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Final term Paper
(Summer)

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ID : 7768

Subject : Structure 2

Submitted to : Engr. Adeed Khan

Date : 25 Sept 2020

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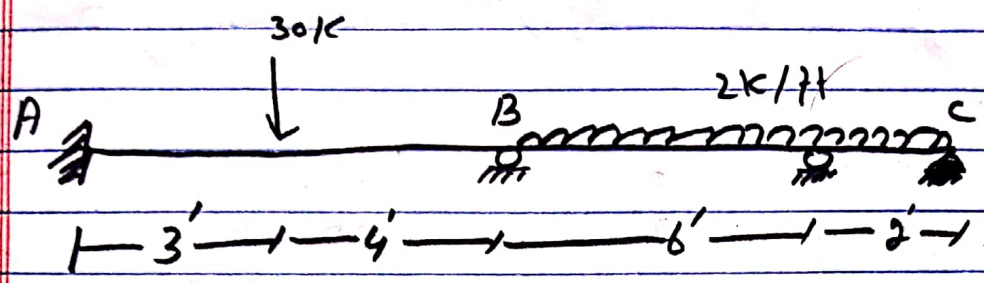
Q No 01

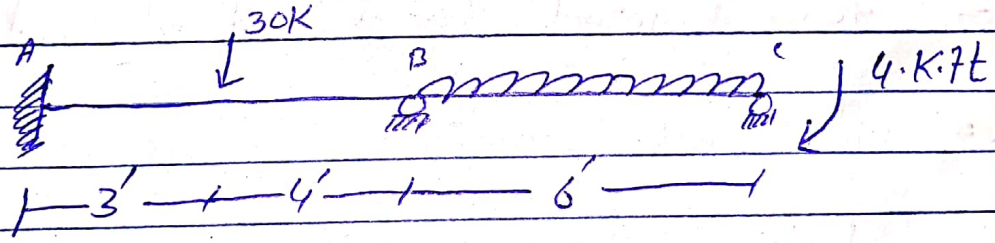


Sol **Step # 1**

Determining Kinemetic Indeterminacy

K.I = 5°

So we have to reduce the extended portion



$$\Rightarrow \frac{2(2)}{1} \Rightarrow 4, K \cdot ft$$

Now

K.I = 2°

Step # 2

Determine unKnow Joint Displacement

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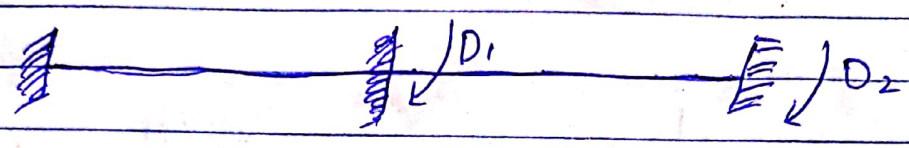
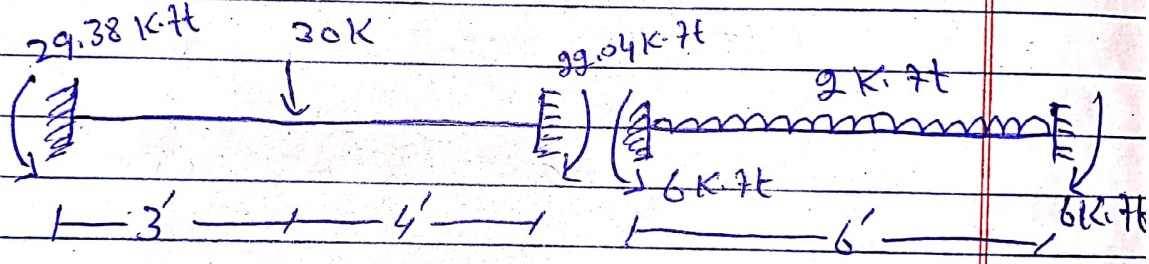


$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \qquad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

Step # 3

Compute [ADL] matrix



⇒ for Pointed load (not at mid)

