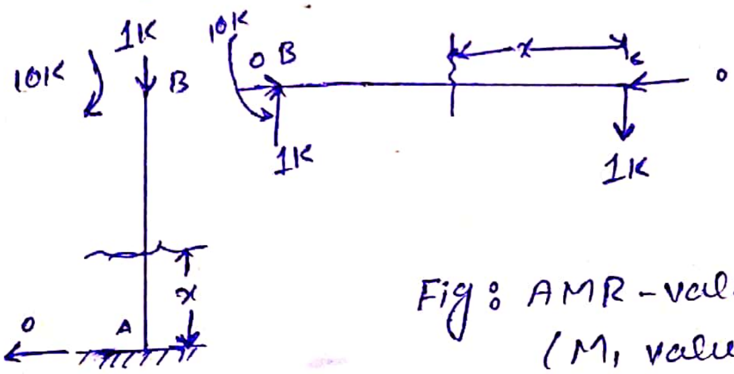


Fig: AMR-values
(M_1 values)

b)

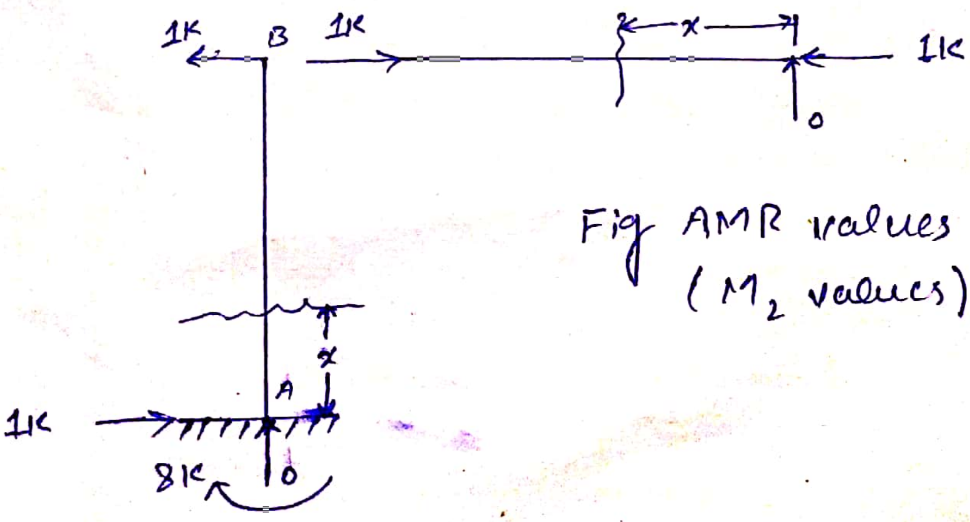


Fig AMR values
(M_2 values)

Member	AB	BC
origin	A	C
Limit	0 - 8	0 - 16
I	I	2I
M	5x - 40	0
M_1	-16	x
M_2	8 - x	0

⇒ <u>For Finding values of DRL</u> :-

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

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

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

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

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

⇒ Compute flexibility Matrix:

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

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

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

$$F_{12} = F_{21} = \int_0^8 \frac{m_1(AB \cdot M_2(AB}{EI} + \int_0^{16} \frac{m_1(BC \cdot M_2(BC)}{EI}$$

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

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

$$F_{22} = \int_0^8 (M_2)^2_{AB}\,dx + \int_0^{16} (m_2)^2_{BC}\,dx$$

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

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

As we know

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

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

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

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

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

QUESTION: 02

ANSWER :

FORCE METHOD	DISPLACEMENT METHOD
• $D_s < D_k$	• $D_s > D_k$
• Forces are redundent or unknowns	• Displacement are redundent or unknowns
• Starts with equilibrium of forces	• Starts with compatible deformations
• Forces found by compatibility equations of displacements	• Displacement found by equilibrium equations of forces.
• No of redundents = D_s	• No of redundents = D_k
• Not suitable for computer	• Not suitable for truss.

⇒ Force method is better method because it has variety of use since displacement method can not be applied to trusses. In force method we start it with the equilibrium force to analyze.