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I. D :- 7690

Sec :- C

Deptt :- BE (civil)

Assignment :- Mid term Paper

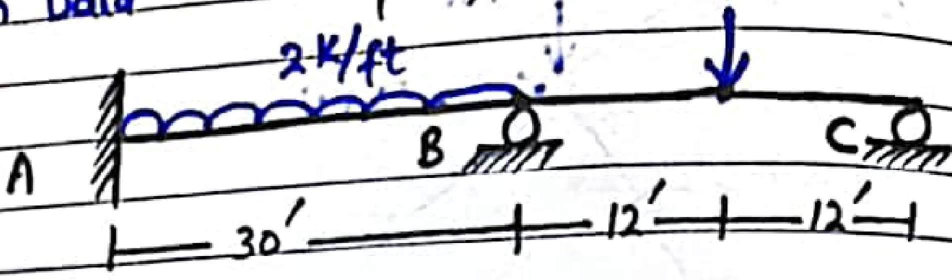
Subbmitted :- Engr. Adeed Khan

Date :- 21-09-2020

Subject :- Structure Analysis II

{Q1}

Given Data :

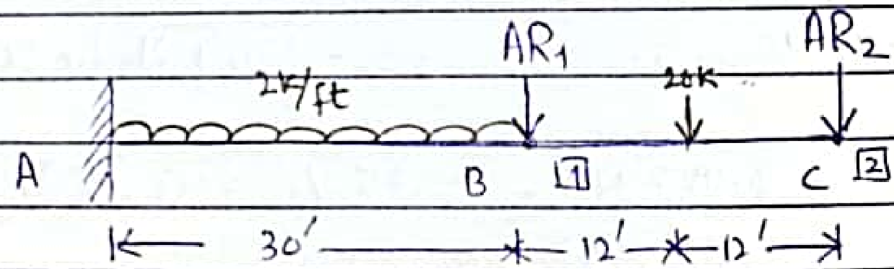


EI = constant

Required Data : S.F.D = ?
B.M.D = ?

Solution :

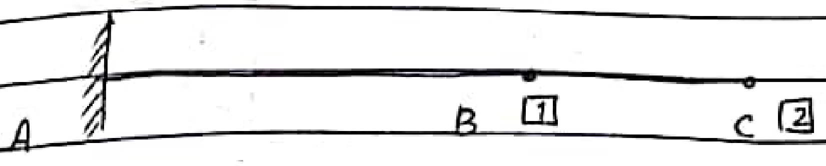
$S.I = r - 3n = 5 - 3(1) = 2^{\circ}$



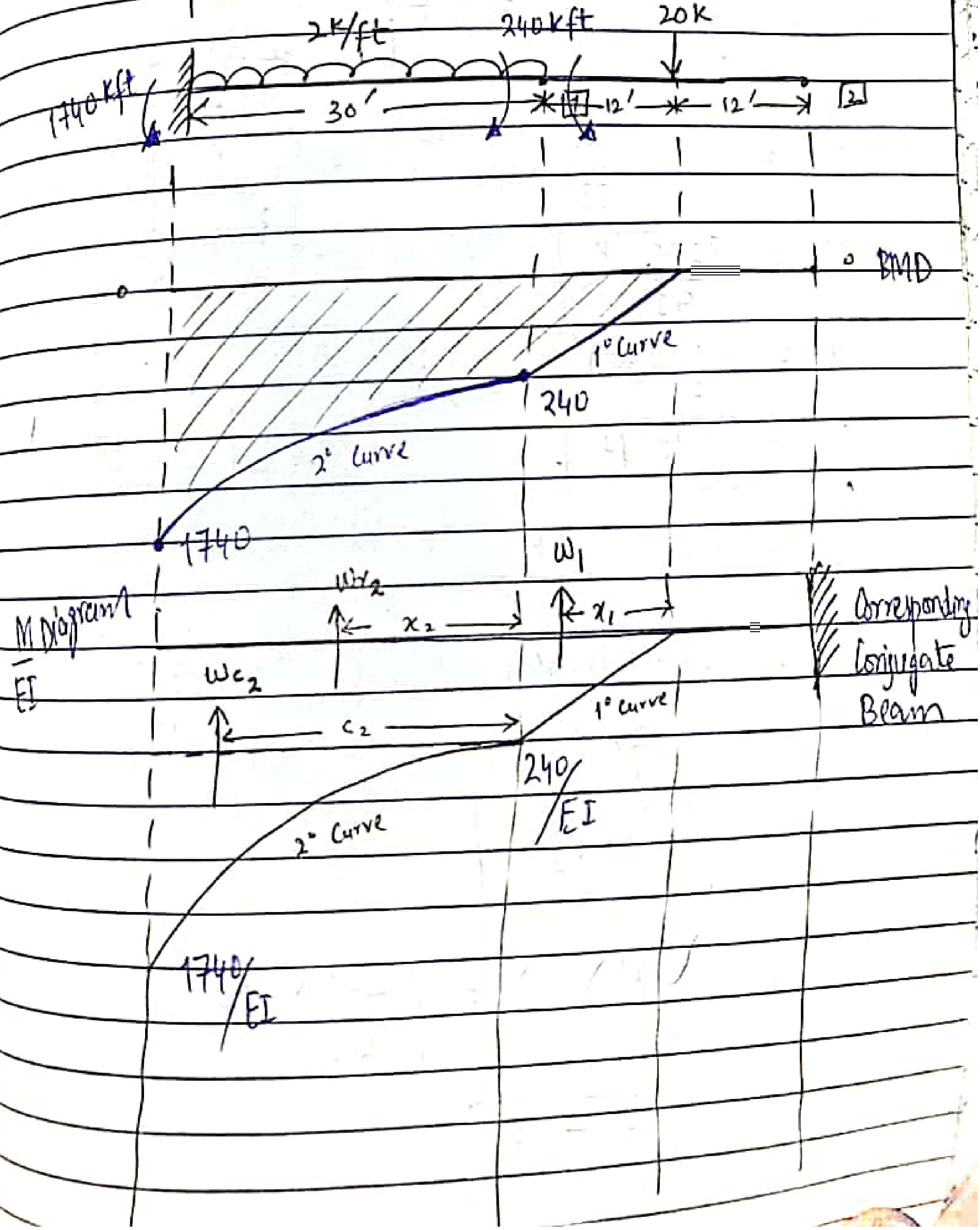
$$[AR] = \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix}$$

