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Subject Structure Analysis II

Department BE (civil)

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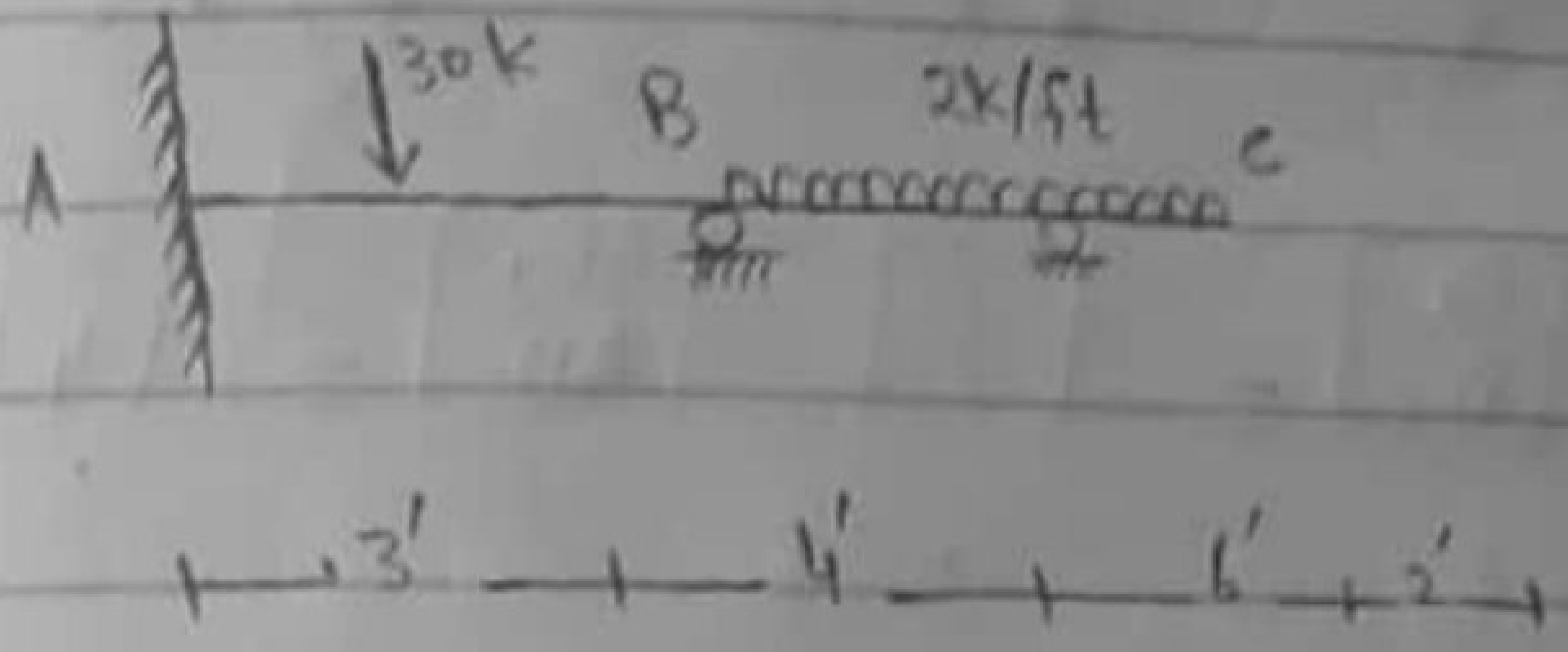
Ans # 01



Step # 1

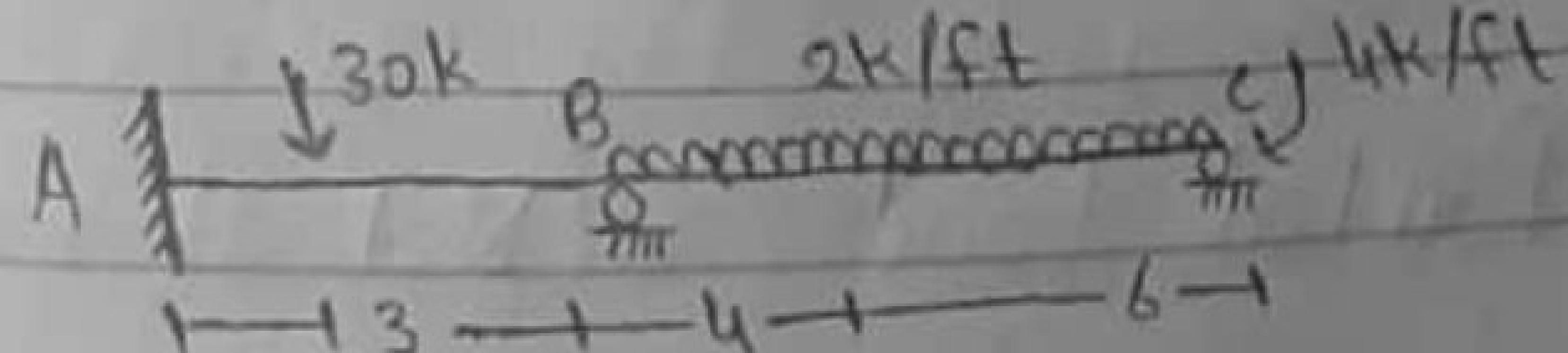
Kinematic Indeterminacy,

EI = constant

$K.I = 5^\circ$

So,

We have to reduce the extended Portion;



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

Now,

$K.I = 2^\circ$

Step # 2

Determine unknown joint displacement.

