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SECTION	'A'
SUBJECT:	STRUCTURAL ANALYSIS-II
INSTRUCTOR:	Engr. ADEED KHAN
EXAM :-	FINAL TERM (SUMMER 2020)
DATE :	25th Sept, 2020.

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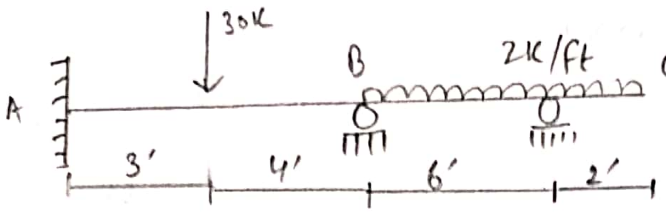
QUESTION: 01



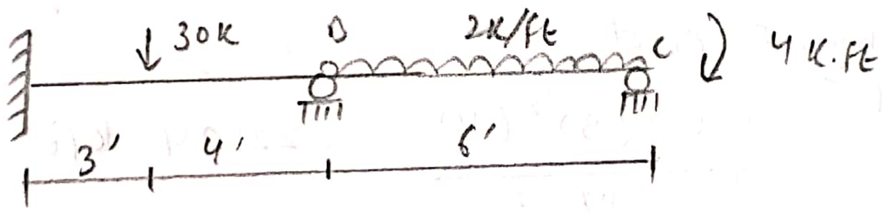
Solution:-

Step: 01

Determining Kinetic Indeterminancy

K.I = 5°

So we need to reduce extended portion

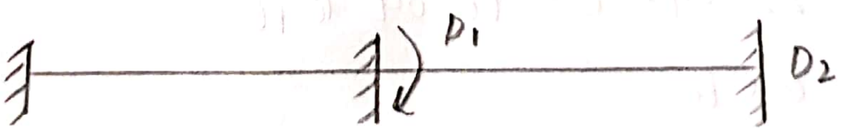


$$\Rightarrow \frac{2(2)}{1} = 4\ kft$$

Now K.I = 2°

Step# 02

Determine unknown joint displacement.



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

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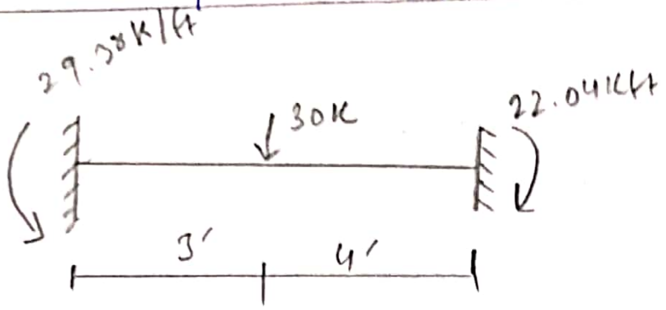
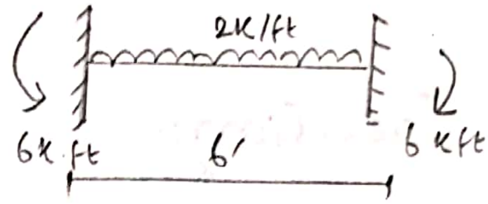
Step: 03

Now Compute [ADL] matrix





Now, 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

we use

$$\frac{WL^2}{12} \Rightarrow \frac{(2)(6)^2}{12} \text{ (putting values)}$$

$$= 6 \text{ K.ft}$$

$$ADL_1 = 22.04 - 6 = 16.04 \text{ K.ft}$$

$$ADL_2 = 6 \text{ K.ft.}$$

Step: 04

Now computing [S] matrix

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

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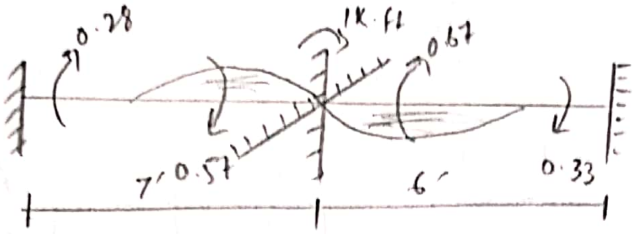
(a) $D_1 = 1K$ $D_2 = 0$



we have

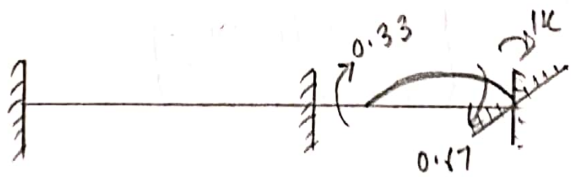
$\frac{4EI}{7} = 0.57$ $\frac{2EI}{6} = 0.33$

