NAME :- MALIK.M.AFNAN

ID :- 7839

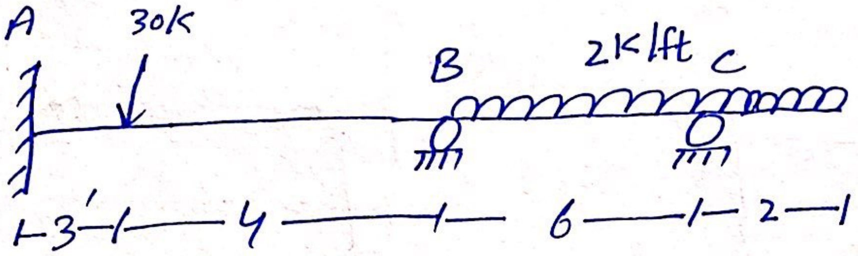
Section :- B

Subject :- Structural Analysis-II

Sir :- Engr. Adeed Khan

Date :- 25/09/2020

Problem # 01

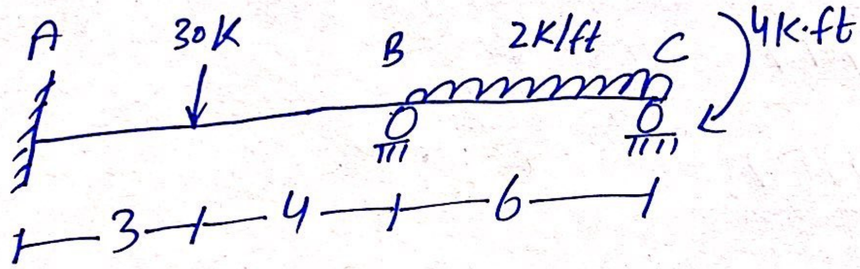


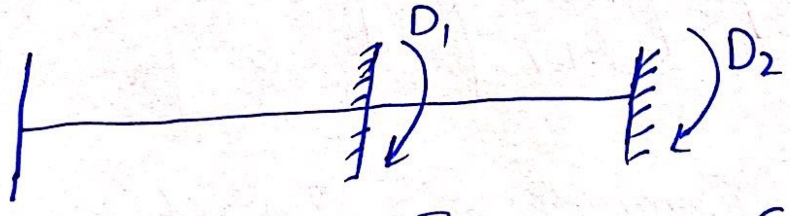
Step # 01 :-

$K.I = 2^{\circ}$ (Neglecting Axial Effects)

Step # 02 :-

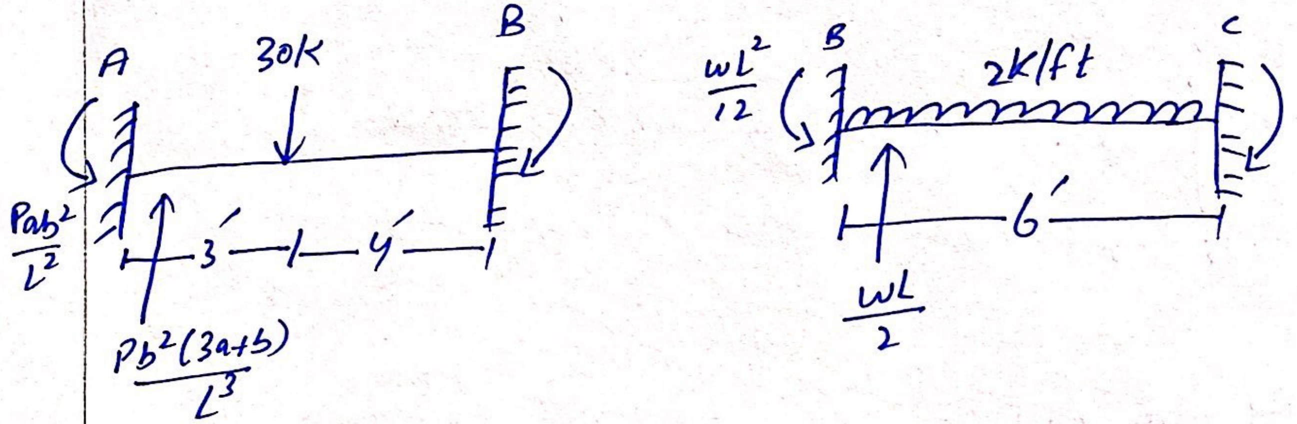
Select the unknow joint displacement.