$$[DRS] = \begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Since No rotation/displacement mentioned in question at redundant location.



Compute [DRL] matrix.



Pg #03

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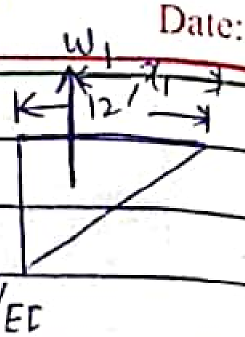
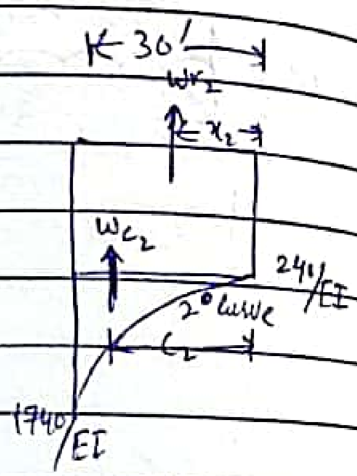


$$w_1 = \frac{1}{2} \times 12 \times \frac{240}{EI}$$

$$\boxed{w_1 = \frac{1440}{EI}\ k}$$

$$\boxed{x_1 = \frac{2}{3}(12) = 8 \text{ feet}}$$

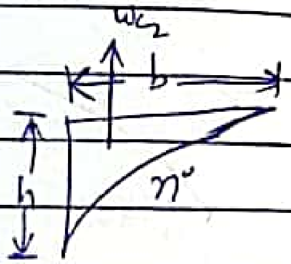


$$w_{r_2} = 30 \times \frac{240}{EI}$$

$$\boxed{w_{r_2} = \frac{7200}{EI}\ k}$$

$$x_2 = \frac{1}{2}(30')$$

$$\boxed{x_2 = 15 \text{ ft}}$$



$$h = \frac{1740}{EI} - \frac{240}{EI}$$

$$h = \frac{1500}{EI}$$

$$w_{c_2} = A = \frac{bh}{n+1}$$

