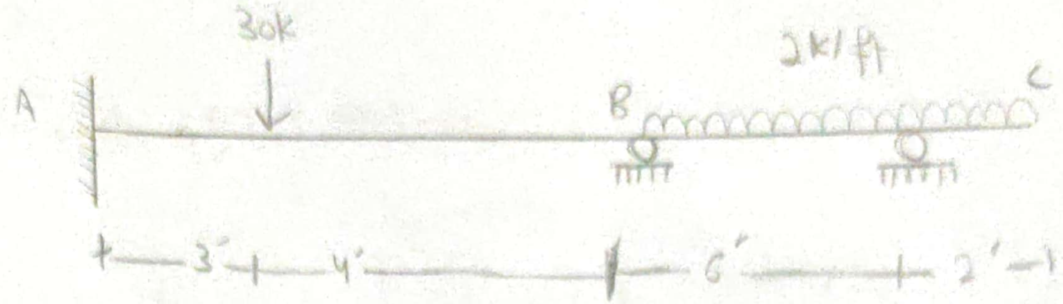
SYED JAWWAD

7386

STRUCTURE ANALYSIS 2

SUMMER FINAL TERM

Q # 1



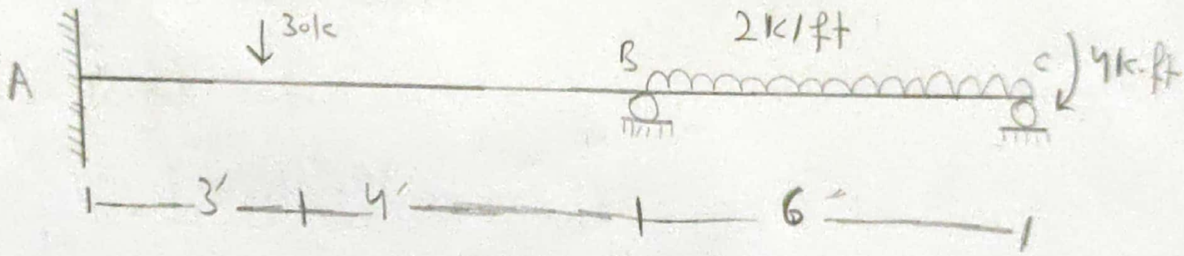
Solution :-

STEP # 1 :-

Determining Kinematic Indeterminancy

K.I = 5°

So we have to reduce the Extended Portion.



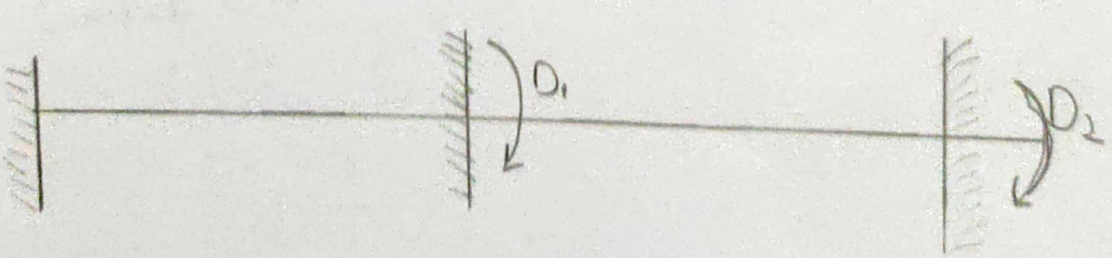
$\Rightarrow \dfrac{2(2)}{1} = 4$ k/ft

Now :-

K.I = 2°

STEP # 2

Determine Unknown Joint Displacement.



