CHAPTER TWO

Analysis of Elastic Solids

Example 2.1 p. 51

Determine stresses in a tetrahedral shaped solid made of concrete shown in Figure 2.2. Assume the base (side on the xy plane) is completely fixed and the solid is subjected to a temperature increase of 50°C. Use the following data.

$E = 22\,\text{GPa};\quad \nu = 0.15;\quad \alpha = 11\times 10^{-6}\,/\,°\text{C}$

Nodal coordinates: {10, 0, 0}, {40, 0, 0}, {25, 25, 0}, {25, 0, 25}

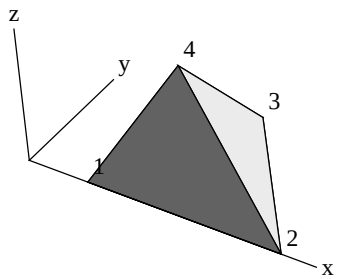


Figure 2.2. A tetrahedral solid subjected to temperature change

■ One element solution for comparison with text

AnsysFiles\Chap02\Ex21.txt

```
!*  Example 2.1 (p. 51)
!* One tetrahedral element
/PREP7
!*
ET,1,SOLID45
!*
KEYOPT,1,1,1
KEYOPT,1,2,0
KEYOPT,1,4,0
KEYOPT,1,5,0
KEYOPT,1,6,0
!*
!*
MPTEMP,,,,,,,,
MPTEMP,1,0
MPDATA,EX,1,,22000
MPDATA,PRXY,1,,0.15
MPTEMP,,,,,,,,
MPTEMP,1,0
UIMP,1,REFT,,,
MPDATA,CTEX,1,,11*10**(-6)
N,1,10000,,,,,,
N,2,40000,,,,,,
N,3,25000,25000,,,,,
N,4,25000,0,25000,,,,
e,1,2,3,3,4,4,4,4
D,1, , , , , ,ALL, , , , ,
D,2, , , , , ,ALL, , , , ,
D,3, , , , , ,ALL, , , , ,
TUNIF,50,
FINISH
/SOL
/STATUS,SOLU
SOLVE
FINISH
/POST1
!*
PRNSOL,DOF
!*
PRESOL,S,PRIN
```

```
PRINT U    NODAL SOLUTION PER NODE

  ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

  LOAD STEP=     1  SUBSTEP=     1
   TIME=    1.0000      LOAD CASE=   0

  THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN GLOBAL COORDINATES

    NODE      UZ
       1   0.0000
       2   0.0000
       3   0.0000
       4   18.603

 MAXIMUM ABSOLUTE VALUES
 NODE          4
 VALUE    18.603


PRINT S    PRIN ELEMENT SOLUTION PER ELEMENT

 ***** POST1 ELEMENT NODAL STRESS LISTING *****

  LOAD STEP=     1  SUBSTEP=     1
   TIME=    1.0000      LOAD CASE=   0

  THE FOLLOWING X,Y,Z VALUES ARE IN GLOBAL COORDINATES


  ELEMENT=       1        SOLID45
    NODE    S1          S2          S3          SINT        SEQV
       1   0.0000     -14.235     -14.235      14.235      14.235
       2   0.0000     -14.235     -14.235      14.235      14.235
       3   0.0000     -14.235     -14.235      14.235      14.235
       3   0.0000     -14.235     -14.235      14.235      14.235
       4   0.0000     -14.235     -14.235      14.235      14.235
       4   0.0000     -14.235     -14.235      14.235      14.235
       4   0.0000     -14.235     -14.235      14.235      14.235
       4   0.0000     -14.235     -14.235      14.235      14.235
```

