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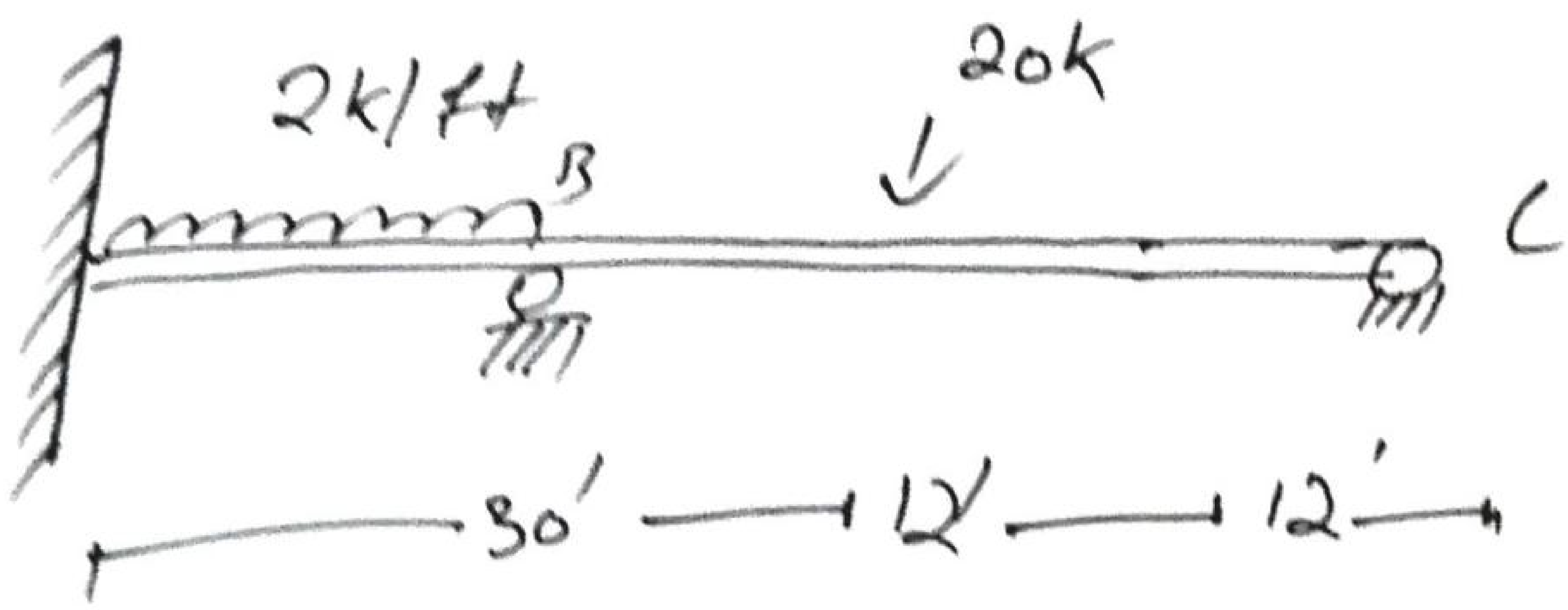
SEC: C.

Submission of MID term papers.

Subject: Structure Analysis II.