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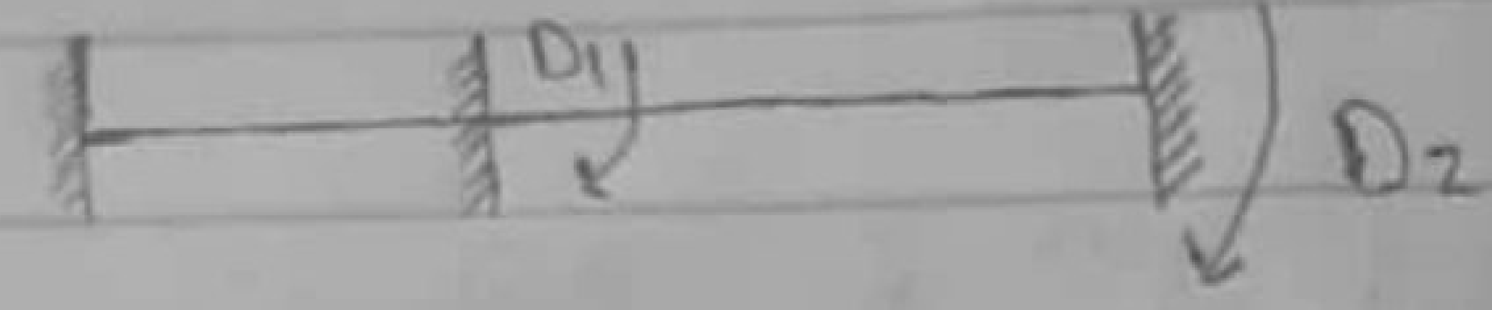
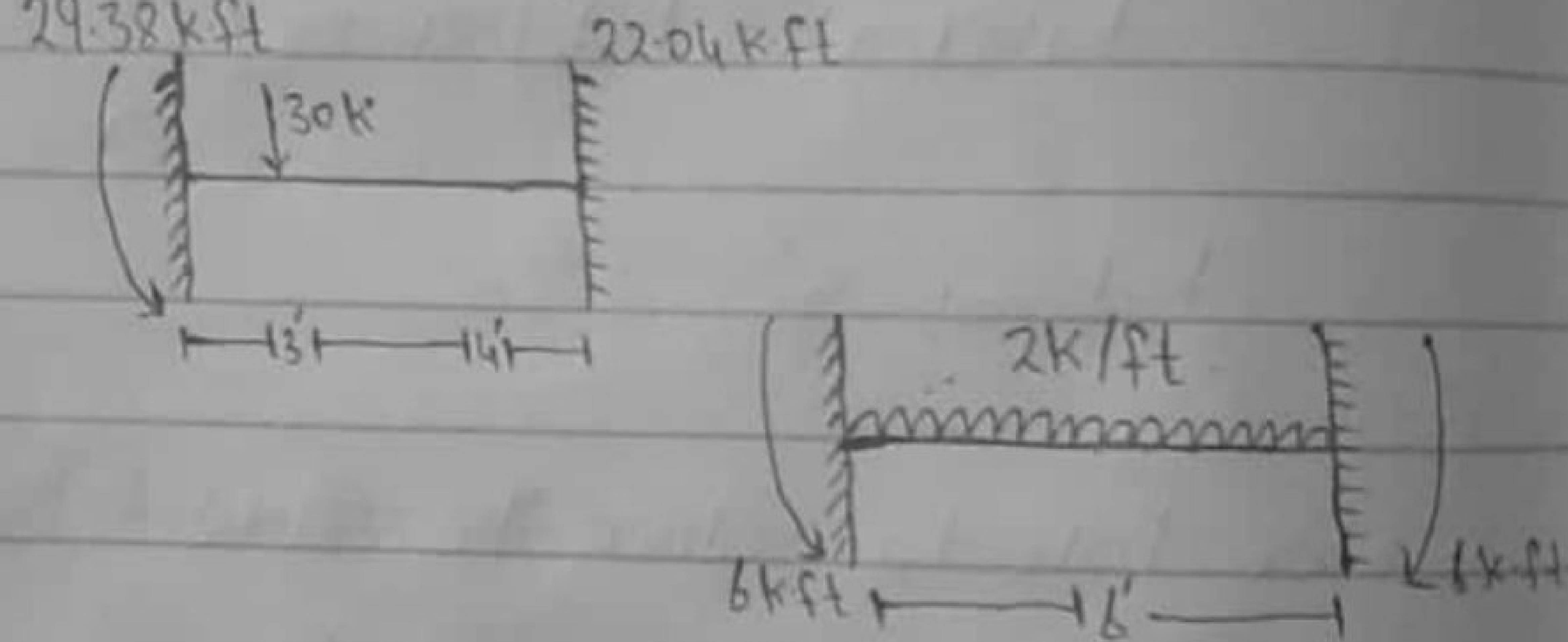


