HW

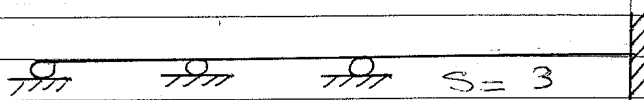
Solution

CE 511

HW # 1

Determine the degree of static indeterminacy and the degree of kinematic indeterminacy for the structures shown:

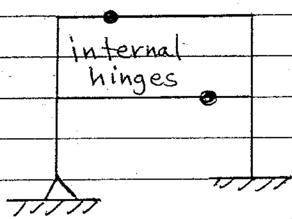
①



S = 3
K = 6

②

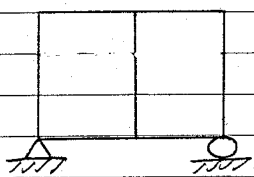
S = 3
K = 21



Plane Frame

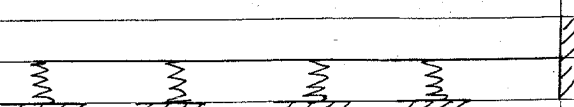
③

S = 6
K = 15



Plane Frame

④

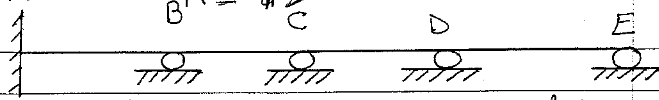


beam on elastic foundations
S = 4
K = 12

(5)

S = 4

K = 12

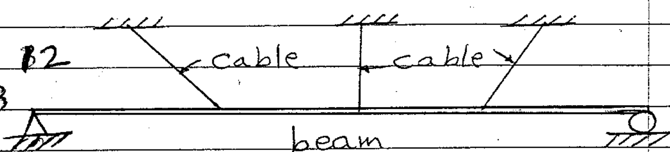


beam with settlements at B, C, D and E.

(6)

K = 12

S = 3

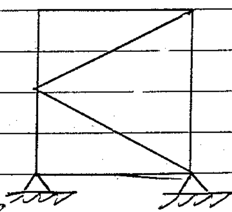


(7) S = 1

K = 20

K = 6

neglecting rotations

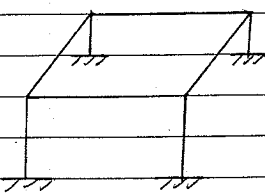


Plane Truss

(8)

S = 24

K = 24

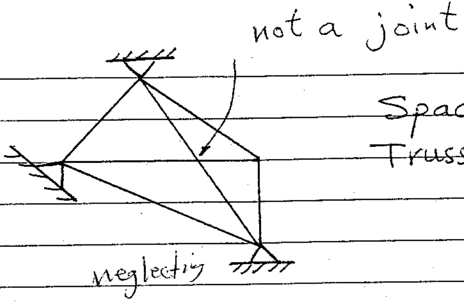


space frame

(9)

S = 3
K = 39

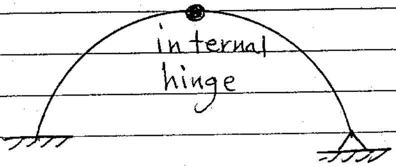
K = 3



Space Truss

(10)

S = 1
K = 5

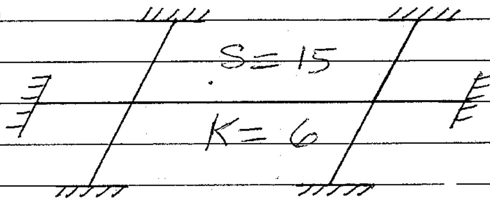


arch

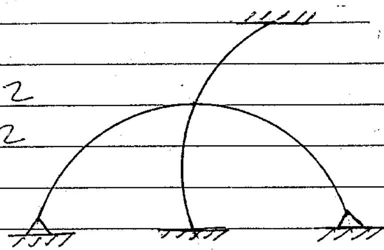
CE 511

HW # 2

State the degree of static indeterminacy and the degree of kinematic indeterminacy for the structures shown:

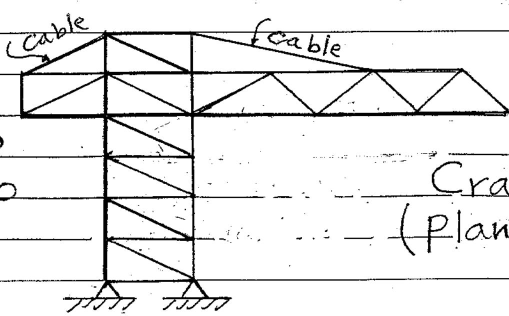
① 

Plane Grid

② 

S = 12
K = 12

Space Grid

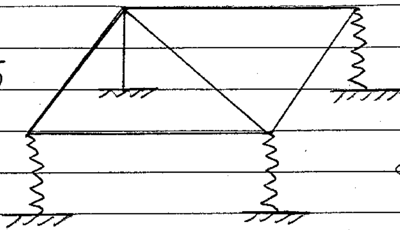
③ 

S = 3
K = 40

Crane (Plane Truss)

④

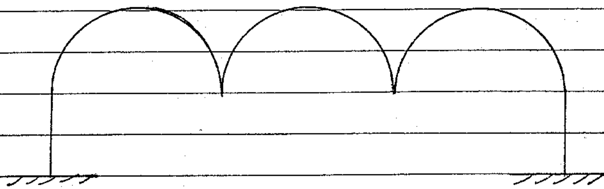
$S = 15$
$K = 24$



Space Frame on Elastic Foundations

⑤

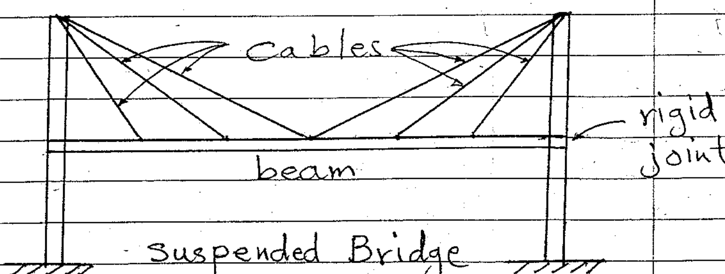
$S = 3$
$K = 6$



Plane Arch

⑥

$S = 9$
$K = 27$

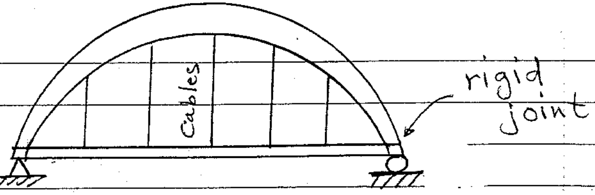


Suspended Bridge

⑦

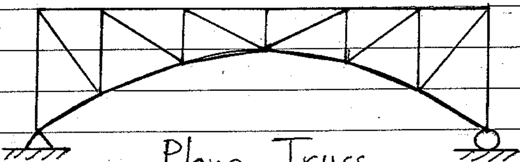
S = 8

K = ~~18~~ 33



Suspended Bridge

⑧



S = 0

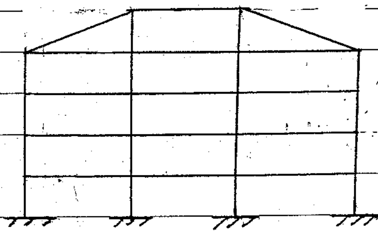
K = 25

Plane Truss

⑨

S = 45

K = 54

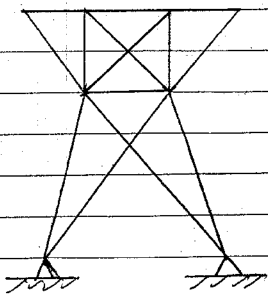


Planar Frame

⑩

S = 2

K = 16



Power Transmission Tower (Plane Truss)