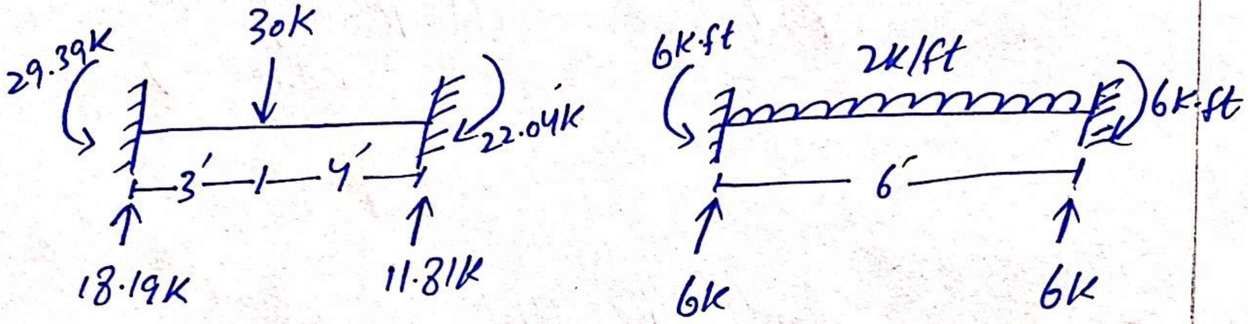




$$[D] = \begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \quad [AD] = \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

Step # 03:- Compute [ADL] matrix





$$ADL_1 = 22.04'K - 6'K$$

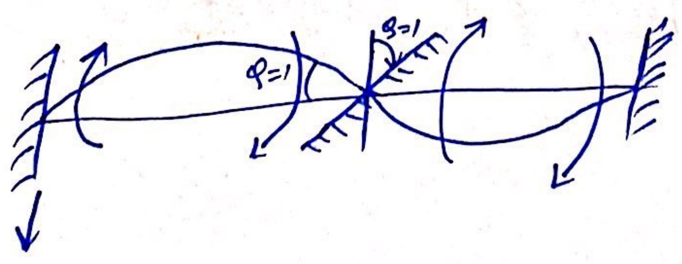
$$\boxed{ADL_1 = 16.04'K}$$

$$\boxed{ADL_2 = 6'K}$$

So $[ADL] = \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix} = \begin{bmatrix} 16.04 \\ 6 \end{bmatrix}$

Step # 04:- Compute [S] matrix

(i)