⇒ for left end,

$$\Rightarrow \frac{Pab^2}{L^2} = \frac{(30)(3)(4)^2}{7^2} = 29.38 \text{ K.ft}$$

⇒ for Right end,

$$\Rightarrow \frac{Pa^2b}{L^2} = \frac{(30)(3)^2(4)}{(7)^2} = 99.04 \text{ K.ft}$$

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⇒ for UDL:

$$\frac{wL^2}{12} \Rightarrow \frac{(2)(6)^2}{12} = 6 \text{ K.ft}$$

$ADL_1 = +22.04 - 6 = 16.04$ K.ft

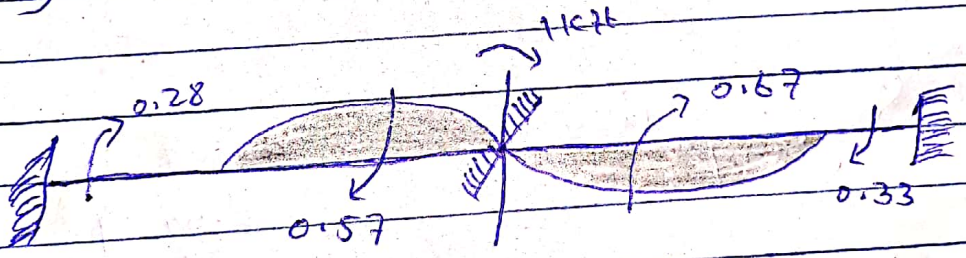
$ADL_2 = 6$ K.ft

Step #4

compute [S] matrix

$$S = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$$

a) $D_1 = 1K$ $D_2 = 0$



$$\Rightarrow \frac{4EI}{7} = 0.57 \quad , \quad \frac{2EI}{6} = 0.33$$

$$\Rightarrow \frac{4EI}{6} = 0.67 \quad , \quad \frac{2EI}{7} = 0.28$$

$S_{11} = 0.57 + 0.67$

$S_{11} = 1.24$ EA

$S_{g1} = 0.33$ EA

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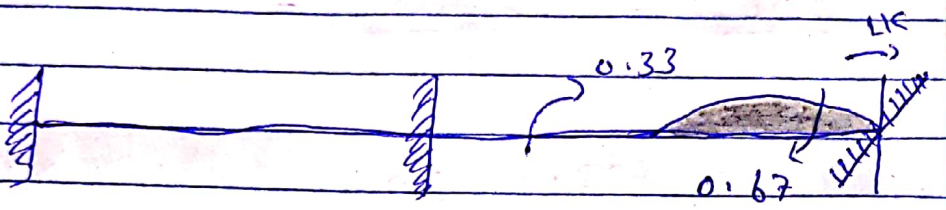
(b) $D_1 = 0$ $D_2 = 1K$



$$\frac{4EI}{6} = 0.67$$

$$\frac{2EI}{6} = 0.33$$

$S_{12} = 0.33$

$S_{22} = 0.67$

$$S = \begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}$$

Step # 5

Compute [D] matrix

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} AL_1 \\ AL_2 \end{bmatrix}$$

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ -0.33 & 0.67 \end{bmatrix}} \times \text{Adj } A \times \begin{bmatrix} 0 \\ 4 \end{bmatrix} - \begin{bmatrix} 16.04 \\ 6 \end{bmatrix}$$

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$$[S] = (1.24 \times 0.67) - (0.33 \times 0.33)$$
$$= 0.8308 - 0.1089$$
$$[S] = 0.7219$$

$$\text{Adj } A = \begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}$$

Now

$$\begin{bmatrix} AD_1 - ADL_1 \\ AD_2 - ADL_2 \end{bmatrix} = \begin{bmatrix} 0 - 16.04 \\ 4 - 6 \end{bmatrix} = \begin{bmatrix} -16.04 \\ -2 \end{bmatrix} EI$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \frac{\begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix} \frac{1}{EI}}{0.7219}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} -13.97 \\ 3.8902 \end{bmatrix} \times EI$$

[redacted]