HW # 3

$$\delta_{11} = \frac{7751.11}{EI} = \delta_{22}$$

$$\delta_{21} = \frac{7360}{EI} = \delta_{12}$$

$$\Delta_1 = -\frac{1.67 \times 10^6}{EI} \; ft$$

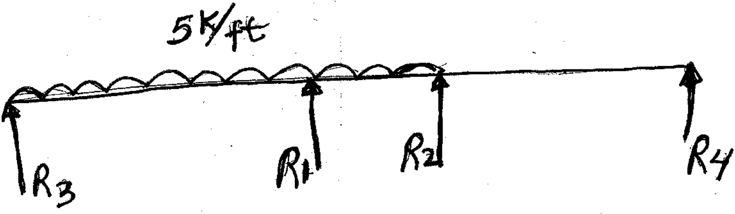
$$\Delta_2 = -1.596 \times 10^6 \; ft$$

$R_3 = 82.8^K$

$R_1 = 203.5$

$R_2 = 12.7 \; K$

$R_4 = 1 \; K$

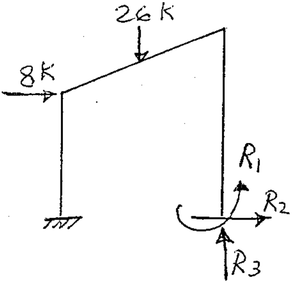


HW # 4 Solution

$$\text{inverse} = \begin{bmatrix} 1.1319 & -0.0500 & 0.1845 & 0.1440 & -3.2159 & -0.7610 & -1.0240 \\ -0.0500 & 1.4809 & -0.0748 & -0.1443 & -5.0583 & 0.6191 & 0.9300 \\ 0.1845 & -0.0748 & 1.0364 & 0.5028 & -6.3158 & -3.8223 & -2.3463 \\ 0.1440 & -0.1443 & 0.5028 & 0.6871 & -4.5322 & -2.9593 & -3.3195 \\ -3.2159 & -5.0583 & -6.3158 & -4.5322 & 111.6470 & 26.5507 & 28.0134 \\ -0.7610 & 0.6191 & -3.8223 & -2.9593 & 26.5507 & 18.5859 & 14.0864 \\ -1.0240 & 0.9300 & -2.3463 & -3.3195 & 28.0134 & 14.0864 & 24.2645 \end{bmatrix}$$

HW #5

Solution



$$\{\mathbf{D}_L\} + [\mathbf{d}_{XX}]\{\mathbf{X}\} = \{\mathbf{D}_X^o\}$$

$$\{\mathbf{D}_L\} = \begin{bmatrix} \delta_{1L} \\ \delta_{2L} \\ \delta_{3L} \end{bmatrix} = \frac{1}{E}\begin{bmatrix} -280{,}507 \\ -2{,}215{,}440 \\ -6{,}642{,}930 \end{bmatrix}$$

$$[\mathbf{d}_{XX}] = \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} \\ \delta_{21} & \delta_{22} & \delta_{23} \\ \delta_{31} & \delta_{32} & \delta_{33} \end{bmatrix} = \frac{1}{E}\begin{bmatrix} 1{,}566.8 & 18{,}375.6 & 20{,}184.3 \\ 18{,}375.6 & 294{,}376.0 & 190{,}411.0 \\ 20{,}184.3 & 190{,}411.0 & 455{,}969.0 \end{bmatrix}$$

$$\{\mathbf{X}\} = \begin{bmatrix} R_1^o \\ R_2^o \\ R_3^o \end{bmatrix}$$

$$\{\mathbf{D}_X^o\} = \begin{bmatrix} \delta_{X1}^0 \\ \delta_{X2}^o \\ \delta_{X3}^o \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\frac{1}{E}\begin{bmatrix} -280{,}507 \\ -2{,}215{,}440 \\ -6{,}642{,}930 \end{bmatrix} + \frac{1}{E}\begin{bmatrix} 1{,}566.8 & 18{,}375.6 & 20{,}184.3 \\ 18{,}375.6 & 294{,}376.0 & 190{,}411.0 \\ 20{,}184.3 & 190{,}411.0 & 455{,}969.0 \end{bmatrix}\begin{bmatrix} R_1^o \\ R_2^o \\ R_3^o \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

