

-----1

1

$$\text{solve} \left( \begin{cases} -va+vb=0 \\ -ha-hb+p=0 \\ -va \cdot l + p \cdot h=0 \\ -p \cdot f - \frac{va \cdot l}{2} + ha \cdot (f+h)=0 \end{cases}, va, vb, ha, hb \right)$$

$$va = \frac{h \cdot p}{l} \text{ and } ha = \frac{(2 \cdot f + h) \cdot p}{2 \cdot (f + h)} \text{ and } hb = \frac{h \cdot p}{2 \cdot (f + h)} \text{ and } vb = \frac{h \cdot p}{l}$$

-----2.1

2.1

$$-p \cdot \cos(\theta) + ha \cdot \cos(\theta) + va \cdot \sin(\theta) | va = \frac{h \cdot p}{l} \text{ and } ha = \frac{(2 \cdot f + h) \cdot p}{2 \cdot (f + h)} \text{ and } hb = \frac{h \cdot p}{2 \cdot (f + h)} \text{ and } vb = \frac{h \cdot p}{l}$$



$$\frac{h \cdot p \cdot \sin(\theta)}{l} - \frac{h \cdot p \cdot \cos(\theta)}{2 \cdot (f + h)}$$

-----2.2

2.2

$$-p \cdot \sin(\theta) + ha \cdot \sin(\theta) - va \cdot \cos(\theta) | va = \frac{h \cdot p}{l} \text{ and } ha = \frac{(2 \cdot f + h) \cdot p}{2 \cdot (f + h)} \text{ and } hb = \frac{h \cdot p}{2 \cdot (f + h)} \text{ and } vb = \frac{h \cdot p}{l}$$



$$\frac{-h \cdot p \cdot \sin(\theta)}{2 \cdot (f + h)} - \frac{h \cdot p \cdot \cos(\theta)}{l}$$

-----2.3

2.3

$$-p \cdot s \cdot \sin(\theta) + ha \cdot (h + s \cdot \sin(\theta)) + va \cdot s \cdot \cos(\theta) \Big|_{va = \frac{h \cdot p}{l} \text{ and } ha = \frac{(2 \cdot f + h) \cdot p}{2 \cdot (f + h)} \text{ and } hb = \frac{h \cdot p}{2 \cdot (f + h)} \text{ and } vb = \frac{h \cdot p}{l}}$$

$$\frac{h \cdot p \cdot ((2 \cdot f \cos(\theta) + 2 \cdot h \cos(\theta) - l \sin(\theta)) \cdot s + (2 \cdot f + h) \cdot l)}{2 \cdot (f + h) \cdot l}$$

$$\frac{h \cdot p \cdot ((2 \cdot f \cos(\theta) + 2 \cdot h \cos(\theta) - l \sin(\theta)) \cdot s + (2 \cdot f + h) \cdot l)}{2 \cdot (f + h) \cdot l} \Big|_{s=0} \quad \frac{(2 \cdot f + h) \cdot h \cdot p}{2 \cdot (f + h)}$$

□

-----em

-em

$$r \cdot x \rightarrow m1$$

$$r \cdot x$$

$$r \cdot l - p \cdot x \rightarrow m2$$

$$l \cdot r - p \cdot x$$

$$\int_0^l \frac{m1^2 + m2^2}{2 \cdot ei} dx \rightarrow u$$

$$\frac{l^3 \cdot (4 \cdot r^2 - 3 \cdot p \cdot r + p^2)}{6 \cdot ei}$$

$$\triangle \text{ solve } \left( \frac{d}{dr}(u) = 0, r \right)$$

$$r = \frac{3 \cdot p}{8} \text{ or } l = 0$$

$$\triangle \frac{d}{dp}(u) \Big|_{r = \frac{3 \cdot p}{8}}$$

$$\frac{7 \cdot p \cdot l^3}{48 \cdot ei}$$

-----sm

-sm

$$\begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ \frac{-1}{l} & \frac{-1}{l} & 0 & 0 \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ \frac{-1}{l} & \frac{-1}{l} & 0 & 0 \end{bmatrix}$$

$$\frac{ei}{l} \cdot \begin{bmatrix} 4 & 2 & 0 & 0 \\ 2 & 4 & 0 & 0 \\ 0 & 0 & 4 & 2 \\ 0 & 0 & 2 & 4 \end{bmatrix} \rightarrow s$$



