Date

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Submitted To	Engr. Adeed Khan
Subject	Structure Analysis-II
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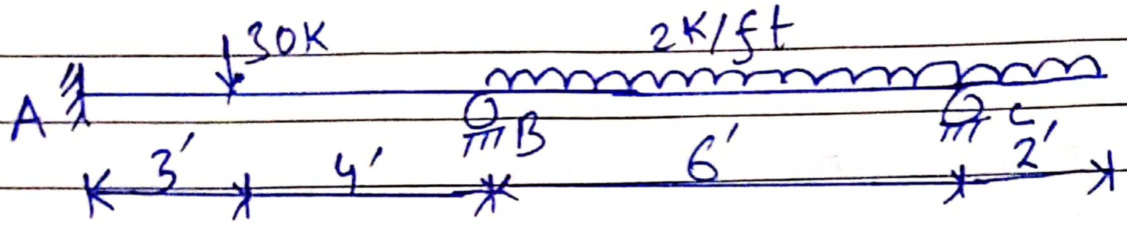
Summer Semester	6th

Final Term Summer Exam

Q1: Analyze the beam by stiffness method. Assume EI is constant.



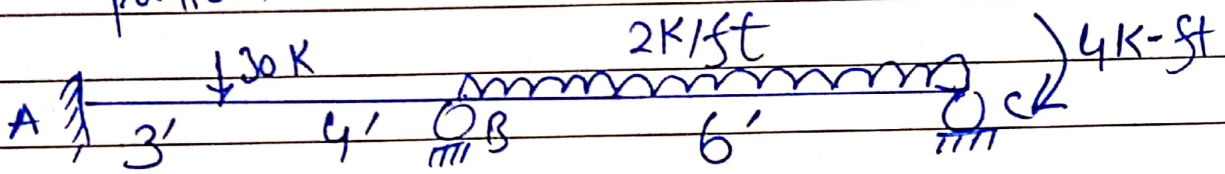
Sol:-

Step 1:-

Determining Kinematic Indeterminacy

$K \cdot I = 5^{\circ}$

So we have to reduce the extended portion.

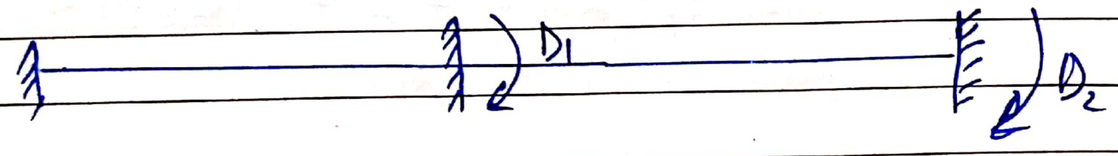


$\frac{(2K/ft)(2ft)}{1} = 4K\text{-}ft$

Now $K \cdot I = 2^{\circ}$

Step 02:-

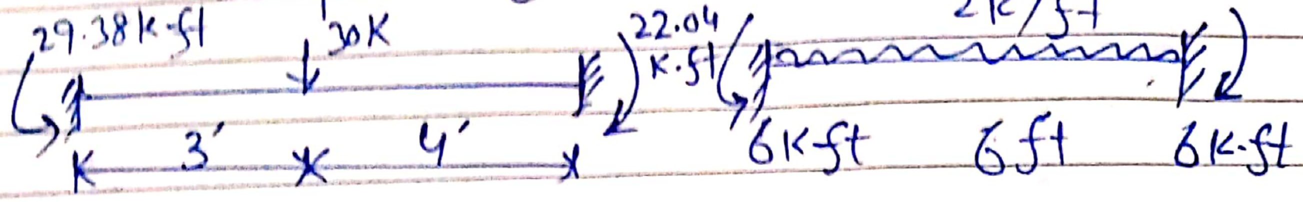
Determine unknown joint displacement



$\begin{Bmatrix} D_1 \\ D_2 \end{Bmatrix} = \begin{Bmatrix} ? \\ ? \end{Bmatrix}, \begin{Bmatrix} AD_1 \\ AD_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 4 \end{Bmatrix}$

Step 3 :-

Compute [ADL] Martix.



