Model O-RING

Characteristics:

Negative Jacobean, total incompressibility

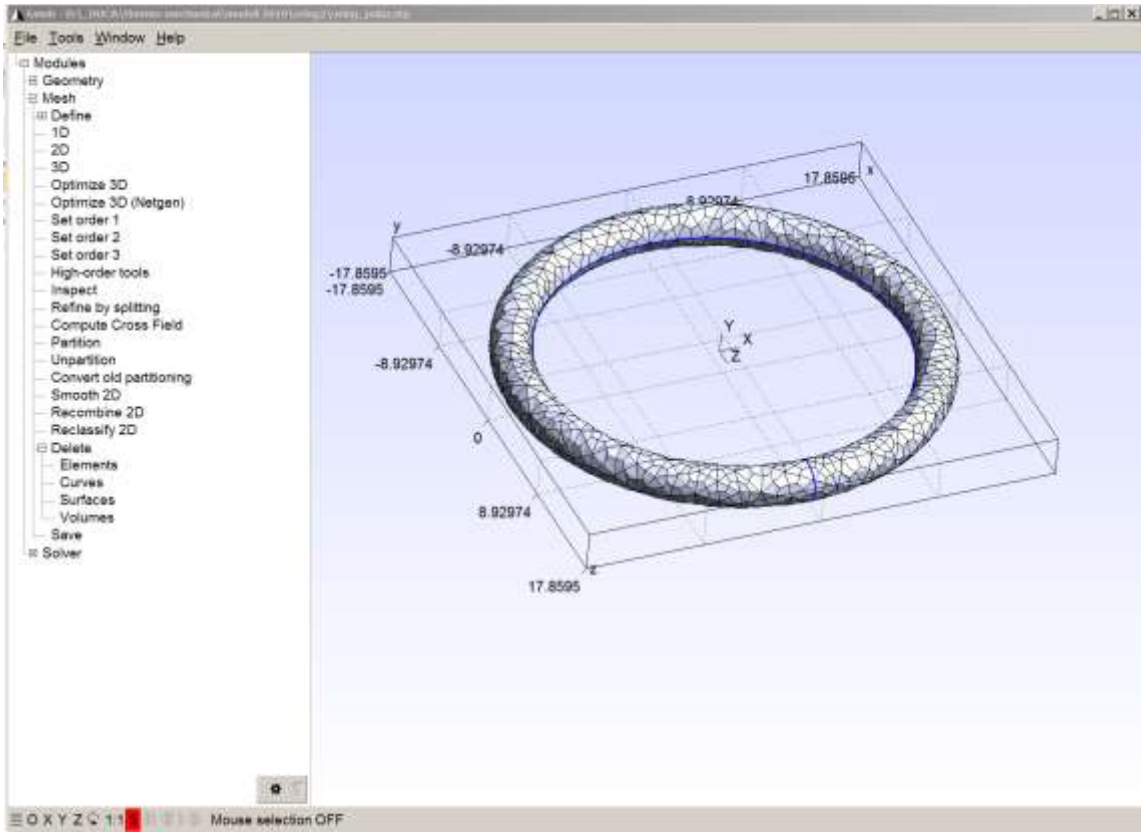
Purpose:

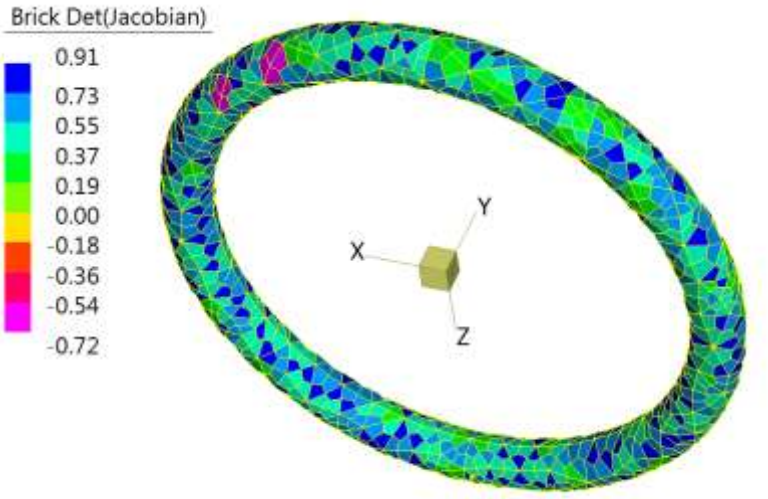
The purpose of this example is to show that present primal-mixed finite element approach with continuous stresses FEmixHC is a reliable black-box simulation code to the user, even over the mesh with negative Jacobean. When using FEmixHC code, there is no need to worry about mesh quality or material. Its HEXA finite elements may have an arbitrary shape, aspect ratio or internal angle, negative Jacobean, while Poisson's ratio could be 0.5. I used GMSH for mesh modeling, and simply transformed tetra elements to hexa elements. See the incompressible rubber O-RING example in the attachment, or if you like you may propose a new one for validation with experiment or experience.