$$\begin{bmatrix} \frac{4 \cdot ei}{l} & \frac{2 \cdot ei}{l} & 0 & 0 \\ \frac{2 \cdot ei}{l} & \frac{4 \cdot ei}{l} & 0 & 0 \\ 0 & 0 & \frac{4 \cdot ei}{l} & \frac{2 \cdot ei}{l} \\ 0 & 0 & \frac{2 \cdot ei}{l} & \frac{4 \cdot ei}{l} \end{bmatrix}$$

$$(a \cdot s \cdot a^T)^{-1} \cdot [0 \ 0 \ p]^T \rightarrow d$$



$$\begin{bmatrix} \frac{l^2 \cdot p}{8 \cdot ei} \\ \frac{-l^2 \cdot p}{16 \cdot ei} \\ \frac{7 \cdot l^3 \cdot p}{48 \cdot ei} \end{bmatrix}$$

$$s \cdot a^T \cdot (a \cdot s \cdot a^T)^{-1} \cdot [0 \ 0 \ p]^T \rightarrow q$$



$$\begin{bmatrix} \frac{-5 \cdot l \cdot p}{8} \\ \frac{-3 \cdot l \cdot p}{8} \\ \frac{3 \cdot l \cdot p}{8} \\ 8 \\ 0 \end{bmatrix}$$



PE.A-89-2-1

-----1 -1

$$\text{solve} \left( \begin{cases} -ha+hd=0 \\ va+vd-10 \cdot 10000=0 \\ -10000 \cdot vd + \frac{10 \cdot 10000^2}{2}=0 \end{cases}, \{hd, va, vd\} \right) \quad hd=ha \text{ and } va=50000 \text{ and } vd=50000$$

-----2 -2

$$-ha \cdot x \rightarrow m1 \quad -ha \cdot x$$

$$ha \cdot 4000 + va \cdot x - \frac{10 \cdot x^2}{2} | va=50000 \rightarrow m2 \quad -5 \cdot x^2 + 50000 \cdot x + 4000 \cdot ha$$

$$-hd \cdot x | hd=ha \rightarrow m3 \quad -ha \cdot x$$

-----3 -3

$$74^2 \cdot 3900 \rightarrow ic \quad 2.13564E7$$

$$240^2 \cdot 13400 \rightarrow ib \quad 7.7184E8$$

$$\int_0^{4000} \frac{m1^2+m3^2}{2 \cdot e \cdot ic} dx + \int_0^{10000} \frac{m2^2}{2 \cdot e \cdot ib} dx \rightarrow u1$$

$$\frac{1102.57 \cdot ha^2 + 4.31868E6 \cdot ha + 5.39836E10}{e}$$

$$u1 + 2 \cdot \frac{50000^2 \cdot 4000}{2 \cdot e \cdot 3900} + \frac{ha^2 \cdot 10000}{2 \cdot e \cdot 13400} \rightarrow u2$$

$$\frac{1102.94 \cdot ha^2 + 4.31868E6 \cdot ha + 5.65477E10}{e}$$

$$u2 + 2 \cdot 2 \cdot \int_0^{4000} \frac{ha^2}{2 \cdot g \cdot 3900} dx + \frac{13400}{600 \cdot 11} \cdot \int_0^{10000} \frac{(50000 - 10 \cdot x)^2}{2 \cdot g \cdot 13400} dx \Big|_g = \frac{e}{2 \cdot (1+0.3)} \rightarrow u3$$

$$\frac{1108.27 \cdot ha^2 + 4.31868E6 \cdot ha + 5.81891E10}{e}$$

-----4

-4

⚠ solve  $\left( \frac{d}{dha}(u1) = 0, ha \right)$

$$ha = -1958.47$$

⚠ solve  $\left( \frac{d}{dha}(u2) = 0, ha \right)$

$$ha = -1957.8$$

$$\triangle \text{ solve}\left(\frac{d}{dha}(u3)=0, ha\right)$$

$$ha=-1948.38$$

$$m1|x=4000 \text{ and } ha=-1958.4656070683$$

$$7.83386\text{E}6$$

$$m1|x=4000 \text{ and } ha=-1957.8030417696$$

$$7.83121\text{E}6$$

$$m1|x=4000 \text{ and } ha=-1948.3815371679$$

$$7.79353\text{E}6$$

[]