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

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

$S_{21} = 0.33\,EA$

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



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

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

So

$S_{12} = 0.33$

$S_{21} = 0.67$

Thus,

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

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Step: 05

Now computing [D] matrix
we have

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

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

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

$$|S| = 0.7219$$

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

Now we have

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

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0.93 & -0.45 \\ -0.45 & 1.72 \end{bmatrix}$$

$$= \begin{bmatrix} 0.93(-16.04) + (-0.45)(-2) \\ -0.45(-16.04) + 1.72(-2 \end{bmatrix}$$

$$= \begin{bmatrix} 14.91 + 0.8 \\ 7.21 + (-3.44) \end{bmatrix}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 15.71 \\ 3.77 \end{bmatrix}$$

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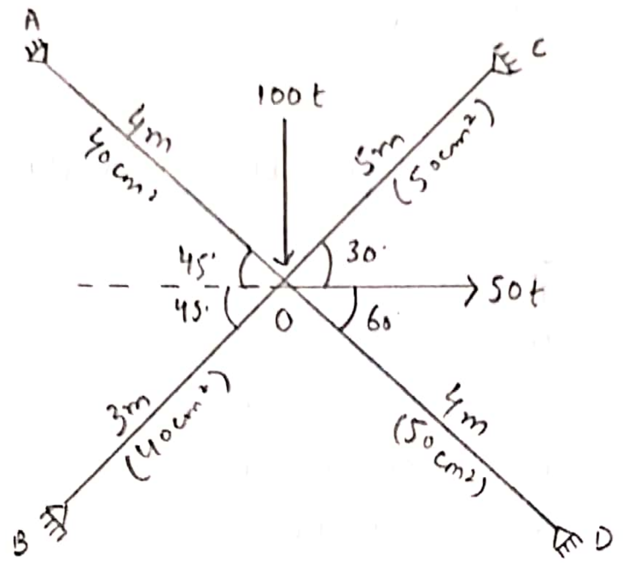
QUESTION: 02



$E = 2000 t/cm^2$

Solution:-

→ For A:

We know $\sin 45° = p/h$

putting values

$\sin 45° = p/4$

$\Rightarrow \quad p = 2.828\ m$

We know $\cos 45° = b/4$

$b = 2.828\ m.$

For B:

We know $\sin 45° = p/h = p/3$ (putting values)

$p = 2.12\ m$

We $\cos 45° = b/h = b/3$

$b = 2.12\ m$

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For C:- We know

$\sin 30^\circ = P/h = P/5$ (putting values)

$P = 2.5m$

$\cos 30^\circ = b/h = b/5$ (putting values)

$b = 4.33\ m$

Now we know

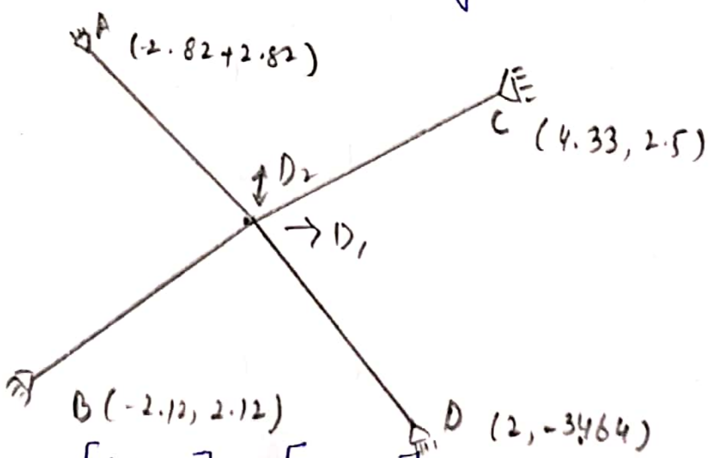
$EA_{(A)} = 2000 \times 40 = 80,000\ t$
$EA_{(B)} = 2000 \times 40 = 80,000\ t$
$EA_{(C)} = 2000 \times 50 = 100,000\ t$
$EA_{(D)} = 2000 \times 50 = 100,000\ t$

Step: 01 $K.I = 2J - r$

putting values

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

Step: 02 Select unknown joint displacement.