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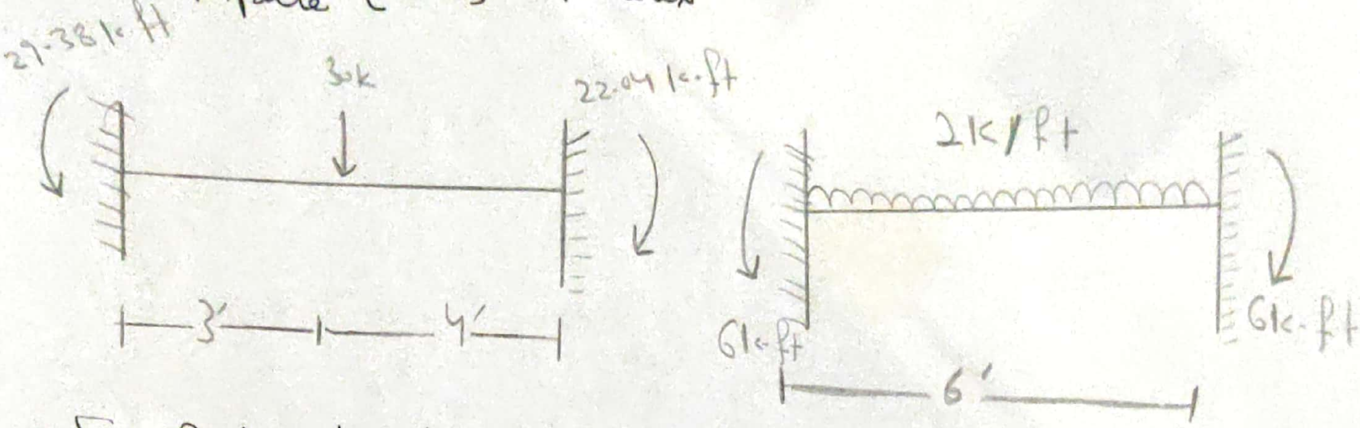
$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \qquad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