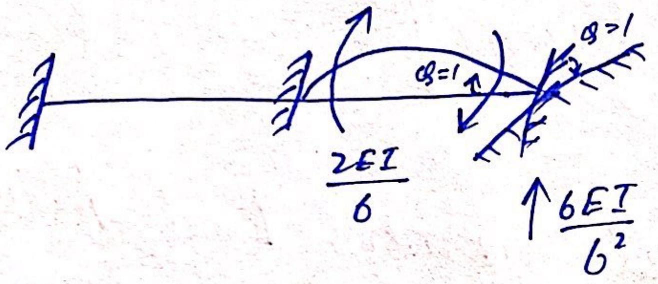


when $D_1 = 1$, $D_2 = 0$

$$S_{11} = \frac{4EI}{7} + \frac{4EI}{6} = 1.238\,EI$$

$$S_{21} = \frac{2EI}{6} = 0.333\,EI$$

ii) when $D_1 = 0$, $D_2 = 1$



$$S_{12} = \frac{2EI}{6} = 0.333EI$$

$$S_{22} = \frac{4EI}{6} = 0.667EI$$

Stiffness Matrix $[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$

$$[S] = \begin{bmatrix} 1.238 & 0.333 \\ 0.333 & 0.667 \end{bmatrix} EI$$

Step#05:- Compute the value of D_1 And D_2

$$[AD] = [ADL] + [S][D]$$

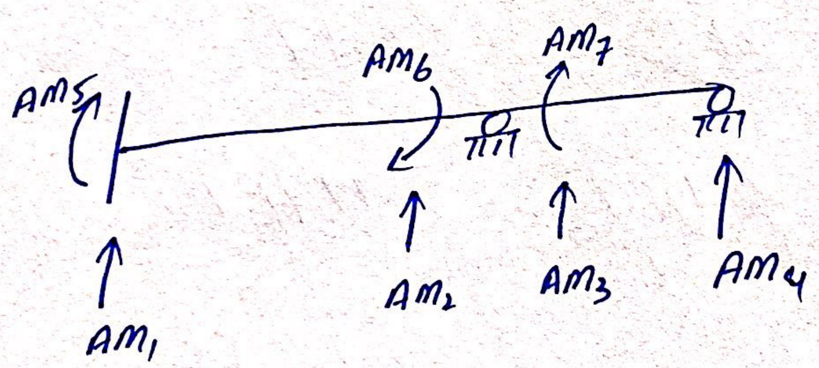
$$[D] = [S]^{-1}[AD - ADL]$$

$$[D] = \left(\begin{bmatrix} 1.238 & 0.333 \\ 0.333 & 0.667 \end{bmatrix} EI\right)^{-1} \begin{bmatrix} 0 - (16.04) \\ 4 - (6) \end{bmatrix}$$

$$= \frac{1}{EI}\begin{bmatrix} 0.933 & -0.466 \\ -0.466 & 1.732 \end{bmatrix}\begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

$$[D] = \frac{1}{EI}\begin{bmatrix} -14.03 \\ 4.01 \end{bmatrix}.$$

Step#06:- Compute member End Actions



$$[AM] = [AML] + [AMD][D]$$

$$[AML];\ [AML] = \begin{bmatrix} AML_1 \\ AML_2 \\ AML_3 \\ AML_4 \\ AML_5 \\ AML_6 \\ AML_7 \end{bmatrix} = \begin{bmatrix} 18.19K \\ 11.81K \\ 6K \\ 6K \\ -29.39'K \\ 22.04'K \\ -6'K \end{bmatrix}$$

[AMD];

$$[AMD] = \begin{bmatrix} AMD_{11} & AMD_{12} \\ AMD_{21} & AMD_{22} \\ AMD_{31} & AMD_{32} \\ AMD_{41} & AMD_{42} \\ AMD_{51} & AMD_{52} \\ AMD_{61} & AMD_{62} \\ AMD_{71} & AMD_{72} \end{bmatrix} = EI \begin{bmatrix} -0.122 & 0 \\ 0.122 & 0 \\ -0.167 & -0.167 \\ 0.167 & 0.167 \\ 0.286 & 0 \\ 0.571 & 0 \\ 0.667 & 0.333 \end{bmatrix}$$

Now; $[AM] = [AML] + [AMD][D]$

$$[AM] = \begin{bmatrix} 18.19 \\ 11.19 \\ 6 \\ 6 \\ -29.39 \\ 22.04 \\ -6 \end{bmatrix} + \begin{bmatrix} -0.122 & 0 \\ 0.122 & 0 \\ -0.167 & -0.167 \\ 0.167 & 0.167 \\ 0.286 & 0 \\ 0.571 & 0 \\ 0.667 & 0.333 \end{bmatrix} \cancel{EI} \times \frac{1}{\cancel{EI}} \begin{bmatrix} -14.03 \\ 4.01 \end{bmatrix}$$

$$[AM] = \begin{bmatrix} 19.9K \\ 10.1K \\ 7.67K \\ 4.33K \\ -33.4K \\ 14.03K \\ -14.03K \end{bmatrix}$$