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-1

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{1}{h} & \frac{1}{h} & \frac{1}{h} & \frac{1}{h} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{1}{h} & \frac{1}{h} & \frac{1}{h} & \frac{1}{h} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} & \frac{-1}{h} \end{bmatrix}$$

-----2

-2

$$\begin{bmatrix} 4 & 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 2 & 4 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 16 & 8 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix}
 0 & 0 & 8 & 16 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 16 & 8 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 8 & 16 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 4 & 2 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 2 & 4 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 16 & 8 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 8 & 16 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 16 & 8 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 8 & 16
 \end{bmatrix} \cdot ei$$

$\rightarrow s$

$$\begin{bmatrix}
 \frac{4 \cdot ei}{h} & \frac{2 \cdot ei}{h} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 \frac{2 \cdot ei}{h} & \frac{4 \cdot ei}{h} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & \frac{16 \cdot ei}{h} & \frac{8 \cdot ei}{h} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & \frac{8 \cdot ei}{h} & \frac{16 \cdot ei}{h} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & \frac{16 \cdot ei}{h} & \frac{8 \cdot ei}{h} & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & \frac{8 \cdot ei}{h} & \frac{16 \cdot ei}{h} & 0 & 0 & 0 & 0 & 0 & 0
 \end{bmatrix}$$



$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & \frac{4 \cdot ei}{h} & \frac{2 \cdot ei}{h} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \frac{2 \cdot ei}{h} & \frac{4 \cdot ei}{h} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{16 \cdot ei}{h} & \frac{8 \cdot ei}{h} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{8 \cdot ei}{h} & \frac{16 \cdot ei}{h} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{16 \cdot ei}{h} & \frac{8 \cdot ei}{h} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{8 \cdot ei}{h} & \frac{16 \cdot ei}{h} \end{bmatrix}$$

-----3

-3

$$(a \cdot s \cdot a^T)^{-1} \cdot \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 100000 \end{bmatrix} |_{ei=2 \cdot 10^5 \cdot 10^8 \text{ and } p=100000 \text{ and } h=5000 \rightarrow d}$$

$$\begin{bmatrix} 0.00625 \\ 0.00625 \\ 0.00625 \\ 0.00625 \\ 20.8333 \\ 27.3437 \end{bmatrix}$$

$d[6,1]$

27.3437

-----4

-4

$$s \cdot a^T \cdot (a \cdot s \cdot a^T)^{-1} \cdot \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 100000 \end{bmatrix} \cdot 10^{-6} |_{ei=2 \cdot 10^5 \cdot 10^8 \text{ and } p=100000 \text{ and } h=5000 \rightarrow q} \begin{bmatrix} -1.E-12 \\ -50. \\ 0. \\ -200. \\ 0. \\ -200. \\ -1.E-12 \\ -50. \\ -125. \\ -125. \\ -125. \\ -125. \end{bmatrix}$$

$$\frac{q[1,1]+q[2,1]}{5} \quad -10.$$

$$\frac{q[3,1]+q[4,1]}{5} \quad -40.$$

[]

-----1

1

$$\frac{3 \cdot ei}{h^3} \rightarrow kab$$

$$\frac{3 \cdot ei}{h^3}$$

$$\frac{3 \cdot 4 \cdot ei}{h^3} \rightarrow kcd$$

$$\frac{12 \cdot ei}{h^3}$$

$$\frac{12 \cdot 4 \cdot ei}{h^3} \rightarrow kde$$

$$\frac{48 \cdot ei}{h^3}$$

$$\left( \frac{1}{kab+kcd} + \frac{1}{kde} \right)^{-1} | ei=200000 \cdot 10^8 \text{ and } h=5000 \rightarrow keq$$

$$\frac{12800}{7}$$

-----2

2

$$\frac{\frac{100}{2}}{keq}$$

$$0.027344$$

$$\frac{10}{500}$$

$$0.02$$

-----3

3

$$\frac{\frac{100}{2}}{kab+kcd} | ei=200000 \cdot 10^8 \text{ and } h=5000$$

0.02083333

$$kab \cdot 0.0208333333333333 | ei=200000 \cdot 10^8 \text{ and } h=5000$$

10.

$$kcd \cdot 0.0208333333333333 | ei=200000 \cdot 10^8 \text{ and } h=5000$$

40.