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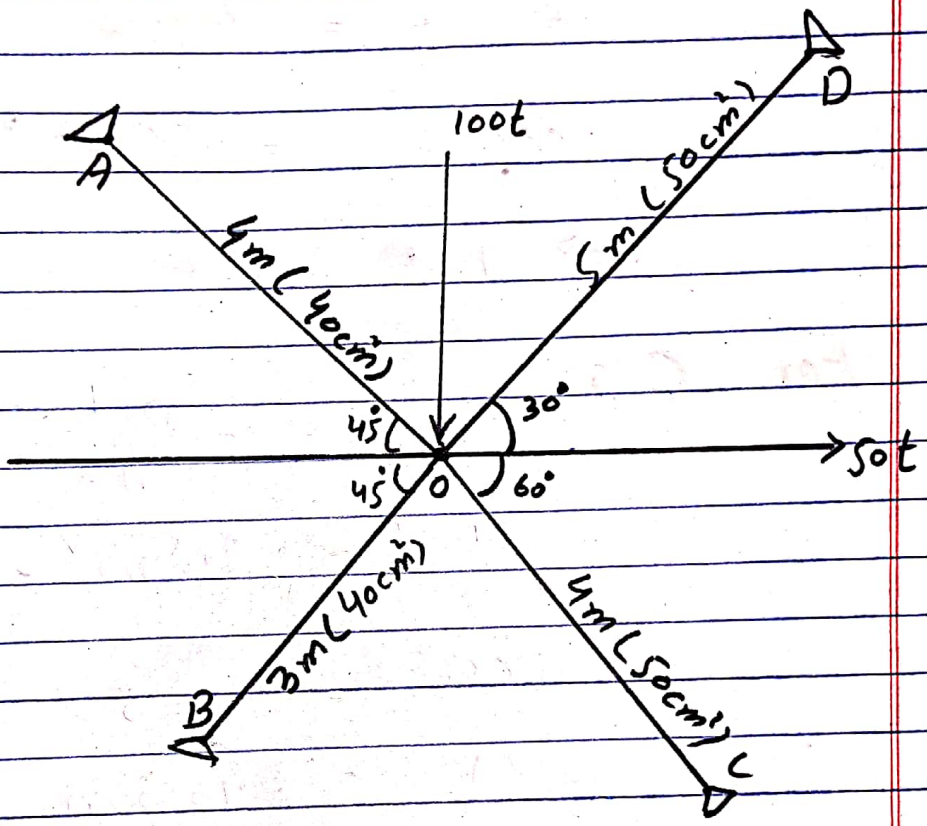
Q No 02



$E = 2000\ t/cm^2$

Sol:

For A

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

$$\Rightarrow P = 2.828m$$

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

$$\Rightarrow b = 2.828m$$

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For B :-

$$\sin 45^\circ = P/3$$

$$\Rightarrow P = 2.12m$$

$$\cos 45^\circ = b/h \Rightarrow b/3$$

$$\Rightarrow b = 2.12m$$

For C :-

$$\sin 30^\circ = P/h = P/5$$

$$\Rightarrow P = 2.5m$$

$$\cos 30^\circ = b/5$$

$$\Rightarrow b = 4.33m$$

Now

$$EA(A) = 2000 \times 40 = 80,000t$$
$$EA(B) = 2000 \times 40 = 80,000t$$
$$EA(C) = 2000 \times 50 = 100,000t$$
$$EA(D) = 2000 \times 50 = 100,000t$$