$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \quad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

Step # 3

Compute [ADL] Matrix



For Pointed Load; (Not at mid)

For left end;

$$Pab^2/L^2 = (30)(3)(4)^2 = 29.38 \text{ k-ft}$$

For right end

$$Pa^2b/L^2 = (30)(3)^2(4) = 22.04 \text{ k ft}$$

For UDL;

$$wl^2/12 = (2)(6)^2/12 = 6\ k\text{-}ft$$

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

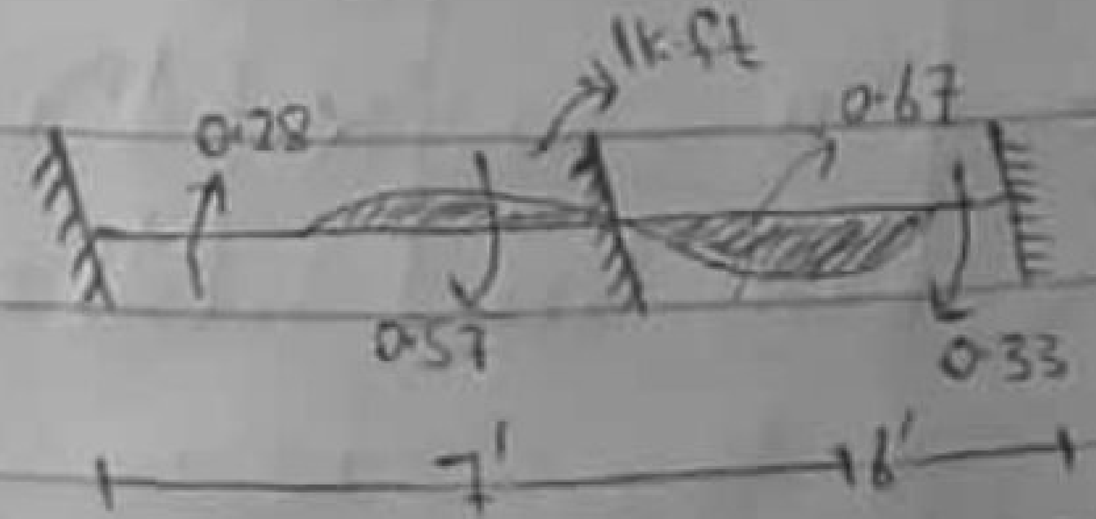
$$ADL_2 = 6\ k\text{-}ft$$

Step # 4

Compute {S} Matrix

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

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



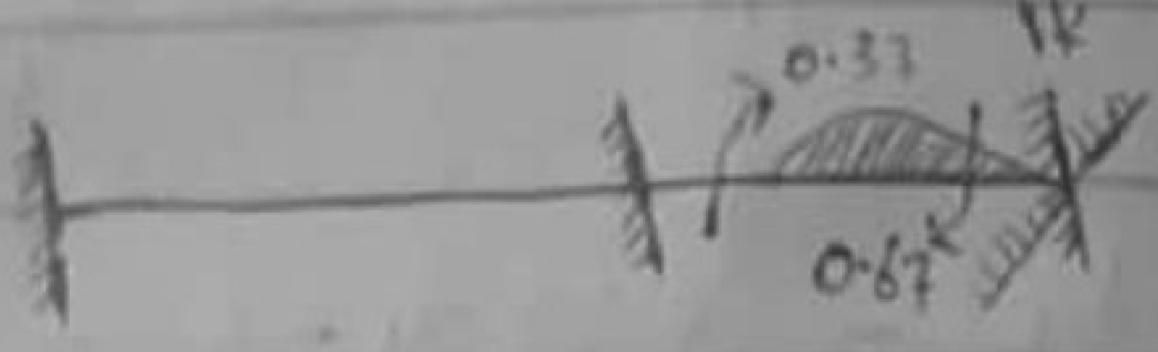
$4EI/7 = 0.57$ $\qquad$ $2EI/6 = 0.33$

$4EI/6 = 0.67$ $\qquad$ $2EI/7 = 0.28$

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

$S_{21} = 0.33\ EA$

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



$4EI/6 = 0.67$

$2EI/6 = 0.33$

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

Step # 5
Compute [D] Matrix

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

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

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

$|S| = 0.7219$

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

Now;

