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Sec :- "A"

Subject :- Structural Analysis II

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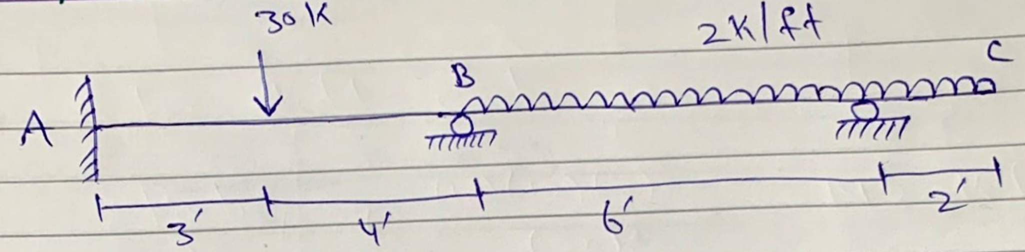
Problem # 01 :-



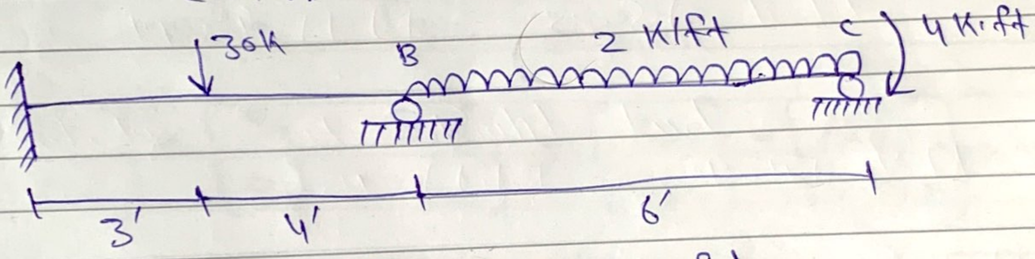
Solution

Step # 1

Determining Kinematic Indeterminancy

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

So we have to reduce the extended Portion



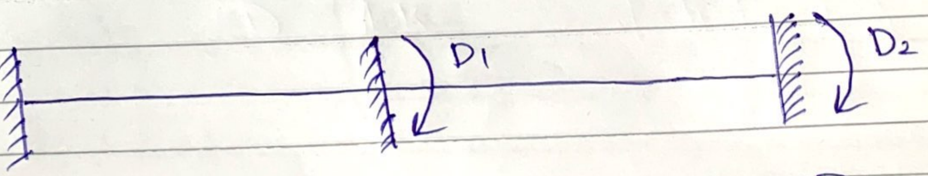
$$\Rightarrow \frac{2(2)}{1} = 4 \text{ K.ft}$$

Now

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

Step # 2

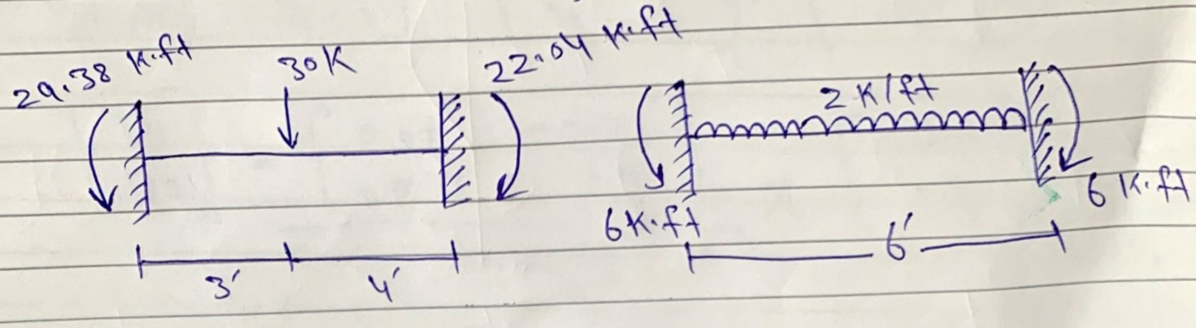
Determine unknow Joint displacement



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

Step # 3

Compute [ADL] Matrix



⇒ For Pointed Load (not at mid)