[]

-----1

1

$$\text{solve}\left(\begin{cases} -4\cdot h-3\cdot v+q1+q2=0 \\ -v+\frac{q3+q4}{6}=0 \\ p3+h+\frac{q5+q6}{4}=0 \end{cases},\{v,h,p3\}\right)$$

$$v=\frac{q3+q4}{6} \text{ and } h=\frac{2\cdot q1+2\cdot q2-q3-q4}{8} \text{ and } p3=\frac{-(2\cdot q1+2\cdot q2-q3-q4+2\cdot (q5+q6))}{8}$$

$$\text{expand}\left(\frac{-(2\cdot q1+2\cdot q2-q3-q4+2\cdot (q5+q6))}{8}\right)$$

$$\frac{-q1}{4}-\frac{q2}{4}+\frac{q3}{8}+\frac{q4}{8}-\frac{q5}{4}-\frac{q6}{4}$$

-----2

2

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ \frac{-1}{4} & \frac{-1}{4} & \frac{1}{8} & \frac{1}{8} & \frac{-1}{4} & \frac{-1}{4} \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ \frac{-1}{4} & \frac{-1}{4} & \frac{1}{8} & \frac{1}{8} & \frac{-1}{4} & \frac{-1}{4} \end{bmatrix}$$

-----3

3

$$\begin{bmatrix} 4 & 2 & 0 & 0 & 0 & 0 \\ 2 & 4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & 2 & 0 & 0 \\ 0 & 0 & 2 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4 & 2 \\ 0 & 0 & 0 & 0 & 2 & 4 \end{bmatrix} \cdot 10^5 \rightarrow s$$

$$\begin{bmatrix} 400000 & 200000 & 0 & 0 & 0 & 0 \\ 200000 & 400000 & 0 & 0 & 0 & 0 \\ 0 & 0 & 400000 & 200000 & 0 & 0 \\ 0 & 0 & 200000 & 400000 & 0 & 0 \\ 0 & 0 & 0 & 0 & 400000 & 200000 \\ 0 & 0 & 0 & 0 & 200000 & 400000 \end{bmatrix}$$

-----4

4

$$(a \cdot s \cdot a^T)^{-1} \cdot \begin{bmatrix} 0 \\ 0 \\ 100 \end{bmatrix} \rightarrow d$$

$$\begin{bmatrix} 0.000048 \\ 0.000048 \\ 0.000635 \end{bmatrix}$$

-----5

5

$$s \cdot a^T \cdot (a \cdot s \cdot a^T)^{-1} \cdot \begin{bmatrix} 0 \\ 0 \\ 100 \end{bmatrix} \rightarrow q$$

$$\begin{bmatrix} -85.7143 \\ -76.1905 \\ 76.1905 \\ 76.1905 \\ -76.1905 \\ -85.7143 \end{bmatrix}$$

[]



-----1

-1

-----2

-2

$$2 \cdot 10^5 \cdot (b - 3 \cdot r1) \rightarrow m1$$

$$200000 \cdot (b - 3 \cdot r1)$$

$$2 \cdot 10^5 \cdot (2 \cdot b - 3 \cdot r1) \rightarrow m2$$

$$200000 \cdot (2 \cdot b - 3 \cdot r1)$$

$$2 \cdot 10^5 \cdot \left( 2 \cdot b + c + \frac{3 \cdot r1}{2} \right) \rightarrow m3$$

$$100000 \cdot (4 \cdot b + 2 \cdot c + 3 \cdot r1)$$

$$2 \cdot 10^5 \cdot \left( b + 2 \cdot c + \frac{3 \cdot r1}{2} \right) \rightarrow m4$$

$$100000 \cdot (2 \cdot b + 4 \cdot c + 3 \cdot r1)$$

$$2 \cdot 10^5 \cdot (2 \cdot c - 3 \cdot r1) \rightarrow m5$$

$$200000 \cdot (2 \cdot c - 3 \cdot r1)$$

$$2 \cdot 10^5 \cdot (c - 3 \cdot r1) \rightarrow m6$$

$$200000 \cdot (c - 3 \cdot r1)$$

-----3

-3

$$\text{solve} \left( \begin{cases} m2+m3=0 \\ m4+m5=0 \\ 100 \cdot 8+15 \cdot ha+12 \cdot hd-m1-m6=0 \\ ha=\frac{m1+m2}{5} \\ hd=\frac{m5+m6}{4} \end{cases}, \{b,c,r1\} \right)$$

