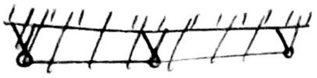
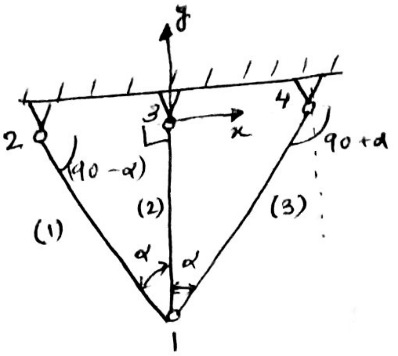
1a) (1)





Name: SAMADRITA KARMAKAR
MSc-CM
2017-19

For Element -2.

$$\cos\theta = \cos(-90) = 0$$

$$\sin\theta = \sin(-90) = -1$$

$$\begin{bmatrix} F_{1x}^{(2)} \\ F_{1y}^{(2)} \\ F_{3x}^{(2)} \\ F_{3y}^{(2)} \end{bmatrix} = \frac{EA}{L} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{3x} \\ U_{3y} \end{bmatrix}$$

which we get from general eqn,

$$\begin{bmatrix} F_{1x}^{(2)} \\ F_{1y}^{(2)} \\ F_{2x}^{(2)} \\ F_{2y}^{(2)} \end{bmatrix} = \frac{EA}{L} \begin{array}{c} \begin{array}{cccc} U_{1x} & U_{1y} & U_{2x} & U_{2y} \end{array} \\ \begin{bmatrix} c_2^2 & c_2s_2 & -c_2^2 & c_2s_2 \\ c_2s_2 & s_2^2 & -c_2s_2 & -s_2^2 \\ -c_2^2 & -c_2s_2 & c_2^2 & c_2s_2 \\ -c_2s_2 & -s_2^2 & c_2s_2 & s_2^2 \end{bmatrix} \end{array} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{bmatrix}$$

where $c_2 = \cos\theta$

$s_2 = \sin\theta$

For Element 1:

$\cancel{\cos\theta = \cos\alpha = \sin\alpha}$

$$\cos\theta = \cos(-90+\alpha) = \sin\alpha = C_1 = S$$

$$\sin\theta = \sin(-90+\alpha) = -\cos\alpha = S_1 = -C$$

$$L_1 = \frac{L}{\cos\alpha} = \frac{L}{C}$$

$$\begin{bmatrix} F_{1x}^{(1)} \\ F_{1y}^{(1)} \\ F_{2x}^{(1)} \\ F_{2y}^{(1)} \end{bmatrix} = \frac{EAC}{L} \begin{bmatrix} C_1^2 & C_1S_1 & -C_1^2 & -C_1S_1 \\ C_1S_1 & S_1^2 & -C_1S_1 & -S_1^2 \\ -C_1^2 & -C_1S_1 & C_1^2 & C_1S_1 \\ -C_1S_1 & -S_1^2 & C_1S_1 & S_1^2 \end{bmatrix} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{bmatrix}$$

$$\begin{bmatrix} F_{1x}^{(1)} \\ F_{1y}^{(1)} \\ F_{2x}^{(1)} \\ F_{2y}^{(1)} \end{bmatrix} = \frac{EA}{L} \begin{array}{c} \begin{array}{cccc} U_{1x} & U_{1y} & U_{2x} & U_{2y} \end{array} \\ \begin{bmatrix} CS^2 & -C^2S & -CS^2 & +C^2S \\ -C^2S & C^3 & C^2S & -C^3 \\ -CS^2 & C^2S & CS^2 & -C^2S \\ C^2S & -C^3 & -C^2S & C^3 \end{bmatrix} \end{array} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{bmatrix}$$

For Element 3.