Question 2 :-

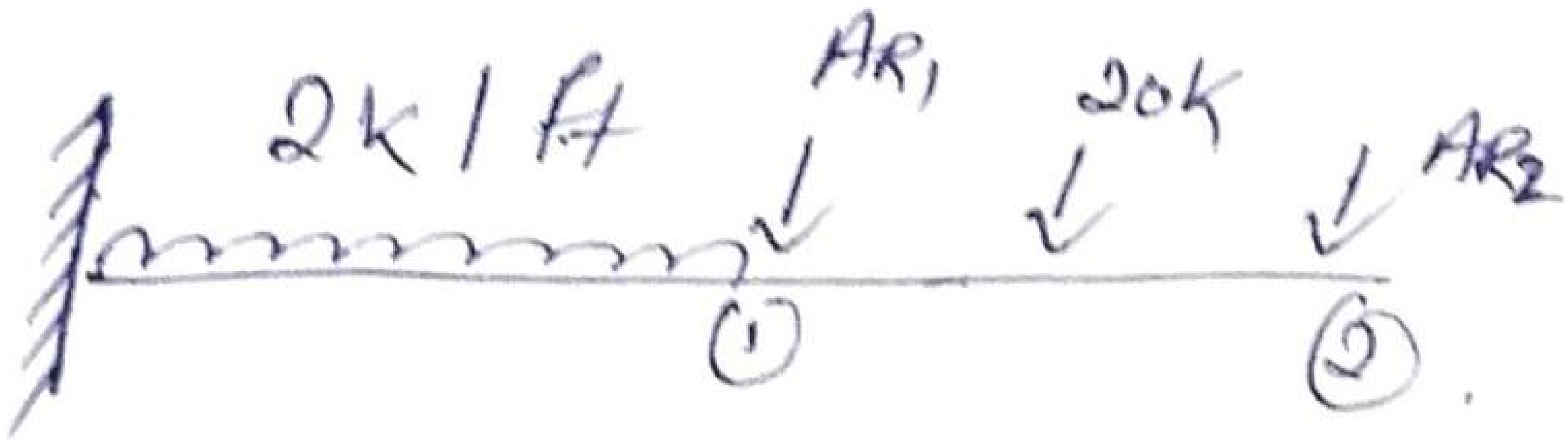
EI = Constant



Sol:-

Structural Indeterminacy = 2°

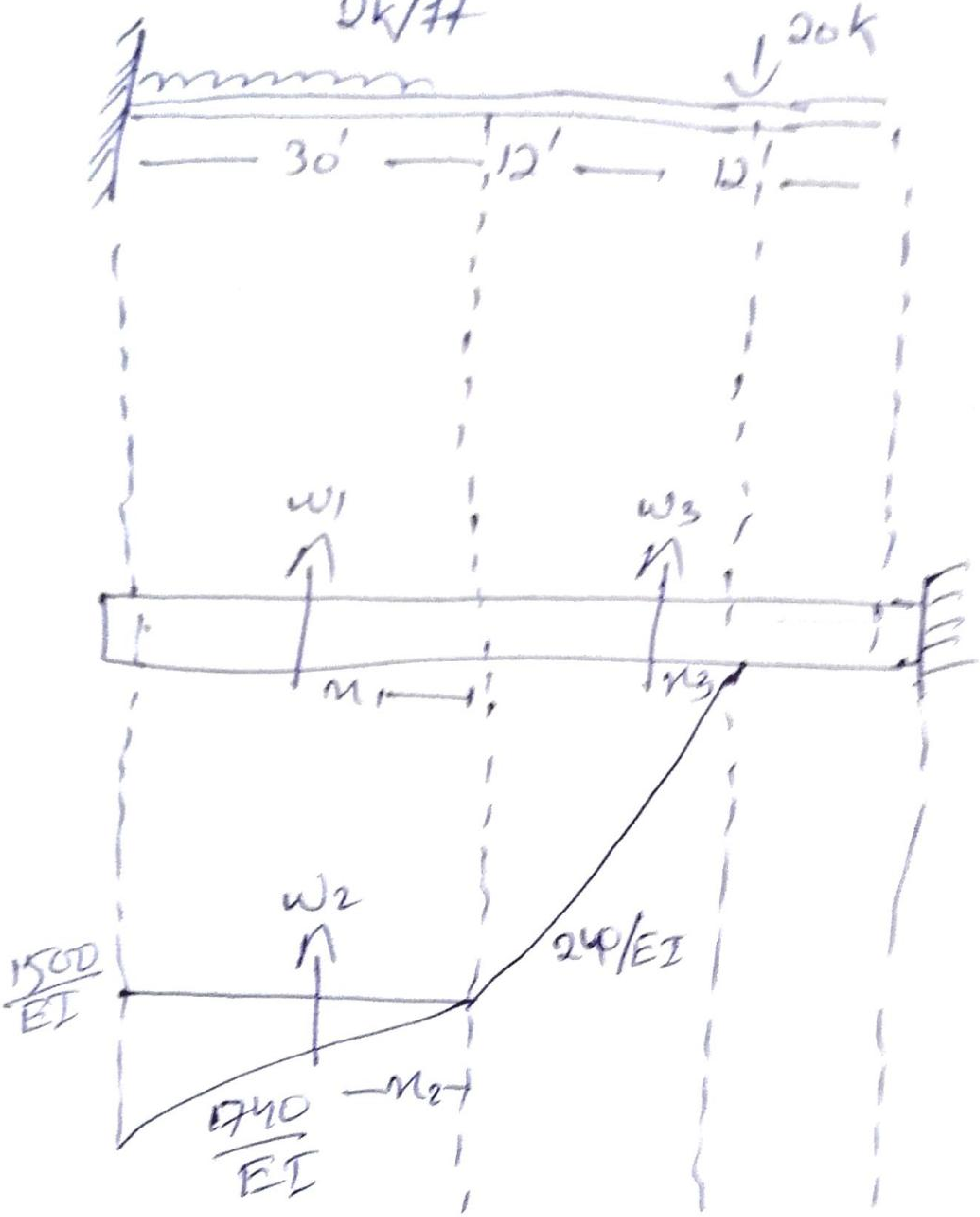
Step #2 Select Redundant Actions.



