HURRAIRAH KABIR

7758

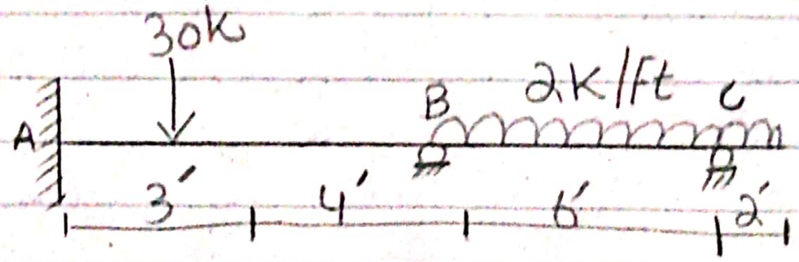
SEC (B)

Summer Final exam

Structural Analysis II

Engr. Adeed Khan.

Question No 1



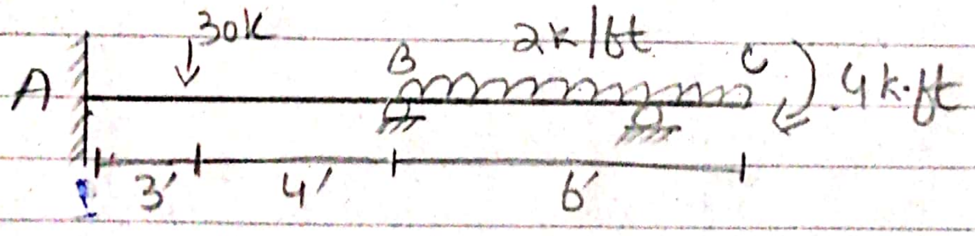
Sol:-

Step:- 01

Determining Kinematic Indeterminacy

$K.I = 5°$

So we have to reduce the extended Portion



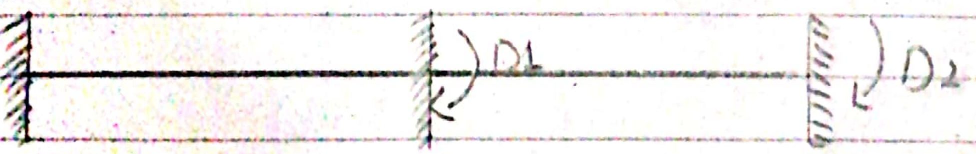
$$\Rightarrow \frac{2(2)}{1} = 4\ k\cdot ft$$

Now

$K.I = 2°$

Step # 2

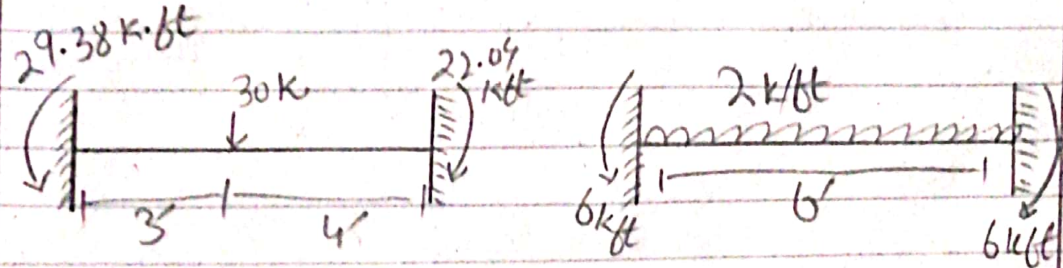
Determine unknown Joint Displacement



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

Step #03

Compute (ADL) Matrix



=> For point 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:

