12

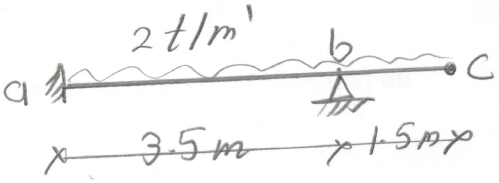
? δ_c by Reduction

Use Primary system for the applied Loads

Q1

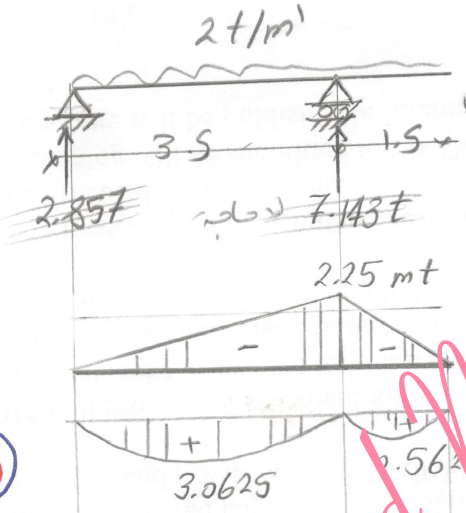
$E = 2100\ t/cm^2$

$I = 6500\ cm^4$

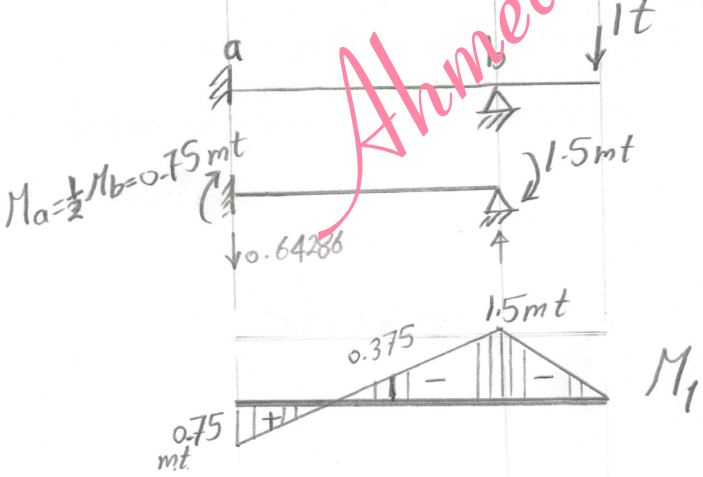


$$\delta_c = \int \frac{M_o M_{f1}}{EI}\, dl$$

M_o



3



3

$$\delta_c = \int \frac{M_o M_{f1}}{EI}\, dl$$

$$= \frac{3.5}{6}\left[0.75 \times 2.25 + 2 \times 1.5 \times 2.25\right]$$

$$+ \frac{2}{3} \times 3.0625 \times 3.5 \times -0.375$$

$$+ \frac{1.5}{6}\left[2 \times 2.25 \times 1.5\right] + \frac{2}{3} \times 0.5625 \times 1.5 \times 0.75$$

3

$$\delta_c = \frac{1.539}{EI} = \frac{1.54}{EI}$$

$\delta_c = 0.001275$ m.

3

Ahmed M. El-Khody

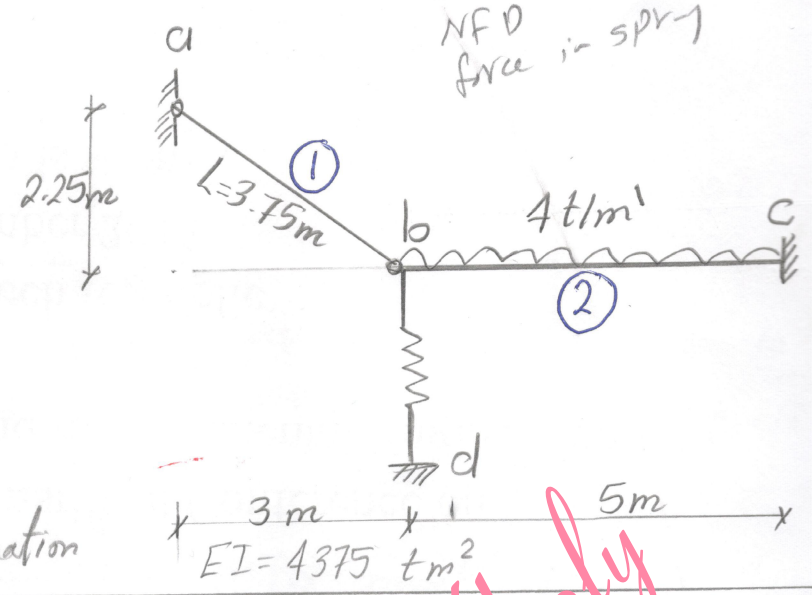
Q2

17

Q3 **33**

BMD
SFD
NFD
force in spring

$E = 2100\ t/cm^2$
$A_{link} = 10\ cm^2$
$A_{beam} = 100\ cm^2$
$I_{beam} = 20833.333\ cm^4$
$k_{spring} = 7\ t/cm$
Consider axial deformation