⇒ For left end :-

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

⇒ For Right end :-

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

⇒ For UDL :-

$\dfrac{WL^2}{12} = \dfrac{(12)(6)^2}{12} = 6$ k.ft

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

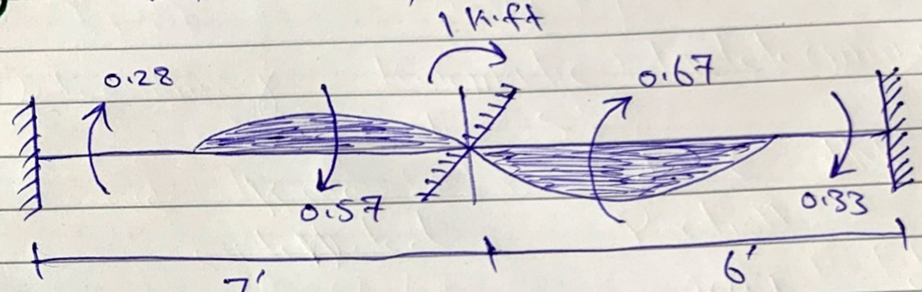
$ADL_2 = 6$ k.ft

Step # 4 :-

Compute [S] Matrix

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

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



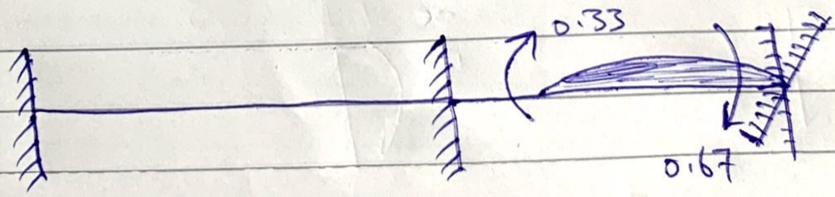
$\frac{4EI}{7} = 0.57$ | $\frac{2EI}{6} = 0.33$

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

$$S_{11} = 0.57 + 0.67$$
$$= 1.24 \; EA$$

$$S_{21} = 0.33 \; EA$$

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



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

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

$S_{12} = 0.33$
$S_{22} = 0.67$

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

Step # 5

Compute [D] matrix

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL1 \\ ADL2 \end{bmatrix}$$

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

$$|S| = (1.24 \times 0.67) - (0.33 \times 0.33)$$
$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

P(5)

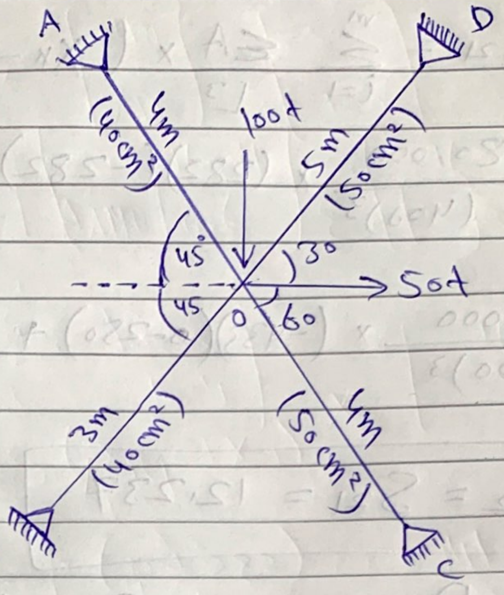
Now

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

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} \quad \end{bmatrix}$$ Ans.