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

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

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

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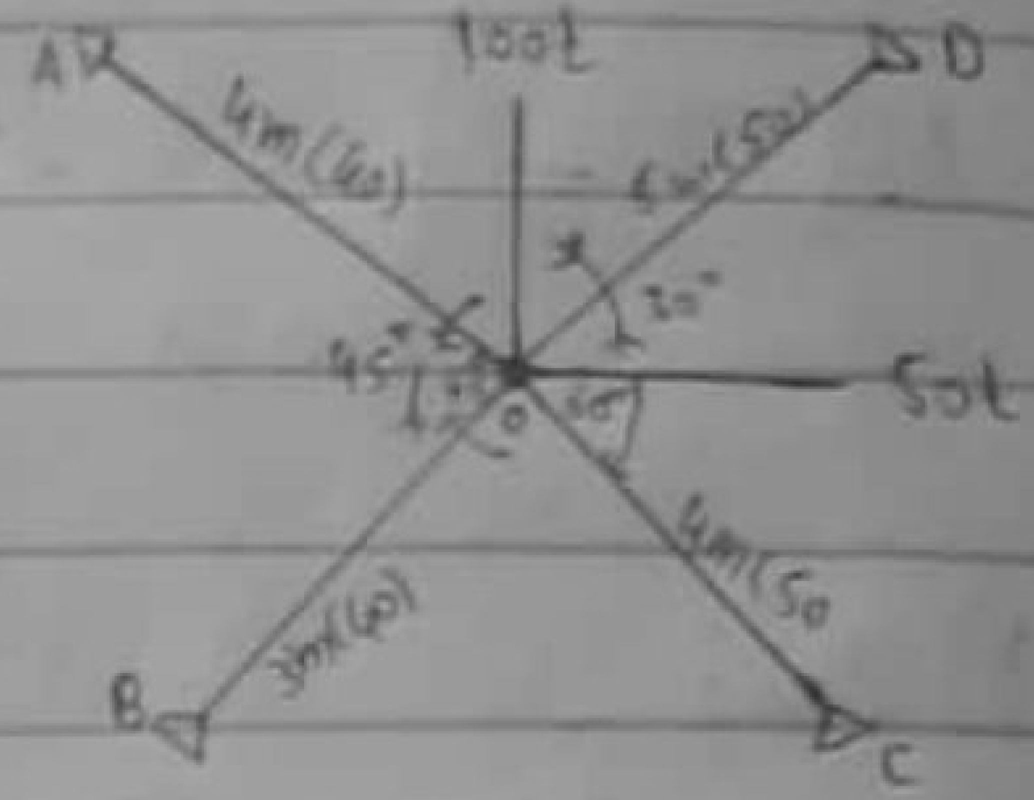
Ans # 02

$E = 2000\, t/cm^2$



For (A)

$\sin 45^\circ = P/h = P/4$

$\Rightarrow P = 2.828\, m$

$\cos 45^\circ = b/4$

$\Rightarrow b = 2.828\, m$

For (B)

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

$\Rightarrow P = 2.12\, m$

$\cos 45^\circ = b/h$

$\Rightarrow b = 2.12\, m$

For (C)

$\sin 30^\circ = P/h = 5$

$\Rightarrow P = 2.5\, m$

$\cos 30^\circ = b/5$

$\Rightarrow b = 4.33\, m$

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Now;