Step # 01

K.I

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

$$K.I = 2^\circ$$

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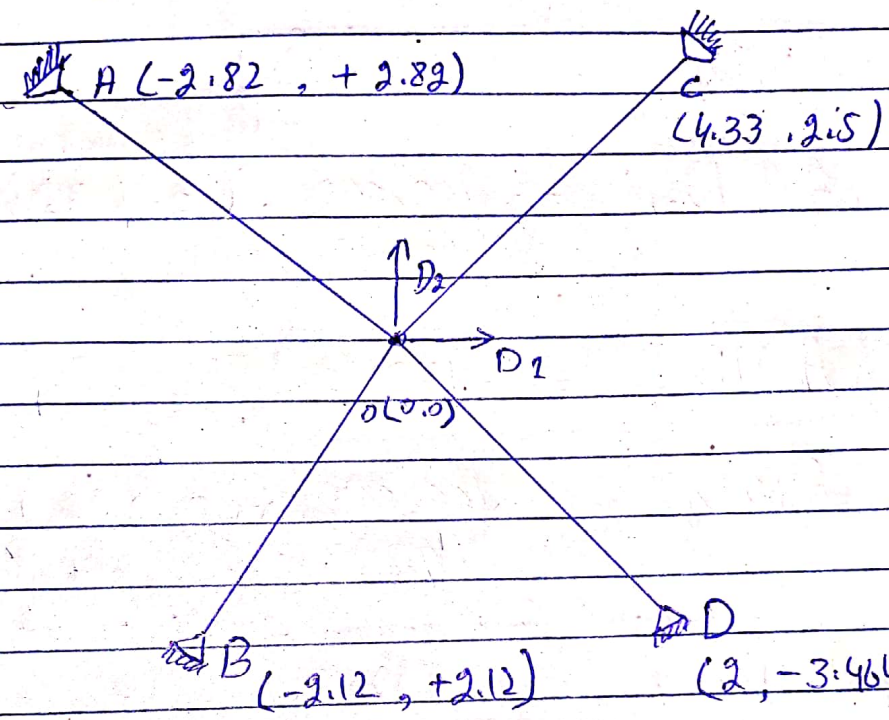
Step # 02

Select unknown joint displacement.



$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \quad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

Step # 03

$[AMD]_{4\times2}$ & $[S]_{2\times2}$

i) $D_1 = 1 \qquad D_2 = 0$

$$AMD = \frac{EA}{L^2}(X_K - X_j)$$

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

$$= \boxed{141}$$

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

$$\boxed{AMD_{21} = 188.44}$$

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

$$\boxed{AMD_{31} = -173.2}$$

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

$$\boxed{AMD_{41} = -125}$$

Now $$S_{11} = \sum_{K}^{m} \frac{EA}{L^3} (X_K - X_j)^2$$

$$S_{11} = \frac{80,000}{400^3}(282)^2 + \frac{80000}{(300)^3}(212)^2$$

$$+ \frac{100,000}{(500)^3} \times (-433)^3 + \frac{100000}{(400)^3} \times (-200)^3$$

$$S_{11} = 99.405 + 133.107 + 149.991 + 82.5$$

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

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$$S_{12} = S_{21} = \sum_{i+1}^{m} \frac{EA}{L^3} \times (X_K - X_j)(Y_K - Y_j)$$

$$S_{12} = \frac{80,000}{(400)^3} \times (282)(-282) + \frac{80,000}{(300)^3}(212)(212)$$

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

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

(ii) $D_1 = 0$ $D_1 = 1K$

$$AMD = \frac{EA}{L^2}(Y_K - Y_j)$$

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

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

$$AMD_{33} = \frac{100,000}{500^2}(-250) = -100$$

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

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

$$S_{22} = \frac{80,000}{400^3}(-282)^2 + \frac{80,000}{300^3}(212)^2$$

$$+ \frac{100,000}{500^3}(-250)^2 + \frac{100,000}{400^3}(346)^2$$

$$S_{22} = 469.628$$

Step #04

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.083 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