$$\cos\theta = \cos(-90-\alpha) = -\sin\alpha = c_3 = -s$$

$$\sin\theta = \sin(-90-\alpha) = -\cos\alpha = s_3 = -c$$

$$L_3 = \frac{L}{\cos\alpha} \; ; \quad c_3^2 = s^2 \qquad -c_3 s_3 = -cs \; ; \; c_3 s_3 = cs \; ; \; s_3^2 = c^2 \; ;$$

$$-s_3^2 = -c^2 \; ; \; -c_3^2 = -s^2$$

$$\begin{bmatrix} F_{1x} \\ F_{1y} \\ F_{4x} \\ F_{4y} \end{bmatrix} = \frac{EAc}{L} \begin{bmatrix} c_3^2 & c_3 s_3 & -c_3^2 & -c_3 s_3 \\ c_3 s_3 & s_3^2 & -c_3 s_3 & -s_3^2 \\ -c_3^2 & -c_3 s_3 & c_3^2 & c_3 s_3 \\ -c_3 s_3 & -s_3^2 & c_3 s_3 & s_3^2 \end{bmatrix} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{4x} \\ U_{4y} \end{bmatrix}$$

$$= \frac{EA}{L} \begin{array}{c} \begin{array}{cccc} U_{1x} & U_{1y} & U_{4x} & U_{4y} \end{array} \\ \begin{bmatrix} cs^2 & c^2 s & -cs^2 & -c^2 s \\ c^2 s & c^3 & -c^2 s & -c^3 \\ -cs^2 & -c^2 s & cs^2 & c^2 s \\ -c^2 s & -c^3 & c^2 s & c^3 \end{bmatrix} \end{array} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{4x} \\ U_{4y} \end{bmatrix}$$

~~For element 4~~

On Assembly of Global Matrix, we obtain,

$$\begin{bmatrix} F_{1x} \\ F_{1y} \\ F_{2x} \\ F_{2y} \\ F_{3x} \\ F_{3y} \\ F_{4x} \\ F_{4y} \end{bmatrix} = \frac{EA}{L} \begin{array}{c} \begin{array}{cccccccc} U_{1x} & U_{1y} & U_{2x} & U_{2y} & U_{3x} & U_{3y} & U_{4x} & U_{4y} \end{array} \\ \begin{bmatrix} 2cs^2 & \cancel{c^2s - c^2s}^{\,0} & -cs^2 & +c^2s & 0 & 0 & \cancel{0}-cs^2 & -c^2s \\ \cancel{c^2s - c^2s}^{\,0} & 2c^3+1 & c^2s & -c^3 & 0 & -1 & -c^2s & -c^3 \\ -cs^2 & c^2s & cs^2 & -c^2s & 0 & 0 & 0 & 0 \\ c^2s & -c^3 & -c^2s & c^3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 1 & 0 & 0 \\ -cs^2 & -c^2s & 0 & 0 & 0 & 0 & cs^2 & c^2s \\ -c^2s & -c^3 & 0 & 0 & 0 & 0 & c^2s & c^3 \end{bmatrix} \end{array} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \\ U_{3x} \\ U_{3y} \\ U_{4x} \\ U_{4y} \end{bmatrix}$$

Only element one (1) can contribute to Forces on node '3' in the x-direction. Since it is assumed that the joints acts as ~~higer~~ hinges, any force acting on element one (1) will not contribute to forces in the x-direction of node 3. This is due to its perpendicular configuration to the x-axis. Hence the row 5 is zero (0). It is also due to the same configuration that displacement if any, of node '3' in x-direction will not contribute to forces on the other nodes. Hence the column 5 is zero.

(b) Appling boundary condition, we get,

$$\frac{EA}{L}\begin{bmatrix} 2cs^2 & 0 & -cs^2 & c^2s & 0 & 0 & -cs^2 & -c^2s \\ & 2c^3+1 & c^2s & -c^3 & 0 & -1 & -c^2s & -c^3 \\ & & cs^2 & -c^2s & 0 & 0 & 0 & 0 \\ & & & c^3 & 0 & 0 & 0 & 0 \\ & & & & 0 & 0 & 0 & 0 \\ & \text{Sym} & & & & 1 & 0 & 0 \\ & & & & & & cs^2 & c^2s \\ & & & & & & & c^3 \end{bmatrix}\begin{bmatrix} U_{1x} \\ U_{1y} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} H \\ -P \\ F_{2x} \\ F_{2y} \\ F_{3x} \\ F_{3y} \\ F_{4x} \\ F_{4y} \end{bmatrix}$$