STEP 3:-

Compute [ADL] Matrix



=> For Pointed Load (not at mid):-

=> For Left end

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

=> For Right End:-

$$= \frac{Pa^2b}{L^2} = \frac{(30)(3)^2(4)}{(7)^2} = 22.04\ k.ft$$

=> For UDL:-

$$\frac{wl^2}{12} \Rightarrow \frac{(2)(6)^2}{12} = 6\ k.ft$$

$$ADL_1 = +22.04 - 6 = 16.04\ k.ft$$

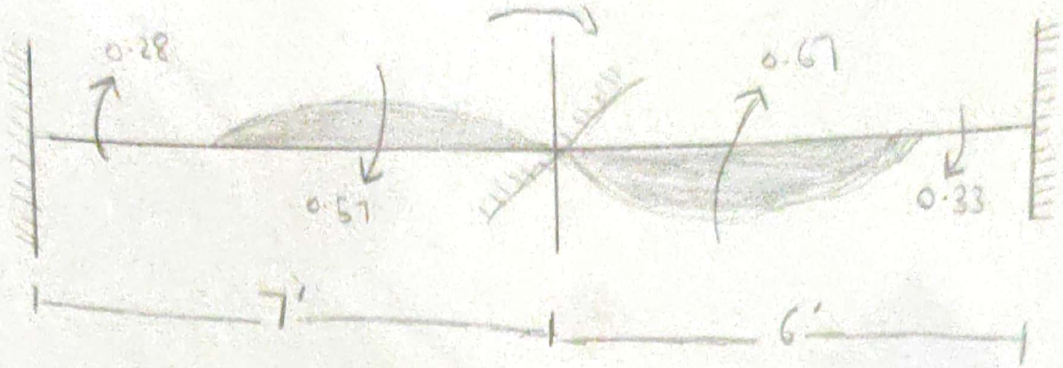
$$ADL_2 = 6\ k.ft$$

STEP 4:-

Compute [S] Matrix:-

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

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



$$\frac{4EI}{7} = 0.57 \qquad \frac{2EI}{6} = 0.33$$

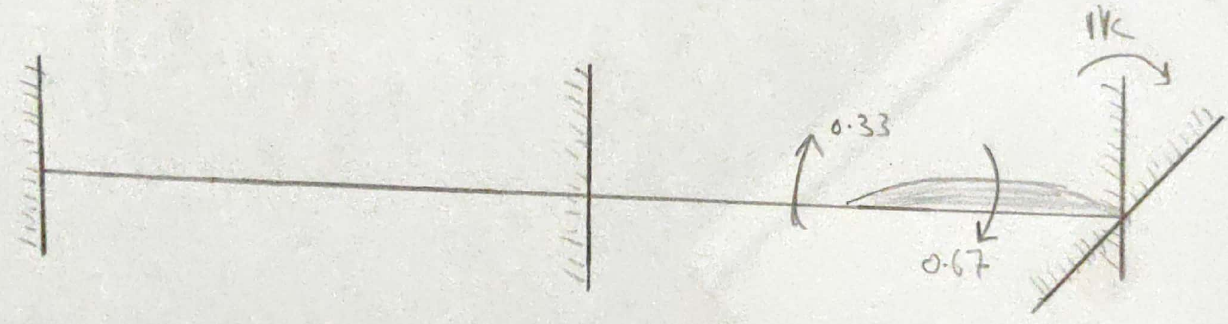
$$\frac{4EI}{6} = 0.67 \qquad \frac{2EI}{7} = 0.28$$

$S_{11} = 0.57 + 0.67$

$= 1.24\,EA$

$S_{21} = 0.33\,EA$

b) $D_1 = 0$ $\qquad$ $D_2 = 1K$



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

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

$S_{12} = 0.33$

$S_{22} = 0.67$

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

Step :- 5

Compute [D] matrix

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

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times \begin{bmatrix} 0 & -16.04 \\ 4 & -6 \end{bmatrix} - \begin{bmatrix} -16.04 \\ -2 \end{bmatrix} E$$

$\times$ Adj A $\times \boxed{}$

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

$= 0.8308 - 0.1089$

$|S| = 0.7219$

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

Now :-

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

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

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

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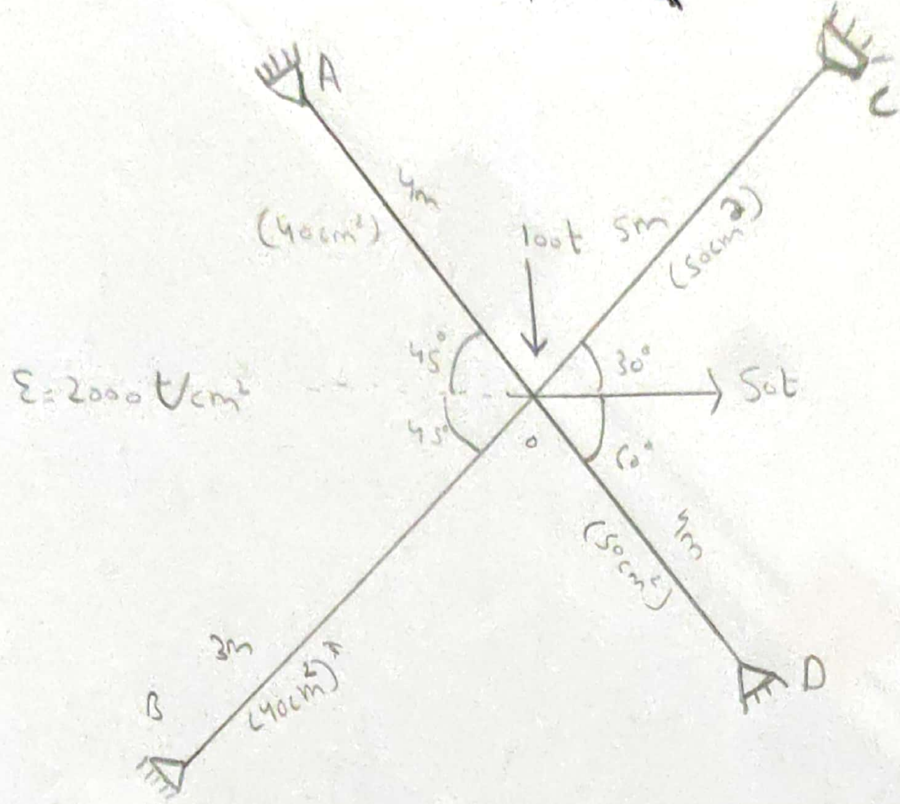
Q#2