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

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

Step 2 :- Compute the values of (DRL)



$w_1 = 1500 \times 30 = 45000$

$w_2 = 1/3 \times 30 \times 240 = 2400$

$w_3 = 1/2 \times 12 \times 240 = 1440.$

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

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

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

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

Now finding DRL :-

$DRL_2 = w_1 \times (\bar{x}_1 + 24) + w_2 \times (x_2 + 24) + w_3 \times (x_3 + 12)$

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

$= 175000 + 111600 + 28800$

$DRL_2 = 1895400 / EI$

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

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

$= 675000 + 54000$

$= 729000.$

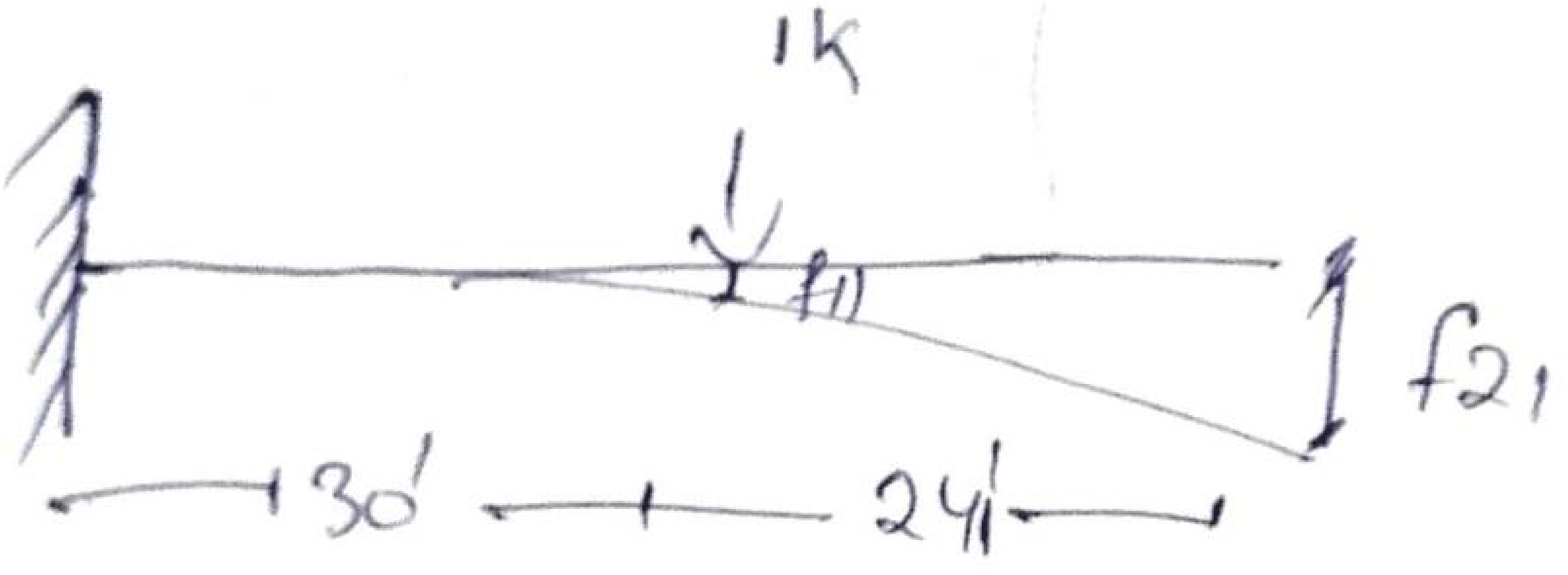
so,

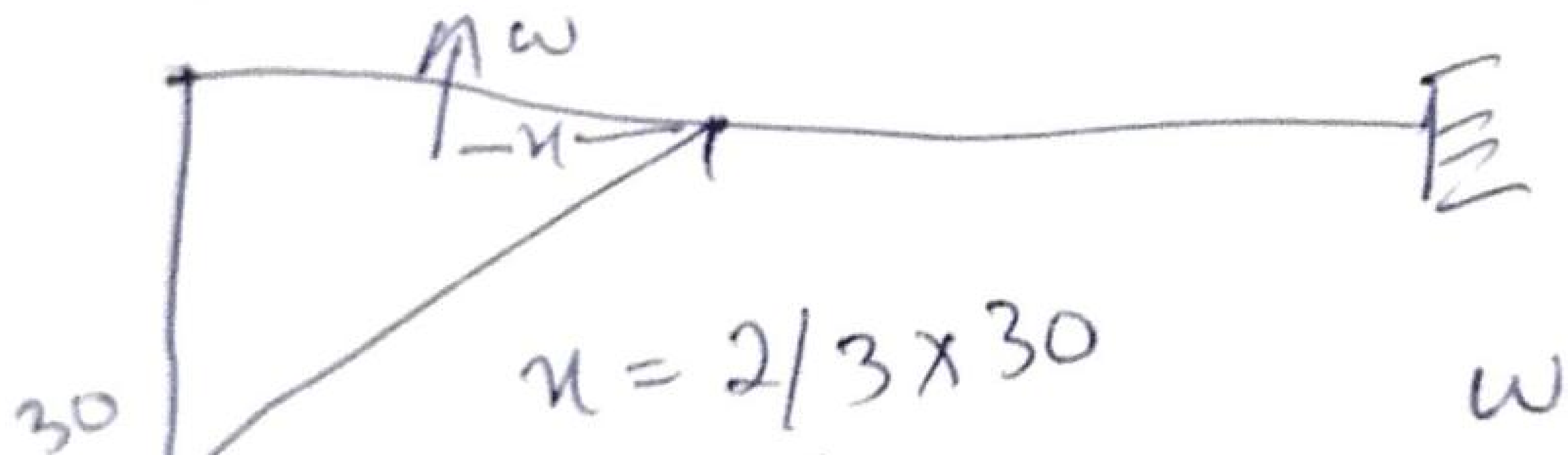
$$DRL = \frac{1}{EI} \begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

Step #3 flexibility matrix.