The two equations are

$$\begin{bmatrix} -H \\ P \end{bmatrix} = \frac{EA}{L}\begin{bmatrix} 2cs^2 & 0 \\ 0 & 1+2c^3 \end{bmatrix}\begin{bmatrix} U_{1x} \\ U_{1y} \end{bmatrix}$$

c) $$\frac{L}{EA}\begin{bmatrix} 2cs^2 & 0 \\ 0 & 1+2c^3 \end{bmatrix}^{-1}\begin{bmatrix} H \\ -P \end{bmatrix} = \begin{bmatrix} U_{1x} \\ U_{1y} \end{bmatrix}$$

~~For $\alpha = 0$,~~

$\cancel{U_{1x}} \Rightarrow \dfrac{L}{EA(2cs^2)(1+2c^3)}\begin{bmatrix} 1+2c^3 & 0 \\ 0 & 2cs^2 \end{bmatrix}\begin{bmatrix} H \\ -P \end{bmatrix}$

For $\alpha \to 0$,

$$u_{1x} = \lim_{\alpha \to 0} \frac{LH}{EA\, 2cs^2}$$

$\therefore$ we have, $U_{1x} \to \infty$

$$\& \quad U_{1y} = \lim_{\alpha \to 0} \frac{-LP}{EA(1+2c^3)}$$

$$U_{1y} = -\frac{LP}{EA(1+2\cancel{c}^3)} \Rightarrow \frac{-LP}{3EA} = U_{1y}$$

For $\alpha \to \frac{\pi}{2}$ ~~let distance for node = l~~

$$U_{1x} = \lim_{\alpha \to \frac{\pi}{2}} \frac{LH}{EA(2cs^2)}$$

$$= \lim_{\alpha \to \frac{\pi}{2}} \frac{LH}{EA \sin 2\alpha \sin\alpha}$$

$\therefore$ $U_{1x} \to \infty$ as $\alpha \to \frac{\pi}{2}$

$$U_{1y} = \lim_{\alpha \to \frac{\pi}{2}} \frac{-LP}{EA(1+2\cancel{c}^3)}$$

$$= -\frac{LP}{EA}.$$

U_{1x} 'blows up' as $\alpha \to 0$ & if $H \neq 0$ because ~~as~~ the element (1) & (3) merge with (2) to form a pendulum like system which can rotate about the node '3'. ~~at~~

(d) For axial forces we use the following equation,

$$[f_\ell] = [K_L][T][u_g]$$

$[f_L] \rightarrow$ local forces

$[u_g] \rightarrow$ global displacement.

$[K_L] \rightarrow$ local Stiffness Matrix.

<u>For element. 1.</u>

$$\begin{pmatrix} f_{1x}^{(1)} \\ f_{1y}^{(1)} \\ f_{2x}^{(1)} \\ f_{2y}^{(1)} \end{pmatrix} = [K_L] \begin{pmatrix} c_1 & s_1 & 0 & 0 \\ -s_1 & c_1 & 0 & 0 \\ 0 & 0 & c_1 & s_1 \\ 0 & 0 & -s_1 & c_1 \end{pmatrix} \begin{pmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{pmatrix}$$

$$\Rightarrow \begin{pmatrix} f_{1x}^{(1)} \\ f_{1y}^{(1)} \\ f_{2x}^{(1)} \\ f_{2y}^{(1)} \end{pmatrix} = \frac{EAc}{L} \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} s & -c & 0 & 0 \\ c & s & 0 & 0 \\ 0 & 0 & s & -c \\ 0 & 0 & c & s \end{bmatrix} \begin{bmatrix} \frac{LH}{2EAcs^2} \\ \frac{-LP}{EA(1+2c^3)} \\ 0 \\ 0 \end{bmatrix}$$