Solving,

$$\begin{bmatrix} R_1^o \\ R_2^0 \\ R_3^o \end{bmatrix} = -\begin{bmatrix} 4.69802 \times 10^{-3} & -2.17488 \times 10^{-4} & -1.17144 \times 10^{-4} \\ -2.17488 \times 10^{-4} & 1.47225 \times 10^{-5} & 3.47946 \times 10^{-6} \\ -1.17144 \times 10^{-4} & 3.47946 \times 10^{-6} & 5.92574 \times 10^{-6} \end{bmatrix}\begin{bmatrix} -280{,}507 \\ -2{,}215{,}440 \\ -6{,}642{,}930 \end{bmatrix}$$

$$\begin{bmatrix} R_1^o \\ R_2^o \\ R_3^o \end{bmatrix} = \begin{bmatrix} 57.82 \text{ ft-k} \\ -5.28 \text{ k} \\ 14.21 \text{ k} \end{bmatrix}$$

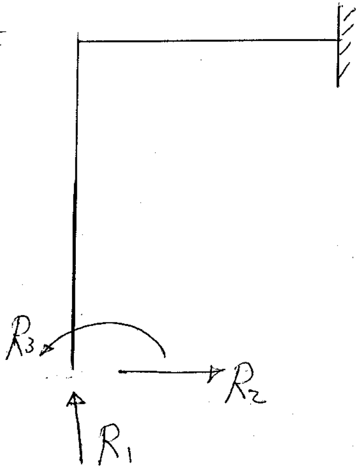
HW # 6

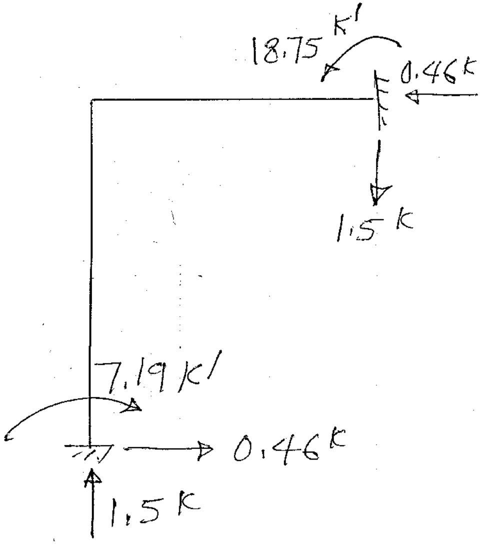
$\Delta_1 = -.026$ ft

$\Delta_2 = -.013$ ft

$\Delta_3 = 0$

$\delta_{11} = 3243/EI$
$\delta_{12} = -8000/EI$
$\delta_{13} = -200/EI$
$\delta_{21} = -8000/EI$
$\delta_{22} = 53621.5/EI$
$\delta_{23} = 1600/EI$
$\delta_{31} = -200/EI$
$\delta_{32} = 1600/EI$
$\delta_{33} = 60/EI$





HW #8 Solution

PROGRAM TO FIND THE STRUCTURAL STIFFNESS MATRIX OF PLANAR ORTHOGONAL STRUCTURES

SMOIN = 1.00000 YOUNG = 1.00000 ELENG = 10.00000

MEMBER STIFFNESS MATRIX

.40000	.20000	.06000	-.06000
.20000	.40000	.06000	-.06000
.06000	.06000	.01200	-.01200
-.06000	-.06000	-.01200	.01200

MEMBER STIFFNESS MATRIX

.40000	.20000	.06000	-.06000
.20000	.40000	.06000	-.06000
.06000	.06000	.01200	-.01200
-.06000	-.06000	-.01200	.01200

