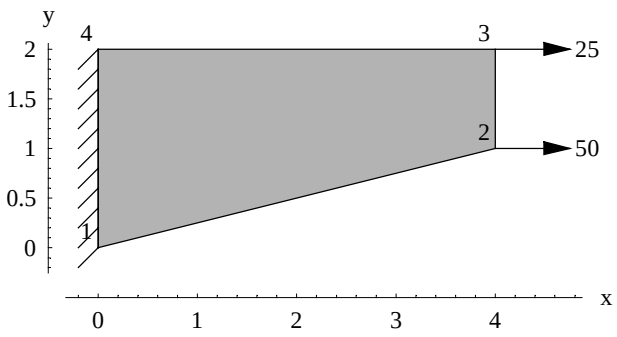
CHAPTER NINE

Geometric Nonlinearity

Tension Plate Example: Hyperelastic material (p. 513)

$E = 100000,\ \nu = 0.25,\ h = 0.1$



■ One element solution

This example uses what the Ansys calls a Neo-Hookean model. However this version is for incompressible materials and is slightly different than that discussed in the book on p. 499. Thus the Ansys results are not exactly the same as those given in the book.

AnsysFiles\\Chap09\\HyperElasticPlate.txt

```
!* Large displacement analysis
!* Hyper elastic material
/PREP7
!* Element type
!*
ET,1,PLANE182
KEYOPT,1,1,0
KEYOPT,1,3,3
KEYOPT,1,6,0
KEYOPT,1,10,0
!*
R,1,0.1
!* Material property
*set, e, 1000
*set, nu, 0.25
*set, mu, e/(2*(1+nu))
*set, k, e/(3*(1-2*nu))
```

```
*set, k, c/(3*(1-2*nu))
*set, d, 2/k
!* Ansys neo-Hookean model
MPTEMP,,,,,,,,
MPTEMP,1,0
TB,HYPE,1,1,2,NEO
TBTEMP,0
TBDATA,,mu,d,,,,
!*
K,1,0,0
K,2,4,1
K,3,4,2
K,4,0,2
A,1,2,3,4
ESIZE,10
AMESH,1
DL,4, ,ALL
/SOLU
ANTYPE,0
NLGEOM,1
ARCLEN,1,1,0.0001
NCNV,2,0,0,0,0
RESCONTRL,DEFINE,ALL,1,1
ERESX,NO
OUTRES,ERASE
OUTRES,ALL,1
AUTOTS,-1.0
!* First load step
!* No applied load
!* Used for initialization of
!* the arc-length controls
LSWRITE,1,
!* Specify applied forces
FK,2,FX,50
FK,3,FX,25
LSWRITE,2,
LSSOLVE,1,2,1
FINISH
!* Postprocessing
/POST1
```

```
/ POST1
SET,LAST
PRNSOL,UX
```

Results after convergence

```
 PRINT U    NODAL SOLUTION PER NODE

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

  LOAD STEP=     2  SUBSTEP=     4
   TIME=    2.0000      LOAD CASE=   0

  THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN GLOBAL COORDINATES

    NODE      UX
       1   0.0000
       2   3.5342
       3   3.5223
       4   0.0000

 MAXIMUM ABSOLUTE VALUES
 NODE          2
 VALUE    3.5342

 PRINT S    ELEMENT SOLUTION PER ELEMENT

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

  LOAD STEP=     2  SUBSTEP=     4
   TIME=    2.0000      LOAD CASE=   0

  THE FOLLOWING X,Y,Z VALUES ARE IN ROTATED GLOBAL COORDINATES,
  WHICH INCLUDE RIGID BODY ROTATION EFFECTS


  ELEMENT=       1        PLANE182
    NODE    SX          SY          SZ          SXY         SYZ
SXZ
       1   688.98      83.141    -0.39790E-12  6.8620      0.0000
0.0000
       2   691.40     -16.731    -0.42107E-09  19.405      0.0000
0.0000
       3   689.56     -17.482    -0.39640E-09 -10.882      0.0000
0.0000
       4   687.67      83.162     0.56843E-13 -12.443      0.0000
0.0000
```