⇒ For pointed load (not at mid)

For left end :-

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

For right end :-

$$\frac{Pa^2b}{L^2} = \frac{(30)(3)^2(4)}{(7)^2} = 22.04 \text{ K-ft}$$

⇒ For UDL

$$\frac{WL^2}{12} = \frac{(2)(6)^2}{12} = 6 \text{ K-ft}$$

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

$ADL_2 = 6$ K-ft

Step 4 :-

Compute {S} Matrix.

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

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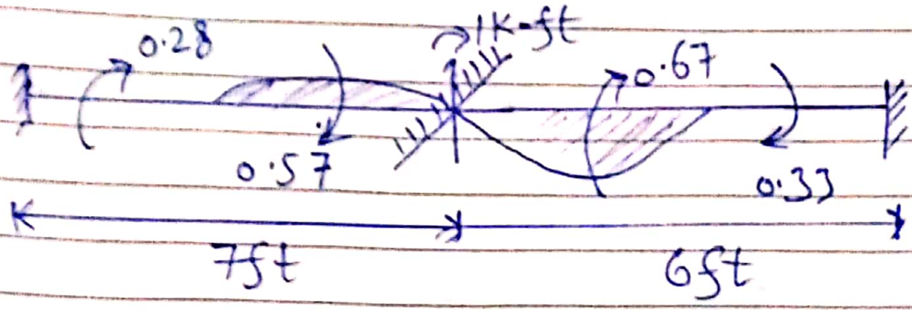
(a) $D_1 = 1K$, $D_2 = 0$



$\frac{4EI}{7} = 0.57$ $\frac{2EI}{7} = 0.28$

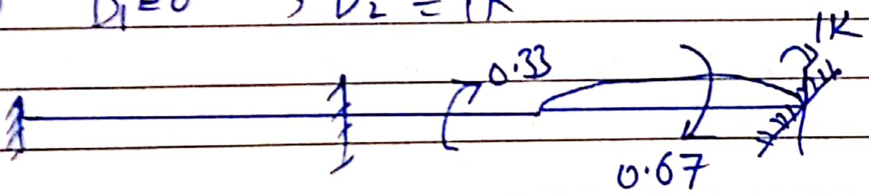
$\frac{4EI}{6} = 0.67$ $\frac{2EI}{6} = 0.33$

$S_{11} = 0.57 + 0.67$

$S_{11} = 1.24 EA$

$S_{21} = 0.33 EA$

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



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

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

$S_{12} = 0.33$

$S_{22} = 0.67$

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

Step 5 :-

compute [D] Matrix

$$\begin{Bmatrix} D_1 \\ D_2 \end{Bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{Bmatrix} ADL_1 \\ ADL_2 \end{Bmatrix}$$

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times \text{Adj } A \times [\quad]$$

$$|S| = (1.24 \times 0.67) - (0.33 \times 0.33)$$

$$|S| = 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

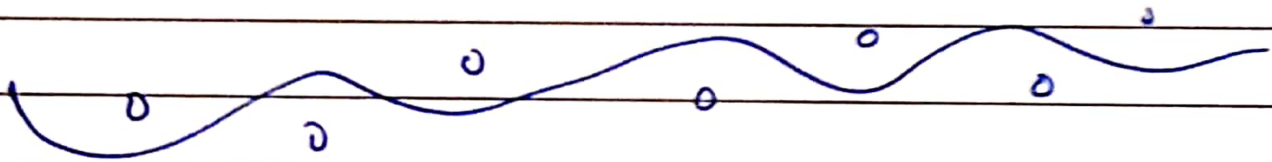
Now

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

$$= \begin{Bmatrix} -16.04 \\ -2 \end{Bmatrix} E$$

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

$$\begin{Bmatrix} D_1 \\ D_2 \end{Bmatrix} = \begin{Bmatrix} -13.97 \\ 3.8902 \end{Bmatrix}$$