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

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

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

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

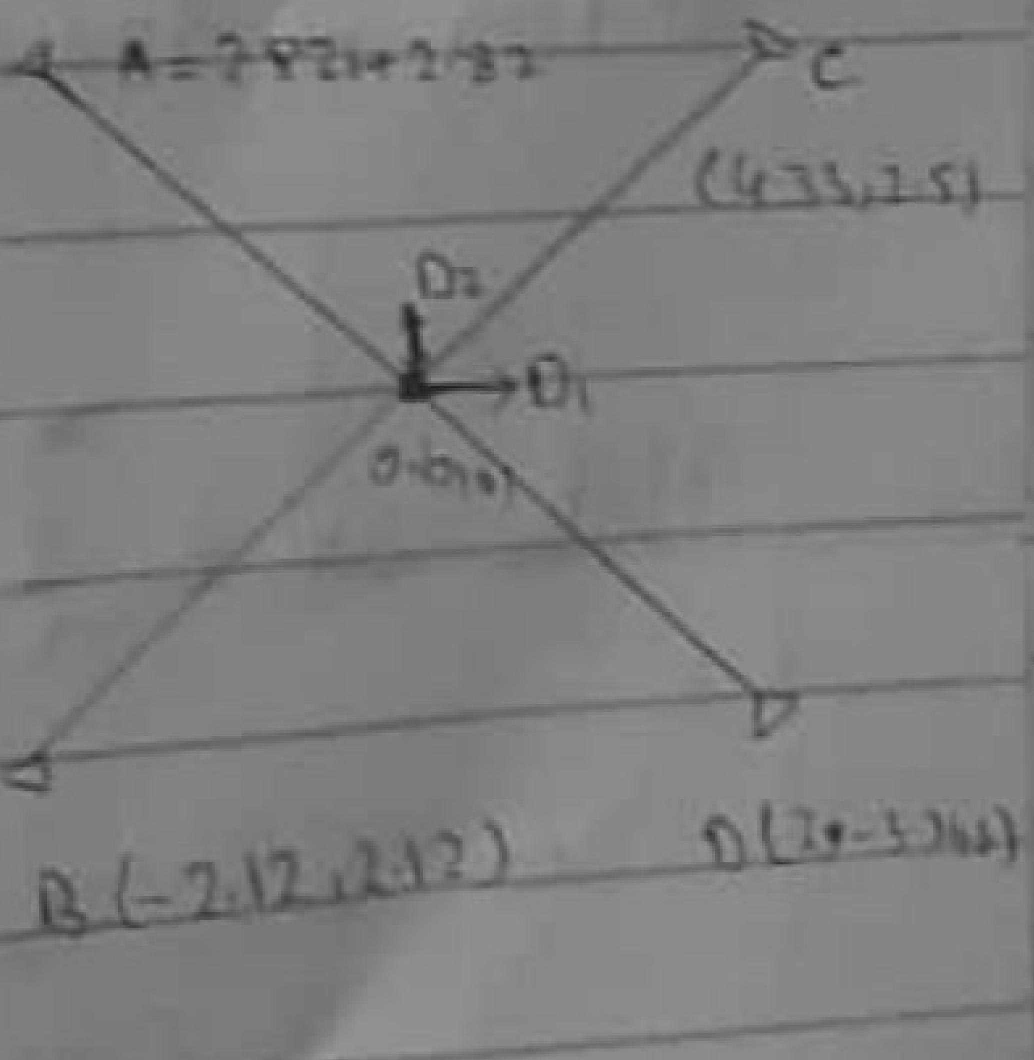
Step # 1 ; K.I ,

$$K.I = 2J - 8 = 2(5) - 8 = 2^\circ$$

Step # 2 ;

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 # 3

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

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

$AMD = EA/L^2 \, (xk \; xj)$

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

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

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

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

Now $S_{11} = \sum_{x}^{m} EA/L^3 \, (xk - xj)^2$

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

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

$S_{11} = 99.405 + 133.107 + 149.995 + 62.5$

$S_{11} = 445.063$

$$S_{12} = S_{21} = \sum_{I=1}^{m} EA/L^3 \times (Xk - Xj)(Yk - Yj)$$

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

$$+ \frac{100{,}000 \times (-433)(-0.250)}{(500)^3} + \frac{100{,}000 \times (-200)(0+340)}{(400)^3}$$

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

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

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

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

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

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

Now, $S_{22} = \sum_{I=1}^{m} EA/L^3 = (Yk - Yj)$

$$\frac{80{,}000}{400^3}(-282)^2 + \frac{80{,}000}{300^3}(212)^2 + \frac{100{,}000}{500^3}(-250)^2 + \frac{100{,}000}{400^3}(346)^2$$

$$S_{22} = 469628$$

Step # 4

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.003 & 12237 \\ 12237 & 469628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