MEMBER STIFFNESS MATRIX

.40000	.20000	.06000	-.06000
.20000	.40000	.06000	-.06000
.06000	.06000	.01200	-.01200
-.06000	-.06000	-.01200	.01200

MEMBER STIFFNESS MATRIX

.40000	.20000	.06000	-.06000
.20000	.40000	.06000	-.06000
.06000	.06000	.01200	-.01200
-.06000	-.06000	-.01200	.01200

MEMBER STIFFNESS MATRIX

.40000	.20000	.06000	-.06000
.20000	.40000	.06000	-.06000
.06000	.06000	.01200	-.01200
-.06000	-.06000	-.01200	.01200

MEMBER STIFFNESS MATRIX

.40000	.20000	.06000	-.06000
.20000	.40000	.06000	-.06000
.06000	.06000	.01200	-.01200
-.06000	-.06000	-.01200	.01200

CORRESPONDING DISPLACEMENT NUMBERS FOR ELEMENTS

1 14 5 11

CORRESPONDING DISPLACEMENT NUMBERS FOR ELEMENTS

1 2 10 9

CORRESPONDING DISPLACEMENT NUMBERS FOR ELEMENTS

2 15 5 12

CORRESPONDING DISPLACEMENT NUMBERS FOR ELEMENTS

2 3 9 8

CORRESPONDING DISPLACEMENT NUMBERS FOR ELEMENTS

3 6 5 13

CORRESPONDING DISPLACEMENT NUMBERS FOR ELEMENTS

3 4 8 7

STRUCTURE STIFFNESS MATRIX

.800	.200	.000	.000	.060	.000	.000	.000	-.060	.060	-.060	.000	.000	.200	.000
.200	1.200	.200	.000	.060	.000	.000	-.060	.000	.060	.000	-.060	.000	.000	.200
.000	.200	1.200	.200	.060	.200	-.060	.000	.060	.000	.000	.000	-.060	.000	.000
.000	.000	.200	.400	.000	.000	-.060	.060	.000	.000	.000	.000	.000	.000	.000
.060	.060	.060	.000	.036	.060	.000	.000	.000	.000	-.012	-.012	-.012	.060	.060
.000	.000	.200	.000	.060	.400	.000	.000	.000	.000	.000	.000	-.060	.000	.000
.000	.000	-.060	-.060	.000	.000	.012	-.012	.000	.000	.000	.000	.000	.000	.000
.000	-.060	.000	.060	.000	.000	-.012	.024	-.012	.000	.000	.000	.000	.000	.000
-.060	.000	.060	.000	.000	.000	.000	-.012	.024	-.012	.000	.000	.000	.000	.000
.060	.060	.000	.000	.000	.000	.000	.000	-.012	.012	.000	.000	.000	.000	.000
-.060	.000	.000	.000	-.012	.000	.000	.000	.000	.000	.012	.000	.000	-.060	.000
.000	-.060	.000	.000	-.012	.000	.000	.000	.000	.000	.000	.012	.000	.000	-.060
.000	.000	-.060	.000	-.012	-.060	.000	.000	.000	.000	.000	.000	.012	.000	.000
.200	.000	.000	.000	.060	.000	.000	.000	.000	.000	-.060	.000	.000	.400	.000
.000	.200	.000	.000	.060	.000	.000	.000	.000	.000	.000	-.060	.000	.000	.400