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

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

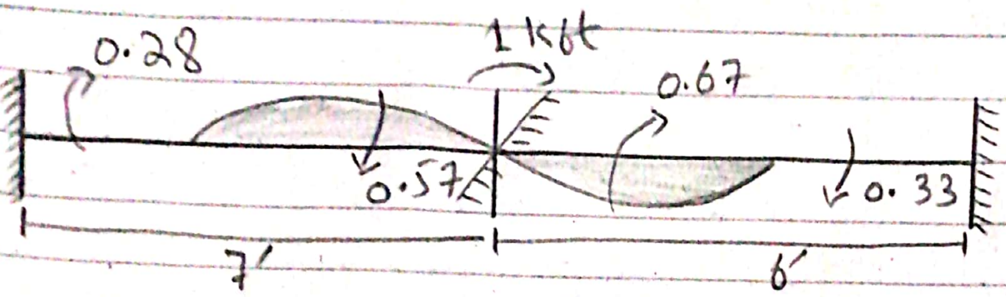
$ADL_2 = 6$ k.ft

Step 4:-

Compute [S] Matrix

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

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



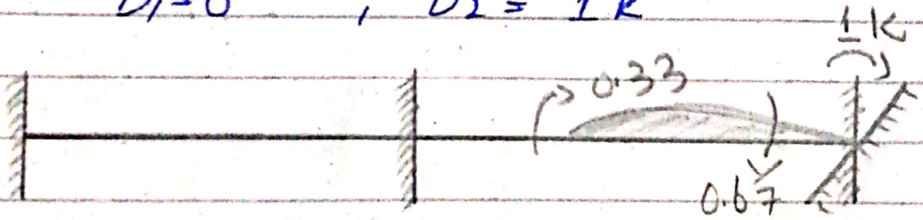
$\frac{4EI}{7} = 0.57$ | $\frac{2EI}{6} = 0.33$

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

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

$S_{21} = 0.33\,EA$

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

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

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

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

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

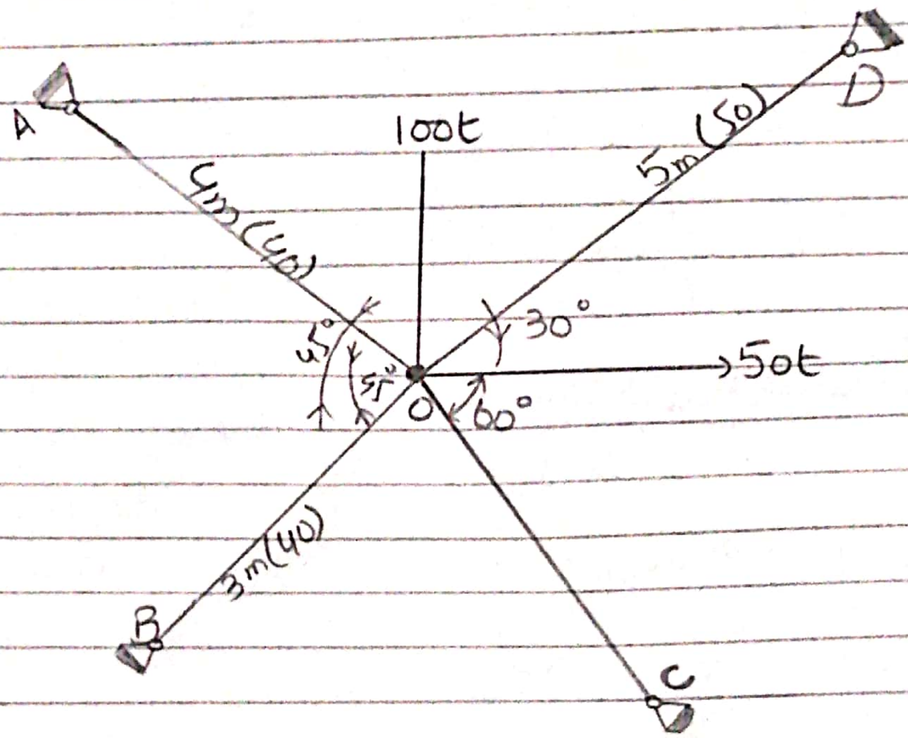
Now

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

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

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

Question No 2



Sol:- For (A)

$\sin 45° = P/h = P/4$

$\Rightarrow P = 2.828\,m$

$\cos 45° = b/4$

$\Rightarrow b = 2.828\,m$

For (B):- $\sin 45° = P/3$

$\Rightarrow P = 2.12\,m$

$\cos 45° = b/h$

$\Rightarrow b = 2.12\,m.$

For C:-

$\sin 30° = \frac{P}{h=5}$

$\Rightarrow P = 2.5\,m$

$\cos 30° = b/5$

$\Rightarrow b = 4.33\,m$

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 $K \cdot I =$
$K \cdot I = 2I - r$
$= 2(5) - 8 = 2^{\circ}$

Step #02 Select unknown joint displacement.