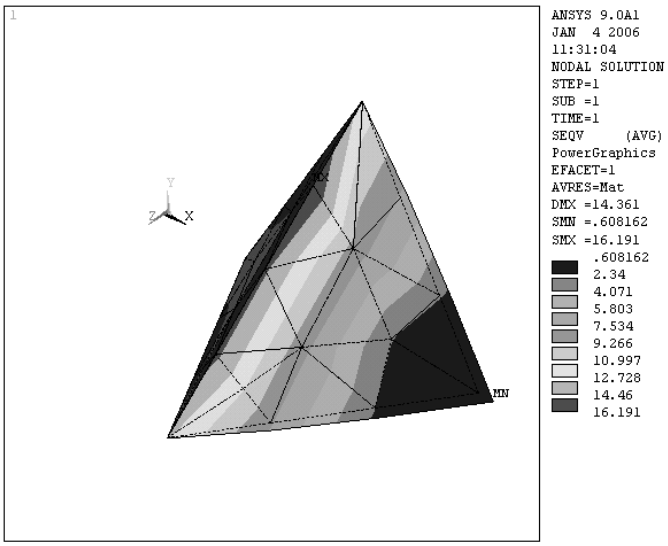
■ Solution with default Ansys mesh

AnsysFiles\Chap02\Ex21Mesh.txt

```
!* Example 2.1 (p. 51)
!* Using a reasoable mesh
/PREP7
!*
ET,1,SOLID45
!*
KEYOPT,1,1,1
KEYOPT,1,2,0
```

```
KEYOPT,1,4,0
KEYOPT,1,5,0
KEYOPT,1,6,0
!*
!*
MPTEMP,,,,,,,,
MPTEMP,1,0
MPDATA,EX,1,,22000
MPDATA,PRXY,1,,0.15
MPTEMP,,,,,,,,
MPTEMP,1,0
UIMP,1,REFT,,,
MPDATA,CTEX,1,,11*10**(-6)
K,1,10000,,,,,,
K,2,40000,,,,,,
K,3,25000,25000,,,,,
K,4,25000,0,25000,,,,
V,1,2,3,4
MSHKEY,0
MSHAPE,1,3d
CM,_Y,VOLU
VSEL, , , ,       1
CM,_Y1,VOLU
CHKMSH,'VOLU'
CMSEL,S,_Y
!*
VMESH,_Y1
!*
CMDELE,_Y
CMDELE,_Y1
CMDELE,_Y2
!*
FLST,2,1,5,ORDE,1
FITEM,2,4
!*
/GO
DA,P51X,ALL,
TUNIF,50,
FINISH
/SOL
/STATUS,SOLU
SOLVE
FINISH
/POST1
!*
PRNSOL,DOF
!*
PRESOL,S,PRIN
```

Plot of vonMises stresses



Cantilever bracket p. 75

The left end of the bracket is fixed. The top face is subjected to a pressure of 10MPa. The material properties are $E = 200$ GPa and $\nu = 0.3$. The nodal coordinates are as follows.

	x (mm)	y (mm)	z (mm)
1	0	0	0
2	400	100	0
3	400	200	0
4	0	200	0
5	0	0	100
6	400	100	100
7	400	200	100
8	0	200	100

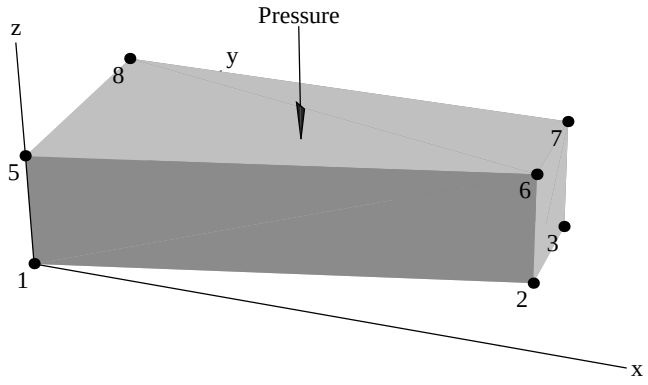


Figure 2.7. One 8 node solid element model of a cantilever bracket

■ One element solution for comparison with text

AnsysFiles\Chap02\CantileverBracketp75.txt

```
!*  Cantilever bracket (p. 75)
!* One 8 node solid element
/PREP7
!*
ET,1,SOLID45
!*
KEYOPT,1,1,1
KEYOPT,1,2,0
KEYOPT,1,4,0
KEYOPT,1,5,0
KEYOPT,1,6,0
!*
!*
MPTEMP,,,,,,,,
MPTEMP,1,0
MPDATA,EX,1,,200000
MPDATA,PRXY,1,,0.3
N,1,,,,,,,
N,2,400,100,,,,,
N,3,400,200,,,,,
N,4,0,200,0,,,,
N,5,0,0,100,,,,
N,6,400,100,100,,,,
N,7,400,200,100,,,,
N,8,0,200,100,,,,
e,1,2,3,4,5,6,7,8
D,1, , , , , ,ALL, , , , ,
D,4, , , , , ,ALL, , , , ,
D,5, , , , , ,ALL, , , , ,
D,8, , , , , ,ALL, , , , ,
SFE,1,6,PRES, ,10, , ,
FINISH
/SOL
/STATUS,SOLU
SOLVE
FINISH
/POST1
!*
PRNSOL,DOF
!*
PRESOL,S,PRIN

  PRINT U    NODAL SOLUTION PER NODE

   ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

   LOAD STEP=     1  SUBSTEP=     1
    TIME=    1.0000      LOAD CASE=   0
```

```
 THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN GLOBAL COORDINATES

   NODE      UZ
      1   0.0000
      2 -0.27802
      3 -0.27986
      4   0.0000
      5   0.0000
      6 -0.28187
      7 -0.28371
      8   0.0000

MAXIMUM ABSOLUTE VALUES
NODE          7
VALUE  -0.28371

PRINT S    PRIN ELEMENT SOLUTION PER ELEMENT

***** POST1 ELEMENT NODAL STRESS LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0

 THE FOLLOWING X,Y,Z VALUES ARE IN GLOBAL COORDINATES


 ELEMENT=       1        SOLID45
   NODE    S1          S2          S3          SINT        SEQV
      1   29.792     -16.052     -78.876      108.67      94.492
      2   5.6325      2.2015     -48.543      54.175      52.544
      3   9.5786     -2.8866     -55.348      64.926      59.678
      4   28.695     -16.965     -80.851      109.55      95.306
      5   81.444      16.574     -28.967      110.41      96.106
      6   40.533     -2.4245     -16.742      57.274      51.627
      7   46.967      1.1917     -19.638      66.606      59.015
      8   83.242      17.393     -28.019      111.26      96.896
```

