Example with three CST triangles.

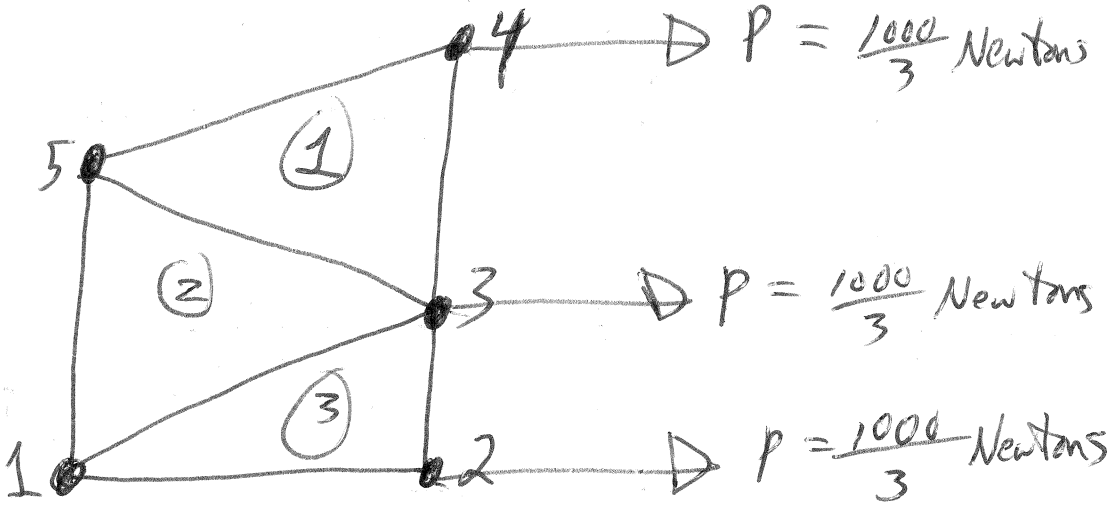
$t = 0.001$ ~~inches~~ meters

$E = 210 \times 10^9 \frac{N}{m^2}$

$\nu = 0.3$ (Poisson's ratio)

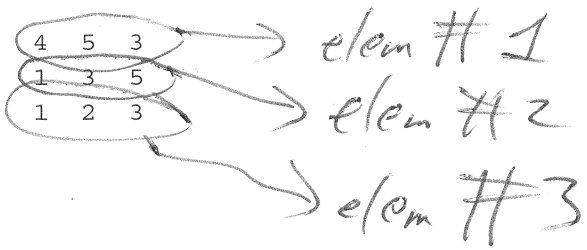
Plane-stress

sketch (not to scale):



Boundary conditions: $u_1 = u_5 = 0$, ~~$v_5 = 0$~~

$v_1 = 0$


4 5 3
1 3 5
1 2 3
elem # 1
elem # 2
elem # 3

0.0000000000000000e+000	0.0000000000000000e+000	— node 1
1.1000000000000001e+000	0.0000000000000000e+000	— node 2
1.2000000000000000e+000	1.3000000000000000e+000	— node 3
9.0000000000000002e-001	2.8999999999999999e+000	— node 4
1.0000000000000001e-001	2.1000000000000001e+000	— node 5

(x, y) locations of nodes

1
5

4
3
2

which_elem =

1

$\vec{d} = \{u_1, v_1, u_2, v_2, u_3, v_3, u_4, v_4, u_5, v_5\}^T$ (1 2 3 4 5 6 7 8 9 10)

K =

	7	8	9	10	5	6
7	8.0731e+007	4.3421e+007	-1.0593e+008	-5.2227e+007	2.5202e+007	8.8057e+006
8	4.3421e+007	1.0886e+008	-4.6457e+007	-5.9059e+007	3.0364e+006	-4.9798e+007
9	-1.0593e+008	-4.6457e+007	1.9672e+008	2.3684e+007	-9.0789e+007	2.2773e+007
10	-5.2227e+007	-5.9059e+007	2.3684e+007	7.4848e+007	2.8543e+007	-1.5789e+007
5	2.5202e+007	3.0364e+006	-9.0789e+007	2.8543e+007	6.5587e+007	-3.1579e+007
6	8.8057e+006	-4.9798e+007	2.2773e+007	-1.5789e+007	-3.1579e+007	6.5587e+007

→ stiffness matrix of elem #1.

Ilist =

7
8

Jlist =

9
10

Mlist =

5
6

list =

7
8
9
10
5
6

} dof list for elem #1

which_elem =

2

K =

	1	2	5	6	9	10
1	5.1344e+007	2.7615e+007	-7.9248e+007	-3.7874e+007	2.7905e+007	1.0259e+007

```
          1             2             5             6             9            10
2   2.7615e+007   6.9231e+007  -3.2105e+007  -2.3077e+007   4.4899e+006  -4.6154e+007
5  -7.9248e+007  -3.2105e+007   2.1308e+008  -6.5900e+006  -1.3383e+008   3.8695e+007
6  -3.7874e+007  -2.3077e+007  -6.5900e+006   7.5000e+007   4.4464e+007  -5.1923e+007
9   2.7905e+007   4.4899e+006  -1.3383e+008   4.4464e+007   1.0592e+008  -4.8954e+007
10  1.0259e+007  -4.6154e+007   3.8695e+007  -5.1923e+007  -4.8954e+007   9.8077e+007
```