For member 1

$$\tilde{K} = \frac{EA}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$

$$\tilde{K} = 5600\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$ 1

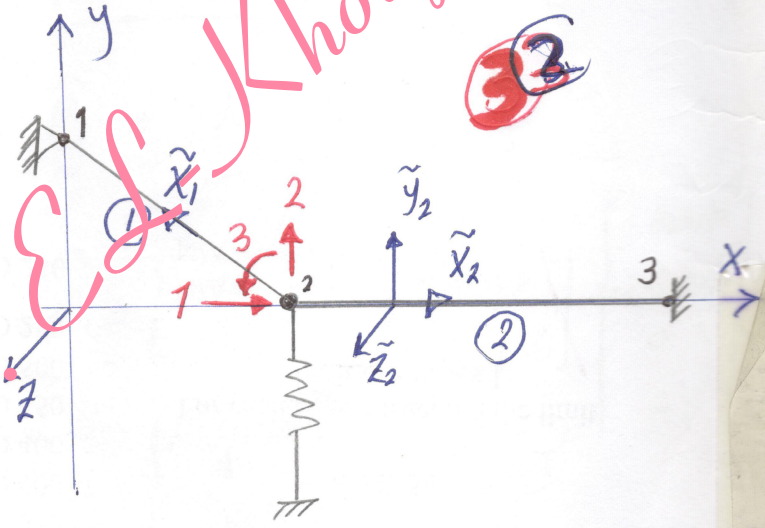
$$T = \begin{bmatrix} l & m & 0 & 0 \\ 0 & 0 & l & m \end{bmatrix}$$

$$T = \begin{bmatrix} -0.8 & 0.6 & 0 & 0 \\ 0 & 0 & -0.8 & 0.6 \end{bmatrix}$$ 1

$$K = T^T \tilde{K} T$$ 2

$$= 5600\begin{bmatrix} 0.64 & & & \\ -0.48 & 0.36 & & \\ -0.64 & 0.48 & 0.64 & \\ 0.48 & -0.36 & -0.48 & 0.36 \end{bmatrix}$$

$$K = \begin{bmatrix} 3584 & & & \\ -2688 & 2016 & & \\ -3584 & 2688 & 3584 & \\ 2688 & -2016 & -2688 & 2016 \end{bmatrix}$$



D.O.F., Connectivity, local & global axes

For element 2 2

$$\tilde{K} = K = \begin{bmatrix} 42000 & 0 & 0 & -42000 & 0 & 0 \\ 0 & 420 & 1050 & 0 & -420 & 1050 \\ 0 & 1050 & 3500 & 0 & -1050 & 1750 \\ -42000 & 0 & 0 & 42000 & 0 & 0 \\ 0 & -420 & -1050 & 0 & 420 & -1050 \\ 0 & 1050 & 1750 & 0 & -1050 & 3500 \end{bmatrix}$$

$T = I$, $\theta = 0$, $l = 1$, $m = 0$ 1

V-C Tables

member	P		q	
	U /1	V /2	U /3	V /4
①	1	2	–	–

1

member	P			q		
	U /1	V /2	θ /3	U /4	V /5	θ /6
②	1	2	3	–	–	–

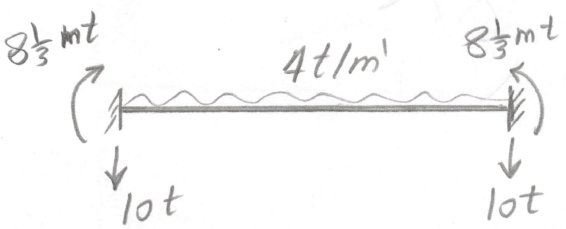
1

$$K_{3\times3} = \begin{bmatrix} K^1_{11}+K^2_{11} & & \\ K^1_{21}+K^2_{21} & K^1_{22}+K^2_{22}+700 & K^2_{23} \\ K^2_{31} & K^2_{32} & K_{33} \end{bmatrix}$$

1

$$K_{3\times3} = \begin{bmatrix} 45584 & -2688 & 0 \\ -2688 & 8136 & 1050 \\ 0 & 1050 & 3500 \end{bmatrix}$$