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

a) Applying unit load on AR,





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

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

Now the distance,

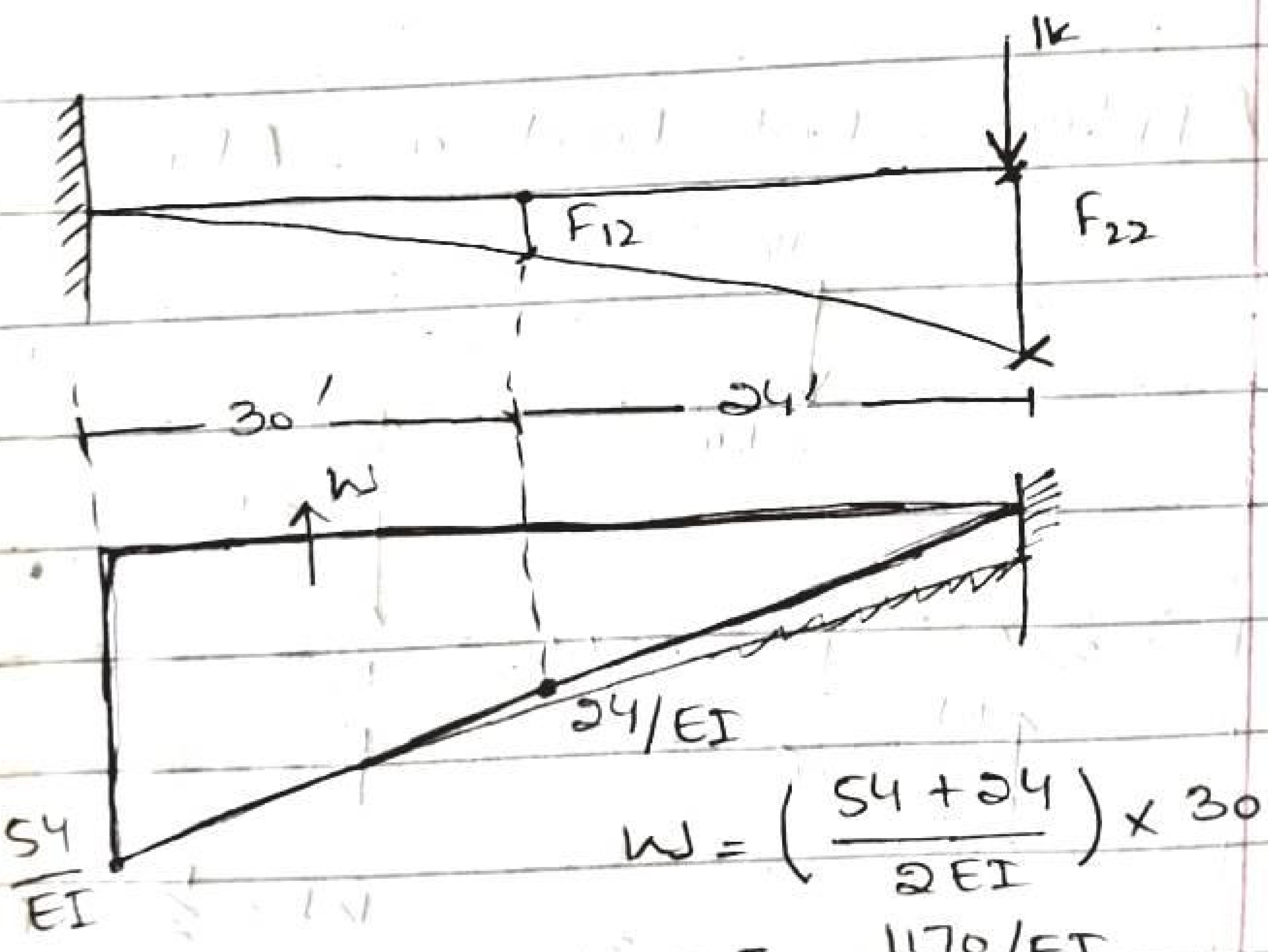
$$x = l/3 \left(\frac{b + 2(a)}{a+b}\right)$$

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.



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

$$= 1170/EI$$

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

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

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

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.

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

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

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

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

$$(430887600 - 391968720).$$

$$\Rightarrow |f| = 38918880.$$

$$\Rightarrow \text{Adj } A = \begin{bmatrix} 47876.4 & -1976.4 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880}$$

$$= \begin{bmatrix} -729000 \\ -1875400 \end{bmatrix} \frac{1}{EI} \times \frac{\begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}}{38918880.}$$

$$\begin{bmatrix} AR1 \\ AR2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}$$ Ans.