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

Step #03 $[AMD]_{4\times 2}$ & $[S]_{2\times 2}$

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

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

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

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

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

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

Now, $S_{11} = \sum_{x}^{4} \frac{EA}{L^3}(x_k - x_j)^2$

$$\Rightarrow \frac{80{,}000 \times (282)^2}{(400)^3} + \frac{80{,}000}{(300)^3} \times (212)^2 + \frac{100{,}000}{(500)^3} \times (-433)^2 + \frac{100000}{(400)^3} \times (-200)^2$$

$S_{11} = 99.405 + 133.107 + 149.991 + 62.5$

$S_{11} = 445.063$

$S_{12} = S_{21} = \sum_{i=1}^{4} \frac{EA}{L^3} \times (x_k - x_j)(y_k - y_j)$

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

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

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

$AMD_{22} = \frac{80000}{300^2}(212) = 188.44$

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

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

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

$= \frac{80,000}{400^3}(-282)^2 + \frac{80000}{300^3}(212)^2 + \frac{100000}{500^2}(-258)^2$

$+ \frac{100000}{400^3}(346)^2$

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

Step 4: $[D] = [S]^{-1} \times [AD]$

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

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

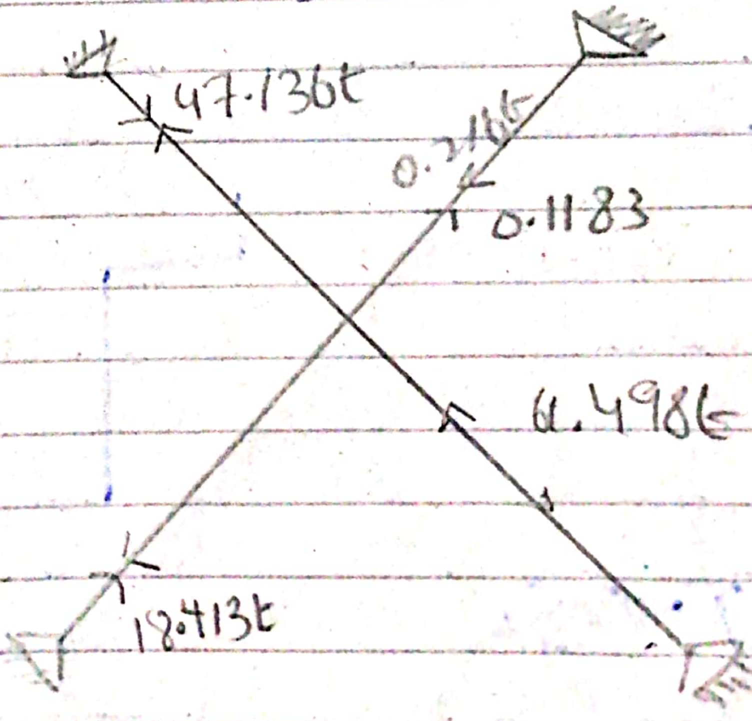
Step 5:-

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

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

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.88 + 30.46 \\ 22.29 + 40.70 \\ -20.49 + 21.6 \\ -14.79 - 46.71 \end{bmatrix}$$