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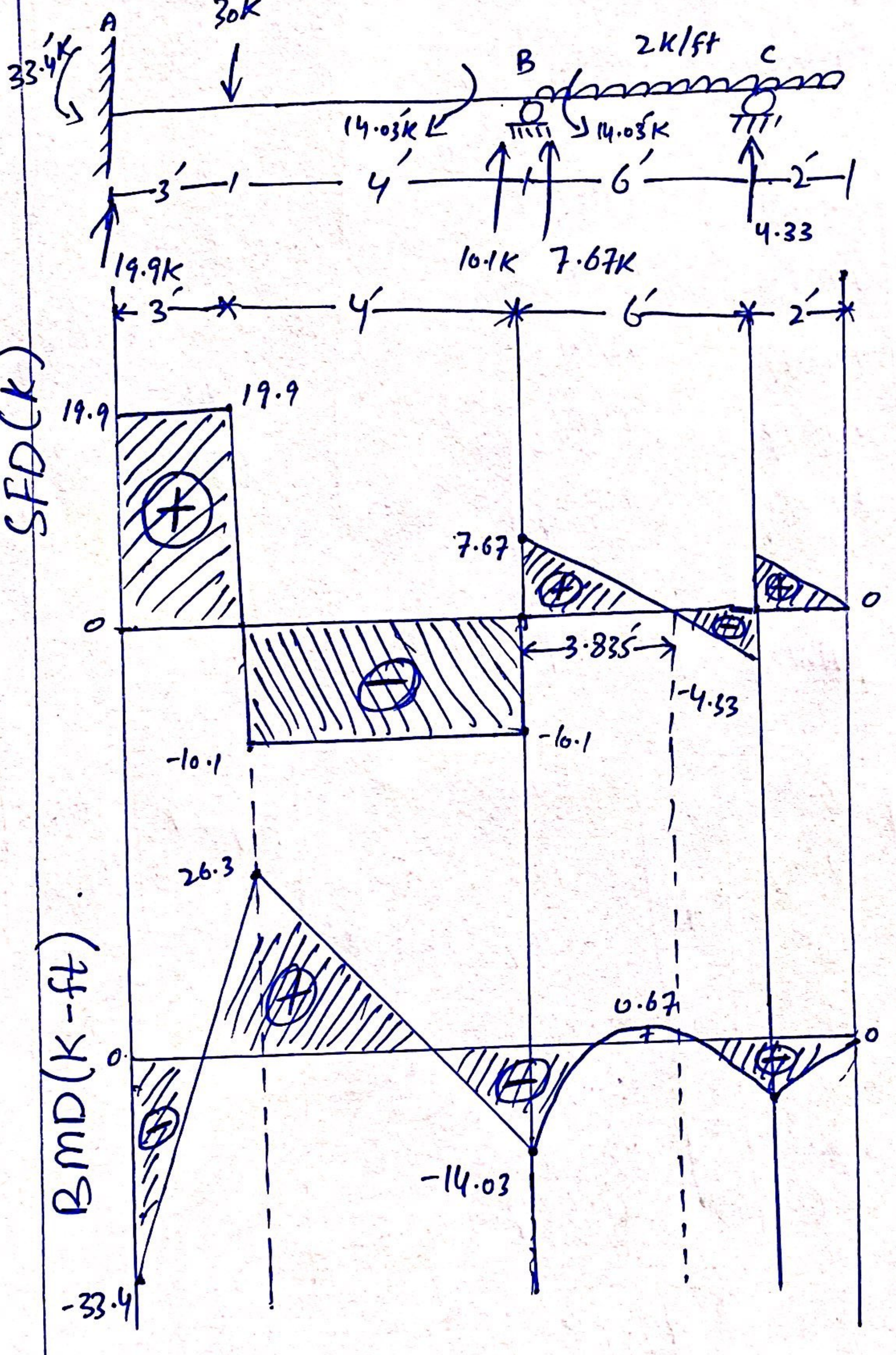
A
30K
33.4K
B
2K/ft
C
14.03K
14.03K
3'
4'
6'
2'
19.9K
10.1K
7.67K
4.33
SFD(K)
19.9
19.9
7.67
0
0
3.835'
-4.33
-10.1
-10.1
BMD(K-ft)
26.3
0.67
0
0
-14.03
-33.4