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

Step #5

$$[AM]$$

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

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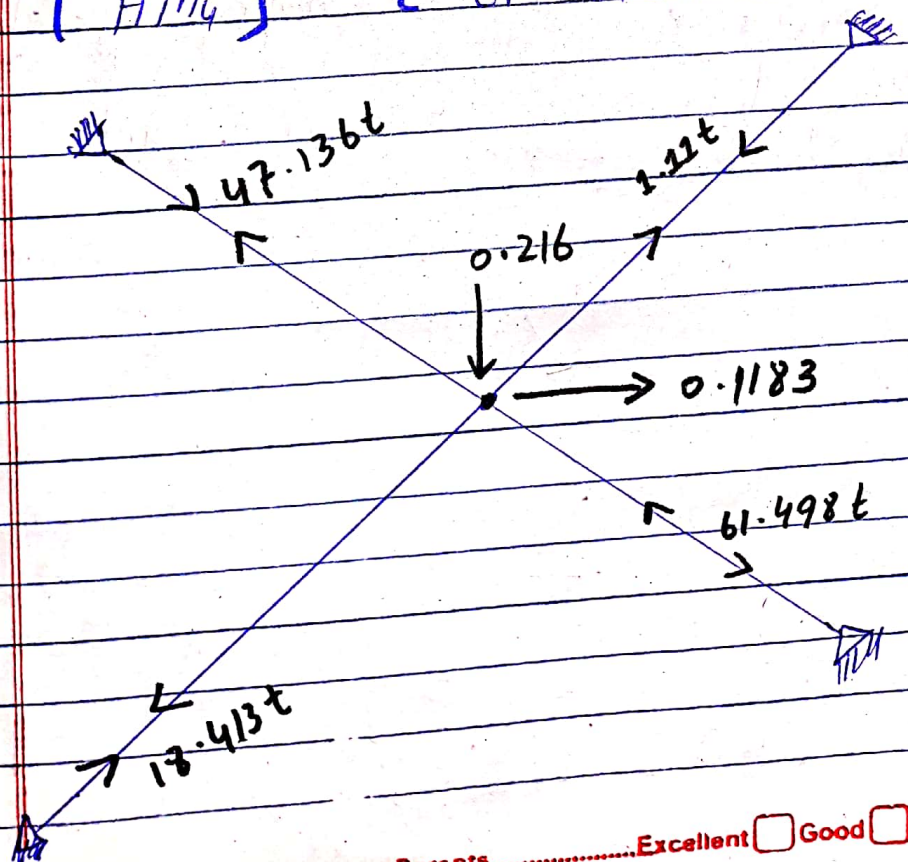
$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (-0.216) \\ 188.44 \times 0.1183 + 188.44 \times (-0.216) \\ -173.2 \times 0.1183 + (-100) \times (-0.216) \\ \\ -125 \times 0.1183 + 216.25 \times (-0.216) \end{bmatrix}$$

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

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



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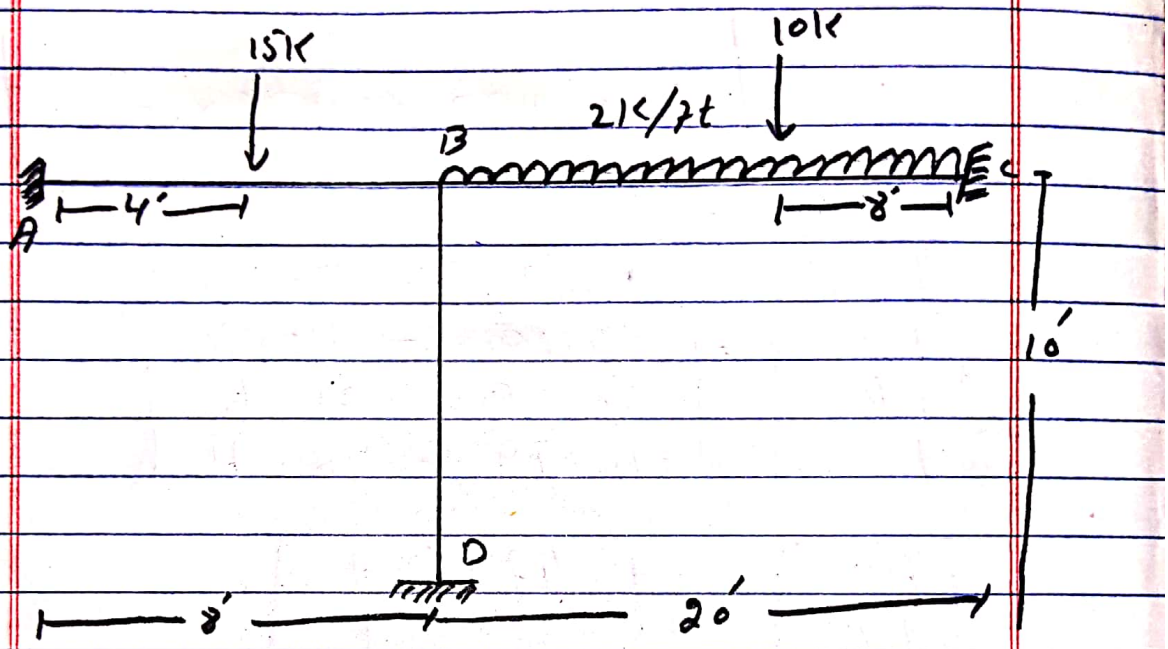
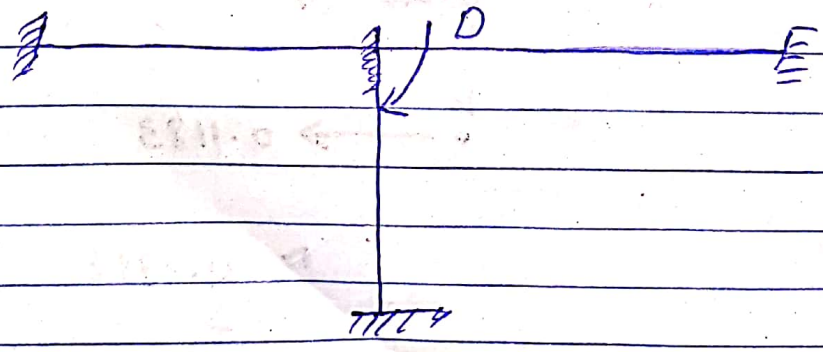
Q No 03