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



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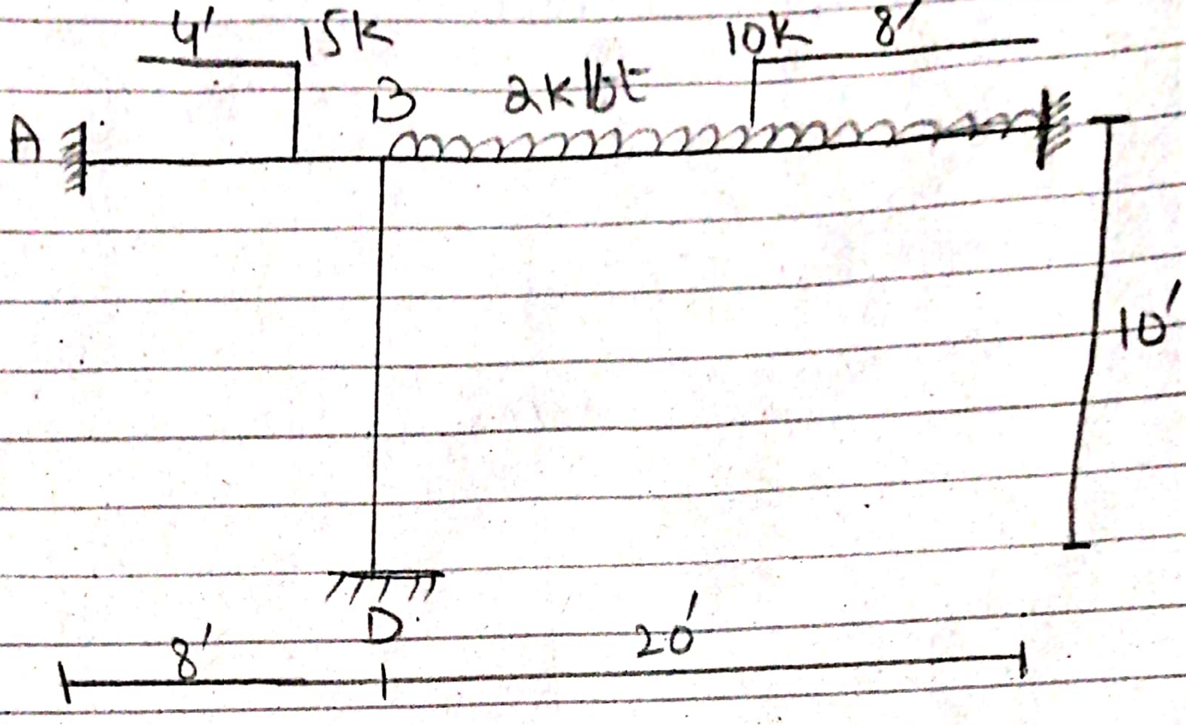
Question No 3