Solution

for A:-

$\sin 45° = \frac{P}{h} = \frac{P}{4}$

$P = 2.828m$

$\cos 45° = \frac{b}{4}$

$\Rightarrow b = 2.828m$

For B:-

$\sin 45° = \frac{P}{3}$

$\Rightarrow P = 2.12m$

$\cos 45° = \frac{b}{h}$

$\Rightarrow b = 2.12 m$

For D.-

$\sin 30° = \frac{P}{h}$, $h = 5$

$\Rightarrow P = 2.5m$

$\cos 30° = \frac{b}{5}$

$\Rightarrow b = 4.33m$

Now $\Sigma A(A) = 2000 \times 40 = 80,000t$

$\Sigma A(B) = 2000 \times 40 = 80,000t$

$\Sigma A(C) = 2000 \times 50 = 100,000t$

$\Sigma A(D) = 2000 \times 50 = 100,000t$

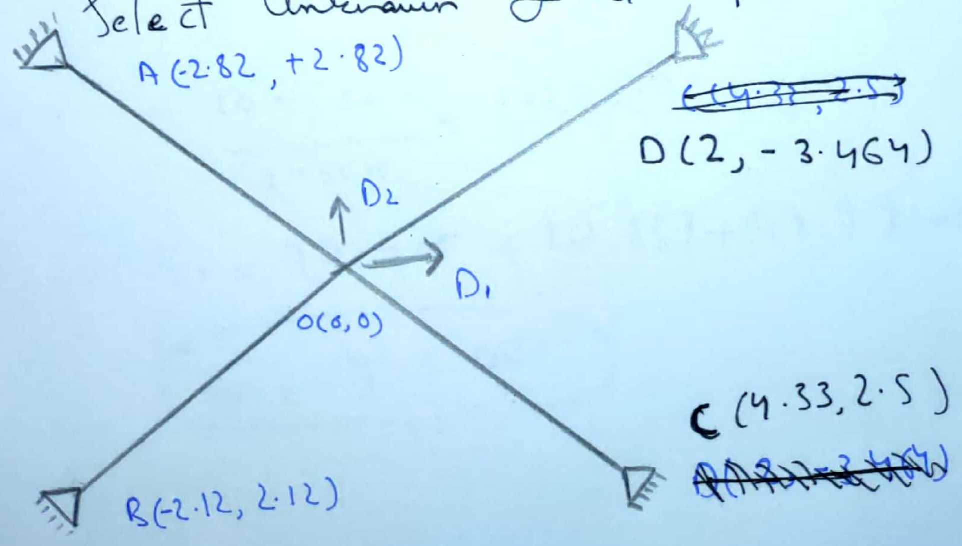
STEP #1 :- K.I

$K.I = 2j - r$

$= 2(5) - 8 = 2°$

STEP #2

Select Unknown 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 # 3 $[AMO]_{4\times 2}$ $\{ES\}_{2\times 2}$

