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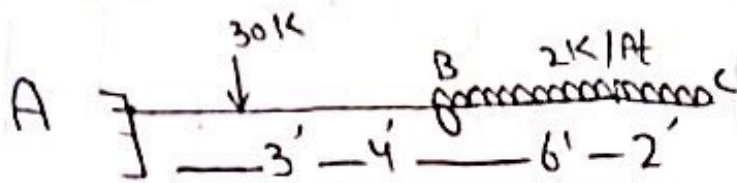
Subject : Structural Analysis II

PAPER : Structural Analysis II

Date : 25 Sep. 2020

INU - Official :

Qno # 01



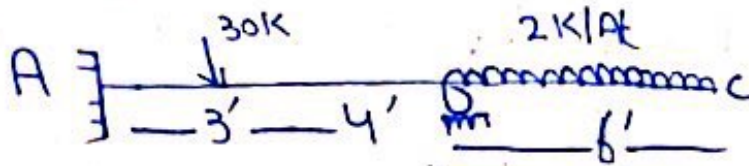
Solution:

Step #01

Determining Kinematic Indeterminacy

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

So we have to reduce the extended portion



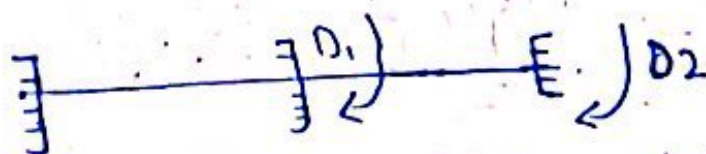
$$\Rightarrow \frac{2(2)}{1} = 4 \text{ kft}$$

Now

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

Step #02

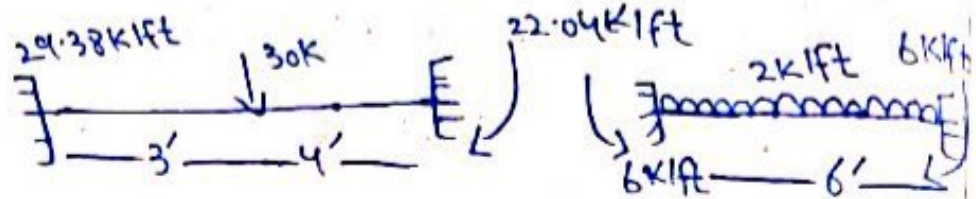
Determine Unknown Joint Displacement



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

Step # 03

Compute $[AD()]$ Matrix



⇒ For Point load (not at mid):-

For left End:-

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

For right End:-

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

⇒ For UDL

$$\frac{wL^2}{12} \Rightarrow \frac{(2)(6)^2}{12} = 6 \text{ Kift}$$

$$ADU = + 22.04 - 6 = 16.04 \text{ Kift}$$

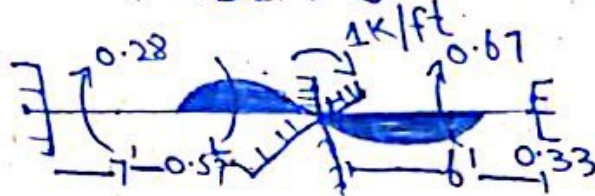
$$ADL^2 = 6 \text{ Kift}$$

Step 4

Compute $[S]$ Matrix

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

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

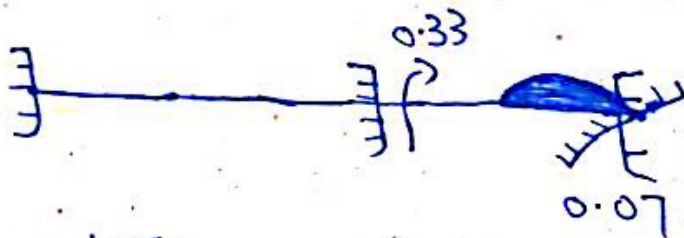


$$\left. \begin{aligned} \frac{4EI}{6} &= 0.57 \\ \frac{4EI}{6} &= 0.67 \end{aligned} \right\} \begin{aligned} \frac{2EI}{6} &= 0.33 \\ \frac{2EI}{7} &= 0.28 \end{aligned}$$