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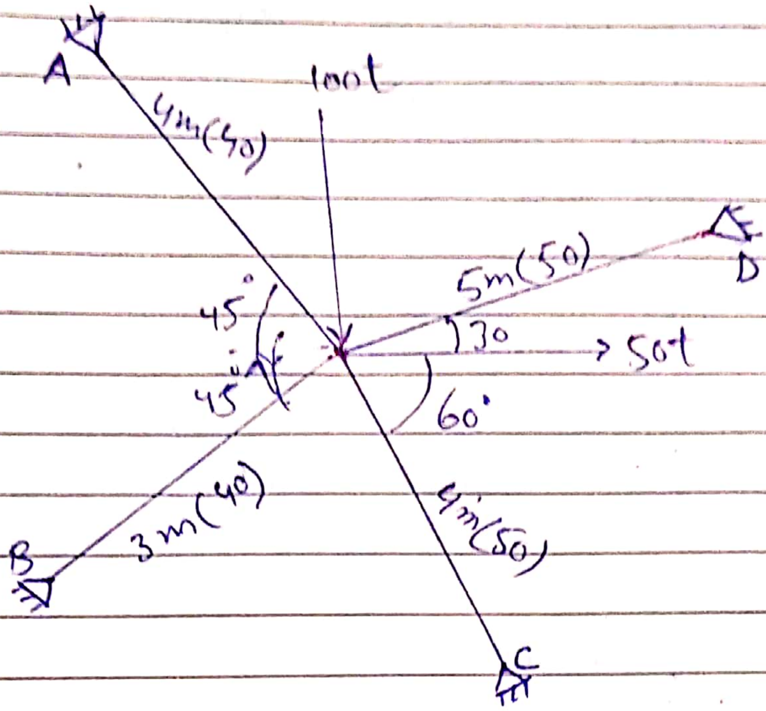
Q2: Analyze the pin jointed frame shown by stiffness method, Length of the members in "m" and cross-sectional area of the members in cm^2 are show in figure. Take E = 2000t / cm^2.



$EI = 2000 t/cm^2$

EA(A) = 2000 × 40 = 80,000 t

EB(B) = 2000 × 40 = 80,000 t

EA(C) = 2000 × 50 = 100,000 t

EA(D) = 2000 × 50 = 100,000 t

Find the distances.

$\sin\theta = P/h$

$\sin 45° = P/4$

$P = 4(\sin 45°)$

$P = 2.828 m$

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$\Rightarrow \cos 45 = b/4$

$b = 2.828\ m$

For B :-

$\sin 45 = P/H$

$\sin 45 = P/3$

$P = 2.12\ m$

Since $\cos 45 = b/H = b/3$

$b = 2.12\ m$

For C :-

$\sin 60 = \frac{P}{H} = P/4$

$\sin 60 (4) = P$

$P = 3.46\ m$

$\cos 60 = b/4$

$b = 2$

For D :-

$\sin 30 = P/5$

$P = 2.5\ m$

$\cos 30 = b/5$

$b = 4.33\ m$

Step 1 :- $K.I = 2j - 8$

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

$K.I = 2^\circ$

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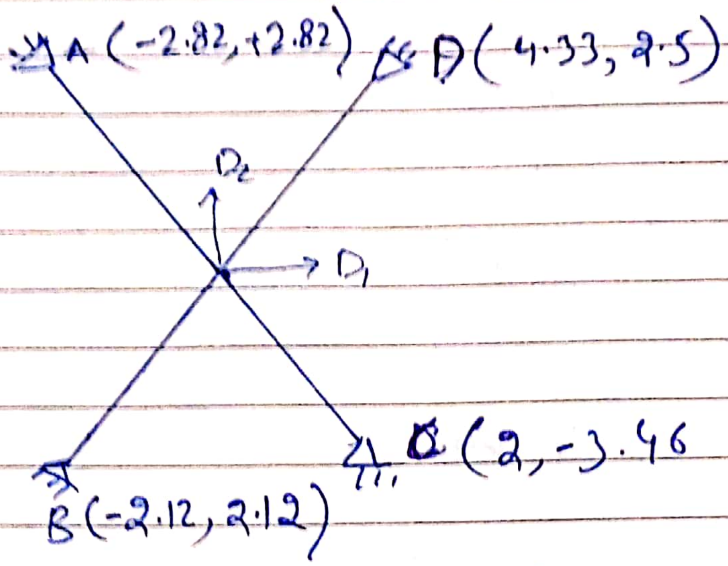
Step 02:

select unknow 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:- $\{AMD\}_{4\times2}$ and $\{S\}_{2\times2}$