Sol:-

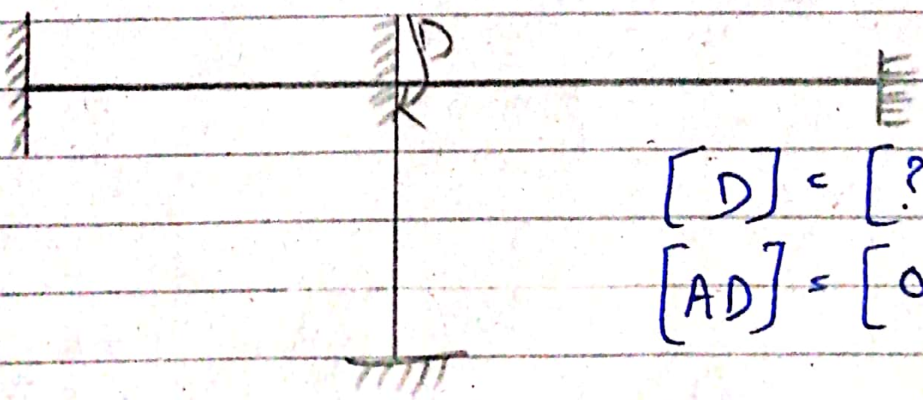
Step # 1

Determine Kinematic Indeterminancy

$K.I = 1^{\circ}$

Step # 02

Determine unknown Joint Displacement

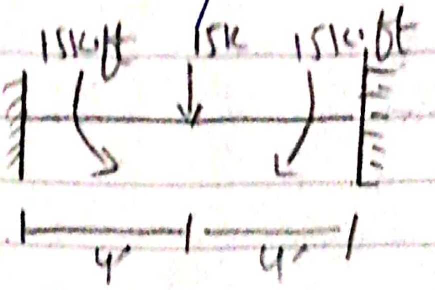


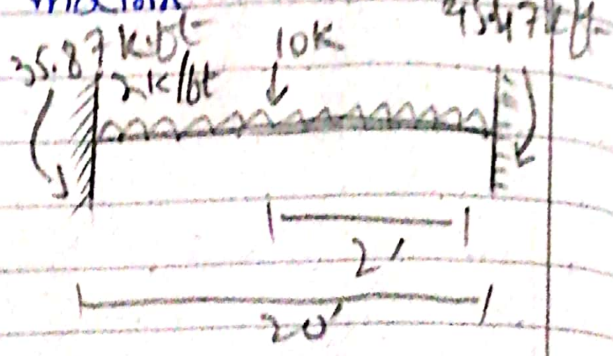
$[D] = [?]$

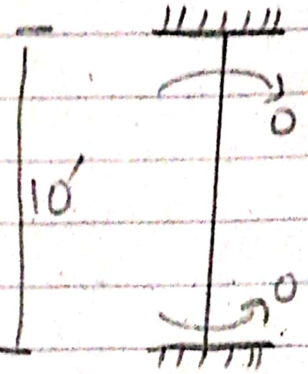
$[AD] = [0]$

Step #03

Compute [ADL] matrix







⇒ Point load at centre:-

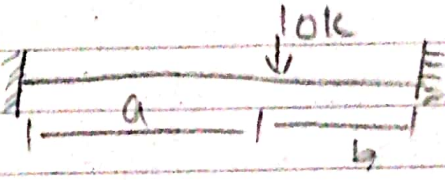
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ k.ft}$$

⇒ 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:-

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

For right end:-

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

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So total moment at left end:

$19.2 + 66.67 = 85.87$ k.ft

Similarly at right end:

$28.8 + 66.67 = 95.47$ k.ft

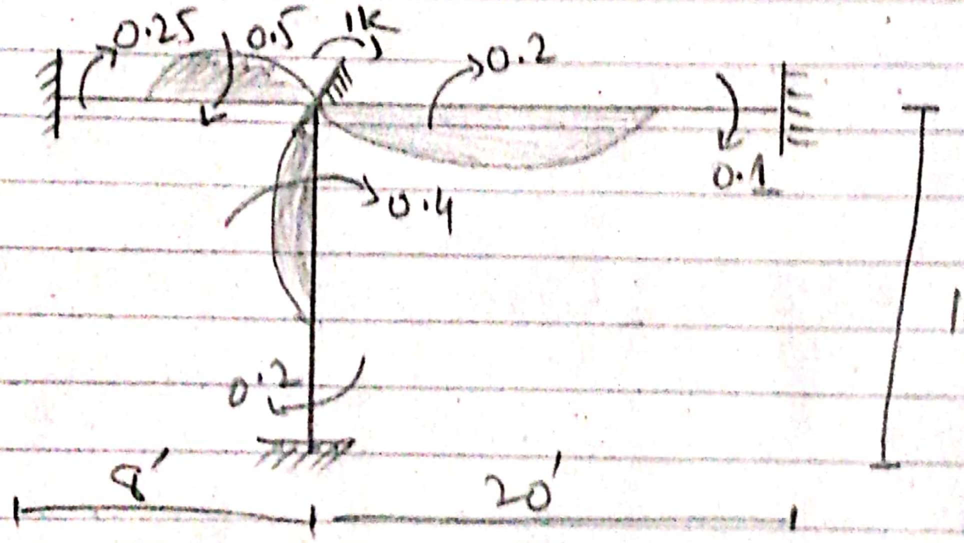
So $[ADL] = -85.87 + 15 = -70.87$ k.ft.

Step 4:-

Detemine $[S]$ matrix

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

Now, $D = 1$ K



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

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

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

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

$= 1.1\ EI$

$[S] = 1.1\ EI$

Step #05

Compute [D] matrix

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

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

$= \frac{70.87}{1.1}$

$[D] = [64.42]\ I/EI$