$$= \frac{EA}{\cancel{L}} \begin{bmatrix} s & -c & -s & c \\ 0 & 0 & 0 & 0 \\ -s & c & s & -c \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \frac{\cancel{L}H}{2EAcs^2} \\ \frac{-\cancel{L}P}{EA(1+2c^3)} \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{pmatrix} f_{1x}^{(1)} \\ f_{1y}^{(1)} \\ f_{2x}^{(1)} \\ f_{2y}^{(1)} \end{pmatrix} = \begin{pmatrix} \dfrac{H}{2cs} + \dfrac{Pc^2}{1+2c^3} \\ 0 \\ \dfrac{-H}{2s} - \dfrac{Pc^2}{1+2c^3} \\ 0 \end{pmatrix}$$

<u>Element 2</u>

$$\begin{pmatrix} f_{1x}^{(2)} \\ f_{1y}^{(2)} \\ f_{3x}^{(2)} \\ f_{3y}^{(2)} \end{pmatrix} = \cancel{\frac{EA}{L}} \begin{pmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & -1 & 0 \end{pmatrix} \begin{pmatrix} \dfrac{\cancel{L}H}{2cs^2 \times \cancel{EA}} \\ \dfrac{-P\cancel{L}}{(1+2c^3)\times \cancel{EA}} \\ 0 \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} f_{1x}^{(2)} \\ f_{1y}^{(2)} \\ f_{3x}^{(2)} \\ f_{3y}^{(2)} \end{pmatrix} = \begin{pmatrix} \dfrac{-P}{1+2c^3} \\ 0 \\ \dfrac{P}{1+2c^3} \\ 0 \end{pmatrix}$$

Element 3

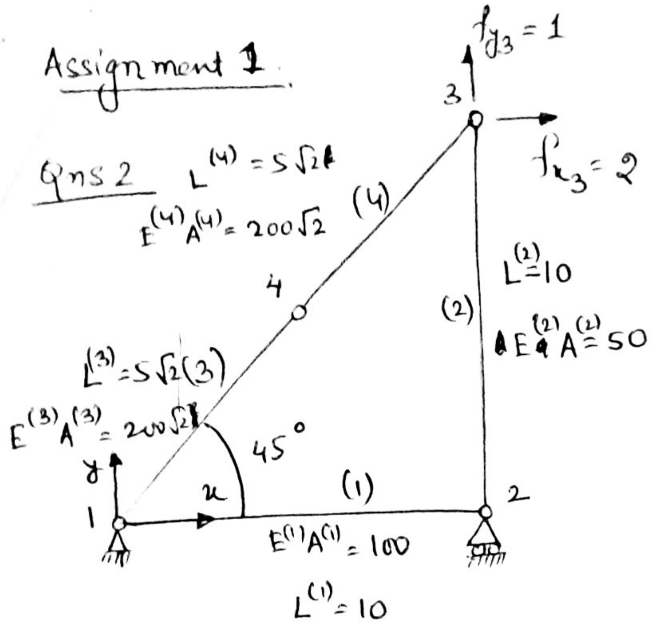
$$\begin{Bmatrix} f_{1x}^{(3)} \\ f_{1y}^{(3)} \\ f_{4x}^{(3)} \\ f_{4y}^{(3)} \end{Bmatrix} = \frac{EA_c}{L} \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} c_3 & s_3 & 0 & 0 \\ -s_3 & c_3 & 0 & 0 \\ 0 & 0 & c_3 & s_3 \\ 0 & 0 & -s_3 & c_3 \end{bmatrix} \begin{bmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{bmatrix}$$

$$= \begin{bmatrix} -s & -c & s & c \\ 0 & 0 & 0 & 0 \\ s & c & -s & -c \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \frac{Hc}{2cs^2} \\ \frac{Pc}{1+2c^3} \\ 0 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} -\frac{H}{2s} - \frac{Pc^2}{1+2c^3} \\ 0 \\ \frac{H}{2s} + \frac{Pc^2}{1+2c^3} \\ 0 \end{bmatrix}$$

(d) $f^{(1)}$ & $f^{(3)}$ "blow up" if $H \neq 0$ and $\alpha \to 0$ because ~~where~~ when $\alpha \to 0$ the structure does not resist the ~~prope~~ force in x-direction, but starts rotating ~~tine~~ about the node '3'

Assignment 1.