Problem # 02



$E = 2000\ t/cm^2$

Solution :- For A :-

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

$\Rightarrow P = 2.828m$

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

$\Rightarrow b = 2.828m$

For B :-

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

$\Rightarrow P = 2.12m$

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

$\Rightarrow b = 2.12m$

For C :- $\sin 30^\circ = \frac{P}{h=5}$

$\Rightarrow P = 2.5\,m$

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

$\Rightarrow b = 4.33\,m$

Now

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

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

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

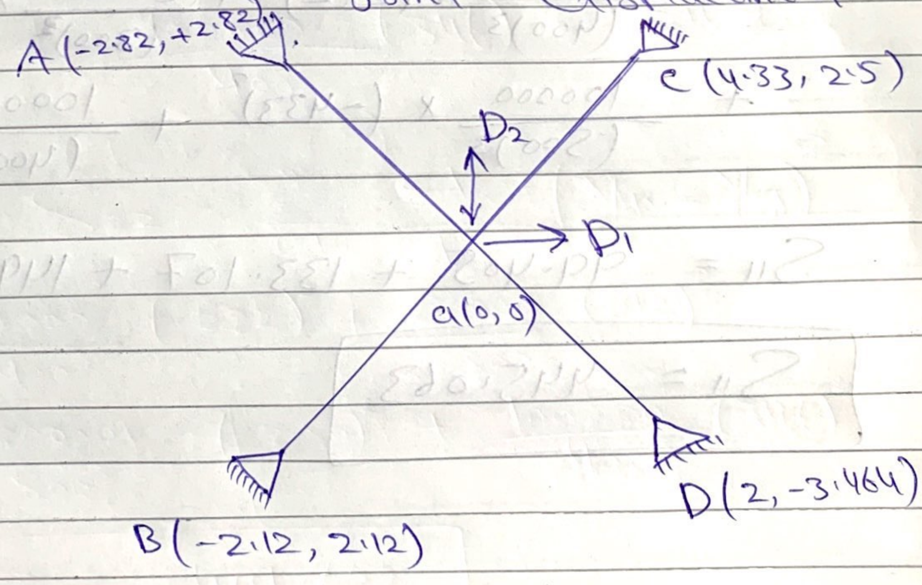
$EA_{(D)} = 2000 \times 50 = 100,000\,t$

Step # 1 K.I

$K.I = 2J - \gamma$

$= 2(5) - 8 = 2^\circ$

Step # 2 :- 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) $D_1 = 1$, $D_2 = 0$

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

$$AMD_{11} = \frac{80000}{(400)^2} \times (0+282) = 141$$

$$AMD_{21} = \frac{80000}{(300)^2} \times (0+212) = 188.44$$

$$AMD_{31} = \frac{100000}{(500)^2} \times (0-433) = -173.2$$

$$AMD_{41} = \frac{100000}{(400)^2} \times (0-200) = -125$$

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

$$= \frac{80000}{(400)^3} \times (282)^2 + \frac{80000}{(300)^3} \times (212)^2$$

$$+ \frac{100000}{(500)^3} \times (-433)^2 + \frac{100000}{(400)^3} \times (-200)^2$$

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

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

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

$$= \frac{80,000}{(400)^3} \times (282)(-282) + \frac{80000}{(300)^3} \times (212)(212)$$

$$+ \frac{100000}{(500)^3} \times (-433)(0-250) + \frac{100000}{(400)^3} \times (-200)(0+346)$$