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

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

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

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

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

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

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

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

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

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

$$S_{11} = 445.063$$

STEP #4

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

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

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

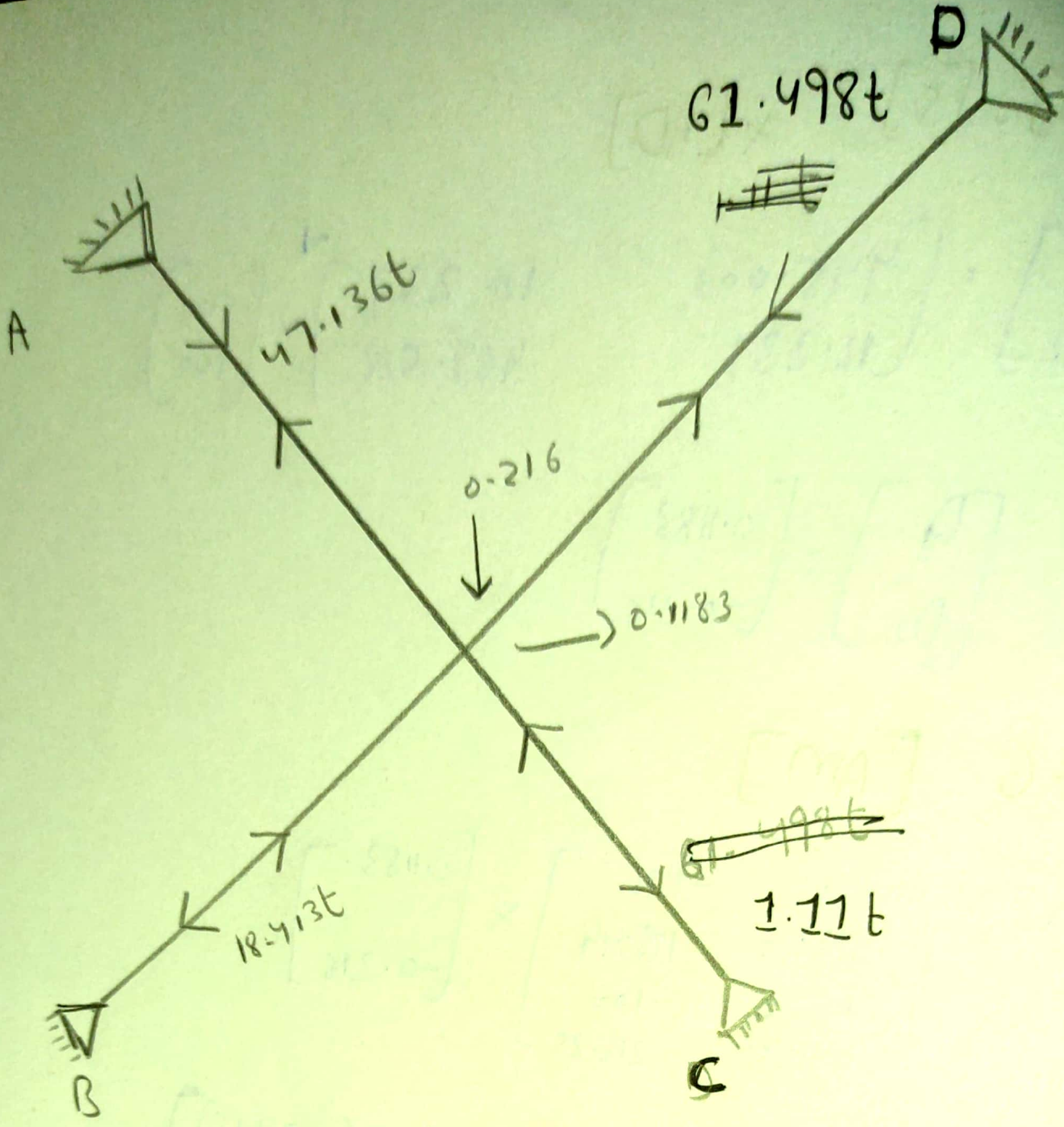
STEP #6 [AM]