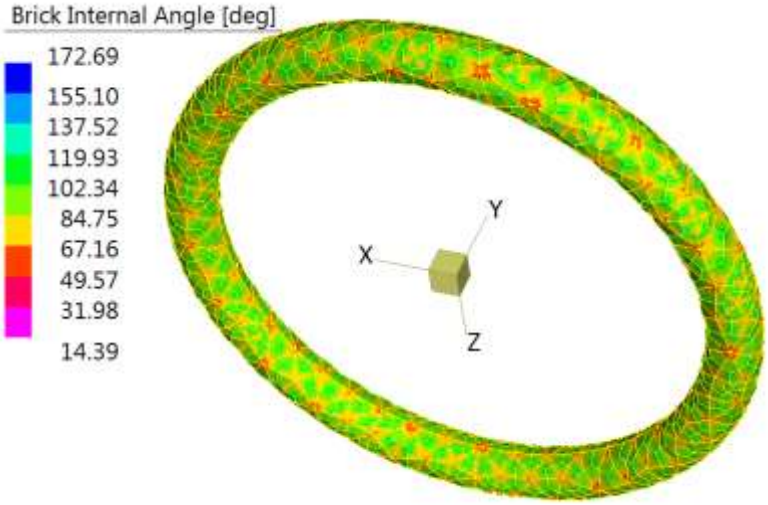
Description:

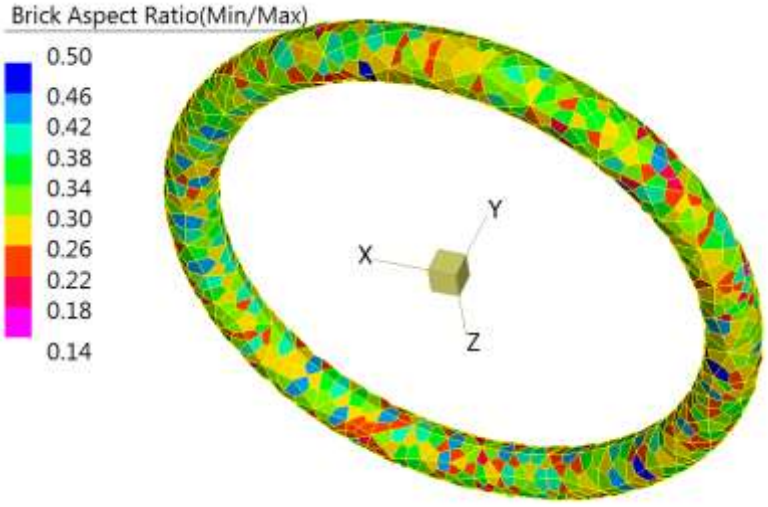
Number of elements 2268
Number of nodes 3316
Modulus of elasticity 1000MPa
Poisson's ratio 0.5
Units: mm, t, MPa, kN

FE mesh:




Brick Det(Jacobian)
0.91
0.73
0.55
0.37
0.19
0.00
-0.18
-0.36
-0.54
-0.72
Y
X
Z

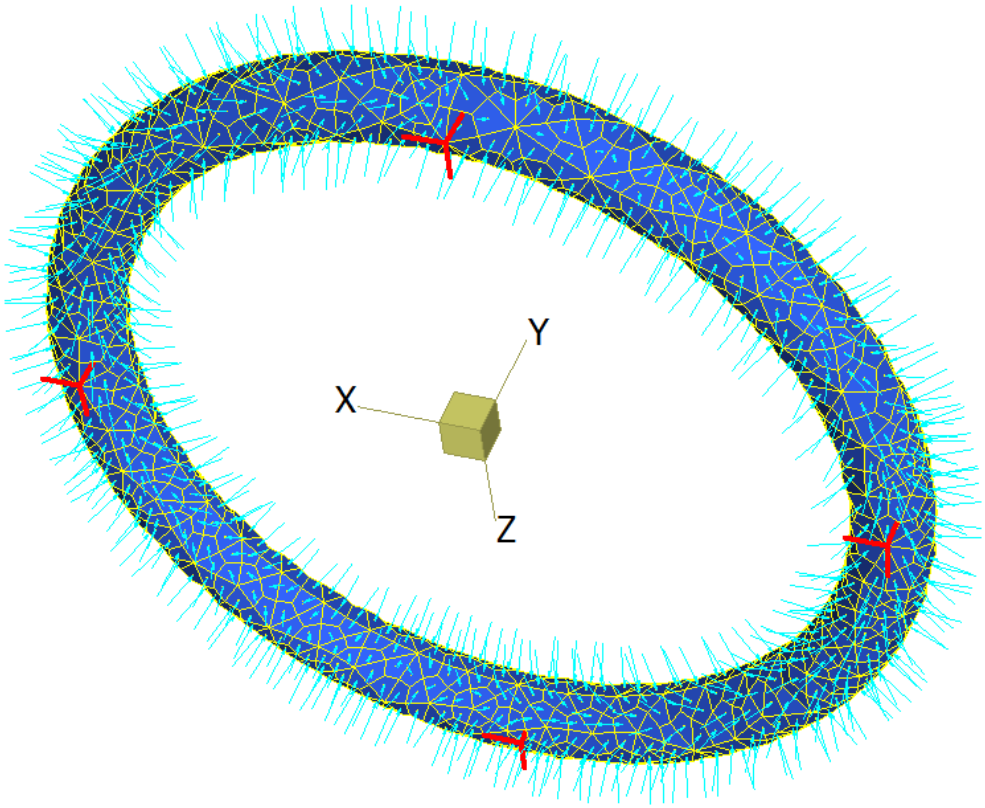

Brick Internal Angle [deg]
172.69
155.10
137.52
119.93
102.34
84.75
67.16
49.57
31.98
14.39
Y
X
Z


Brick Aspect Ratio(Min/Max)
0.50
0.46
0.42
0.38
0.34
0.30
0.26
0.22
0.18
0.14
Y
X
Z