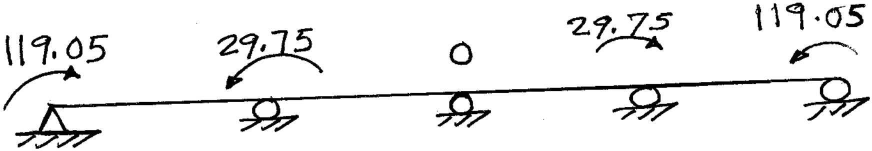
THE STRUCTURAL STIFFNESS MATRIX

.800	.200	.000	.000	.060	.000	.000	.000	-.060	.060	-.060	.000	.000	.200	.000
.200	1.200	.200	.000	.060	.000	.000	-.060	.000	.060	.000	-.060	.000	.000	.200
.000	.200	1.200	.200	.060	.200	-.060	.000	.060	.000	.000	.000	-.060	.000	.000
.000	.000	.200	.400	.000	.000	-.060	.060	.000	.000	.000	.000	.000	.000	.000
.060	.060	.060	.000	.036	.060	.000	.000	.000	.000	-.012	-.012	-.012	.060	.060
.000	.000	.200	.000	.060	.400	.000	.000	.000	.000	.000	.000	-.060	.000	.000
.000	.000	-.060	-.060	.000	.000	.012	-.012	.000	.000	.000	.000	.000	.000	.000
.000	-.060	.000	.060	.000	.000	-.012	.024	-.012	.000	.000	.000	.000	.000	.000
-.060	.000	.060	.000	.000	.000	.000	-.012	.024	-.012	.000	.000	.000	.000	.000
.060	.060	.000	.000	.000	.000	.000	.000	-.012	.012	.000	.000	.000	.000	.000
-.060	.000	.000	.000	-.012	.000	.000	.000	.000	.000	.012	.000	.000	-.060	.000
.000	-.060	.000	.000	-.012	.000	.000	.000	.000	.000	.000	.012	.000	.000	-.060
.000	.000	-.060	.000	-.012	-.060	.000	.000	.000	.000	.000	.000	.012	.000	.000
.200	.000	.000	.000	.060	.000	.000	.000	.000	.000	-.060	.000	.000	.400	.000
.000	.200	.000	.000	.060	.000	.000	.000	.000	.000	.000	-.060	.000	.000	.400

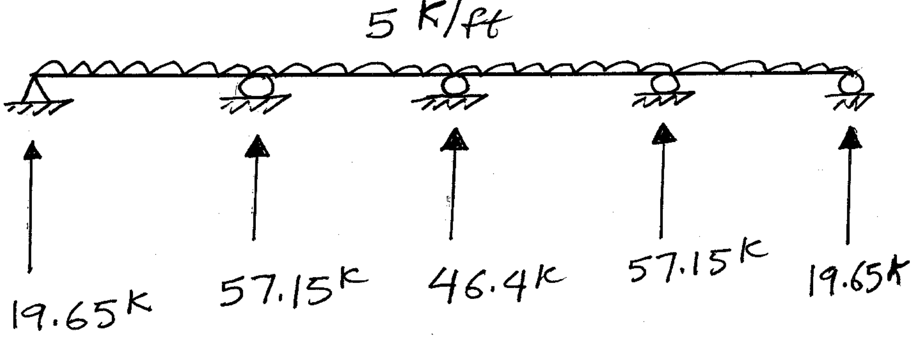
Stop - Program terminated.