Question 2

ANSWER:-

FORCE METHOD	DISPLACEMENT METHOD.
=> DS < DK	=> DS > DK
=> Forces are redundant or Unknowns	=> Displacement are reduntant or Unknowns.
=> Starts with equilibrium of forces	=> Starts with compatable deformation.
=> forces found by compatibility eq's of displacements.	Displacents found by equlibrium eqs of forces.
=> no of reduntants = DS	=> No of reduntents = DK
=> not suitable for compu	=> Not suitable for truss.

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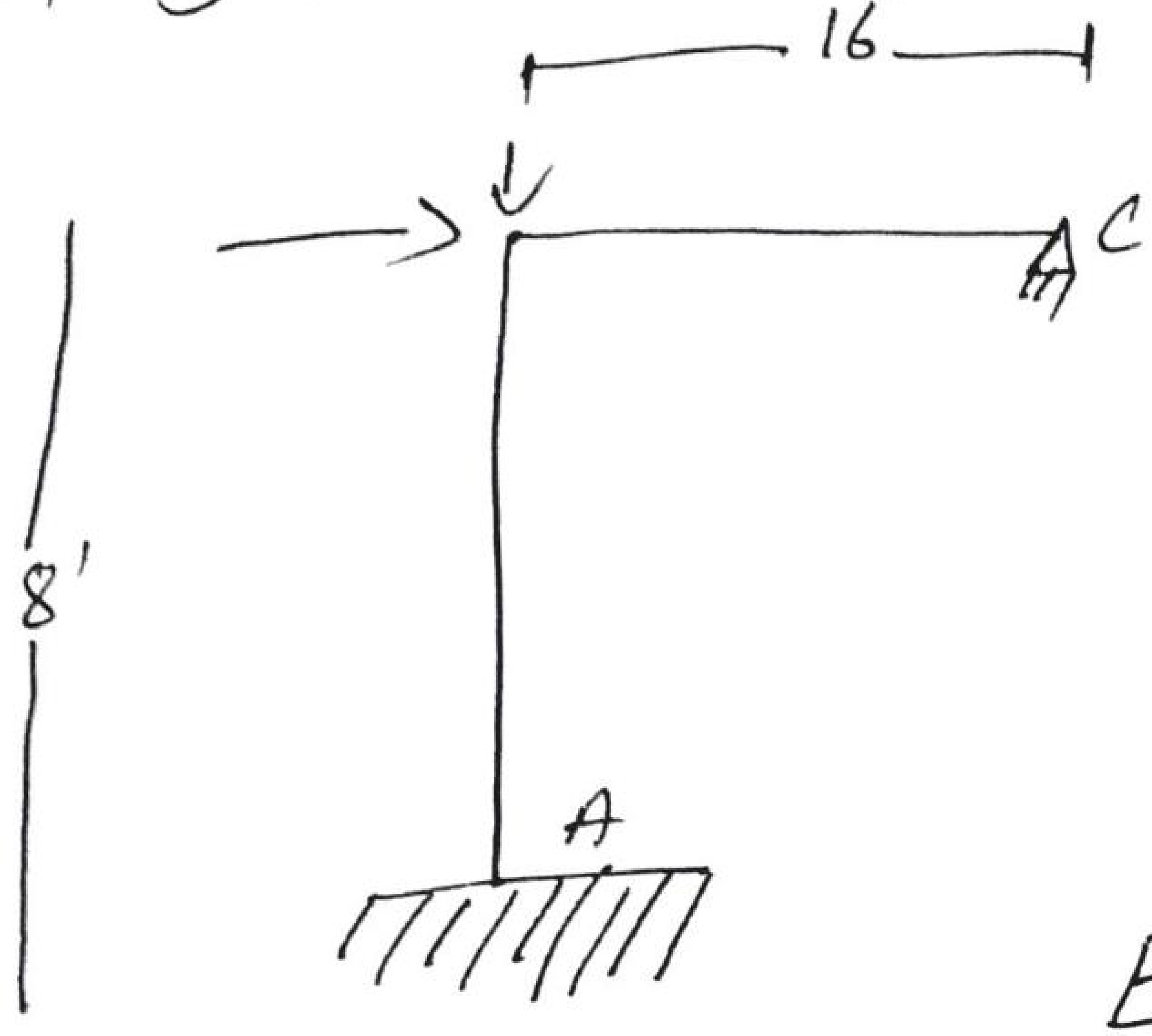
* SUITABLE METHOD :-

Stiffness method also called Displacement 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 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 analysis.

Question 3:-



E = constant.