$b=0.000048$  and  $c=0.000048$  and  $ha=-32.381$  and  $hd=-40.4762$  and  $r1=0.000159$

-----4

-4

$4 \cdot r1|r1=1.59E-4$

0.000636

-----5

-5

$\{m1,m2,m3,m4,m5,m6\}|b=4.7619047619048E-5$  and  $c=4.7619047619048E-5$  and  $r1=1.5873015873016E-4$

$\{-85.7143,-76.1905,76.1905,76.1905,-76.1905,-85.7143\}$

[]

PE.C-89-3-3

-----1

-1

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ \frac{-1}{6} & \frac{-1}{6} & 0 & 0 & \frac{-1}{8} & \frac{-1}{8} \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ \frac{-1}{6} & \frac{-1}{6} & 0 & 0 & \frac{-1}{8} & \frac{-1}{8} \end{bmatrix}$$

$$2 \cdot 10^{-3} \rightarrow k$$

$$\frac{1}{500}$$

$$2 \cdot 10^8 \rightarrow e$$

$$200000000$$

$$e \cdot k \cdot \begin{bmatrix} 4 & 2 & 0 & 0 & 0 & 0 \\ 2 & 4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & 2 & 0 & 0 \\ 0 & 0 & 2 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4 & 2 \\ 0 & 0 & 0 & 0 & 2 & 4 \end{bmatrix} \rightarrow s$$

$$\begin{bmatrix} 1600000 & 800000 & 0 & 0 & 0 & 0 \\ 800000 & 1600000 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1600000 & 800000 & 0 & 0 \\ 0 & 0 & 800000 & 1600000 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1600000 & 800000 \\ 0 & 0 & 0 & 0 & 800000 & 1600000 \end{bmatrix}$$

-----2

-2

$$6 \cdot k \rightarrow i1$$

$$\frac{3}{250}$$

$$10 \cdot k \rightarrow i2$$

$$\frac{1}{50}$$

$$50$$

$$8 \cdot k \rightarrow i3$$

$$\frac{2}{125}$$

$$125$$

$$\frac{1 \cdot 10^{-5} \cdot 30}{h} \cdot e \cdot [i1 \quad -i1 \quad i2 \quad -i2 \quad i3 \quad -i3]^T \rightarrow fem$$

$$\begin{bmatrix} \frac{720}{h} \\ -\frac{720}{h} \\ \frac{1200}{h} \\ -\frac{1200}{h} \\ \frac{960}{h} \\ -\frac{960}{h} \end{bmatrix}$$

$$-a \cdot fem$$



$$\begin{bmatrix} \frac{-480}{h} \\ 240 \\ h \\ 0 \end{bmatrix}$$

$$-a \cdot fem \rightarrow p$$



$$\begin{bmatrix} \frac{-480}{h} \\ 240 \\ h \\ 0 \end{bmatrix}$$

$$-----3$$

$$-3$$

$$s \cdot a^{\mathsf{T}} \cdot (a \cdot s \cdot a^{\mathsf{T}})^{-1} \cdot p + fem$$

$$\begin{bmatrix} \frac{653.793}{h} \\ -951.724 \\ \frac{951.724}{h} \\ -1200. \\ \frac{1200.}{h} \\ -802.759 \\ h \end{bmatrix}$$