(i) $D_1 = 1K, \quad D_2 = 0$

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

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

$$AMD_{11} = 141$$

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

$$AMD_{21} = 188.44$$

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(9)

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

$$AMD_{31} = -173.2$$

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

$$AMD_{41} = -125$$

Now

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

$$S_{11} = \frac{80{,}000}{(400)^3} (282)^2 + \frac{80{,}000}{(300)^3} + \frac{100{,}000}{(500)^3}$$

$$\times (-433)^2 + \frac{100{,}000}{(400)^3} \times (-200)^2$$

$$S_{11} = 99.405 + 133.1074 + 149.991 + 62.5$$

$$S_{11} = 445.063$$

$$\Rightarrow S_{12} = S_{21} = \sum_{i=1}^{m} \frac{EA}{L^3} (x_k - x_j)(y_k - y_j)$$

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

$$+ \frac{100{,}000}{(500)^3} (-433)(0-250) + \frac{100{,}000}{(400)^3} (-200)(46)$$

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$$S_{12} = S_{21} = 12.87$$

(ii) $D_1 = 0$, $D_2 = 1K$

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

$$AMD_{12} = \frac{80,000}{(400)^2}(-282) = 1141$$

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

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

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

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

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

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

$$S_{22} = 469.628$$

Step 4:-

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

$$\begin{Bmatrix} D_1 \\ D_2 \end{Bmatrix} = \begin{bmatrix} 445.003 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{Bmatrix} 50 \\ -100 \end{Bmatrix}$$

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

Step 5:-

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

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

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

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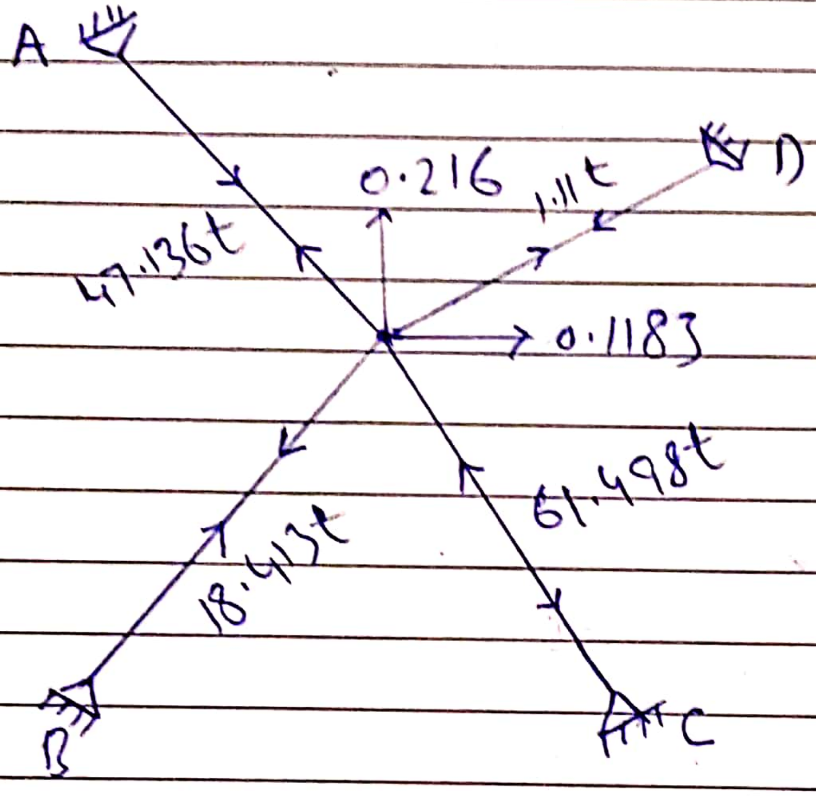
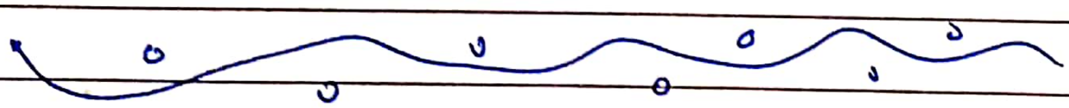
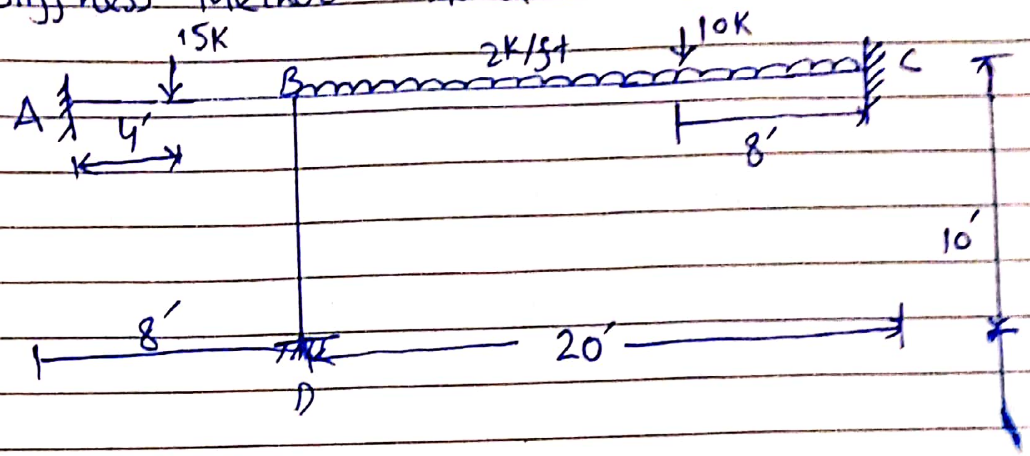
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -61.498t \end{bmatrix}$$