stiffness matrix of elem #2

```
Ilist =

     1
     2


Jlist =

     5
     6


Mlist =

     9
    10


list =

     1
     2
     5
     6
     9
    10
```

dof list for elem #2

```
which_elem =

     3


K =
          1             2             3             4             5             6
1   1.3665e+008  -6.8182e+006  -1.3975e+008   4.1434e+007   3.1065e+006  -3.4615e+007
2  -6.8182e+006   4.8534e+007   4.7203e+007  -5.7410e+007  -4.0385e+007   8.8757e+006
3  -1.3975e+008   4.7203e+007   1.7703e+008  -8.1818e+007  -3.7278e+007   3.4615e+007
4   4.1434e+007  -5.7410e+007  -8.1818e+007   1.6392e+008   4.0385e+007  -1.0651e+008
5   3.1065e+006  -4.0385e+007  -3.7278e+007   4.0385e+007   3.4172e+007             0
6  -3.4615e+007   8.8757e+006   3.4615e+007  -1.0651e+008             0   9.7633e+007


Ilist =
```

stiffness matrix of element #3

```
     1
     2


Jlist =

     3
     4


Mlist =

     5
     6


list =

     1
     2
     3
     4
     5
     6
```

dof list for element #3

```
Kglobal_columns_1thru5 =

          1             2             3             4             5
 1  1.8799e+008   2.0797e+007  -1.3975e+008   4.1434e+007  -7.6142e+007
 2  2.0797e+007   1.1776e+008   4.7203e+007  -5.7410e+007  -7.2490e+007
 3 -1.3975e+008   4.7203e+007   1.7703e+008  -8.1818e+007  -3.7278e+007
 4  4.1434e+007  -5.7410e+007  -8.1818e+007   1.6392e+008   4.0385e+007
 5 -7.6142e+007  -7.2490e+007  -3.7278e+007   4.0385e+007   3.1283e+008
 6 -7.2490e+007  -1.4201e+007   3.4615e+007  -1.0651e+008  -3.8169e+007
 7             0             0             0             0   2.5202e+007
 8             0             0             0             0   3.0364e+006
 9   2.7905e+007   4.4899e+006             0             0  -2.2462e+008
10   1.0259e+007  -4.6154e+007             0             0   6.7237e+007


Kglobal_columns_6thru10 =

          6             7             8             9            10
 1 -7.2490e+007             0             0   2.7905e+007   1.0259e+007
 2 -1.4201e+007             0             0   4.4899e+006  -4.6154e+007
 3  3.4615e+007             0             0             0             0
 4 -1.0651e+008             0             0             0             0
 5 -3.8169e+007   2.5202e+007   3.0364e+006  -2.2462e+008   6.7237e+007
 6  2.3822e+008   8.8057e+006  -4.9798e+007   6.7237e+007  -6.7713e+007
 7  8.8057e+006   8.0731e+007   4.3421e+007  -1.0593e+008  -5.2227e+007
 8 -4.9798e+007   4.3421e+007   1.0886e+008  -4.6457e+007  -5.9059e+007
```

global stiffness matrix

6
0
5

```
          6             7             8             9            10
9   6.7237e+007 -1.0593e+008 -4.6457e+007  3.0265e+008 -2.5270e+007
10 -6.7713e+007 -5.2227e+007 -5.9059e+007 -2.5270e+007  1.7293e+008
```

```
nodal_load =

             0  1
             0  2
  3.3333e+002  3
             0  4
  3.3333e+002  5
             0  6
  3.3333e+002  7
             0  8
             0  9
             0  10
```

```
listdofremove =

     1
     9
     2
```

constrained dof's. These are zero.

```
listkeep =

     3
     4
     5
     6
     7
     8
    10
```

list of unconstrained degrees of freedom

```
Kreduced_colums_1thru_5 =
          3             4             5             6             7
3   1.7703e+008 -8.1818e+007 -3.7278e+007  3.4615e+007             0
4  -8.1818e+007  1.6392e+008  4.0385e+007 -1.0651e+008             0
5  -3.7278e+007  4.0385e+007  3.1283e+008 -3.8169e+007  2.5202e+007
6   3.4615e+007 -1.0651e+008 -3.8169e+007  2.3822e+008  8.8057e+006
7             0             0  2.5202e+007  8.8057e+006  8.0731e+007
8             0             0  3.0364e+006 -4.9798e+007  4.3421e+007
10            0             0  6.7237e+007 -6.7713e+007 -5.2227e+007
```

```
Kreduced_colums_6thru_7 =
          8            10
3         0             0
4         0             0
```

```
   3.0364e+006  6.7237e+007
  -4.9798e+007 -6.7713e+007
   4.3421e+007 -5.2227e+007
   1.0886e+008 -5.9059e+007
  -5.9059e+007  1.7293e+008


nodal_load_reduced =

   3.3333e+002
             0
   3.3333e+002
             0
   3.3333e+002
             0
             0


disp_reduced =

   2.4854e-006
   8.4473e-007
   6.8114e-007
  -3.5089e-007
   5.3969e-006
  -2.0451e-006
   5.2927e-007


disp =

             0
             0
   2.4854e-006
   8.4473e-007
   6.8114e-007
  -3.5089e-007
   5.3969e-006
  -2.0451e-006
             0
   5.2927e-007


maxsx =

   6.4132e+005
```

maximum ∇_x over all three elements.