2



$$P = \begin{Bmatrix} 0 \\ -10 \\ -8\frac{1}{3} \end{Bmatrix} \begin{matrix} t \\ \\ mt \end{matrix}$$

2

$$K\,D = P$$

$$U = \begin{Bmatrix} -1.6611 \times 10^{-4} \\ -2.8169 \times 10^{-3} \\ -1.5359 \times 10^{-3} \end{Bmatrix} \begin{matrix} m \\ m \\ rad. \end{matrix}$$

2

For member 1

$$\tilde{P} = \tilde{K}\,\tilde{U}$$

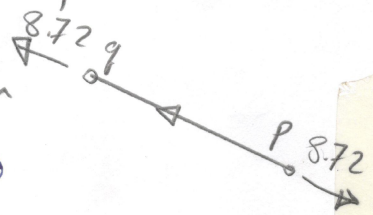
$$\tilde{U} = \tilde{T}\,U$$

$$\tilde{U} = \begin{bmatrix} -0.8 & 0.6 & 0 & 0 \\ 0 & 0 & -0.8 & 0.6 \end{bmatrix} \begin{bmatrix} -1.6611\times10^{-4} \\ -2.8169\times10^{-3} \\ 0 \\ 0 \end{bmatrix}$$

$$\tilde{U} = \begin{Bmatrix} -1.557\times10^{-3} \\ 0 \end{Bmatrix}$$

$$\tilde{P} = \tilde{K}\,\tilde{U} = \begin{Bmatrix} -8.72 \\ 8.72 \end{Bmatrix} \begin{matrix} t \\ t \end{matrix}$$

① $f = +8.72$ tension



2

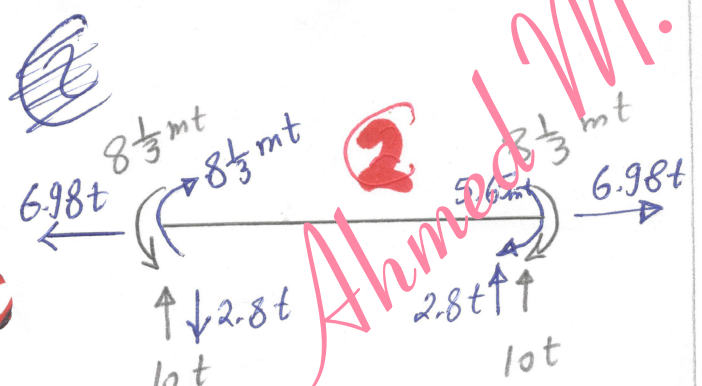
for element 2

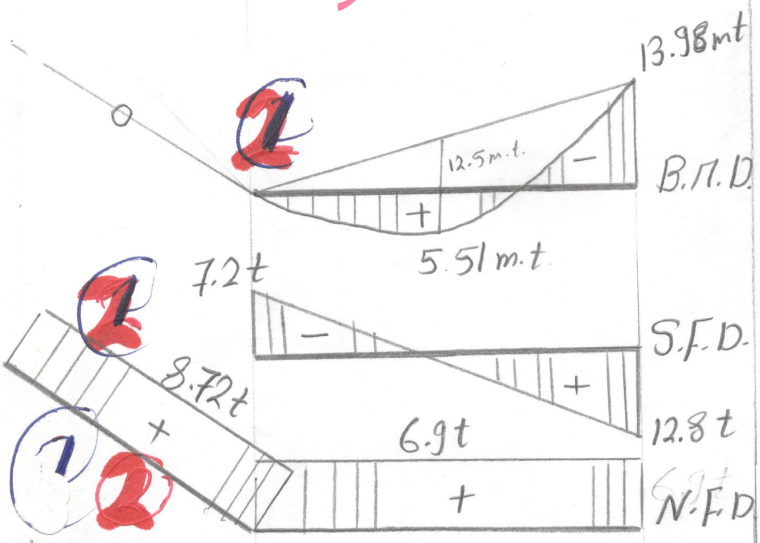
$$\tilde{P} = \tilde{K}\ \tilde{U}$$

$$\tilde{P}_{6\times1} = \tilde{K}_{6\times6} \begin{Bmatrix} U_1 \\ U_2 \\ U_3 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$

$$\tilde{P} = \begin{Bmatrix} -6.98 \\ -2.80 \\ -8\frac{1}{3} \\ 6.98 \\ 2.8 \\ -5.65 \end{Bmatrix}$$

2





force in Spring = $KU_2 = 700\,U_2 = 1.97$ t Compression