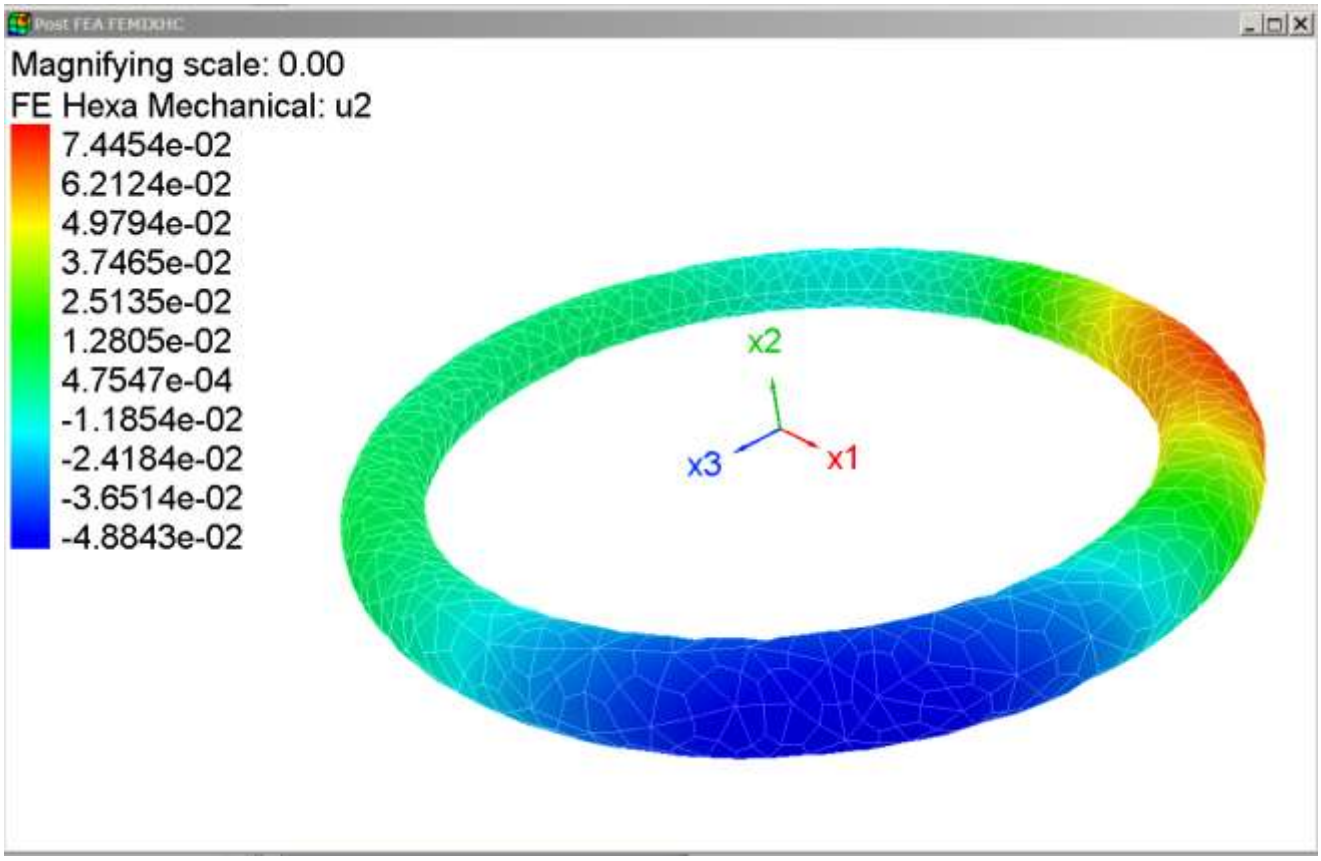
Primal-mixed FE code FEmixHC HEXA HC8/9 results:

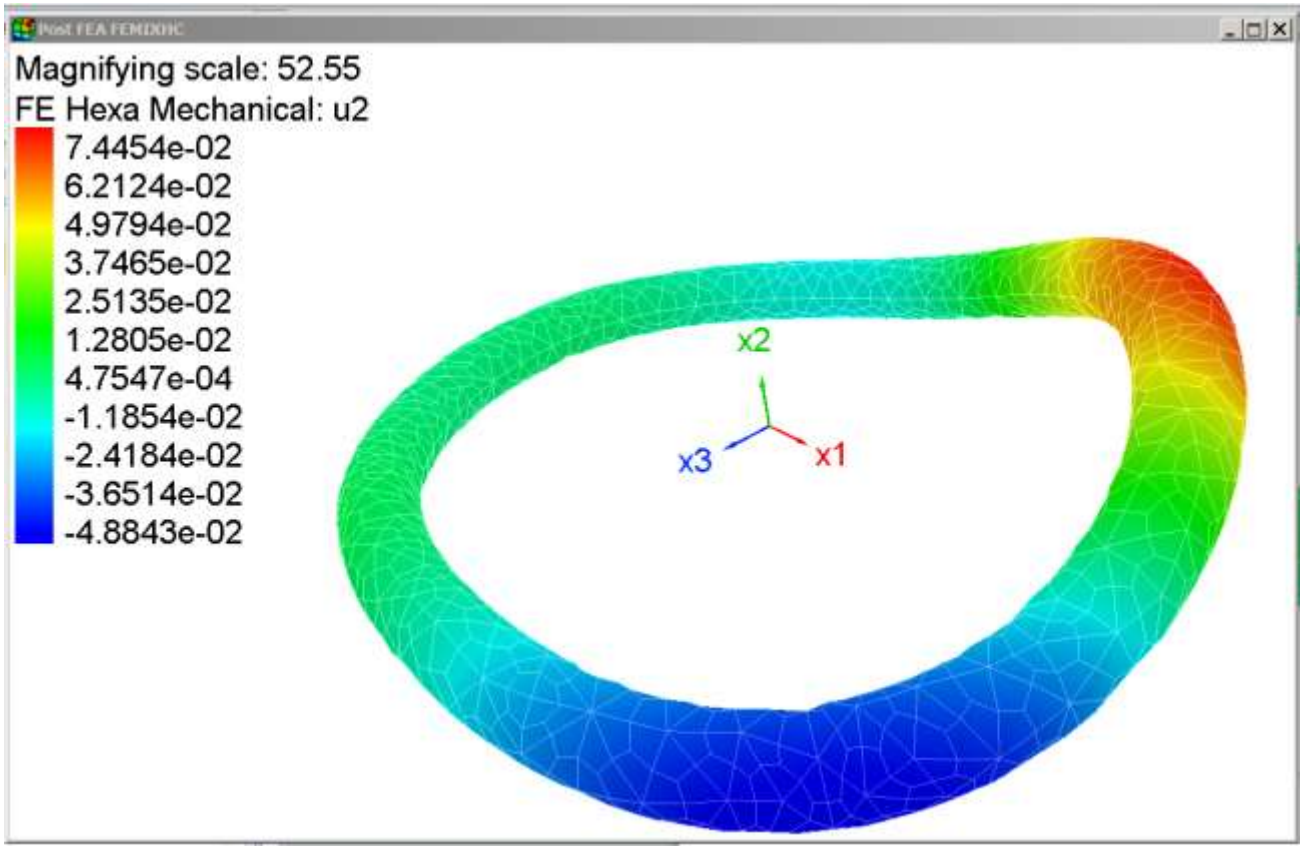
BC's and Loadings

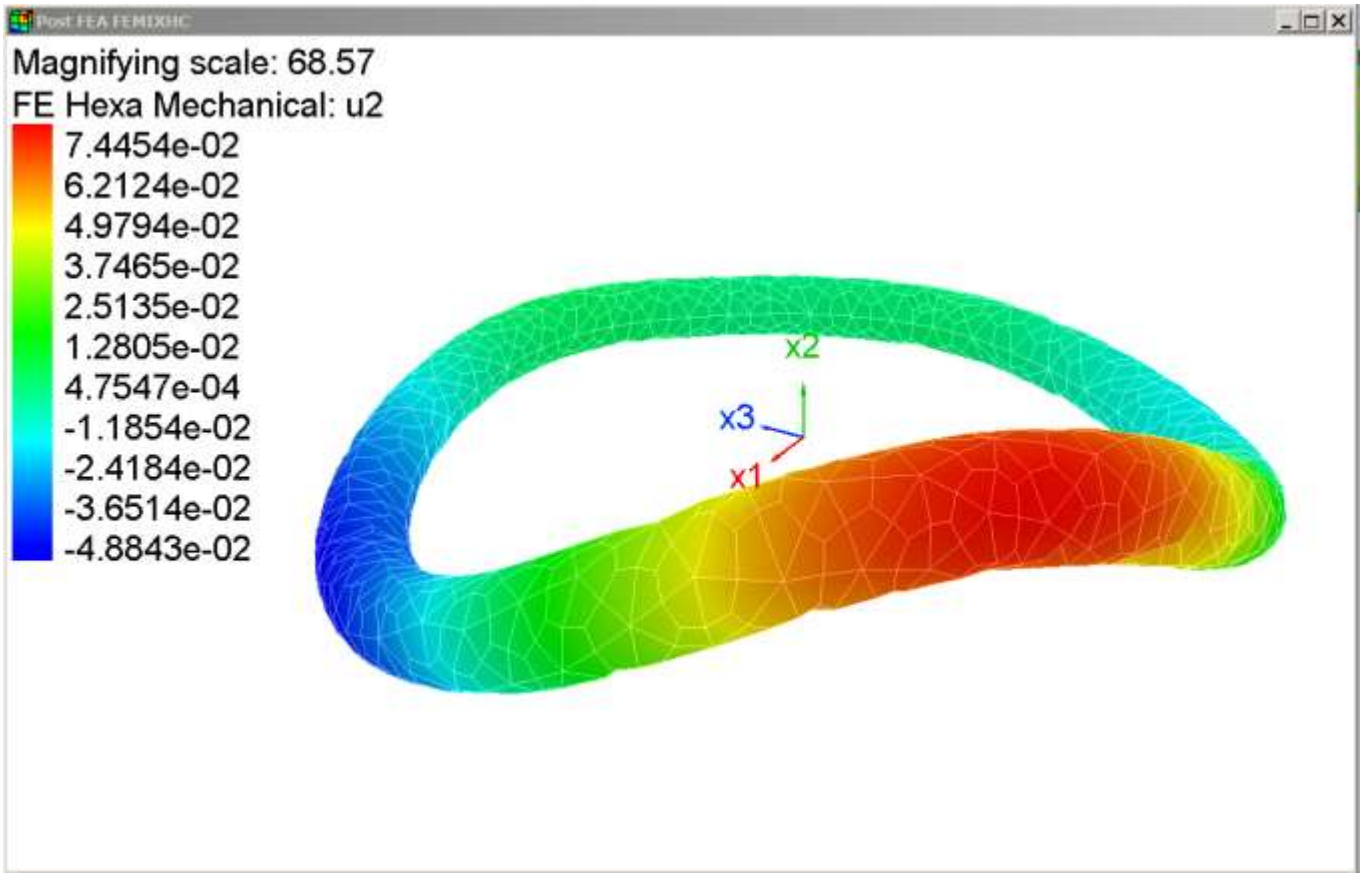
4 sporadic almost opposite nodes are totally constrained. Faces are loaded with normal pressure of 0.1 MPa.