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

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

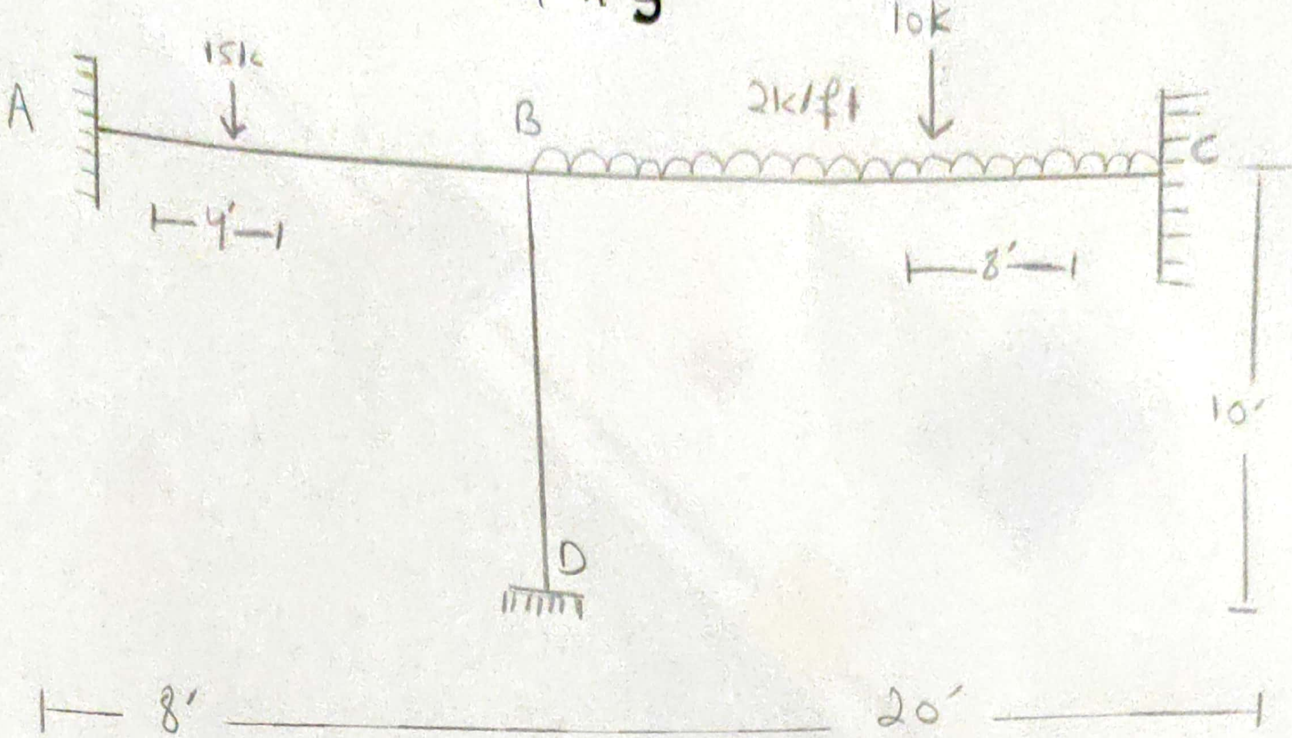
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.68 & +30.46 \\ 22.29 & -40.70 \\ -20.49 & +21.6 \\ -14.79 & -46.71 \end{bmatrix}$$