For element 1

$\theta = 0°$; $\cos\theta = 1$; $\sin\theta = 0$

$$\begin{pmatrix} f_{1x}^{(1)} \\ f_{1y}^{(1)} \\ f_{2x}^{(1)} \\ f_{2y}^{(1)} \end{pmatrix} = \frac{10\cancel{0}}{1\cancel{0}} \begin{pmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{pmatrix}$$

~~For element~~ 2.

$$\Rightarrow \begin{pmatrix} f_{1x}^{(1)} \\ f_{1y}^{(1)} \\ f_{2x}^{(1)} \\ f_{2y}^{(1)} \end{pmatrix} = \begin{array}{c} \begin{array}{cccc} U_{1x} & U_{1y} & U_{2x} & U_{2y} \end{array} \\ \begin{pmatrix} 10 & 0 & -10 & 0 \\ 0 & 0 & 0 & 0 \\ -10 & 0 & 10 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \end{array} \begin{pmatrix} U_{1x} \\ U_{1y} \\ U_{2x} \\ U_{2y} \end{pmatrix}$$

For element 2

~~$\cos$~~ $\theta = 90°$

$\cos\theta = 0$

$\sin\theta = 1$.

$$\begin{pmatrix} f_{2x} \\ f_{2y} \\ f_{3x} \\ f_{3y} \end{pmatrix} = \frac{5\cancel{0}}{1\cancel{0}} \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \end{pmatrix} \begin{pmatrix} U_{2x} \\ U_{2y} \\ U_{3x} \\ U_{3y} \end{pmatrix}$$

$$\Rightarrow \begin{pmatrix} f_{2x} \\ f_{2y} \\ f_{3x} \\ f_{3y} \end{pmatrix} = \begin{array}{c} \begin{array}{cccc} U_{2x} & U_{2y} & U_{3x} & U_{3y} \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 5 & 0 & -5 \\ 0 & 0 & 0 & 0 \\ 0 & -5 & 0 & 5 \end{pmatrix} \end{array} \begin{pmatrix} U_{2x} \\ U_{2y} \\ U_{3x} \\ U_{3y} \end{pmatrix}$$

For element 3. $\theta = 45^\circ$; $\cos\theta = \frac{1}{\sqrt{2}}$; $\sin\theta = \frac{1}{\sqrt{2}}$

$$\begin{Bmatrix} f_{1x} \\ f_{1y} \\ f_{4x} \\ f_{4y} \end{Bmatrix} = \frac{\overset{40}{\cancel{200}}\,\cancel{\sqrt{2}}}{\cancel{5}\,\cancel{\sqrt{2}}} \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & -\frac{1}{2} \\ -\frac{1}{2} & -\frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ -\frac{1}{2} & -\frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{Bmatrix} U_{1x} \\ U_{1y} \\ U_{4x} \\ U_{4y} \end{Bmatrix} \Rightarrow \begin{Bmatrix} f_{1x} \\ f_{1y} \\ f_{4x} \\ f_{4y} \end{Bmatrix} = \begin{array}{c} \begin{array}{cccc} U_{1x} & U_{1y} & U_{4x} & U_{4y} \end{array} \\ \begin{bmatrix} 20 & 20 & -20 & -20 \\ 20 & 20 & -20 & -20 \\ -20 & -20 & 20 & 20 \\ -20 & -20 & 20 & 20 \end{bmatrix} \end{array} \begin{Bmatrix} U_{1x} \\ U_{1y} \\ U_{4x} \\ U_{4y} \end{Bmatrix}$$

For element 4.