Press any key to continue

HW #9

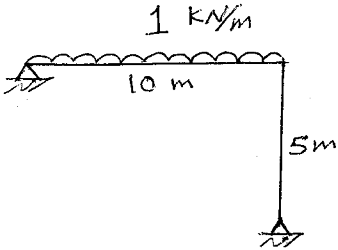


displacements



reactions

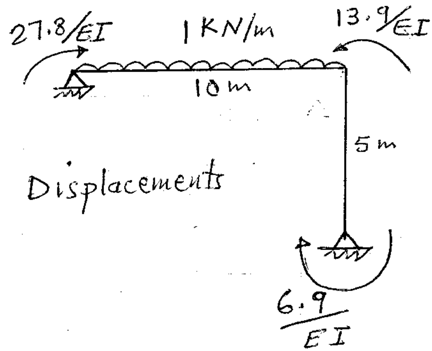
HW # 10



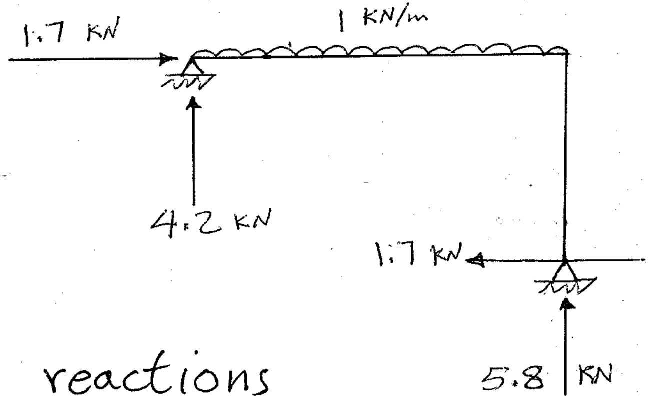
Constant E & I

Stiffness Method

Not including axial deformations

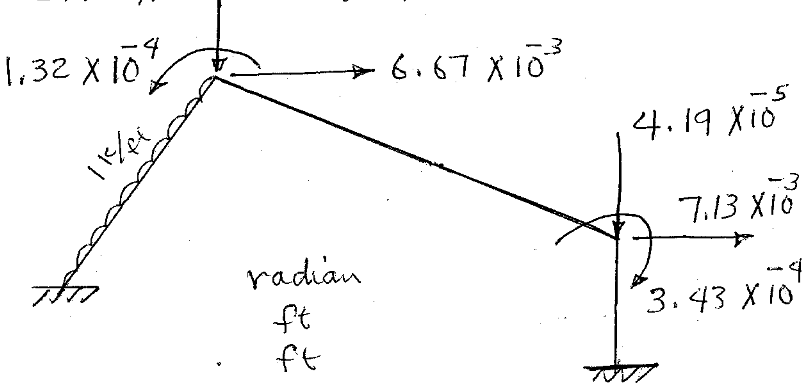


Displacements

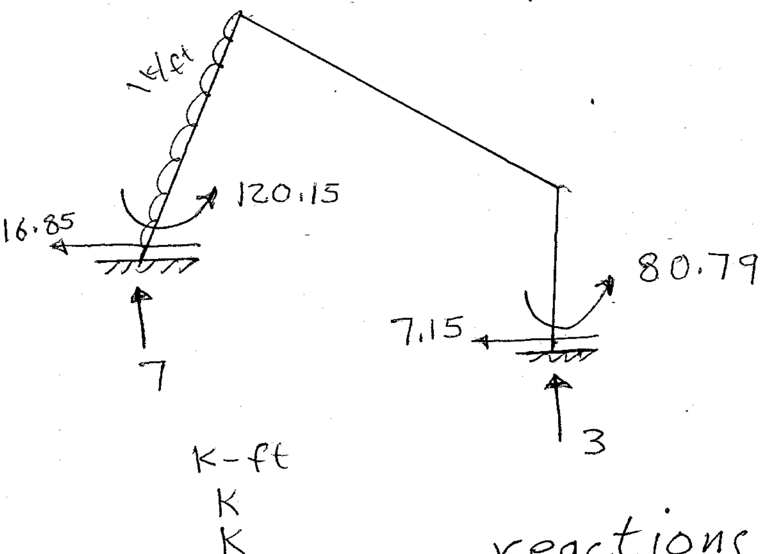


reactions

HW # 11 Solution

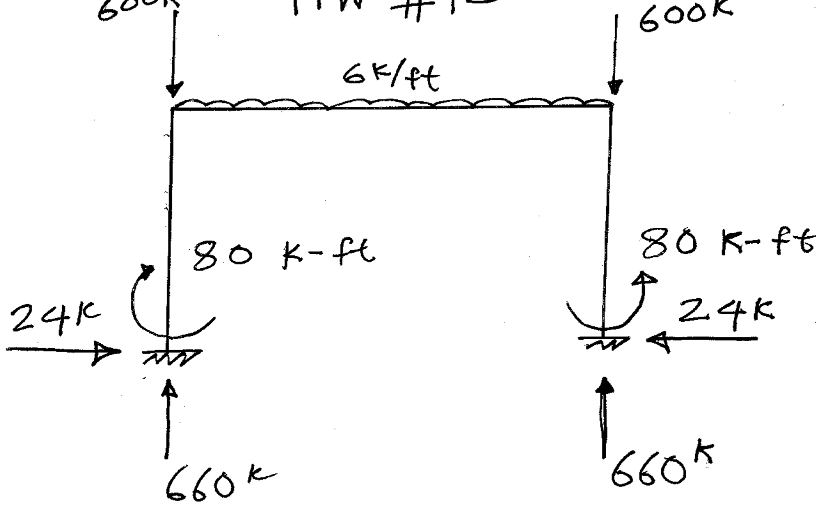


displacements

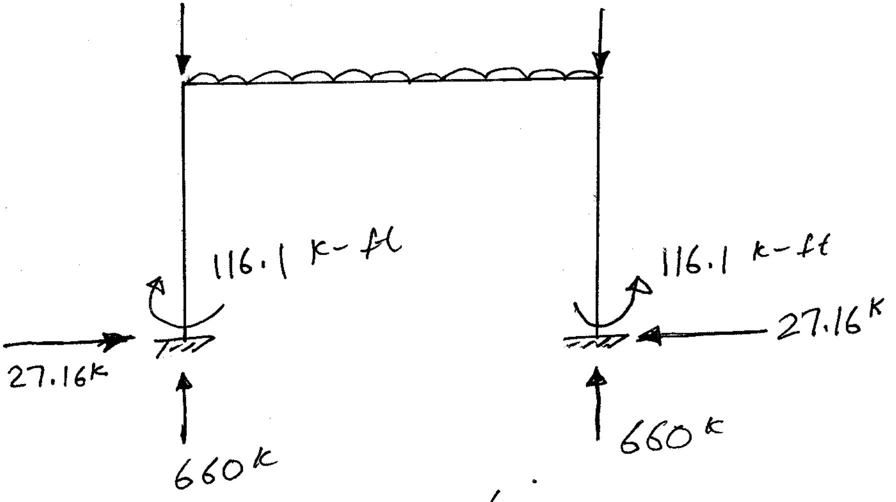


reactions

HW #15

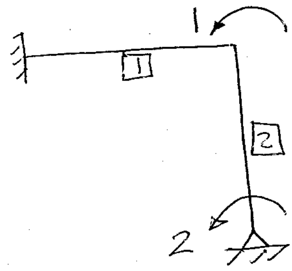


reactions
without axial load effect



reactions
with axial load effect

Solution #16



$$K_1 = \begin{bmatrix} \frac{r_1}{L_1} \end{bmatrix}$$