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

Step # 6 ; $[AM]$

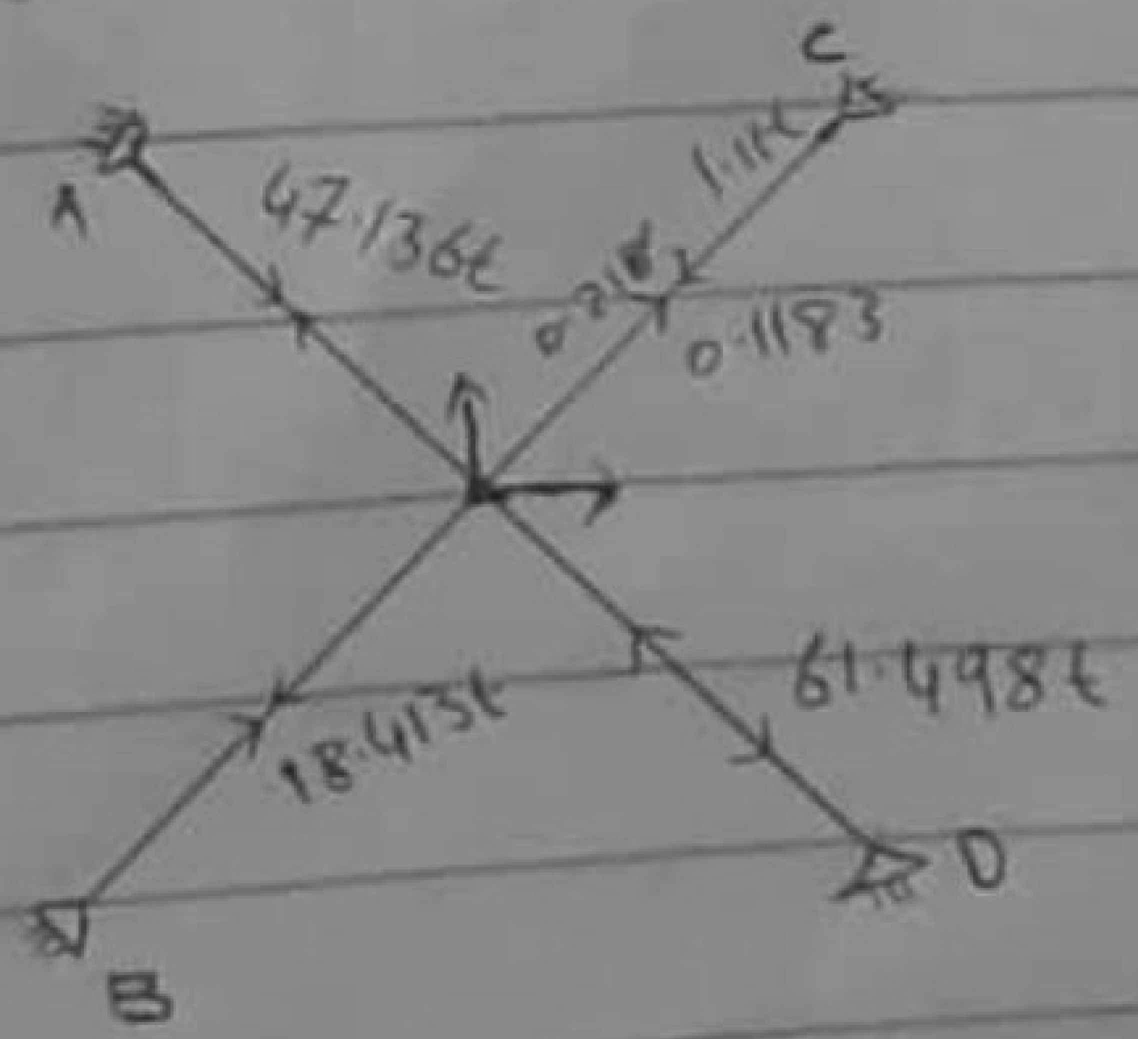
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

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

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

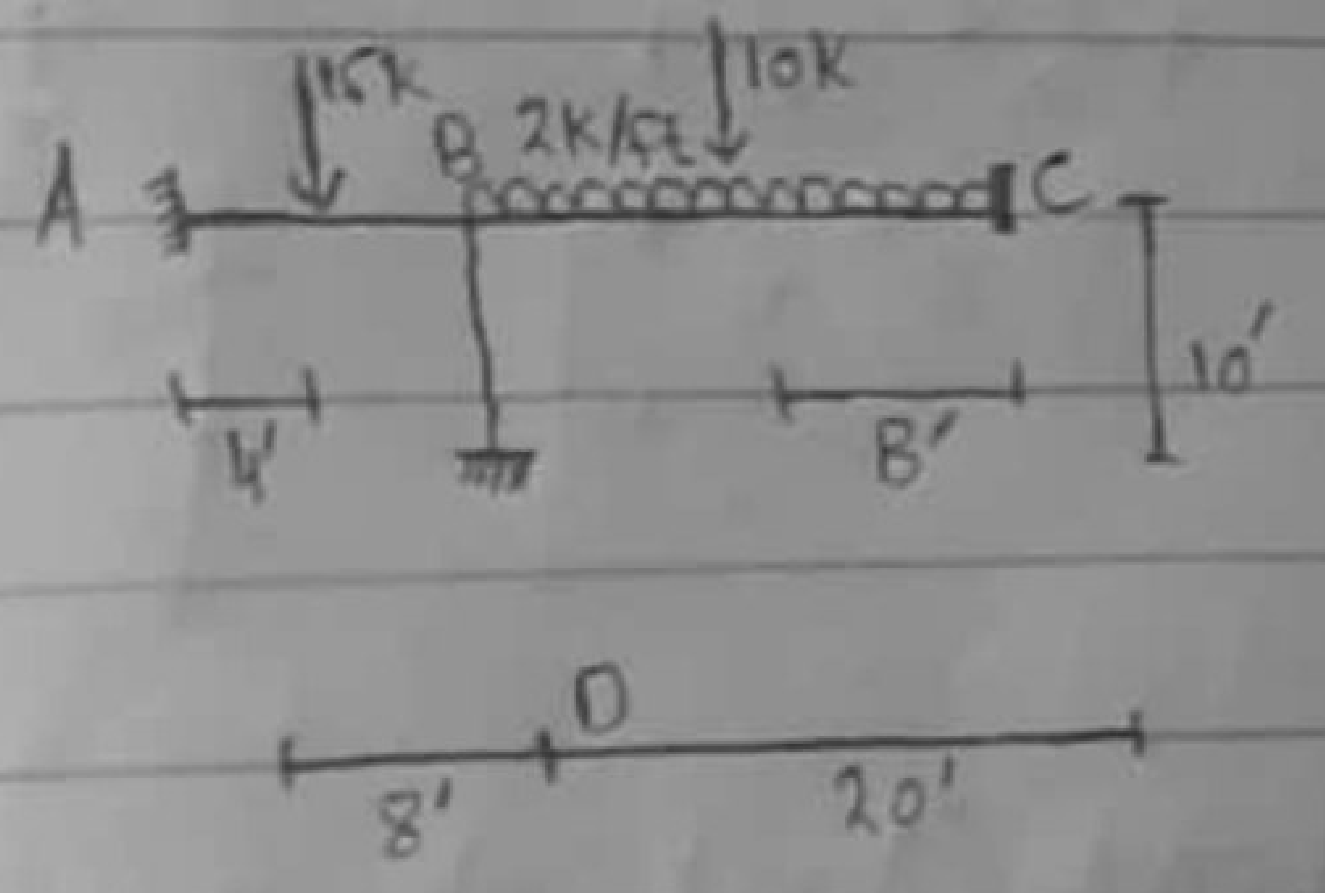
$$= \begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -61.498t \end{bmatrix}$$