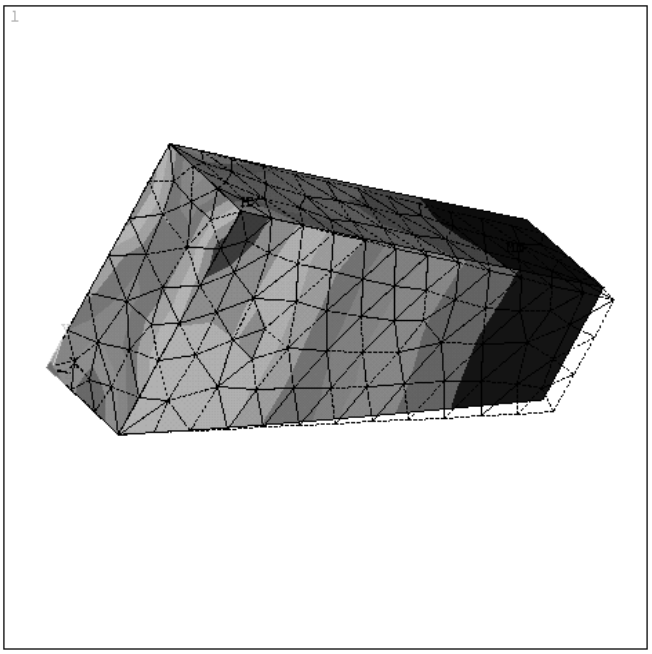
■ Solution with default Ansys mesh

AnsysFiles\Chap02\CantileverP75Mesh.txt

```
!*  Cantilever bracket (p. 75)
!* Using Ansys default mesh
/PREP7
!*
ET,1,SOLID45
!*
KEYOPT,1,1,1
KEYOPT,1,2,0
KEYOPT,1,4,0
KEYOPT,1,5,0
KEYOPT,1,6,0
```

```
!*
!*
MPTEMP,,,,,,,,
MPTEMP,1,0
MPDATA,EX,1,,200000
MPDATA,PRXY,1,,0.3
k,1,,,,,,,
k,2,400,100,,,,,
k,3,400,200,,,,,
k,4,0,200,0,,,,
k,5,0,0,100,,,,
k,6,400,100,100,,,,
k,7,400,200,100,,,,
k,8,0,200,100,,,,
v,1,2,3,4,5,6,7,8
MSHKEY,0
MSHAPE,1,3d
CM,_Y,VOLU
VSEL, , , ,       1
CM,_Y1,VOLU
CHKMSH,'VOLU'
CMSEL,S,_Y
!*
VMESH,_Y1
!*
CMDELE,_Y
CMDELE,_Y1
CMDELE,_Y2
!*
DA,5,ALL,
SFA,6,1,PRES,10
FINISH
/SOL
/STATUS,SOLU
SOLVE
FINISH
/POST1
!*
PRNSOL,DOF
!*
PRESOL,S,PRIN
```

Plot of vonMises stresses


1
ANSYS 9.0A1
JAN 4 2006
13:26:48
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
PowerGraphics
EFACET=1
AVRES=Mat
DMX =1.159
SMN =1.641
SMX =237.035
1.641
27.796
53.951
80.106
106.261
132.415
158.57
184.725
210.88
237.035