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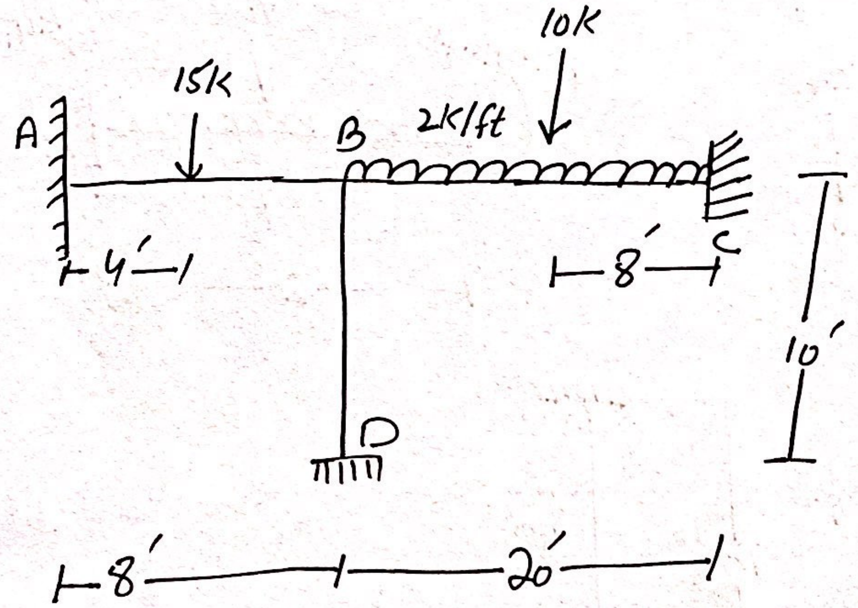
Problem # 02



Solution :-

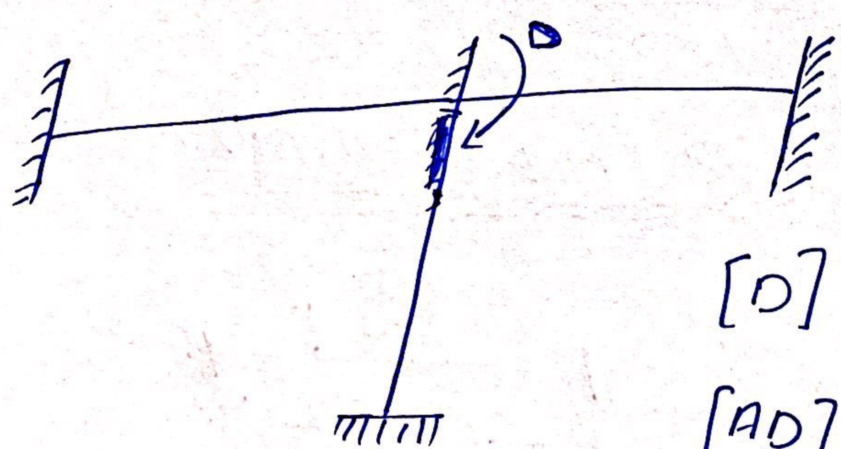
Step # 01 :-

Determine Kinematic Inderterminacy

$K.I = 1$

Step # 2 :-

Determine unknow Joint Displacement

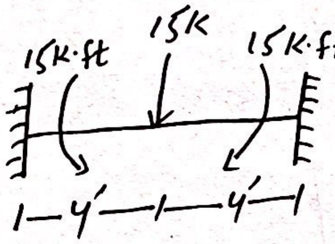


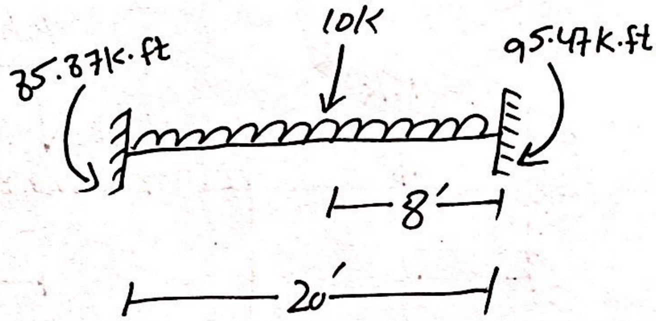
$[D] = [?]$

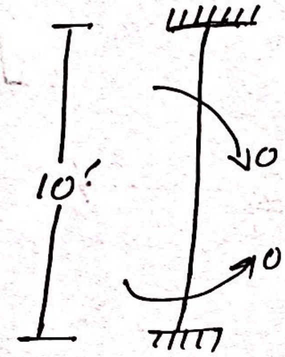
$[AD] = [0]$

Step#03:-

Compute [ADL] Matrix







=> **Point load at Center:-**

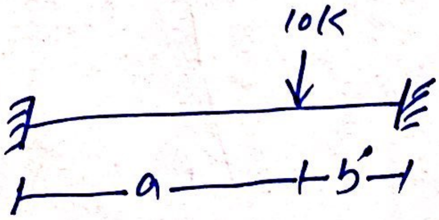
$$\frac{PL}{8} = \frac{(15)(8)}{8} = 15 \text{ kip·ft}$$