$$w_{c_2} = \frac{30 \times 1500/EI}{2+1}$$

$$\boxed{w_{c_2} = 15000/EI\ k}$$

$$c_2 = \left(\frac{n+1}{n+2}\right)(b) = \left(\frac{2+1}{2+2}\right)(30)$$

$$\boxed{c_2 = 22.5 \text{ ft}}$$

$$DRL_1 = W_{x_2} x_2 + W_{c_2} \times C_2$$

$$DRL_1 = \frac{7200}{EI} \times 15 + \frac{15000}{EI} \times 22.5$$

$$DRL_1 = 445500/EI$$

$$DRL_2 = W_{x_2}(x_2 + 24) + W_{c_2}(24 + C_2) + W_1(x_1 + 12)$$

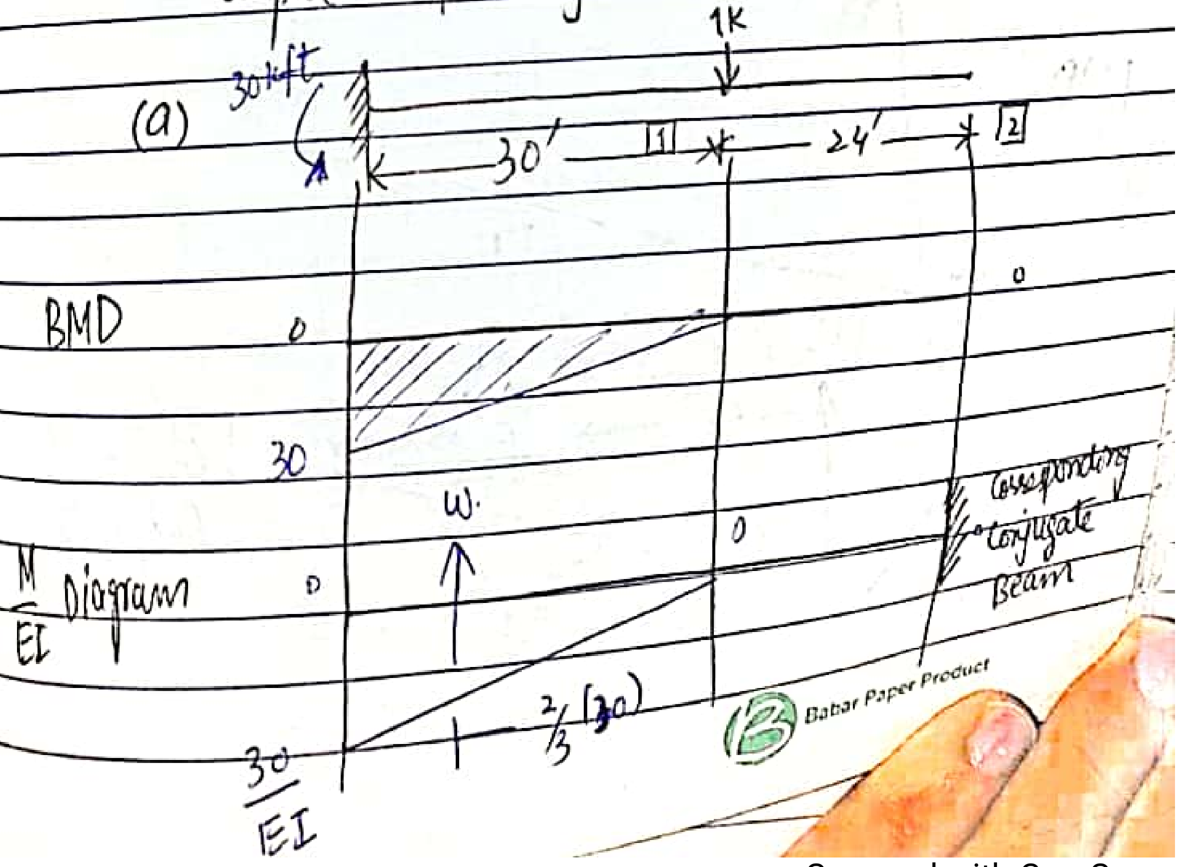
$$DRL_2 = \frac{7200}{EI}(15+24) + \frac{15000}{EI}(24+22.5) + \frac{1440}{EI}(8+12)$$

$$DRL_2 = 1007100/EI$$

$$\begin{bmatrix} DRL \end{bmatrix} = \begin{bmatrix} DRL_1 \\ DRL_2 \end{bmatrix} = \frac{1}{EI}\begin{bmatrix} 445500 \\ 1007100 \end{bmatrix}$$

compute flexibility matrix [f].

(a)