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

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

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

$$AMD_{12} = \frac{80000}{400^2}(-282) = -141$$

$$AMD_{22} = \frac{80000}{300}(212) = 188.44$$

$$AMD_{32} = \frac{100000}{500^2}(-250) = -100$$

$$AMD_{42} = \frac{100000}{400^2}(346) = 216.25$$

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

$$= \frac{80000}{400^3}(-282)^2 + \frac{80000}{300^3}(212)^2$$

$$+ \frac{100000}{500^3}(-250)^2 + \frac{100,000}{400^3}(346)^2$$

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

Step # 04

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

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

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

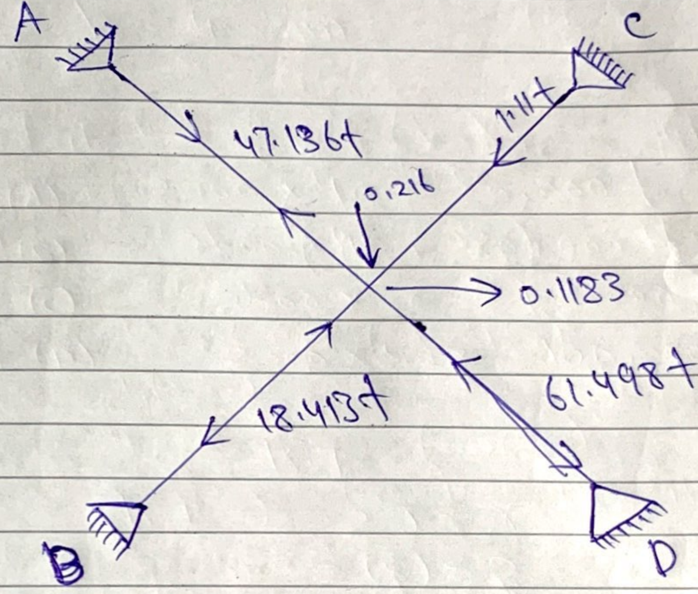
Step # 05

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

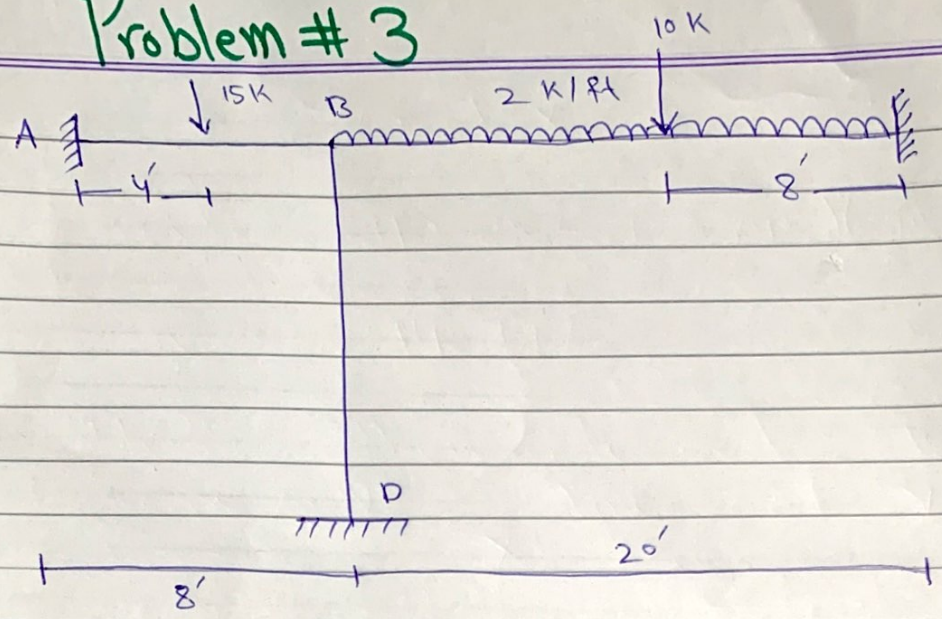
$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (-0.216) \\ 188.44 \times 0.1183 + 188.44 \times (-216) \\ -173.2 \times 0.1183 + (-100)(-0.216) \\ -125 \times 0.1183 + 216.25 \times (-0.216) \end{bmatrix}$$