=> **Uniformly Distributed Load:-**

$$\frac{wL^2}{12} = \frac{(2)(20)^2}{12} = 66.67 \text{ k·ft}$$

=> **Point Load (Not at mid):-**

Suppose:-



For Left End:-

$$\frac{Pab^2}{L^2} = \frac{(10)(12)(8)^2}{(20)^2} = 19.2 \text{ k·ft}$$

For Right End:-

$$\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = 28.8 \text{ k·ft}$$

So Total moment at Left End:-

$$19.2 + 66.67 = 85.87 \text{ k·ft}$$

Similary at right End:-

$$28.8 + 66.67 = 95.47 \text{ k·ft}$$

So $[ADL] = -85.87 + 15 = -70.87$ k·ft

Step # 04:-

Determine [S] Matrix

$$[S] = [S_{11}]$$

Now $D = 1K$

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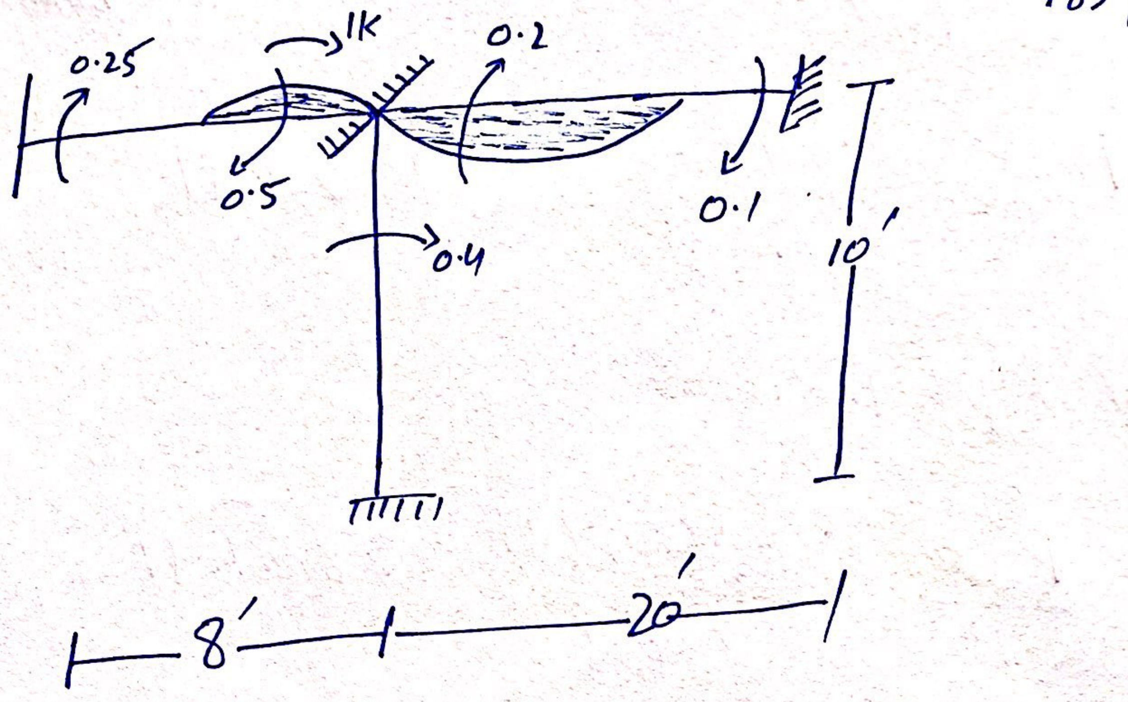