$$W = \frac{1}{2} \times 30 \times \frac{30}{EI}$$

$$W = 450/EI$$

$$\text{Moment arm} = \frac{2}{3}(30) = 20$$

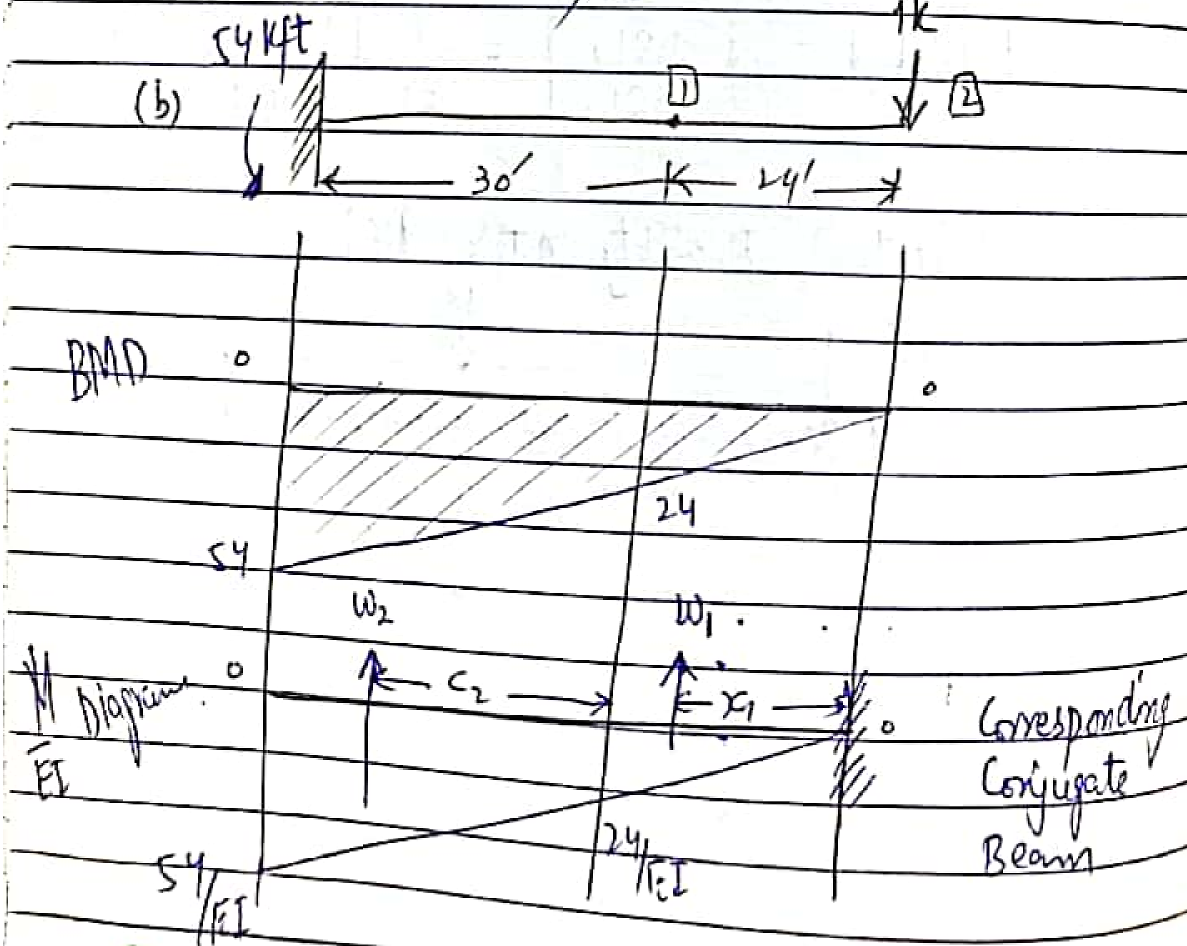
$$\Delta_{1} = f_{11} = \frac{450}{EI} \times 20$$

$$f_{11} = \frac{9000}{EI}$$

$$\Delta_{2} = f_{21} = \frac{450}{EI} \times (24+20)$$

$$f_{21} = 19800/EI$$

(b)



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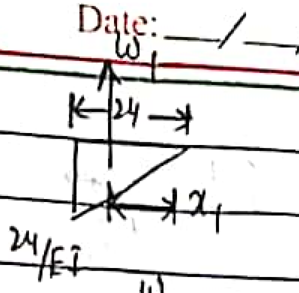
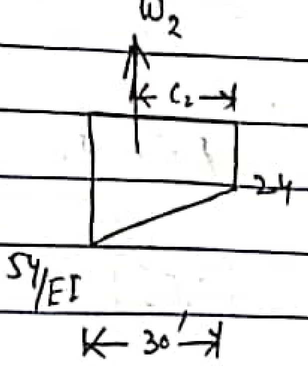


$$\omega_1 = \frac{1}{2} \times 24 \times 24/EI$$

$$\boxed{\omega_1 = 288/EI}$$



$$x_1 = \frac{2}{3}(24)$$

$$\boxed{x_1 = 16\,ft}$$

$$\omega_2 = \left(\frac{a+b}{2}\right) L = \left(\frac{54/EI + 24/EI}{2}\right)(30)$$

$$\boxed{\omega_2 = 1170/EI}$$

$$c_2 = \frac{L}{3}\left(\frac{2a+b}{a+b}\right) = \frac{30}{3}\left(\frac{2(54)+24}{54+24}\right)$$

$$\boxed{c_2 = 16.92\,ft}$$

$$\Delta_{\boxed{1}} = f_{12} = \omega_2 \times c_2 = \frac{1170}{EI} \times 16.92$$

At one — due to unit load at $\boxed{2}$.

$$f_{12} = 19800/EI$$

$$\Delta_{\boxed{2}} = f_{22} = \omega_1 \times x_1 + \omega_2 \times (c_2 + 24)$$

$$f_{22} = 52485/EI$$

Pg #07

$$[f] = \begin{bmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{bmatrix} = \frac{1}{EI} \begin{bmatrix} 9000 & 19800 \\ 19800 & 52485 \end{bmatrix}$$

Now;

Apply the compatability equation;

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

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

$$[AR] = EI \begin{bmatrix} 9000 & 19800 \\ 19800 & 52485 \end{bmatrix}^{-1} \begin{bmatrix} 0 - 445500 \\ 0 - 1007100 \end{bmatrix} \frac{1}{EI}$$