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

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Step: 03

$[AMD]_{4\times2}$ $\quad$ & $[S]_{2\times2}$

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

Now

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

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

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

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

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

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

(putting values)

$$S_{11} = \frac{80,000}{400^3}(282)^2 + \frac{80,000}{300^3}(212)^2 + \frac{100,000}{(500)^3}(-433)^2 + \frac{100,000}{400^3}(-200)^2$$

$$S_{11} = 99.405 + 133.107 + 149.99 + 82.5$$

$$S_{11} = 445.063.$$

Now we have

$$S_{12} = S_{21} = \sum_{i=1}^{m} \frac{EA}{L^3} (X_K - X_J)(Y_K - Y_J) \quad \text{(putting values}$$

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

$$+ \frac{100,000}{500^3}(-433)(0-250) + \frac{100,000}{400^3}(200)(346)$$

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

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

We know

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

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

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

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

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

Now we have

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

putting values

$$= \frac{80,000}{400^3}(-282)^2 + \frac{80,000}{300^3}(212)^2 + \frac{100,000}{500^3}(-250)^2$$

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

$$S_{22} = 469.628.$$

Step: 04

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

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

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

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Step: 05

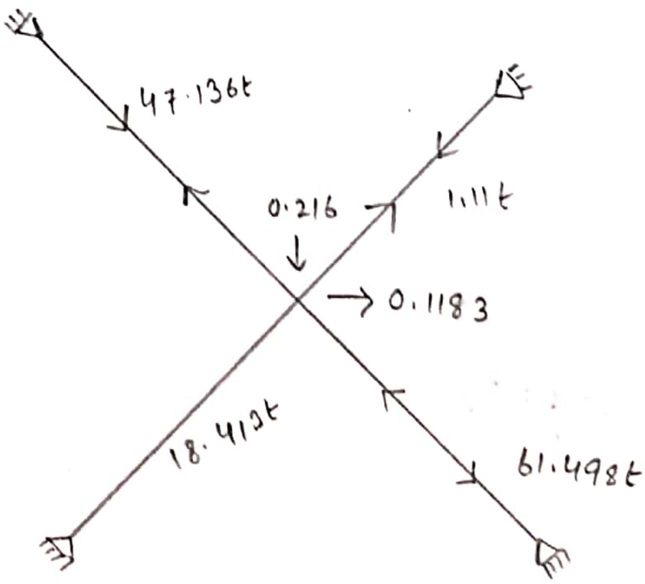
$$[AM]$$

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

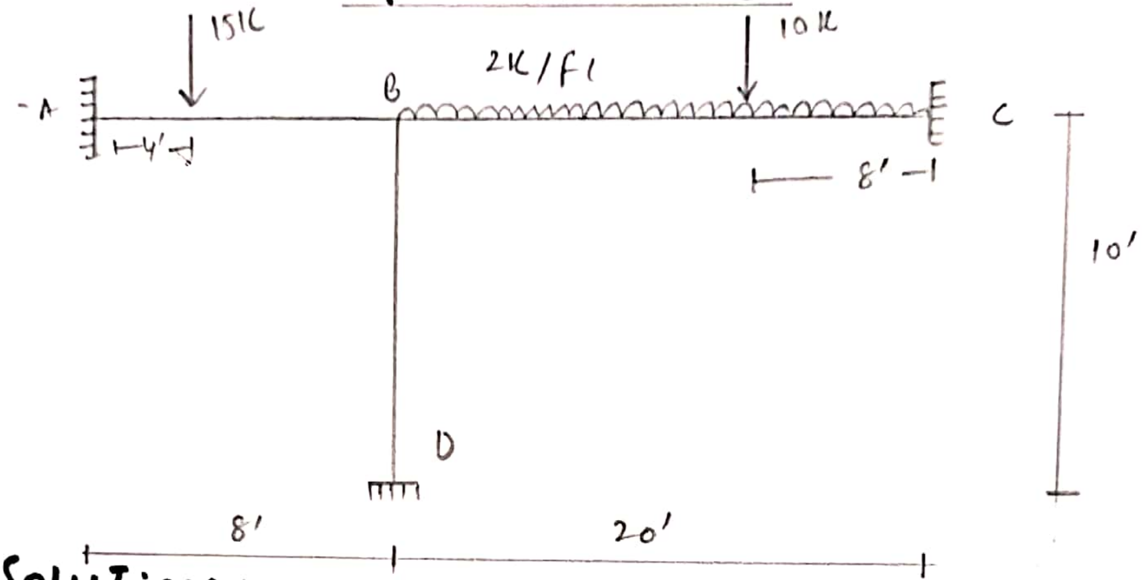
$$= \begin{bmatrix} 141 \times 0.1183 + (-141)(-0.216) \\ 188.44\,(0.1183) + 188.44\,(-0.216) \\ -173.2\,(0.1183) + (-100)(-0.216) \\ -125\,(0.1183) + 216.25\,(-0.216) \end{bmatrix}$$