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



D
61.498t
A
47.136t
0.216
0.1183
~~61.498t~~
1.11t
18.413t
B
C

Q#3



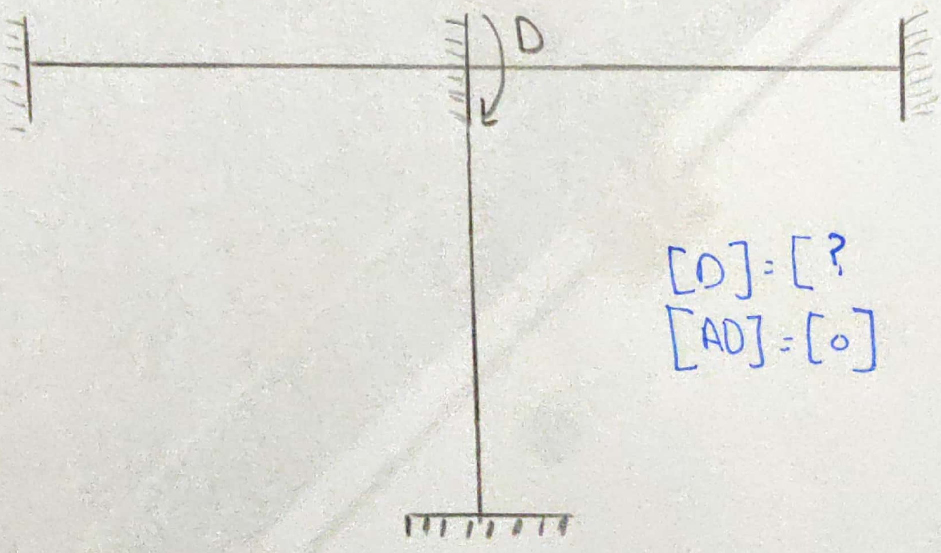
Step # 1

Determinate Kinematic Indeterminancy

K.I = 1°

Step # 2

Determine Unknown Joint Displacement



[D] = [?]

[AD] = [0]

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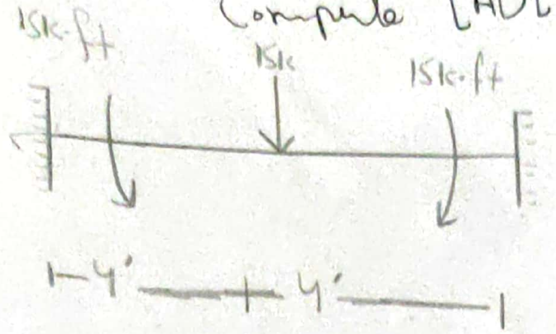
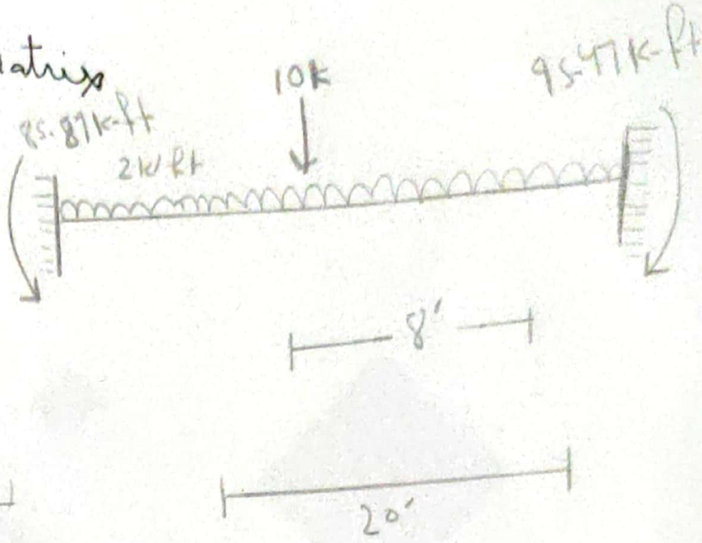
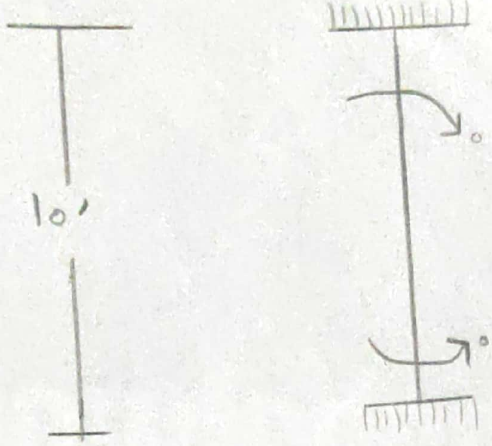
Step #3