Sol **Step # 1** : Determine Kinematic Indeterminacy
K.I = 1°

Step # 02
Determine unknown joint Displacement.



$$[D] = [?]$$
$$[AD] = [0]$$

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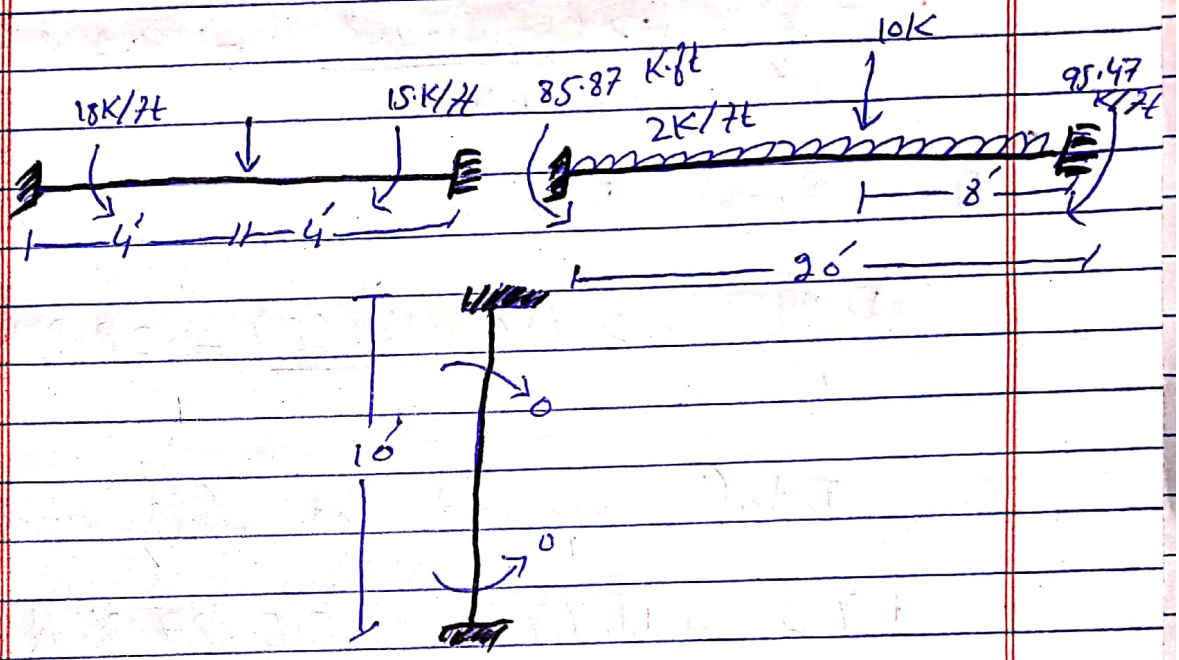
Step # 3