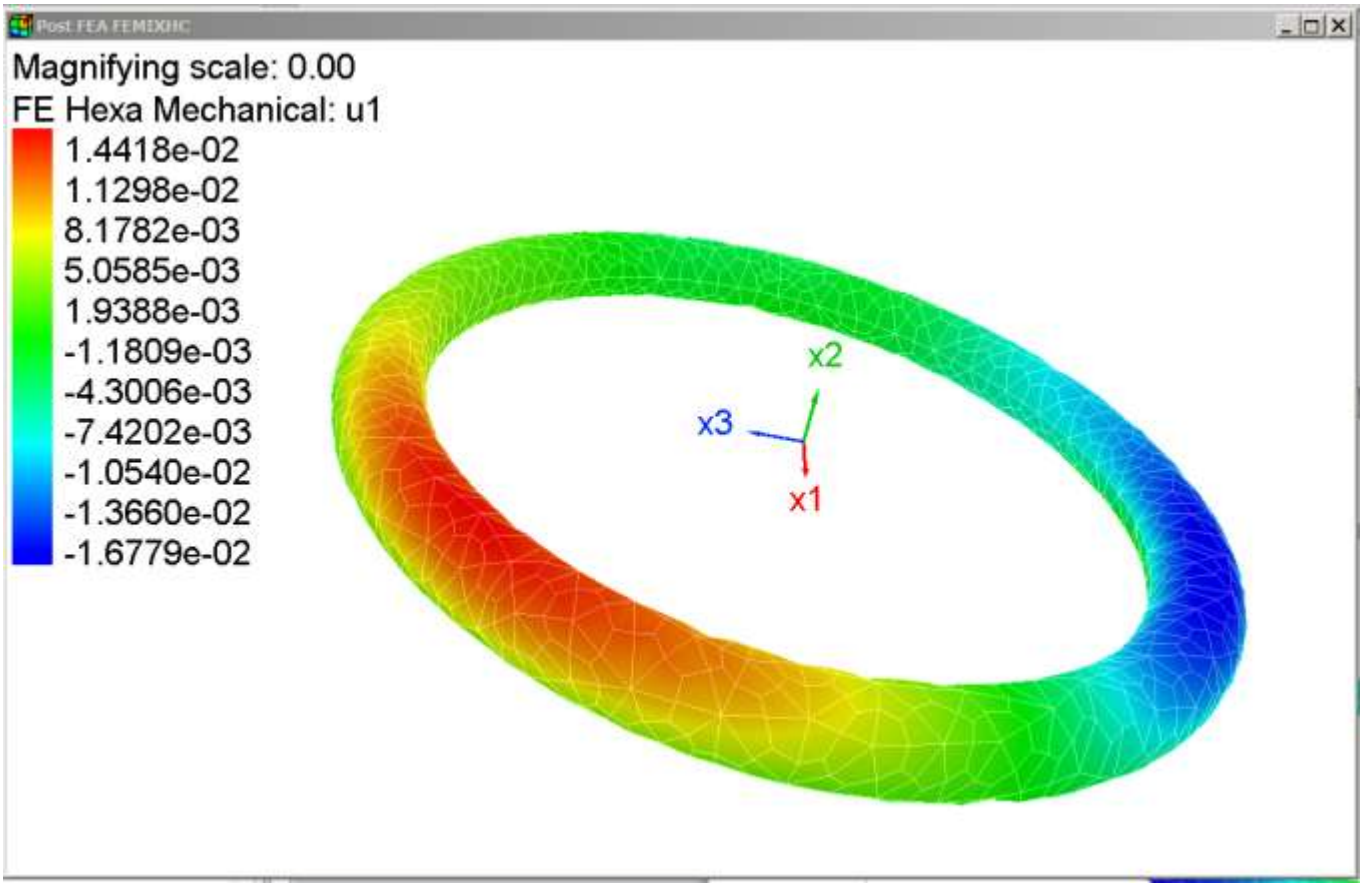


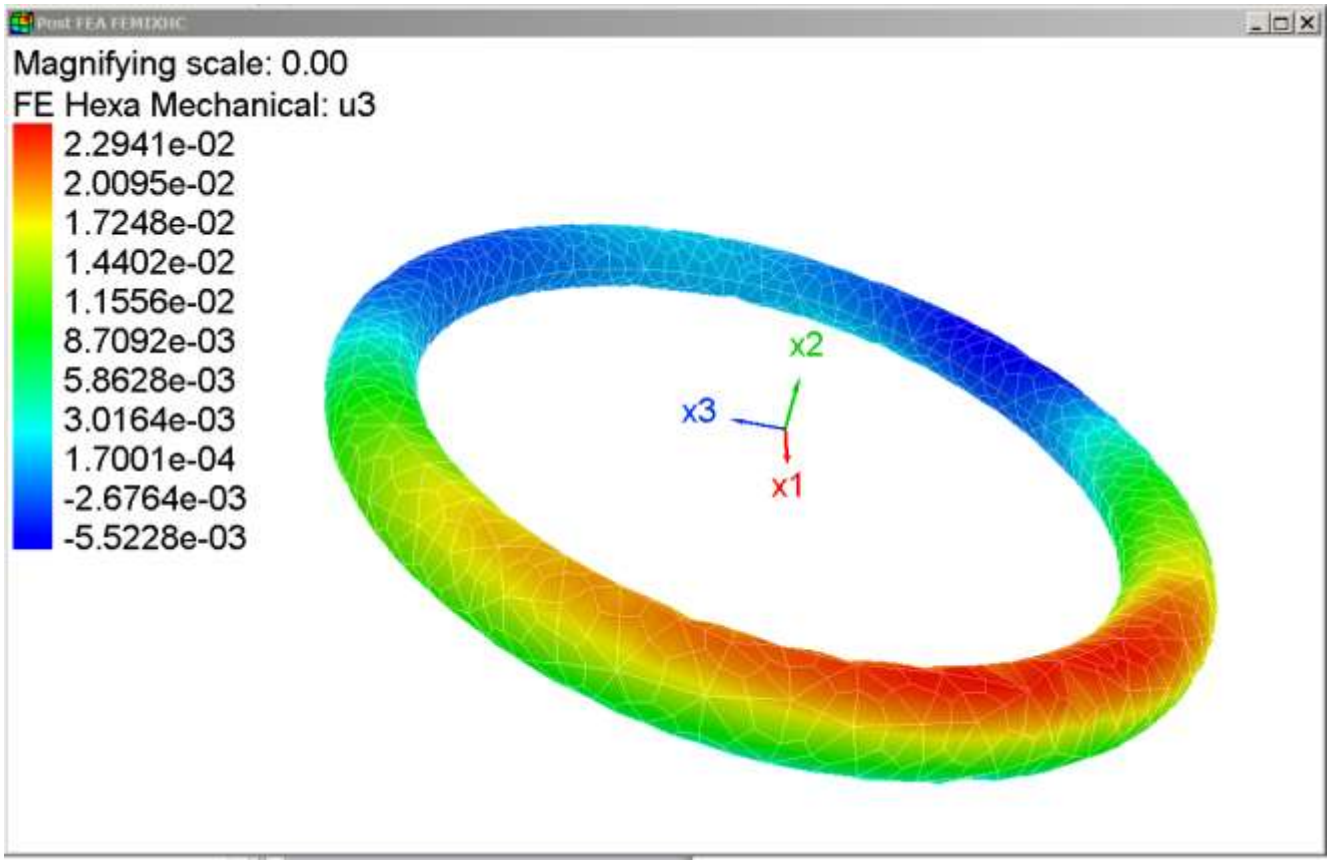
Results

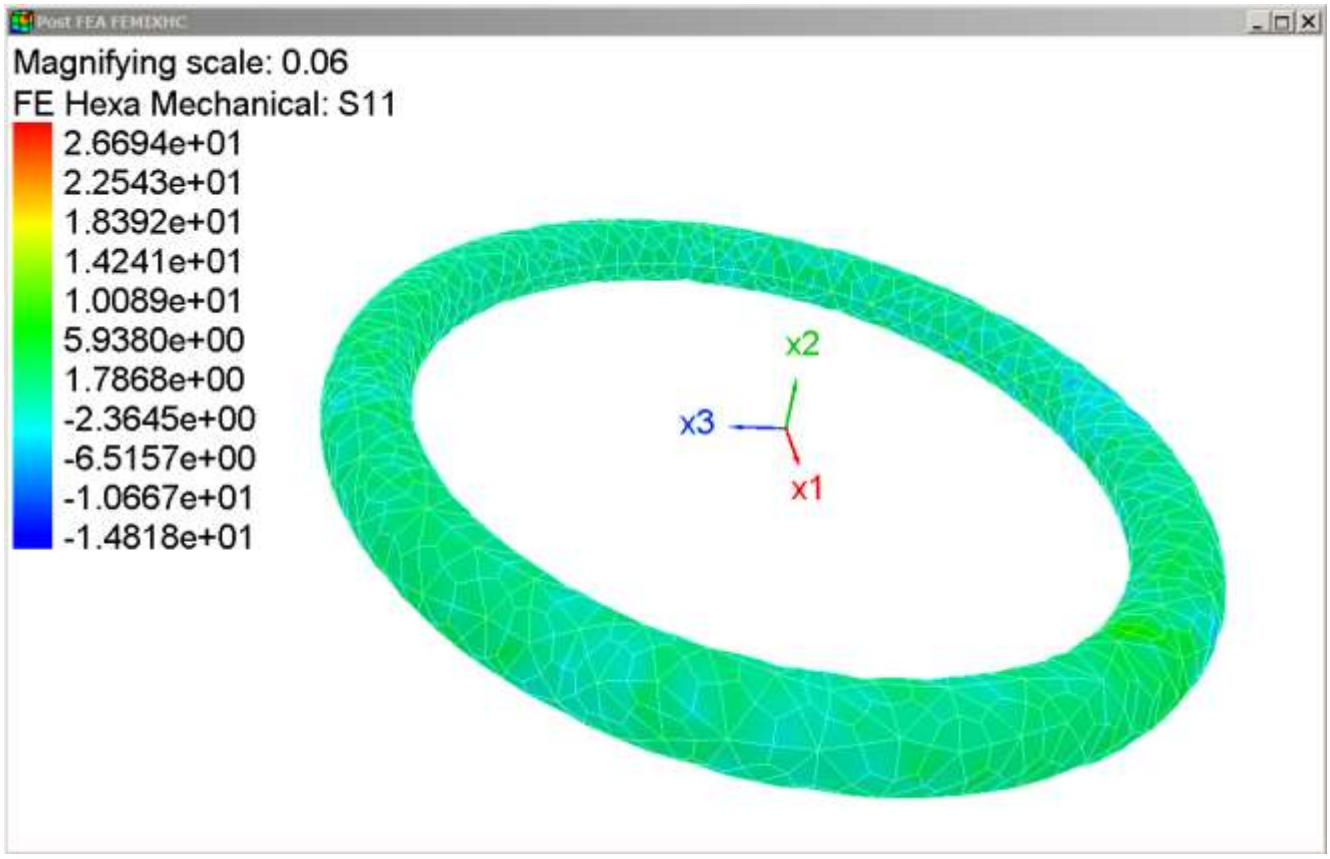

Post FEA FEMDOHC
Magnifying scale: 0.00
FE Hexa Mechanical: u2