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

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



Problem # 3



Solution :-

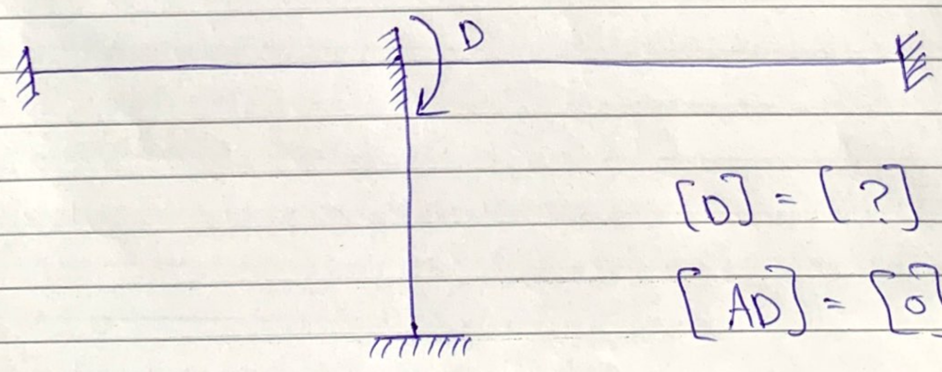
Step # 1

Determine Kinematic Indeterminacy

K.I = 1°

Step # 2

Determine unknown Joint displacement

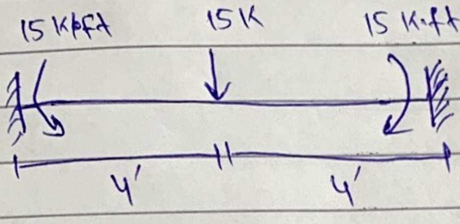


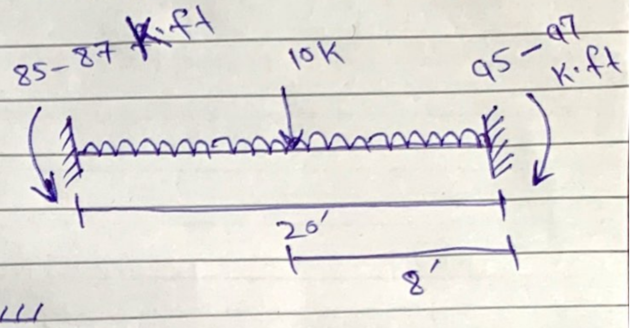
[D] = [?]

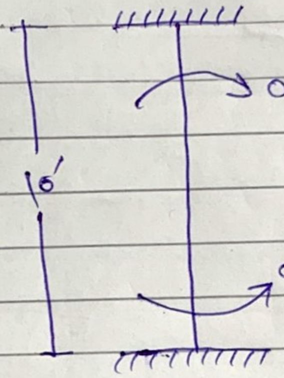
[AD] = [0]

Step #3

Compute [ADL] Matrix







⇒ Point load at Center :-

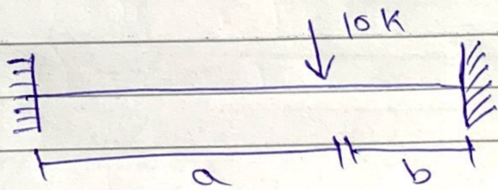
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ K.ft}$$

⇒ Uniformly Distributed Load :-

$$\frac{WL^2}{12} = \frac{(2)(20)^2}{12} = 66.67 \text{ K.ft}$$

⇒ Point load (Not at mid) :-

Suppose



$\Rightarrow$ For left End :-

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

$\Rightarrow$ For Right End :-

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

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 $[ADL]$ $-85.87 + 15 = -70.87$ K.ft

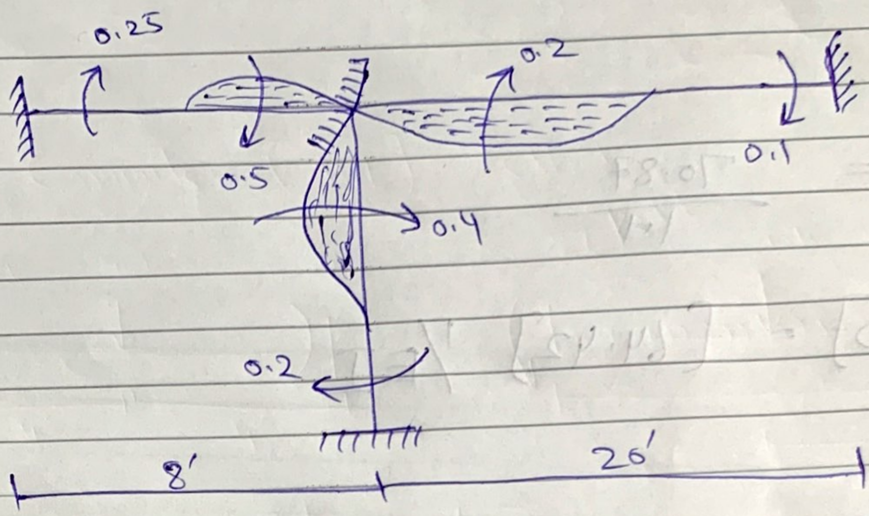
Step # 4

Determine $[S]$ Matrix

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

Now

$$D = 1K$$



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

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

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

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

$$= 1.1\ EI$$

$$[S] = 1.1\ EI$$

Step # 5

Compute [D] Matrix

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

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

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

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

The End of Paper....!!!