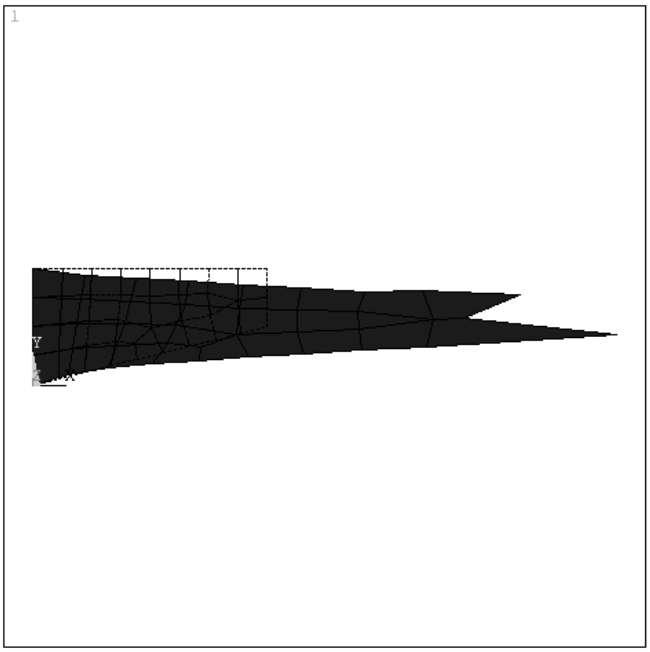
■ Using a finer mesh

AnsysFiles\\Chap09\\HyperElasticPlateMesh.txt

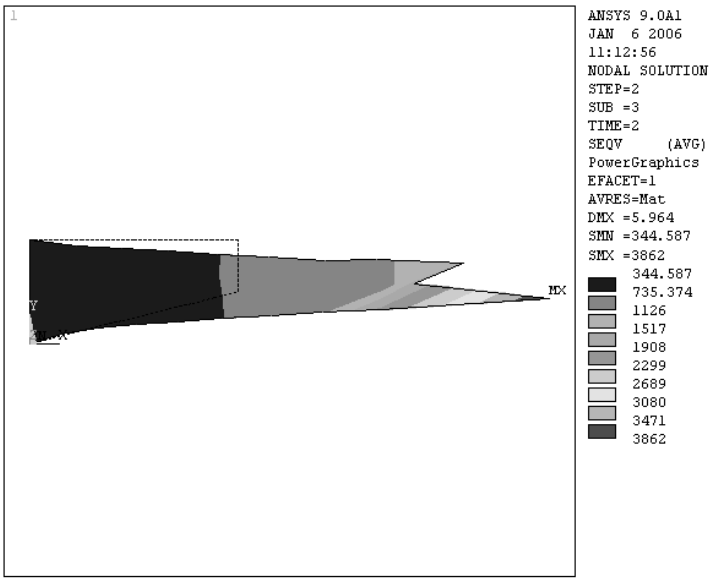
```
!* Large displacement analysis
!* Hyper elastic material
/PREP7
!* Element type
!*
ET,1,PLANE182
KEYOPT,1,1,0
KEYOPT,1,3,3
KEYOPT,1,6,0
KEYOPT,1,10,0
!*
R,1,0.1
!* Material property
*set, e, 1000
*set, nu, 0.25
*set, mu, e/(2*(1+nu))
*set, k, e/(3*(1-2*nu))
*set, d, 2/k
!* Ansys neo-Hookean model
MPTEMP,,,,,,,,
MPTEMP,1,0
TB,HYPE,1,1,2,NEO
TBTEMP,0
TBDATA,,mu,d,,,,
!*
K,1,0,0
K,2,4,1
K,3,4,2
K,4,0,2
A,1,2,3,4
ESIZE,.5
AMESH,1
```

```
AMESH,1
DL,4, ,ALL
/SOLU
ANTYPE,0
NLGEOM,1
ARCLEN,1,1,0.0001
NCNV,2,0,0,0,0
RESCONTRL,DEFINE,ALL,1,1
ERESX,NO
OUTRES,ERASE
OUTRES,ALL,1
AUTOTS,-1.0
!* First load step
!* No applied load
!* Used for initialization of
!* the arc-length controls
LSWRITE,1,
!* Specify applied forces
FK,2,FX,50
FK,3,FX,25
LSWRITE,2,
LSSOLVE,1,2,1
FINISH
!* Postprocessing
/POST1
SET,LAST
PRNSOL,UX
```

Deformed shape



VonMises stresses


1
MX
ANSYS 9.0A1
JAN 6 2006
11:12:56
NODAL SOLUTION
STEP=2
SUB =3
TIME=2
SEQV (AVG)
PowerGraphics
EFACET=1
AVRES=Mat
DMX =5.964
SMN =344.587
SMX =3862
344.587
735.374
1126
1517
1908
2299
2689
3080
3471
3862