$$\Rightarrow \frac{4EI}{8} = 0.5 \qquad \frac{2EI}{8} = 0.25$$

$$\Rightarrow \frac{4EI}{20} = 0.2 \qquad \frac{2EI}{20} = 0.1$$

$$\Rightarrow \frac{4EI}{10} = 0.4 \qquad \frac{2EI}{10} = 0.2.$$

$$[S] = (0.5 + 0.4 + 0.2)EI$$

$$[S] = 1.1\,EI$$

Scanned with CamScanner

Step # 05 :-

Compute [D] Matrix

$$[D] = [S]^{-1} \times [AD] - [ADL]$$

$$[D] = \frac{1}{1.1} \times [0] - [-70.87]$$

$$= \frac{70.87}{1.1}$$

$$\boxed{[D] = [64.42]\ ^{1}/_{EI}}$$

Problem # 03

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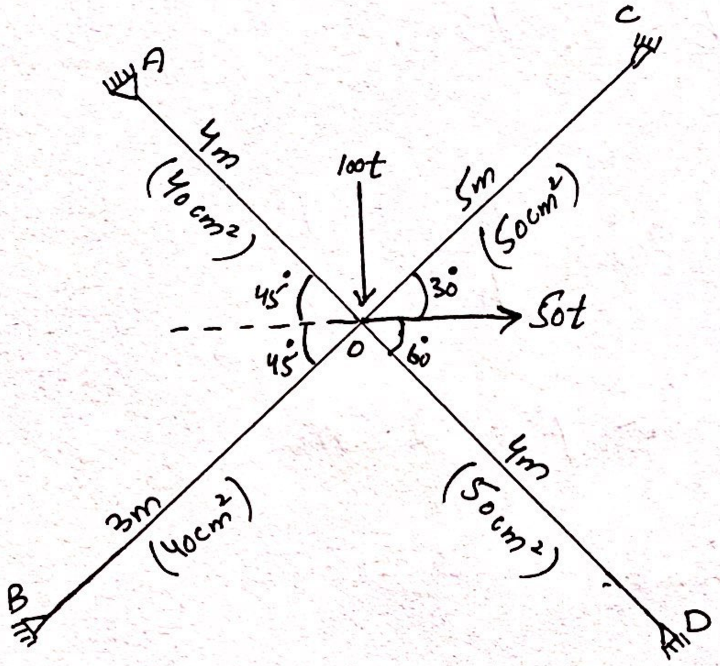