$$\begin{Bmatrix} f_{4x} \\ f_{4y} \\ f_{3x} \\ f_{3y} \end{Bmatrix} = \frac{\overset{40}{\cancel{200}}\,\cancel{\sqrt{2}}}{\cancel{5}\,\cancel{\sqrt{2}}} \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & -\frac{1}{2} \\ -\frac{1}{2} & -\frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ -\frac{1}{2} & -\frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{Bmatrix} U_{4x} \\ U_{4y} \\ U_{3x} \\ U_{3y} \end{Bmatrix} \Rightarrow \begin{Bmatrix} f_{4x} \\ f_{4y} \\ f_{3x} \\ f_{3y} \end{Bmatrix} = \begin{array}{c} \begin{array}{cccc} U_{4x} & U_{4y} & U_{3x} & U_{3y} \end{array} \\ \begin{bmatrix} 20 & 20 & -20 & -20 \\ 20 & 20 & -20 & -20 \\ -20 & -20 & 20 & 20 \\ -20 & -20 & 20 & 20 \end{bmatrix} \end{array} \begin{Bmatrix} U_{4x} \\ U_{4y} \\ U_{3x} \\ U_{3y} \end{Bmatrix}$$

Global Matrix

$$\begin{array}{r} \\ \\ \\ 0 \leftarrow \\ \\ 2 \leftarrow \\ 1 \leftarrow \\ 0 \leftarrow \\ 0 \leftarrow \end{array} \begin{Bmatrix} F_{1x} \\ F_{1y} \\ F_{2x} \\ F_{2y} \\ F_{3x} \\ F_{3y} \\ F_{4x} \\ F_{4y} \end{Bmatrix} = \begin{array}{c} \begin{array}{cccccccc} U_{1x} & U_{1y} & U_{2x} & U_{2y} & U_{3x} & U_{3y} & U_{4x} & U_{4y} \end{array} \\ \begin{bmatrix} 10+20 & 0+20 & -10 & 0 & 0 & 0 & -20 & -20 \\ 0+20 & 0+20 & 0 & 0 & 0 & 0 & -20 & -20 \\ -10 & 0 & 10 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0+ & 0+5 & 0 & -5 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cancel{-20}\,20 & 20 & -20 & -20 \\ 0 & 0 & 0 & -5 & 20 & 5+20 & -20 & -20 \\ -20\,\cancel{+20} & -20 & 0 & 0 & -20 & -20 & 20+20 & 20+20 \\ -20 & -20 & 0 & 0 & -20 & -20 & 20+20 & 20+20 \end{bmatrix} \end{array} \begin{Bmatrix} U_{1x} \to 0 \\ U_{1y} \to 0 \\ U_{2x} \\ U_{2y} \to 0 \\ U_{3x} \\ U_{3y} \\ U_{4x} \\ U_{4y} \end{Bmatrix}$$

$$\begin{pmatrix} 10 & 0 & 0 \\ 0 & 20 & 20 \\ 0 & 20 & 25 \end{pmatrix}$$

$$\begin{pmatrix} F_{2x}=0 \\ F_{3x}=2 \\ F_{3y}=1 \\ F_{4x}=0 \\ F_{4y}=0 \end{pmatrix} = \begin{pmatrix} 10 & 0 & 0 & 0 & 0 \\ 0 & 20 & 20 & -20 & -20 \\ 0 & 20 & 25 & -20 & -20 \\ 0 & -20 & -20 & 40 & 40 \\ 0 & -20 & -20 & 40 & 40 \end{pmatrix} \begin{pmatrix} U_{2x} \\ U_{3x} \\ U_{3y} \\ U_{4x} \\ U_{4y} \end{pmatrix}$$

Since the last two rows are same, the rank of the matrix is ~~sing~~ 4. So the matrix is singular.

One of the basic assumption of truss system is that truss has to be composed of $m = 3 + 2(j-3)$ members, when m = number of members & j = number of joint

So for 4 joint the number of members should be 5 where as in reality it is 4. So the structure has a tendency to rotate about node 4 which makes the solution ~~unstable~~ "blow up".