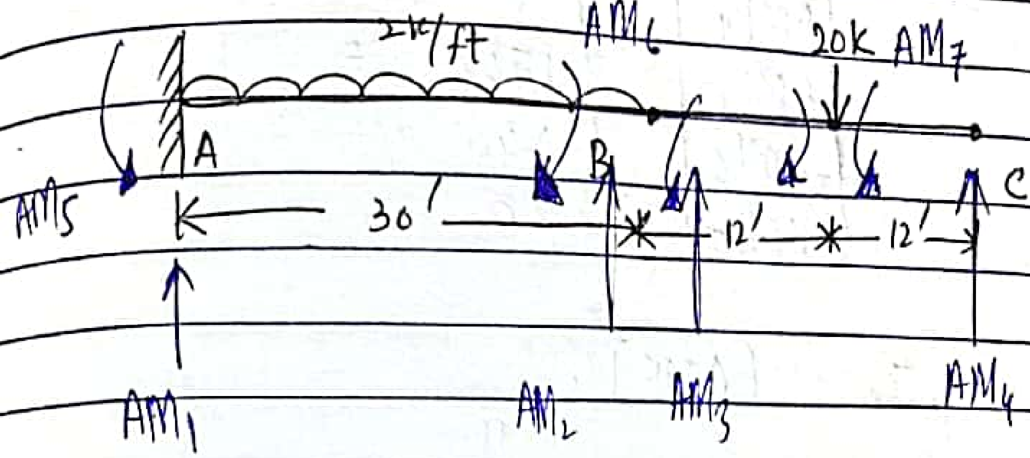
$$[AR] = \begin{bmatrix} 0.0006534 & -0.0002465 \\ -0.0002465 & 0.00011204 \end{bmatrix} \begin{bmatrix} -44500 \\ -1007100 \end{bmatrix}$$

$$[AR] = \begin{bmatrix} 219.174 \text{ k} \\ -101.87 \text{ k} \end{bmatrix}$$

where $AR_2 = -101.87$ k shows that the choosen direction is incorrect and Thus, acts vertically upward.

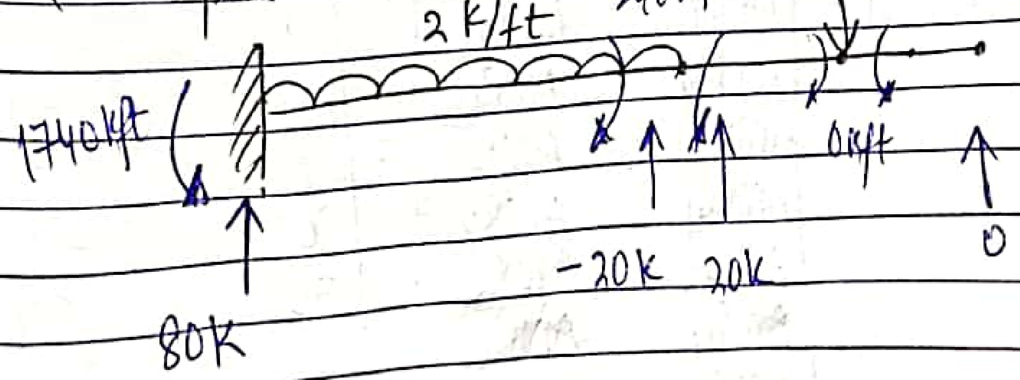
Compute Member end actions ;

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



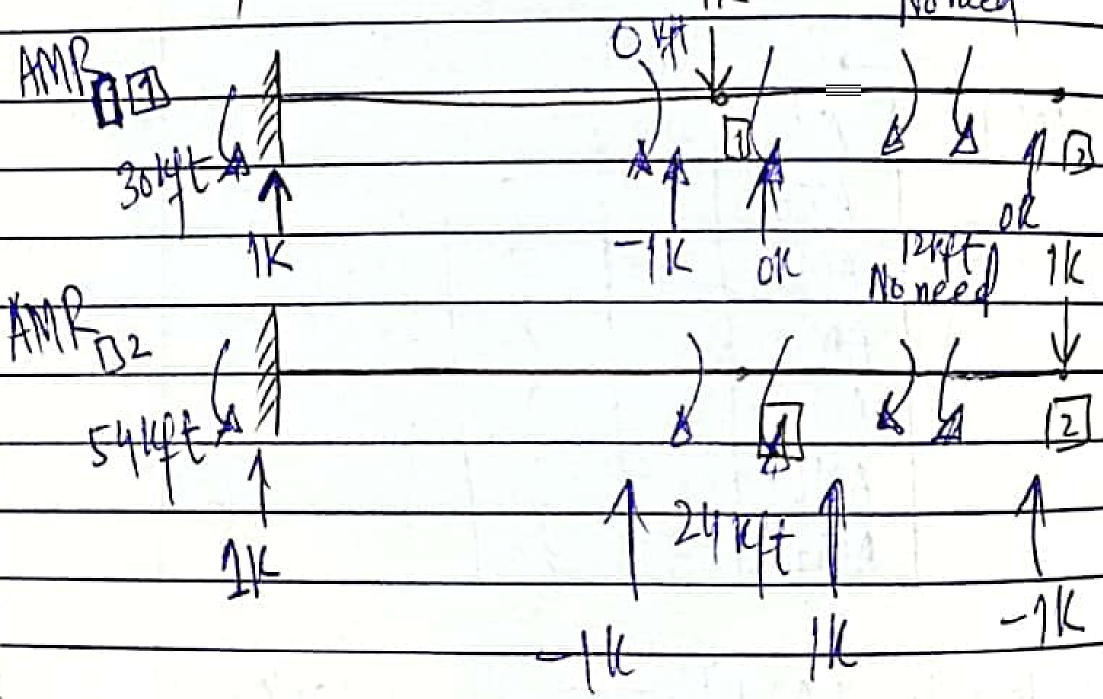
$$[AM] = \begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \\ AM_5 \\ AM_6 \\ AM_7 \end{bmatrix} = \begin{bmatrix} ? \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \end{bmatrix}$$