7.4454e-02
6.2124e-02
4.9794e-02
3.7465e-02
2.5135e-02
1.2805e-02
4.7547e-04
-1.1854e-02
-2.4184e-02
-3.6514e-02
-4.8843e-02
x2
x3
x1

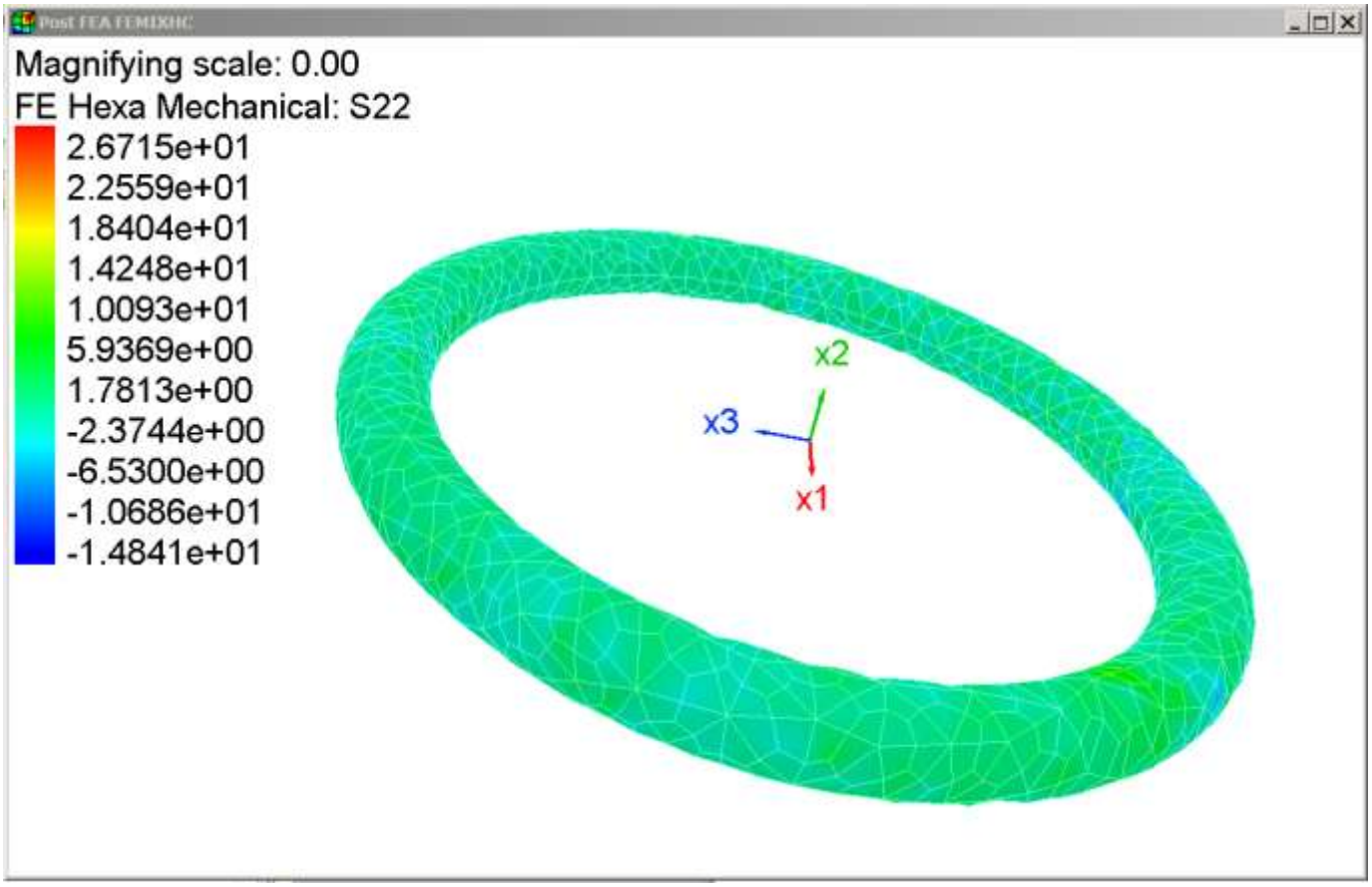

Post FEA FEMDOHC
Magnifying scale: 52.55
FE Hexa Mechanical: u2
7.4454e-02
6.2124e-02
4.9794e-02
3.7465e-02
2.5135e-02
1.2805e-02
4.7547e-04
-1.1854e-02
-2.4184e-02
-3.6514e-02
-4.8843e-02
x2
x3
x1