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

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



QUESTION: 03



Solution :-

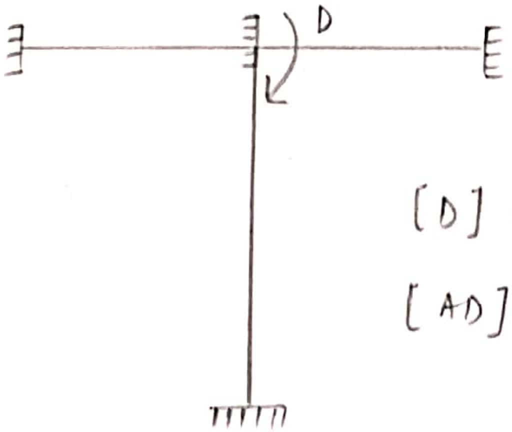
Step: 01

Determining Kinetic indeterminancy

K.I = 1

Step: 02 :

Now, Determine unknown joint displacement



[D] = [?]

[AD] = [0]

Step: 03

Now, Compute [ADL] matrix

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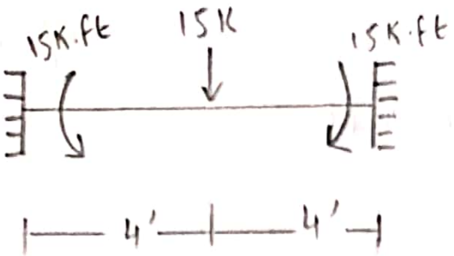
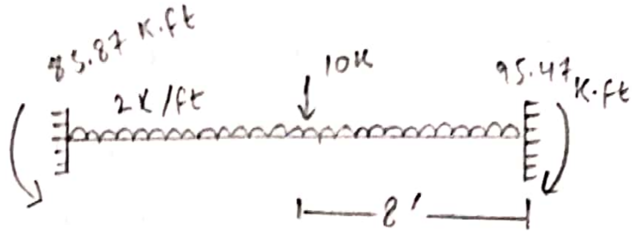
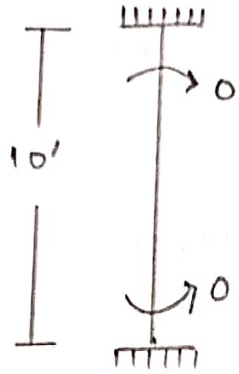






⇒ <u>point load at centre :</u>

$PL/8 \Rightarrow \frac{(15)(8)}{8}$ (putting values)

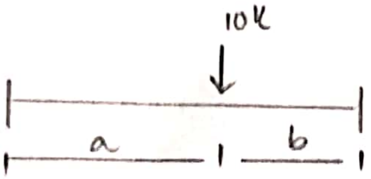
$= 15 Kip/ft$

⇒ <u>Uniformly Distributed load</u>

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

⇒ <u>Point load not at mid</u> :

Suppose :



⇒ For left End :

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

⇒ For Right End

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

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So we have total movement at left end

$19.2 + 66.67 = 85.87$ K.ft.

Similarly at right end

$28.8 + 66.67 = 95.47$ Kft.

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

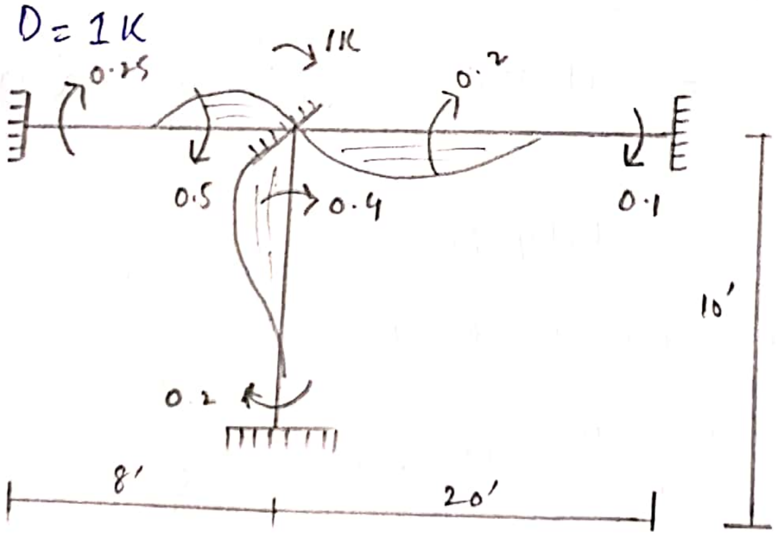
Step: 04

Determine [S] matrix

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

Now

D = 1K



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

$\Rightarrow \dfrac{4EI}{20} = 0.24$ $\qquad \dfrac{2EI}{20} = 0.1$

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

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

$= 1.1\ EI$

$[S] = 1.1 EI$

Step: 05

Compute [D] matrix

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

putting values

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

$= \frac{70.87}{1.1}$

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

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