(a) Compute [AML].



$$[AML] = \begin{bmatrix} AML_1 \\ AML_2 \\ AML_3 \\ AML_4 \\ AML_5 \\ AML_6 \\ AML_7 \end{bmatrix} = \begin{bmatrix} 80\ k \\ -20\ k \\ 20\ k \\ 0\ k \\ 1740\ kft \\ 240\ kft \\ 0\ kft \end{bmatrix}$$

(b) Compute [AMR].



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

$$[AM] = \begin{bmatrix} 80 \\ -20 \\ 20 \\ 0 \\ 1740 \\ 240 \\ 0 \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ -1 & -1 \\ 0 & 1 \\ 0 & -1 \\ 30 & 54 \\ 0 & 24 \\ 0 & 12 \end{bmatrix} \begin{bmatrix} 219.174k \\ -101.87k \end{bmatrix}$$

$$[AM] = \begin{bmatrix} 197.304k \\ -137.304k \\ -81.87k \\ 101.87k \\ 2814.24\,kft \\ -2204.88\,kft \\ -1222.44\,kft \end{bmatrix}$$

Final Diagram!

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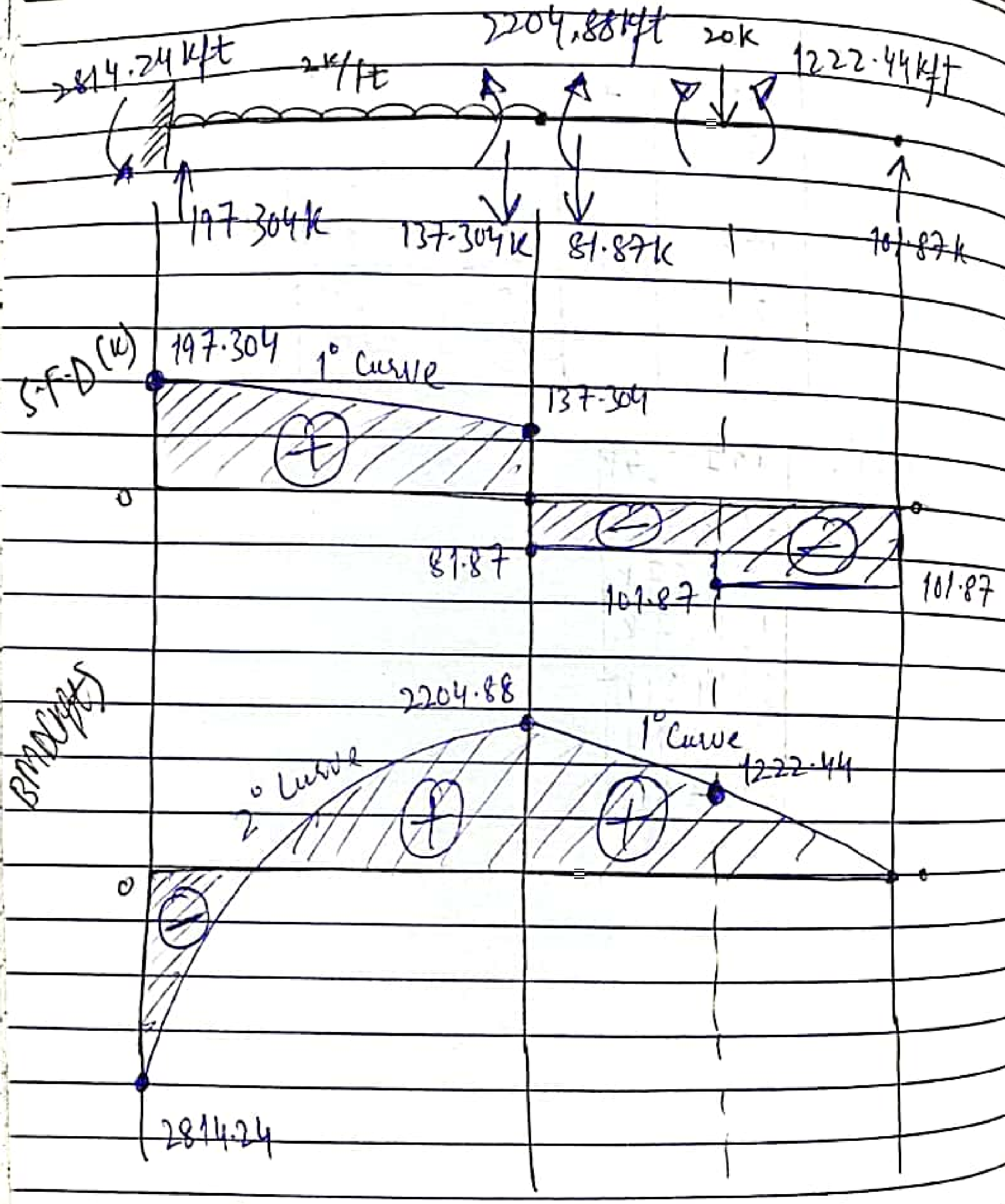