Compute [AOL] matrix



⇒ Point load at centre:

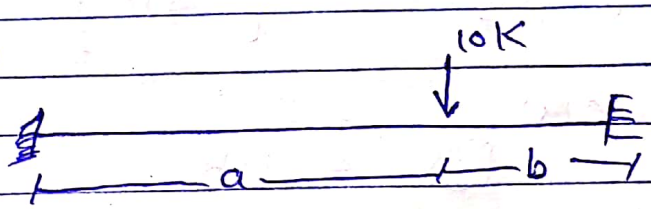
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ K/ft}$$

⇒ Uniformly Distributed load

$$\frac{wL^2}{12} \Rightarrow \frac{(2)(20)^2}{12} \Rightarrow 66.67 \text{ K-ft}$$

⇒ Point load (Not at mid):

Suppose



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For Left End:

$$\frac{Pab^2}{L^2} \Rightarrow \frac{(10)(12)(8)^2}{(20)^2} = 19.2 \text{ K.ft}$$

For Right End:

$$\frac{Pa^2b}{L^2} \Rightarrow \frac{(10)(12)^2(8)}{(20)^2} \Rightarrow 28.8 \text{ K.ft}$$

So Total moment at left end:

$$19.2 + 66.67 = 85.87 \text{ K.ft}$$

Similarly at right End:

$$28.8 + 66.67 = 95.47 \text{ K.ft}$$

$$SO[ADL] = -85.87 + 15 = -70.87 \text{ K.ft}$$

Step #4

Determine [S] matrix

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

Now

$$D = 1^{\circ}K$$

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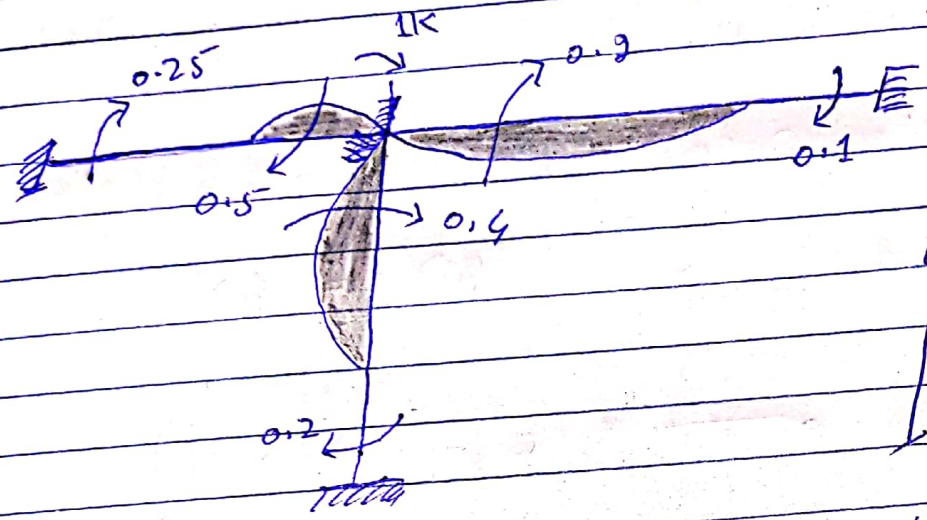

$$\Rightarrow \frac{4EI}{8} = 0.5 \quad , \quad \frac{2EI}{8} = 0.25$$

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

$$\Rightarrow \frac{4EI}{10} = 0.4 \quad , \quad \frac{2EI}{10} = 0.2$$

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

$$= 1.1\, EI$$

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

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Step #5

Compute [D] matrix

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

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

$$[D] = \frac{70.87}{1.1}$$

$$\boxed{[D] = [64.49] \ \frac{1}{EI}}$$