□

$$\text{-----}1 \qquad 1$$

$$\frac{-20 \cdot 4 \cdot 4^2}{8^2} \rightarrow femab \qquad -20$$

$$\frac{--20 \cdot 4 \cdot 4^2}{8^2} \rightarrow femba \qquad 20$$

$$\text{-----}2 \qquad -2$$

$$2 \cdot ek \cdot \left( b - \frac{3}{8} \cdot \delta \right) - 20 \rightarrow mab \qquad 2 \cdot b \cdot ek - \frac{3 \cdot ek \cdot \delta}{4} - 20$$

$$2 \cdot ek \cdot \left( 2 \cdot b - \frac{3}{8} \cdot \delta \right) + 20 \rightarrow mba \qquad 4 \cdot b \cdot ek - \frac{3 \cdot ek \cdot \delta}{4} + 20$$

$$2 \cdot ek \cdot (2 \cdot b + c) \rightarrow mbc \qquad 2 \cdot (2 \cdot b + c) \cdot ek$$

$$2 \cdot ek \cdot (b + 2 \cdot c) \rightarrow mcb \qquad 2 \cdot (b + 2 \cdot c) \cdot ek$$


$$2 \cdot ek \cdot \left( 2 \cdot c - \frac{3}{4} \cdot \delta \right) \rightarrow mcd \qquad \frac{(8 \cdot c - 3 \cdot \delta) \cdot ek}{2}$$

$$2 \cdot ek \cdot \left( c - \frac{3}{4} \cdot \delta \right) \rightarrow mdc \quad \frac{(4 \cdot c - 3 \cdot \delta) \cdot ek}{2}$$

-----3 -3

$$\text{solve} \left( \begin{cases} mba + mbc = 0 \\ mcb + mcd = 0 \\ ha + hd + 30 = 0 \end{cases}, \{b, c, \delta\} \right) \left| \begin{aligned} ha &= \frac{mab + mba - 20 \cdot 4}{8} \text{ and } hd = \frac{mcd + mdc}{4} \end{aligned} \right. \quad b = \frac{-20}{17 \cdot ek} \text{ and } c = \frac{100}{17 \cdot ek} \text{ and } \delta = \frac{1520}{51 \cdot ek}$$

-----4 -4

  $\{mab, mba, mbc, mcb, mcd, mdc\} \left| \begin{aligned} b &= \frac{-20}{17 \cdot ek} \text{ and } c = \frac{100}{17 \cdot ek} \text{ and } \delta = \frac{1520}{51 \cdot ek} \\ &\{-44.7059, -7.05882, 7.05882, 21.1765, -21.1765, -32.9412\} \end{aligned} \right.$

$$ha = \frac{mab + mba - 20 \cdot 4}{8} \text{ and } hd = \frac{mcd + mdc}{4} \left| \begin{aligned} mab &= -44.7059 \text{ and } mba = -7.05882 \text{ and } mcd = -21.1765 \text{ and } mdc = -32.9412 \\ ha &= -16.4706 \text{ and } hd = -13.5294 \end{aligned} \right.$$

$$30 - 16.4706 \quad 13.5294$$

$$\text{solve}(-7.0588 + 21.1756 - 6 \cdot x = 0, x) \quad x = 2.3528$$

$$-44.7065 + 16.4706 \cdot 4 \quad 21.1759$$



-----1

1

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ \frac{-1}{4} & \frac{-1}{4} & \frac{1}{4} & \frac{1}{4} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{-1}{4} & \frac{-1}{4} & 0 & 0 & \frac{-1}{4} & \frac{-1}{4} \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ \frac{-1}{4} & \frac{-1}{4} & \frac{1}{4} & \frac{1}{4} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{-1}{4} & \frac{-1}{4} & 0 & 0 & \frac{-1}{4} & \frac{-1}{4} \end{bmatrix}$$

-----2

2

$$\begin{bmatrix} 8 & 4 & 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 8 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 8 & 4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & 8 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 4 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2 & 4 \end{bmatrix} \cdot e \rightarrow s$$

$$\begin{bmatrix} 8 \cdot e & 4 \cdot e & 0 & 0 & 0 & 0 & 0 & 0 \\ 4 \cdot e & 8 \cdot e & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 8 \cdot e & 4 \cdot e & 0 & 0 & 0 & 0 \\ 0 & 0 & 4 \cdot e & 8 \cdot e & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4 \cdot e & 2 \cdot e & 0 & 0 \\ 0 & 0 & 0 & 0 & 2 \cdot e & 4 \cdot e & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 4 \cdot e & 2 \cdot e \\ 0 & 0 & 0 & 0 & 0 & 0 & 2 \cdot e & 4 \cdot e \end{bmatrix}$$