Solved;



Ans # 03

Rigid- Jointed Frame.



EI = constant

Using stiffness Method ;

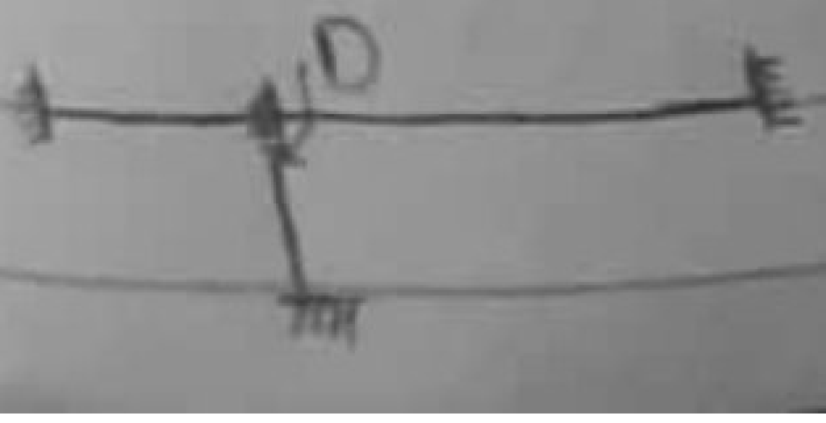
Step # 1

Kinematic Indeterminacy ;