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

$$S_{21} = 0.33EA$$

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



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

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

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

Step # 05

Compute $[D]$ matrix

$$\begin{aligned} \begin{bmatrix} D_1 \\ D_2 \end{bmatrix} &= \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix} \\ &= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times \text{Adj } A \times \begin{bmatrix} 0 \\ 4 \end{bmatrix} = \begin{bmatrix} 16.04 \\ 6 \end{bmatrix} \end{aligned}$$

$$\begin{aligned} |S| &= (1.24 \times 0.67) - (0.33 \times 0.33) \\ &= 0.8308 - 0.1089 \end{aligned}$$

$$|S| = 0.7219$$

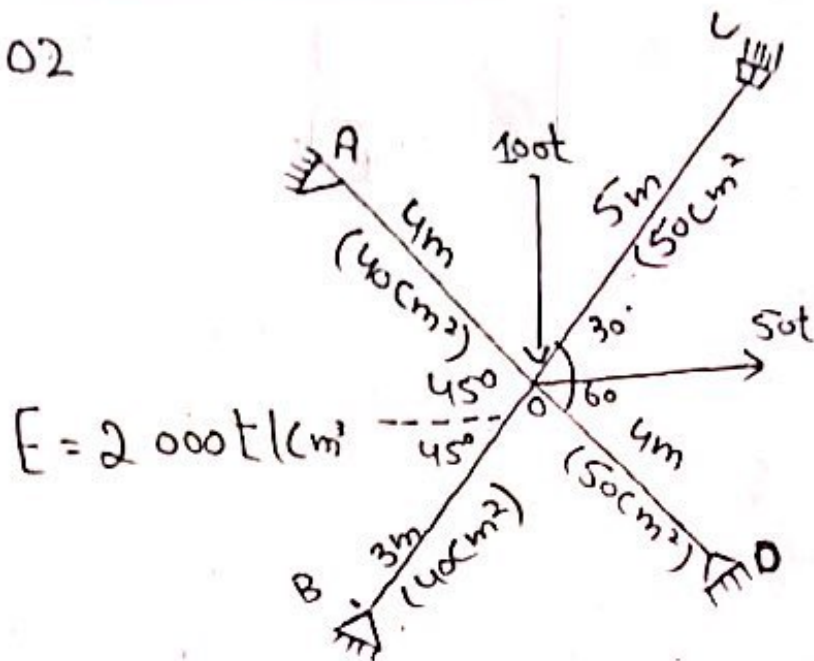
$$\text{Adj } A = \begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}$$

Now

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} -13.415 \\ 3.894 \end{bmatrix}$$