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THE END

Question:- 02

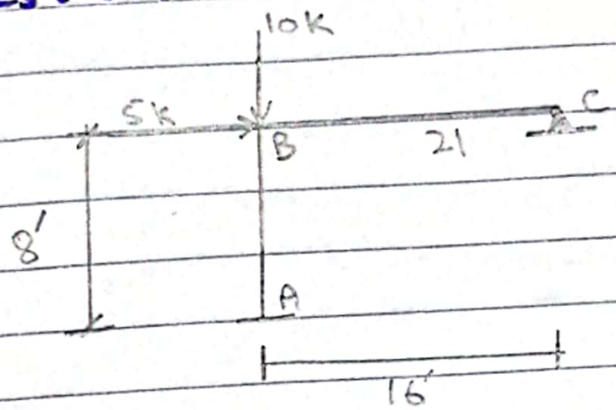
Ans:-

Force Method	Displacement Method
→ $D_s < D_K$	→ $D_s > D_K$
→ Force are reduntent or unknows.	→ Displacement are reduntent or unknows
→ Start with equillibruim of force	→ Start with compatible deformation.
→ Force found by compatility eqns of displacements.	→ Displacement found by equilibrium eqns of forces.
→ No. of reduntants = D_s	→ No. of reduntants = D_K
→ Not suitable for compute	→ Not suitable for truses.

Suggest which Method is more suitable for structure Analysis of matrix approach:-

Stiffness Method also called Displacement Method is more suitable for structure anaylsis matrix approach, as it is primary method used in matrix analysis. The main advantages of this method over flexiblility method is. that it is conductive to computer programming. Once the analytical model of structure has been defined, No further engineering decisions are required in the stiffness method in order to carry out the analysis.

Question :- 03



E = constant
$I_c = I$
$I_B = 2I$

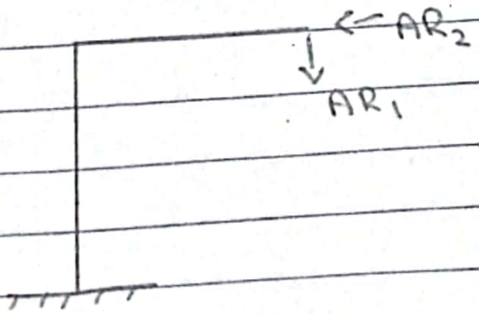
Sol :-

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]

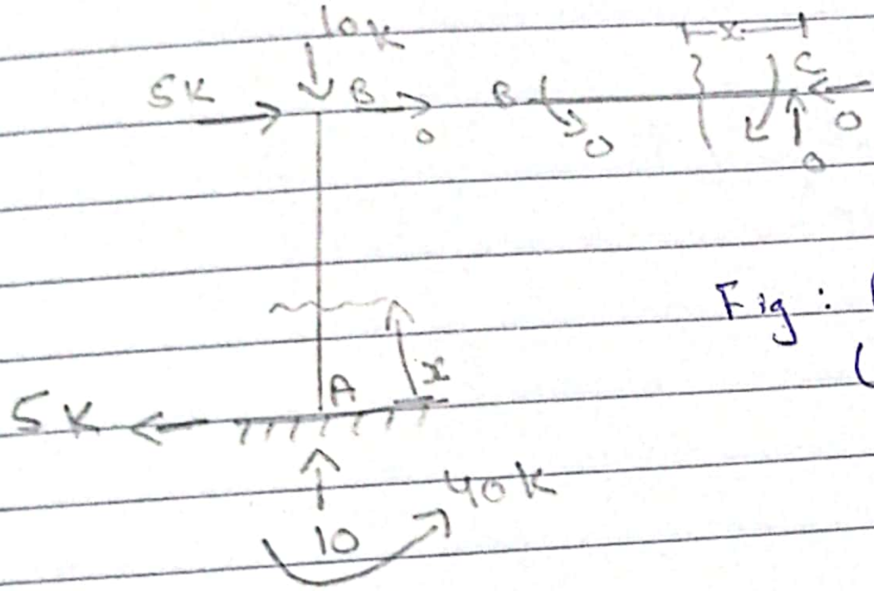


Fig : AML values (M-values)

Step:03

[F] or [AMR]