$I_C = I$

$I_B = 2I$

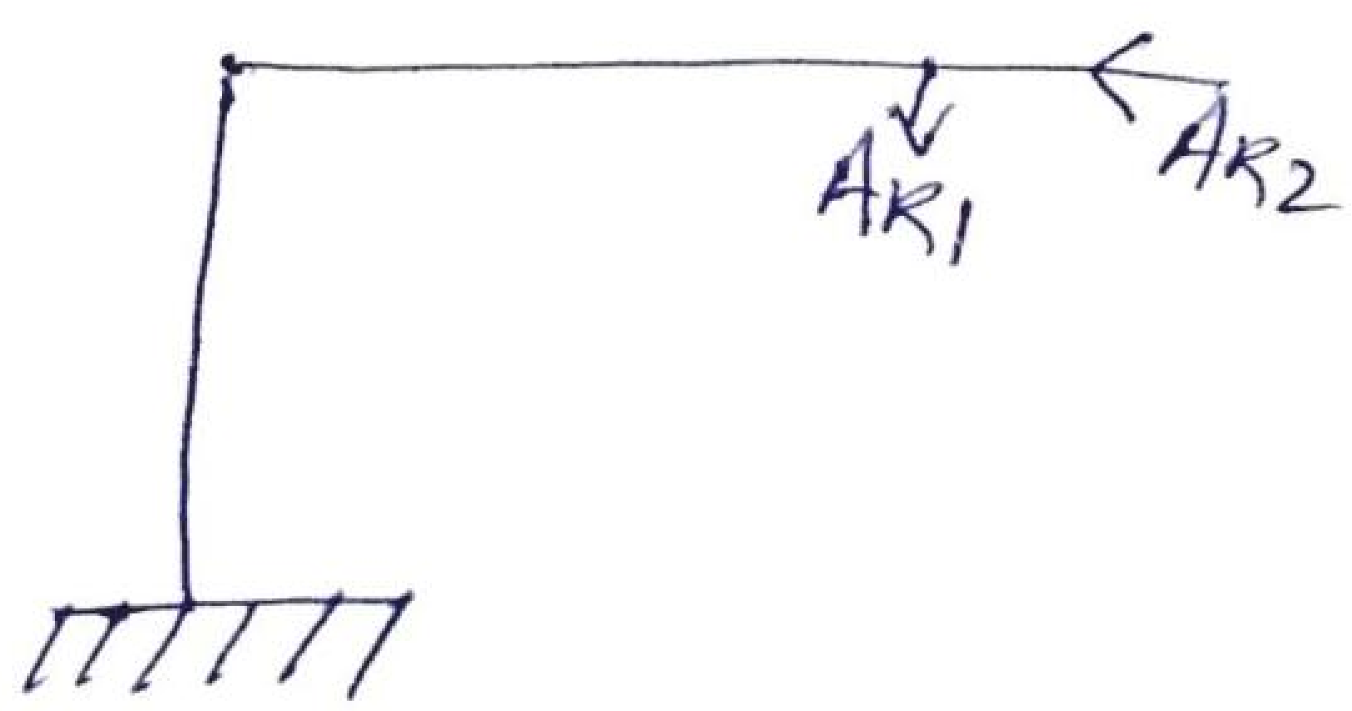
Sol:-

Total statical indeterminacy

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

Step 2:-

Identify Redundent Actions



(2)

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

Step 2:-

Compute value of [DRL]