Q no #02



Solution:-

For A

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

$$\Rightarrow P = 2.828 \text{ m}$$

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

$$\Rightarrow b = 2.828 \text{ m}$$

For B

$$\sin 45^\circ = \frac{P}{3}$$

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

$$\Rightarrow b = 2.12 \text{ m}$$

For C

$$\sin 30^\circ = \frac{P}{h=s}$$

$$\Rightarrow D \Rightarrow 2.5 \text{ m}$$

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

$$\Rightarrow b = 4.33 \text{ m}$$

Now

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

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

Step 1

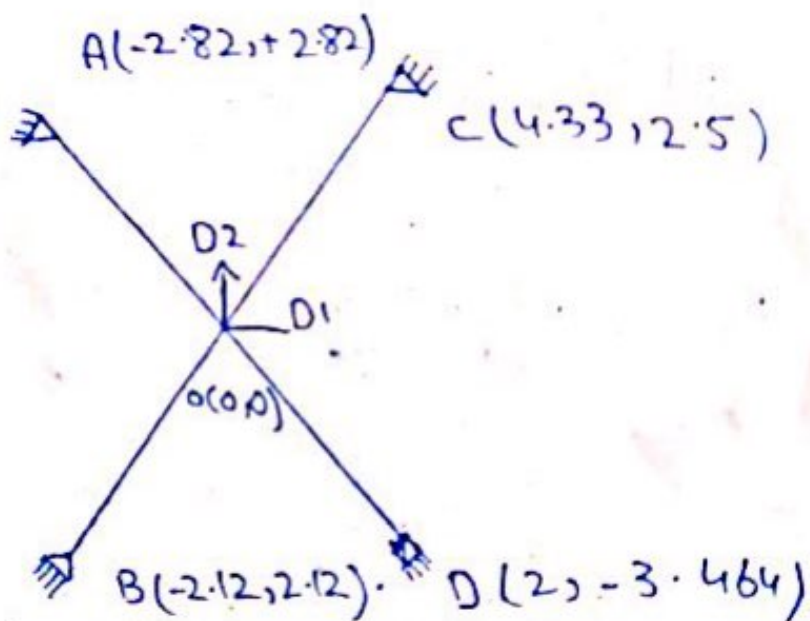
$$K \cdot I$$

$$K \cdot I = 2j - 8$$

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

Step #02

Select unknown joint as
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

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

i) $D_1 = 1, D_2 = 0$

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

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

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

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

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

$$\text{Now } S_{11} = \sum_{i=1}^M \frac{EA}{L^3} (x_i - x_j)^2$$

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

$$+ \frac{100,000}{500^3} (-433)^2 + \frac{100,000}{400^3}$$

$$S_{11} = 445.063$$

$$S_{12} = S_{21} = \sum_{j,k} \frac{EA}{L} (x_k - x_j) (y_k - y_j)$$

$$= \frac{80,000}{400^3} (282) (-282) + \frac{86,000}{300^3} (212) (212) + \frac{100,000}{500^3} (-433) (0 - 250) + \frac{100,000}{400^3} (-200) (0 + 346)$$

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

ii) $D_1 = 0$ $D_{11} = 1K'$

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

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

$$AMD_2 = \frac{80,000}{300} (212) = 189.44$$

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

$$AM_1) = \frac{100,000}{400^2} \quad (346 = 216 \cdot 25)$$

$$\text{Now } S_{22} = \sum_{i=1}^n \frac{EA}{L^3} (Y_{ik} - X_j)^2$$

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

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

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 # 05

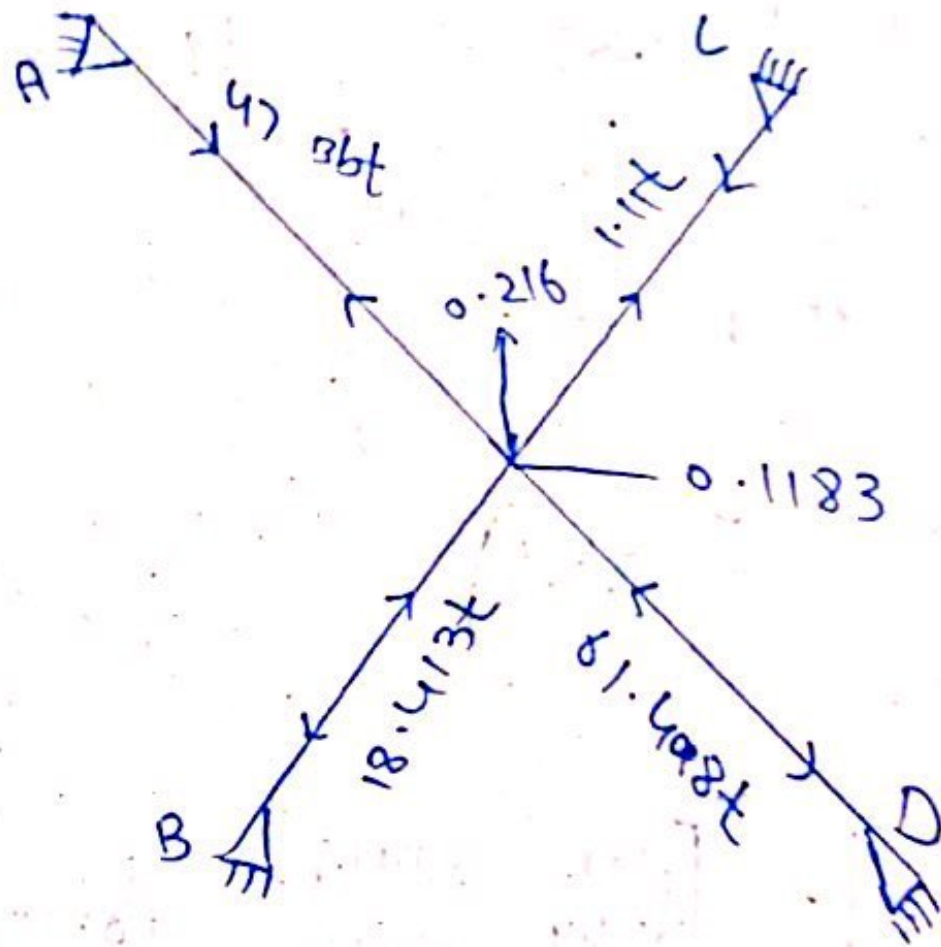
[AM]