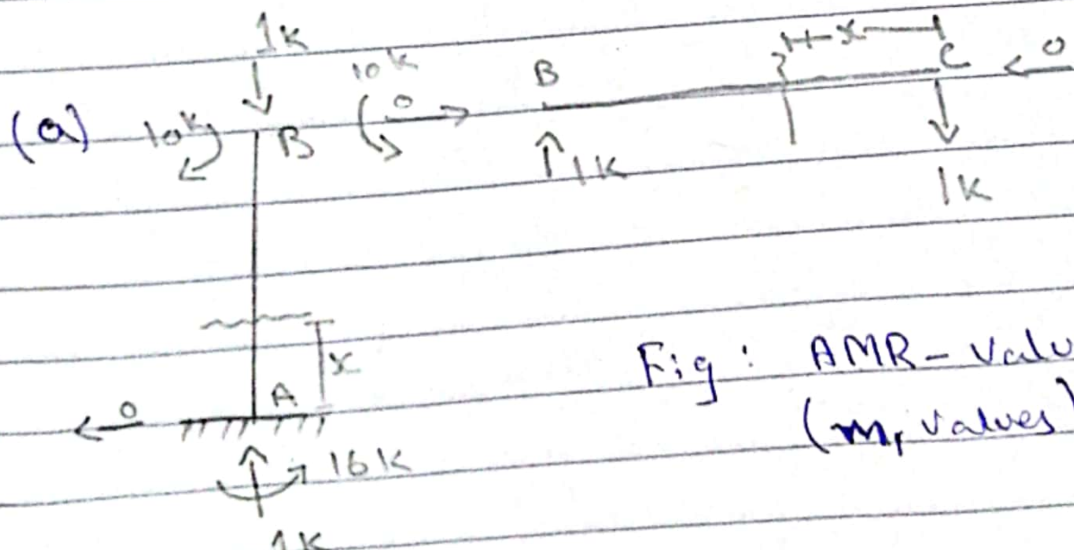


Fig : AMR-values (m_1 values)

Date:

(b)

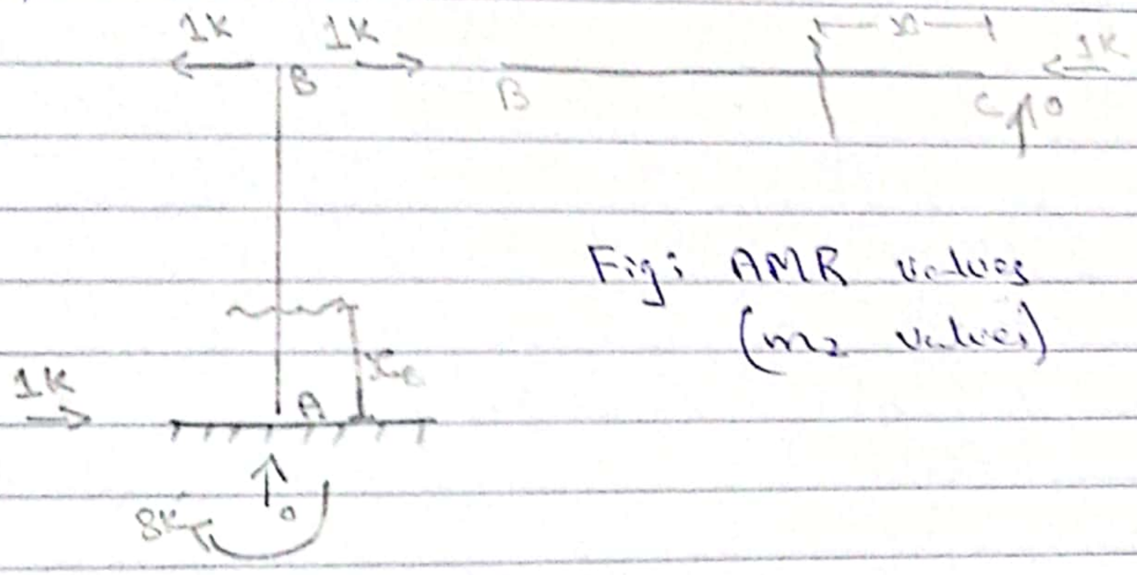


Fig: AMR values (m_2 values)

Member	AB	BC
(select orgin should be select the support) Orgin	A	C
Limits	0 — 8	0 — 16
I	I	2 I
(Take x-section AMR Fig-M and find moment → from orgin) M	5x − 40	0
m_1	−16	x (Take x-section on m_2 Fig from the orgin)
m_2	8 − x	0

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⇒ For Finding Values of DRL :-

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot m_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot m_2(BC)}{EI}$$

$$DRL_1 = \int_0^8 \frac{(5x-40)(-16)\,dx}{EI} + \int_0^{16} \frac{0 \cdot x\,dx}{E(2I)}$$

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

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

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

⇒ Compute Flexibility Method :-

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

Date:

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

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

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

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

$$F_{12} = F_{21} = \int_0^8 \frac{(-16)(8-x)}{EI} dx + \int_0^{16} \frac{(x)(0)}{2EI} dx$$

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

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

$$F_{22} = \int_0^8 \frac{(8-x)^2}{EI} dx + \int_0^{16} \frac{(0)^2}{2EI} dx$$

Date:

$$F_{22} = 170.67$$

As we know that

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

$$\Rightarrow [AR] = \frac{[DRR] - RRL}{[F]}$$

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

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

$$[AR] = \begin{bmatrix} -0.0005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$

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