Q3:- Analyze the rigid joint frame by Stiffness Method. Assume EI constt.



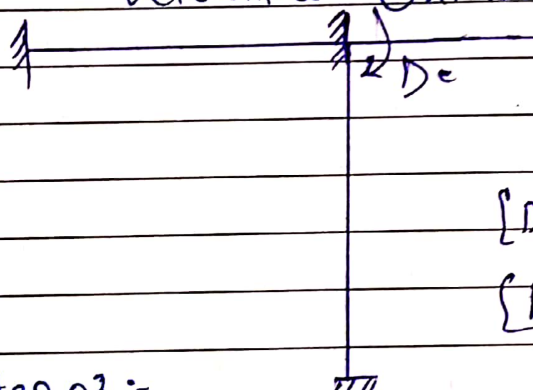
Sol:- Step 01:-

Determine Kinematic Indeterminacy

K.I = 1^{0}

Step 02:-

Determine Unknown Joint Displacement

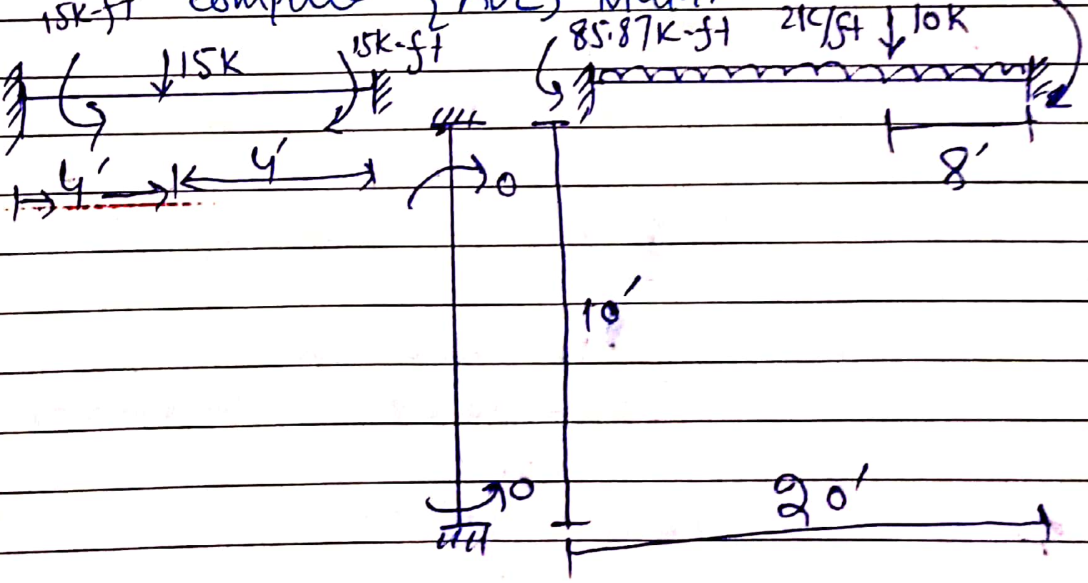


$\{D\} = \{?\}$

$\{AD\} = \{0\}$

Step 03:-

compute {ADL} Matrix.



⇒ Point load at centre :-

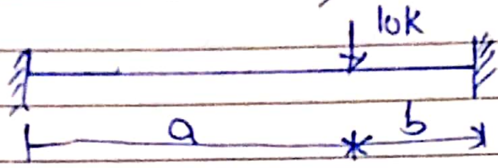
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15\ K\text{-}ft$$

⇒ Uniformly Distributed load :-

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

Point load (Not at mid) ::

Suppose



For left End ::

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

For right End.

$$\frac{Pa^2b}{L^2} = \frac{(10)(12^2)(8)}{(20)^2} = 28.8\ K\cdot ft$$

So that moment of left end.

$$19.2 + 66.67 = 85.87\ K\cdot ft$$