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

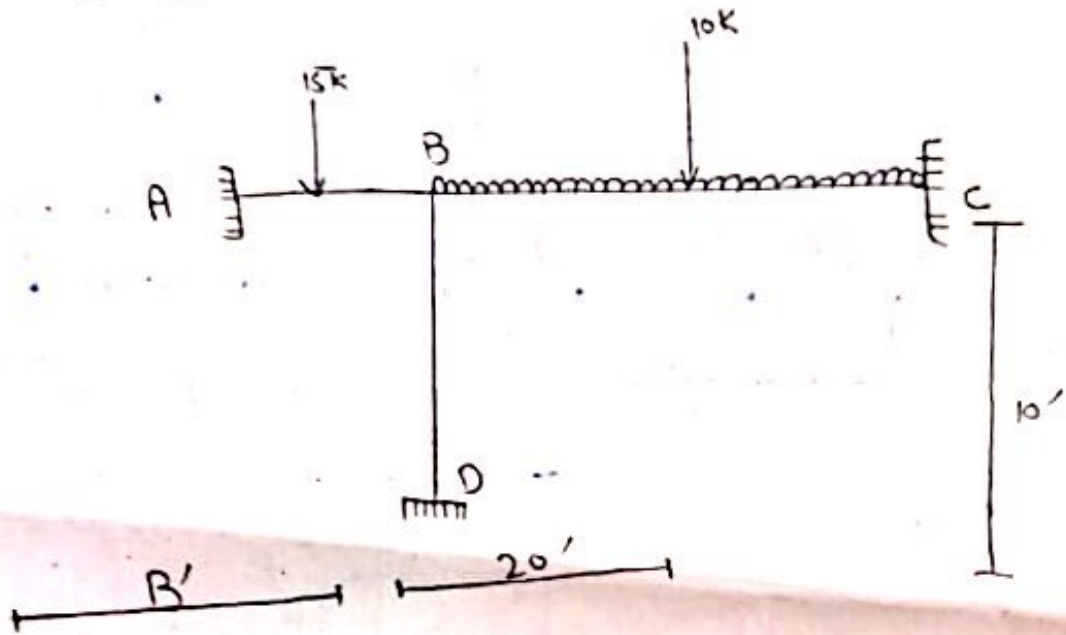
$$\begin{bmatrix} 141 \times 0.1183 & + (-141) \times (-0.216) \\ 188.44 \times 0.1183 & + 188.44 \times (-0.216) \\ -173.2 \times 0.1183 & + (-100) \times (-0.216) \\ -125 \times 0.1183 & + 216.25 \times (-0.216) \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.68 & + 30.46 \\ 22.29 & - 40.70 \\ -20.49 & + 21.6 \\ -14.71 & - 46.71 \end{bmatrix}$$

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



Qno # 03



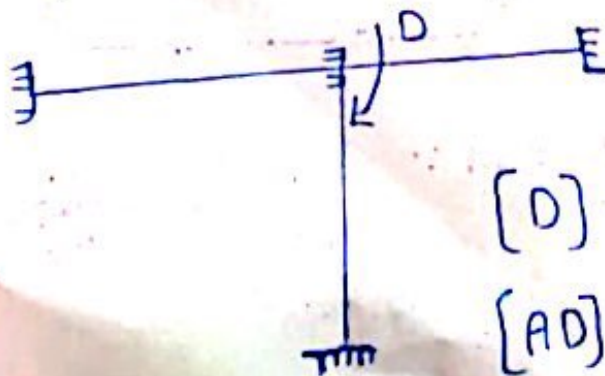
Solution

Step # 1

Determine Kinematic intermi-
namey

$$K.I = 1^0$$

Step # 2 Determine Unknown Joint
Displacement

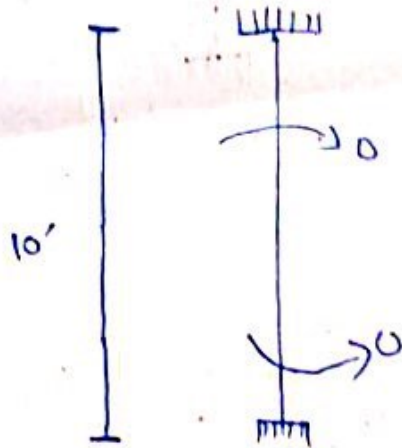
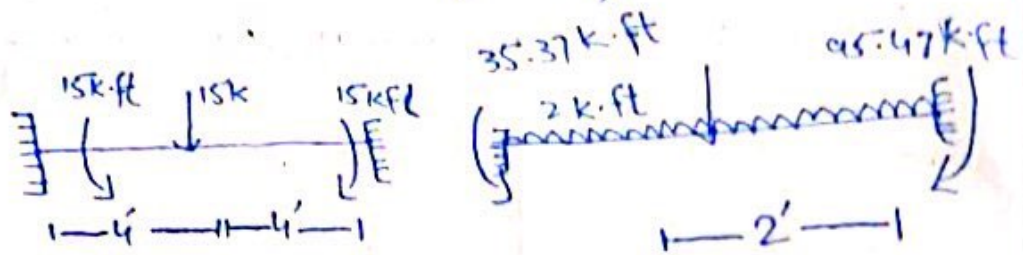