Compute [ADL] Matrix







=) Point Load at Center:-

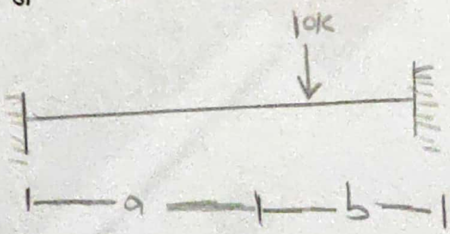
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15\ \text{kip.ft}$$

=) Uniformly Distributed Load:-

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

=) Point Load (Not at Mid):-

Suppose:-



For left End:-

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

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For Right End:-

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

So total moment at left End:-

$19.2 + 66.67 = 85.87\text{ k}\cdot\text{ft}$

Similarly at Right End:-

$28.8 + 66.67 = 95.47\text{ k}\cdot\text{ft}$

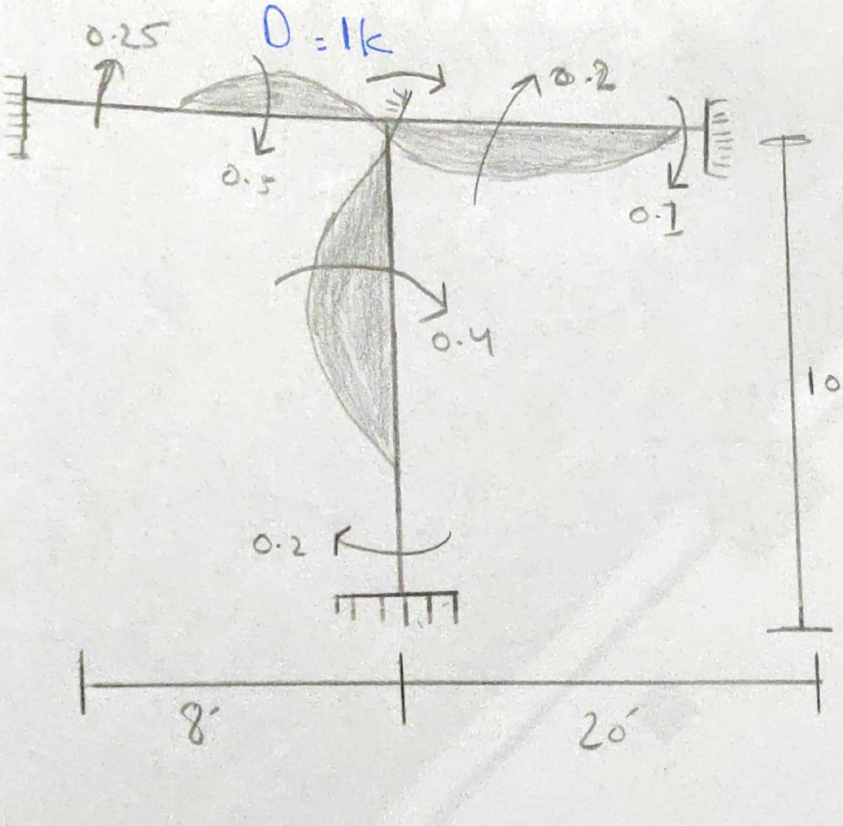
So $[ADL] = -85.87 + 15 = -70.87\text{ k}\cdot\text{ft}$

Step 4:-

Determine (S) Matrix

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

Now



$$\Rightarrow \frac{4EI}{8} = 0.5$$

$$\frac{2EI}{8} = 0.25$$

$$\Rightarrow \frac{4EI}{20} = 0.2$$

$$\frac{2EI}{20} = 0.1$$

$$\frac{2EI}{10} = 0.2$$

$$\Rightarrow \frac{4EI}{10} = 0.4$$

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

$$= 1.1EI$$

$$[S] = 1.1EI$$

Step # 5

Compute [D] Matrix

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

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

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

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