Similarly at right end :-

$$28.8 + 66.67 = 95.47.\ K\cdot ft$$

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

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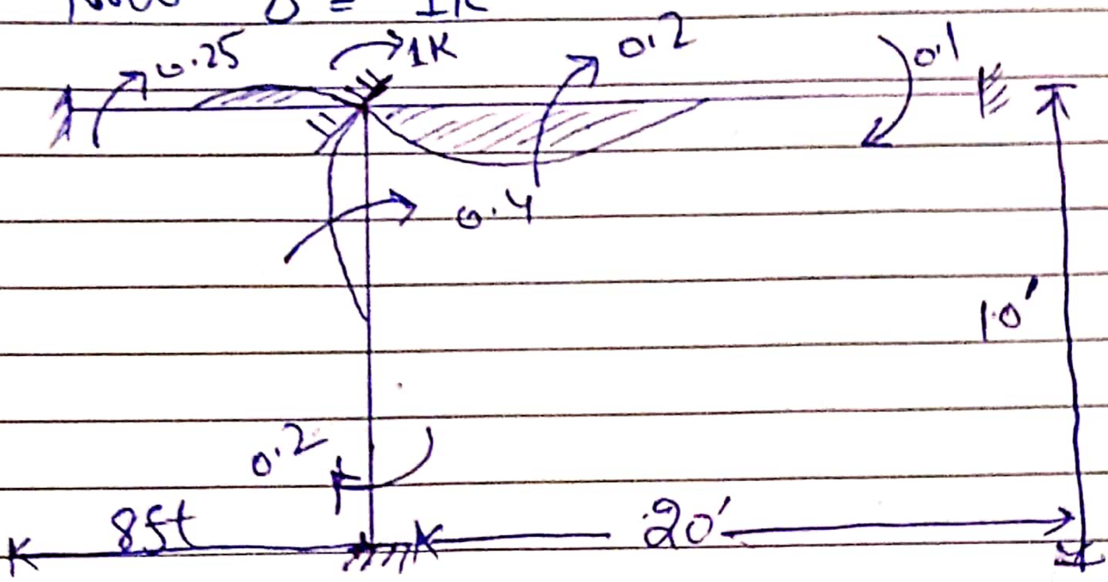
Step 04:

Determine [S] Matrix.

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

Now $\Delta = 1K$



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

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

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

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

$[S] = 1.1 EI$

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Step 05:-

compute [D] Matrix.

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

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

$$\{D\} = \frac{1}{1.1} \{+70.87\}$$

$$\{D\} = 70.87/1.1$$

$$\{D\} = \{64.42\} \, 1/EI$$

The End