$$[0] = [?]$$

$$[AD] \quad [0]$$

Step #03

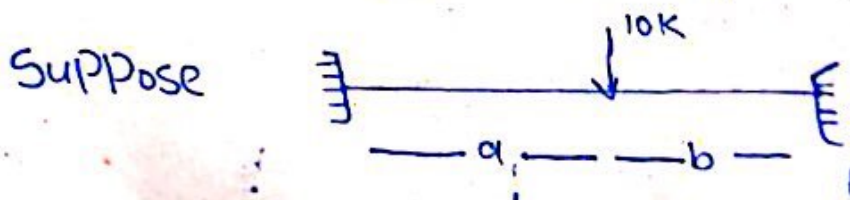
Compute $[ADL]$ Matrix



= Point load at center $\therefore \frac{PL}{8} = \frac{(15 \times 8)}{8}$
 $= 15 \text{ k} \cdot \text{ft}$

=> Uniformly Distributed load $\therefore \frac{wL^2}{12} = \frac{2(20)^2}{12}$
 $= 66.67 \text{ k} \cdot \text{ft}$

=> Point load (Not at mid) :-



For left end $\therefore \frac{Pab^2}{L^2} = \frac{(10)(8)(8)^2}{(20)^2}$
 $= 19.2 \text{ k} \cdot \text{ft}$

For right end :- $\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} =$
 $28.8 \text{ k}\cdot\text{ft}$

So total Moment at left end :-

$101.2 + 66.67 = 85.87 \text{ k}\cdot\text{ft}$

Similarly at right end :-

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

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

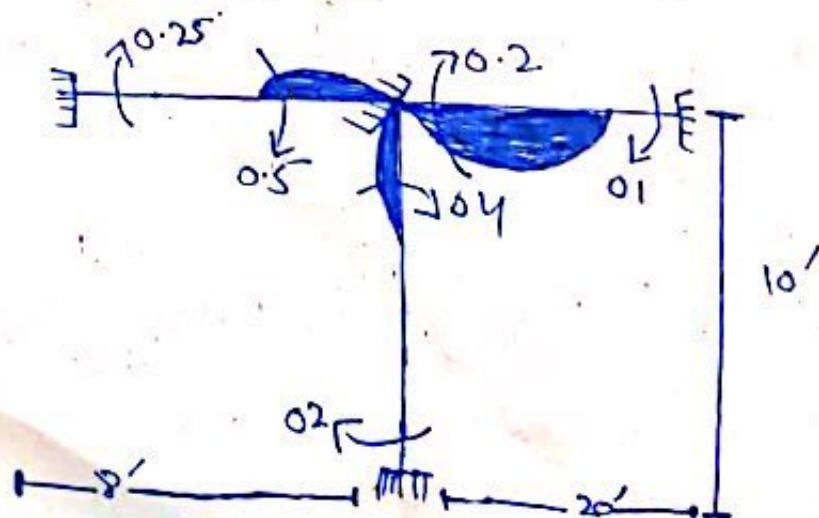
Step # 04

Determine $[S]$ Matrix

$[S] = [S'']$

Now

$D = 1 \text{ K}$



$$\Rightarrow \frac{4EI}{8} = 0.5 \quad \frac{2EI}{8} = 0.25 \Rightarrow \frac{4EI}{10} = 0.4$$

$$= \frac{4EI}{20} = 0.2 \quad \frac{2EI}{20} = 0.1 \Rightarrow \frac{2EI}{10} = 0.2$$

$$[S] = (0.5 + 0.4 + 0.2) EI \\ = 1.1 EI$$

$$[S] = 1.1 EI$$

Step # 05

Compute $[D]$ Matrix

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

$$[D] = \frac{1}{1.1} \times [0] = [-70, 81]$$

$$= \frac{70 \cdot 81}{1.1}$$

$$[D] = [64.42] \frac{1}{EI}$$