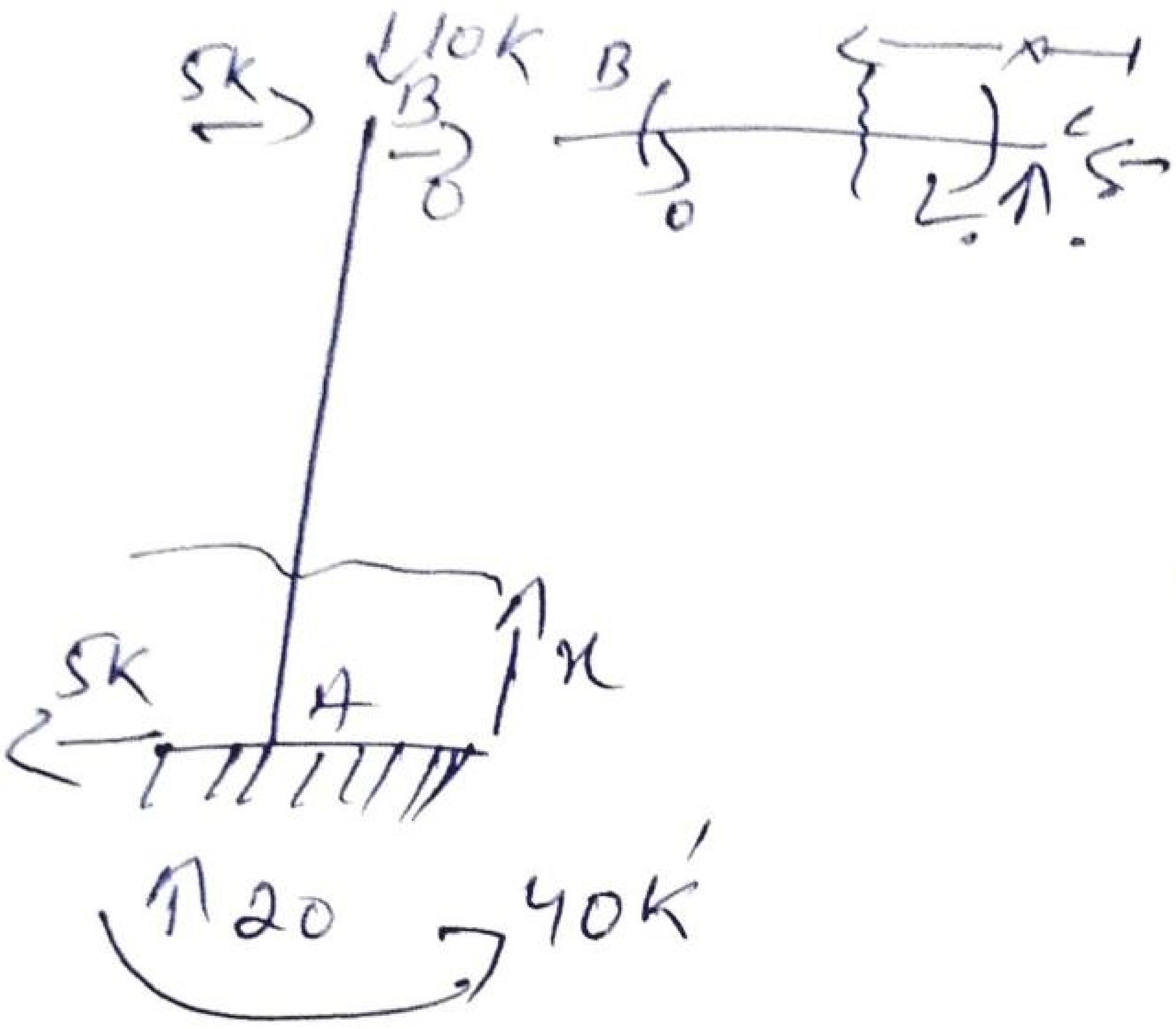


fig AmL values (M-values)

Step 3:- [F] OR [AMR]

a)

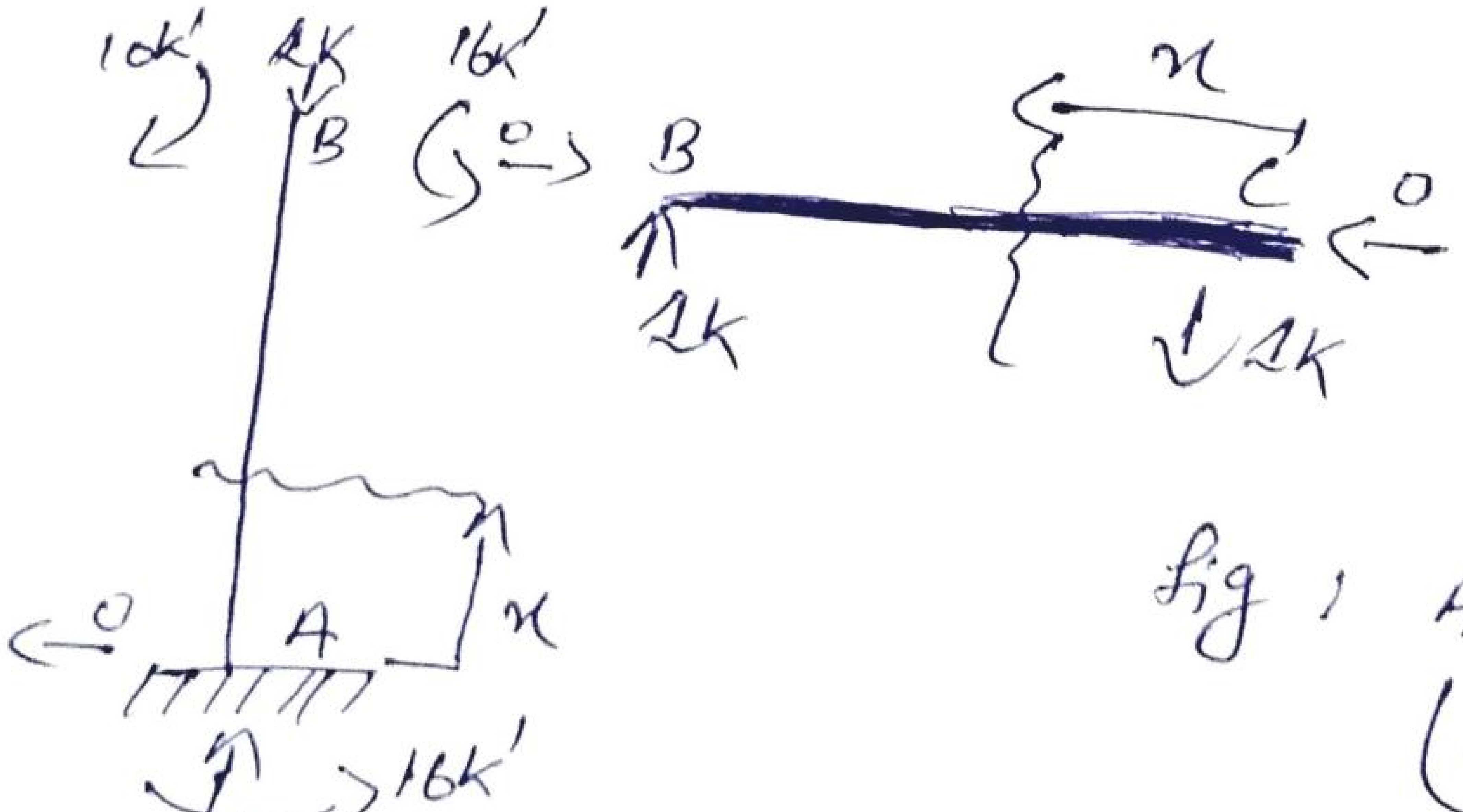


fig: AMR - values (m, values)