$$K_2 = \begin{bmatrix} \frac{r_2}{L_2} & \frac{C_2 r_2}{L_2} \\ \frac{C_2 r_2}{L_2} & \frac{r_2}{L_2} \end{bmatrix}$$

$$S_{uu} = \begin{bmatrix} \frac{r_1}{10} + \frac{r_2}{10} & \frac{C_2 r_2}{10} \\ \frac{C_2 r_2}{10} & \frac{r_2}{10} \end{bmatrix}$$

$$|S_{uu}| = r_2(r_1 + r_2) - C_2^2 r_2^2$$

$F_1 = F\cos 45 = 0.707F$

$F_2 = F\sin 45 = 0.707F$

$\therefore F_1 = F_2 \quad \therefore r_1 = r_2 = r$

$\therefore 2r^2 - c^2r^2 = 0 \Rightarrow r^2(2 - c^2) = 0$

$\therefore r = 0 \quad$ or $c = \sqrt{2} = \pm 1.4142$

$\therefore \phi = 2 \quad$ or $\quad \phi = 1.3$ or $\phi = 3$

Smallest $\phi = 1.3$

$\therefore \phi = \frac{.707F}{P_E} = \frac{.707F \times 100}{\pi^2 EI} = 1.3$

$\therefore F = .18EI = 1800\ K$