-----3

3

$$(a \cdot s \cdot a^T)^{-1} \cdot [0 \ 0 \ 0 \ 20 \ 10]^T \rightarrow d$$



$$\begin{bmatrix} 100 \\ 17 \cdot e \\ -20 \\ 17 \cdot e \\ 100 \\ 17 \cdot e \\ 1160 \\ 51 \cdot e \\ 1520 \\ 51 \cdot e \end{bmatrix}$$

$$-----4$$

$$4$$

$$s \cdot a^T \cdot d \rightarrow q$$



$$\begin{bmatrix} -44.7059 \\ -21.1765 \\ 21.1765 \\ -7.05882 \\ 7.05882 \\ 21.1765 \\ -21.1765 \\ -32.9412 \end{bmatrix}$$



-----1

-1

$$\frac{-1 \cdot 12^2}{12} \rightarrow fembc$$

-12

$$\frac{1 \cdot 12^2}{12} \rightarrow femcb$$

12

-----2

-2

$$\frac{2 \cdot ei}{8} \cdot (2 \cdot a + b) \rightarrow mab$$

$$\frac{(2 \cdot a + b) \cdot ei}{4}$$

$$\frac{2 \cdot ei}{8} \cdot (a + 2 \cdot b) \rightarrow mba$$

$$\frac{(a + 2 \cdot b) \cdot ei}{4}$$

$$\frac{4 \cdot ei}{12} \cdot (2 \cdot b + c) - 12 \rightarrow mbc$$

$$\frac{2 \cdot b \cdot ei}{3} + \frac{c \cdot ei}{3} - 12$$

$$\frac{4 \cdot ei}{12} \cdot (b + 2 \cdot c) + 12 \rightarrow mcb$$

$$\frac{b \cdot ei}{3} + \frac{2 \cdot c \cdot ei}{3} + 12$$

-----3

-3

$$\text{solve}\left(\begin{cases} mab=0 \\ mba+mbc=0 \\ mcb=0 \end{cases}, \{a,b,c\}\right)$$

$$a=\frac{-72}{7\cdot ei} \text{ and } b=\frac{144}{7\cdot ei} \text{ and } c=\frac{-198}{7\cdot ei}$$

-----4

-4

{ 2.5E-13,7.714285714286,-7.7142857142853,0. }

{ 2.5E-13,7.71429,-7.71429,0. }

□

-----1

-1

$$\frac{2 \cdot ei}{2 \cdot l} \cdot a \rightarrow mba$$

$$\frac{a \cdot ei}{l}$$

$$\frac{2 \cdot ei}{2 \cdot l} \cdot 2 \cdot a \rightarrow mab$$

$$\frac{2 \cdot a \cdot ei}{l}$$

$$\frac{2 \cdot ei}{\frac{15}{10} \cdot l} \cdot a \rightarrow mca$$

$$\frac{4 \cdot a \cdot ei}{3 \cdot l}$$

$$\frac{2 \cdot ei}{\frac{15}{10} \cdot l} \cdot 2 \cdot a \rightarrow mac$$

$$\frac{8 \cdot a \cdot ei}{3 \cdot l}$$

$$\frac{2 \cdot ei}{\frac{15}{10} \cdot l} \cdot a \rightarrow mda$$

$$\frac{4 \cdot a \cdot ei}{3 \cdot l}$$

$$\frac{2 \cdot ei}{\frac{15}{10} \cdot l} \cdot 2 \cdot a \rightarrow mad$$

$$\frac{8 \cdot a \cdot ei}{3 \cdot l}$$

-----2

-2

solve( $mab+mac+mad=m,a$ )

$$a = \frac{3 \cdot l \cdot m}{22 \cdot ei}$$

$$a = \frac{3 \cdot l \cdot m}{22 \cdot ei}$$

$$a = \frac{0.136364 \cdot l \cdot m}{ei}$$

-----3

-3

  $\{ mba, mac, mca, mac, mda, mad \} | a = \frac{3 \cdot l \cdot m}{22 \cdot ei}$

$$\left\{ \frac{3 \cdot m}{22}, \frac{4 \cdot m}{11}, \frac{2 \cdot m}{11}, \frac{4 \cdot m}{11}, \frac{2 \cdot m}{11}, \frac{4 \cdot m}{11} \right\}$$