(b)

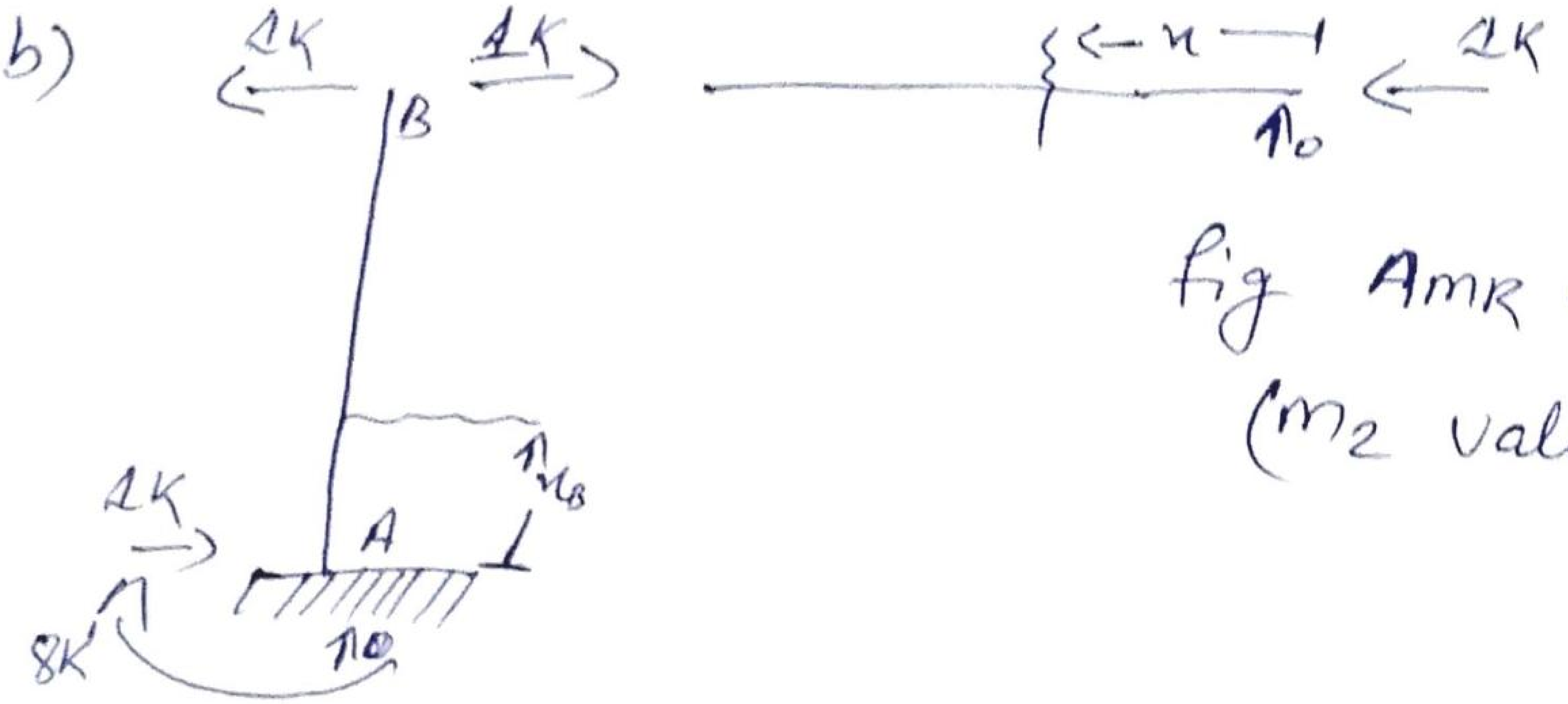


fig AMR Values (M_2 values)

Members	AB	BC
Origin	A	C
limits	0-8	0-16
I	I	2I
M	5x-40	0
M_1	-16	x → Take x section on M_1 fig from the origin
M_2	8-x	0

⇒ for finding values of DRL :-

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

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

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

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

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

⇒ Compute flexibility matrix.

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

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

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

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

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

$$f_{12} = f_{21} = \frac{-512}{EI}.$$

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

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

$$F_{22} = 170.67$$

As we know

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

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

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

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

$$\begin{bmatrix} A_{R1} \\ A_{R2} \end{bmatrix} = \begin{bmatrix} -0.00005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$ Ans.