$E = 2000 t/cm^3$

Solution:-

For A :-

$$\sin 45^\circ = \frac{P}{h} = \frac{P}{4}$$

$$\Rightarrow P = 2.828m$$

$$\cos 45^\circ = \frac{b}{4}$$

$$\Rightarrow b = 2.828m$$

For B :-

$$\sin 45^\circ = \frac{P}{3}$$

$$\Rightarrow P = 2.12m$$

$$\cos 45^\circ = \frac{b}{h}$$

$$\Rightarrow b = 2.12m$$

For C :-

$$\sin 30^\circ = \frac{P}{h} = \frac{P}{5}$$

$$\Rightarrow P = 2.5m$$

$$\cos 30^\circ = \frac{b}{5}$$

$$\Rightarrow b = 4.33m.$$

Now:-

$$EA(A) = 2000 \times 40 = 80{,}000\,t$$

$$EA(B) = 2000 \times 40 = 80{,}000\,t$$

$$EA(C) = 2000 \times 50 = 100{,}000\,t$$

$$EA(D) = 2000 \times 50 = 100{,}000\,t$$

Step# 01 :- K.I

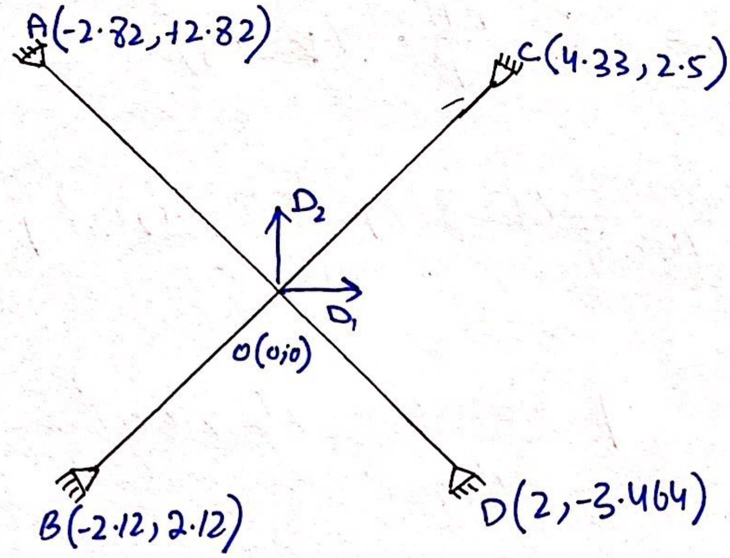
$$K.I = 2j - r$$

$$K.I = 2(5) - 8$$

$$\boxed{K.I = 2^\circ}$$

Step # 02 :-

Select unknow Joint displacement



$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \quad \begin{bmatrix} AD_1 \\ AD_1 \end{bmatrix} = \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

Step # 03 :- $[AMD]_{4\times 2}$ and $[S]_{2\times 2}$

i) $D_1 = 1$, $D_2 = 0$

$$AMD = \frac{EA}{l^2}(x_k - x_j)$$

$$AMD_{11} = \frac{80,000}{(400)^2} \times (0 + 282) = 141$$

$$AMD_{21} = \frac{80,000}{(300)^2} \times (0 + 212) = 188.44$$

$$AMD_{31} = \frac{100,000}{(500)^2} \times (0 - 433) = -173.2.$$

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$$AMD_{41} = \frac{100{,}000}{(400)^2} \times (0-200) = -125$$

Now $$S_{11} = \sum_{i=1}^{m} \frac{EA}{L^3} (x_K - x_j)^2$$

$$= \frac{80{,}000}{(400)^3} \times (282)^2 + \frac{80{,}000}{(300)^3} \times (212)^2 + \frac{100{,}000}{(500)^3} \times (-433)^2$$

$$+ \frac{100{,}000}{(400)^3} \times (-200)^2$$

$$S_{11} = 99.405 + 133.167 + 149.991 + 62.5$$

$$\boxed{S_{11} = 445.063}$$

$$S_{12} = S_{21} = \sum_{i=1}^{m} \frac{EA}{L^3} \times (x_K - x_j)(y_K - y_j)$$

$$= \frac{80{,}000}{(400)^3} \times (282)(-282) + \frac{80{,}000}{(300)^3} \times (212)(212)$$

$$+ \frac{100{,}000}{(500)^3} \times (-433)(0-250) + \frac{100{,}000}{(400)^3} \times (-200)(0+346)$$

$$\boxed{S_{12} = S_{21} = 12.237}$$

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Step#04:-

$$[D] = [S]^{-1} \times [AD]$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.063 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

Step#05:- $[AM]$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}.$$

$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (-0.216) \\ 188.44 \times 0.1183 + 188.44 \times (-0.216) \\ -173.2 \times 0.1183 + (-100) \times (-0.216) \\ -125 \times 0.1183 + 216.25 \times (0.216) \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 - 46.71 \end{bmatrix}.$$

ii) $D_1 = 0$, $D_1 = 1K'$

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$$AMD = \frac{EA}{L^2}(y_K - y_j)$$

$$AMD_{12} = \frac{80{,}000}{(400)^2}(-282) = -141$$

$$AMD_{22} = \frac{80{,}000}{(300)^2}(212) = 188.44$$

$$AMD_{32} = \frac{100{,}000}{(500)^2}(-250) = -100$$

$$AMD_{42} = \frac{100{,}000}{(400)^2}(346) = 216.25$$

Now $S_{22} = \sum_{i=1}^{m} \frac{EA}{L^3}(y_K - y_j)^2$

$$= \frac{80{,}000}{(400)^3}(-282)^2 + \frac{80{,}000}{(300)^2}(212)^2 + \frac{100{,}000}{(500)^3}(-250)^2$$

$$+ \frac{100{,}000}{(400)^3}(346)^2$$

$$\boxed{S_{22} = 469.628}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -61.498t \end{bmatrix}.$$