K.I = 1°

Step # 2

Determination of unknown joint displacement

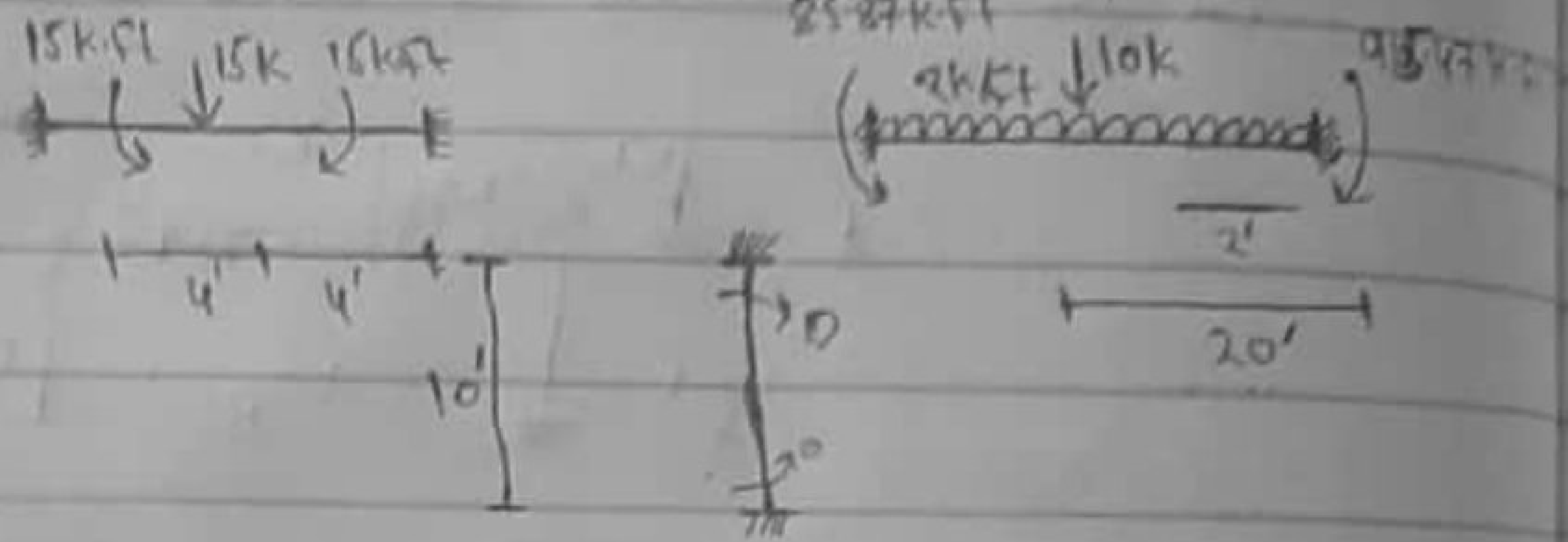


[D] = [?]

[AD] = [0]

Step # 3

Compute [ADL] Matrix ;



Point Load at centre ;

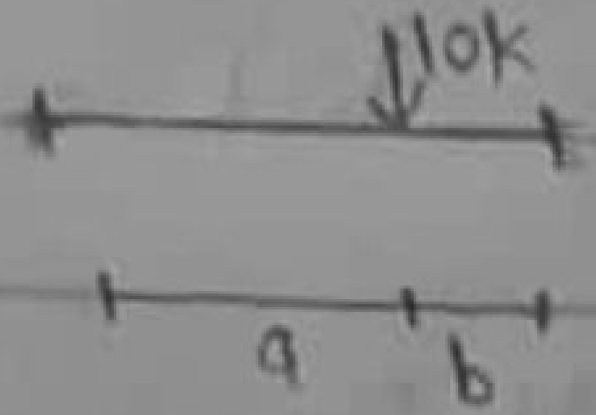
$$PL/8 = 15(8)/8 = 15 \text{ k.ft}$$

Uniformly distributed Load ;

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

Point Load ; (Not at Mid Point)

suppose ;



For left end ;

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

For right end,

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

Total Moment at left end;

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

Total Moment at right end,

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

So,

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

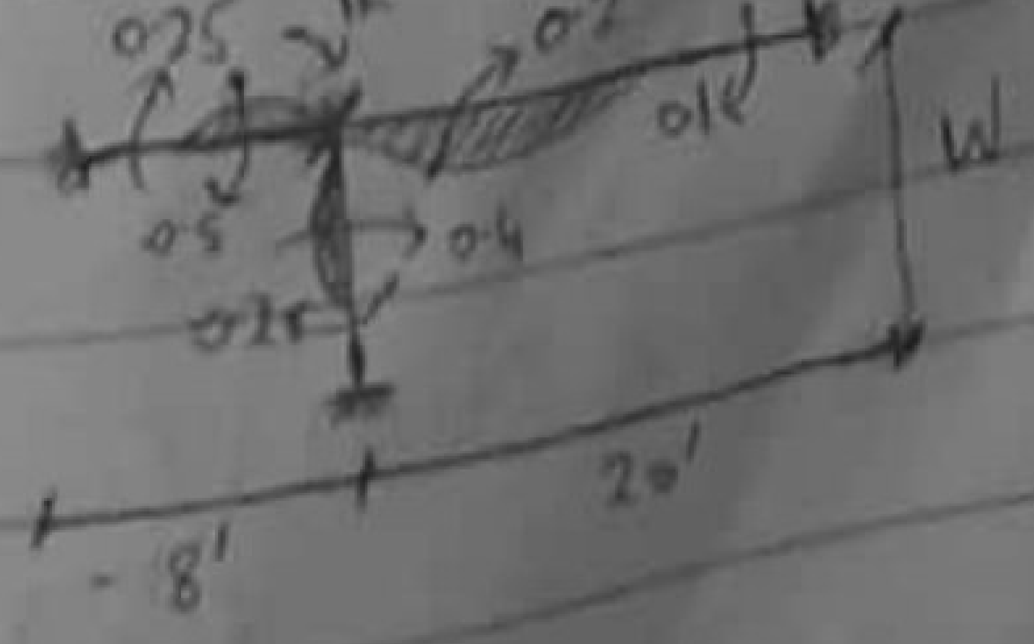
Step # 4

Determine [S] Matrix;

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

Now;

$$D = 1k$$



$4EI/8 = 0.5$ $2EI/8 = 0.25$

$4EI/20 = 0.2$ $2EI/20 = 0.1$

$4EI/10 = 0.4$ $2EI/10 = 0.2$

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

$[S] = 1.1\ EI$

Step # 5

Compute [D] Matrix ;

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

$[D] = 1/1.1 \times [0] - [-70.87]$

$= 70.87 / 1.1$

$[D] = [64.42] / EI$