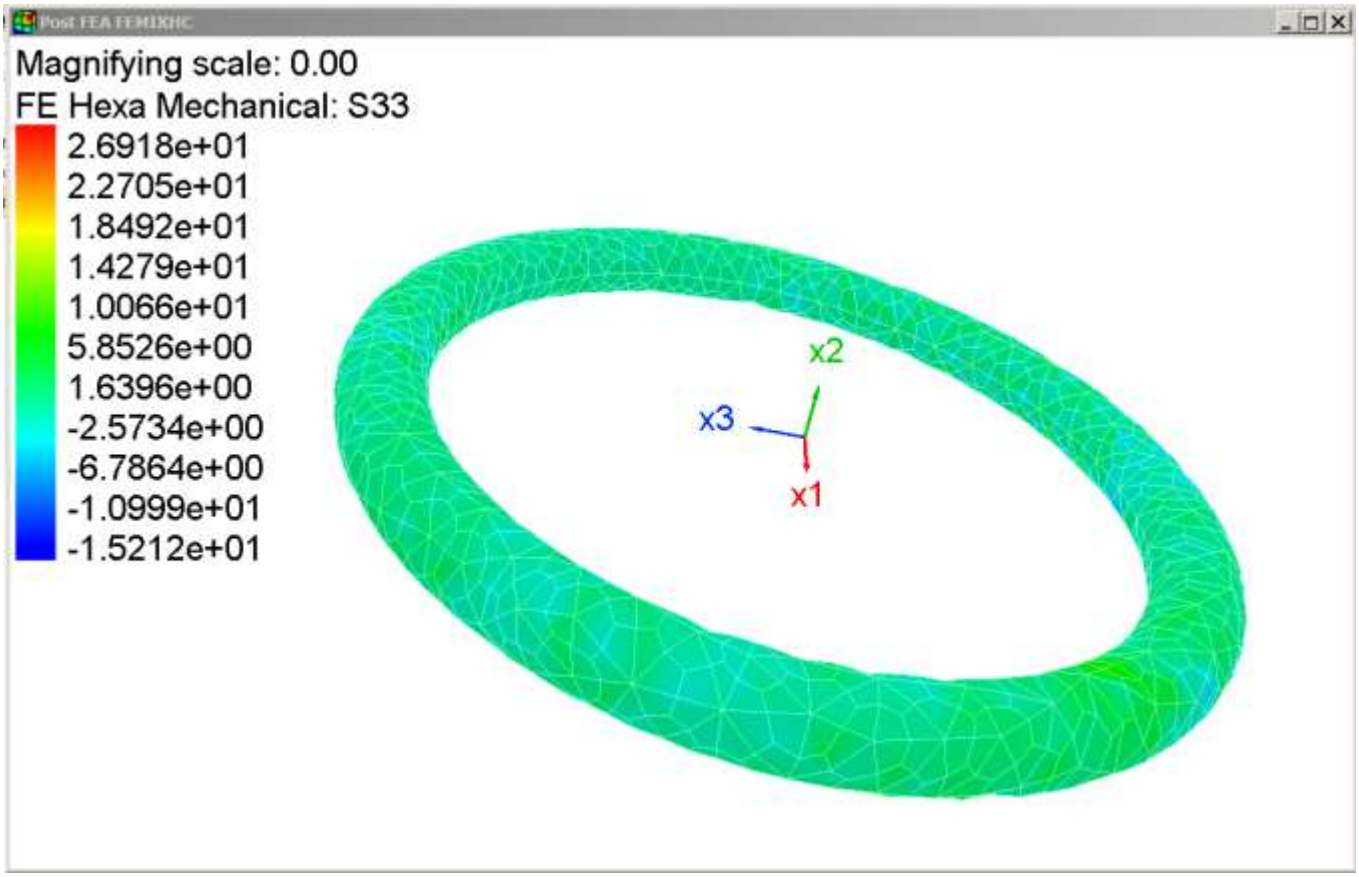

Post FEA FEMIXHC
Magnifying scale: 68.57
FE Hexa Mechanical: u2
7.4454e-02
6.2124e-02
4.9794e-02
3.7465e-02
2.5135e-02
1.2805e-02
4.7547e-04
-1.1854e-02
-2.4184e-02
-3.6514e-02
-4.8843e-02
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.00
FE Hexa Mechanical: u1
1.4418e-02
1.1298e-02
8.1782e-03
5.0585e-03
1.9388e-03
-1.1809e-03
-4.3006e-03
-7.4202e-03
-1.0540e-02
-1.3660e-02
-1.6779e-02
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.00
FE Hexa Mechanical: u3
2.2941e-02
2.0095e-02
1.7248e-02
1.4402e-02
1.1556e-02
8.7092e-03
5.8628e-03
3.0164e-03
1.7001e-04
-2.6764e-03
-5.5228e-03
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.06
FE Hexa Mechanical: S11
2.6694e+01
2.2543e+01
1.8392e+01
1.4241e+01
1.0089e+01
5.9380e+00
1.7868e+00
-2.3645e+00
-6.5157e+00
-1.0667e+01
-1.4818e+01
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.00
FE Hexa Mechanical: S22
2.6715e+01
2.2559e+01
1.8404e+01
1.4248e+01
1.0093e+01
5.9369e+00
1.7813e+00
-2.3744e+00
-6.5300e+00
-1.0686e+01
-1.4841e+01
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.00
FE Hexa Mechanical: S33
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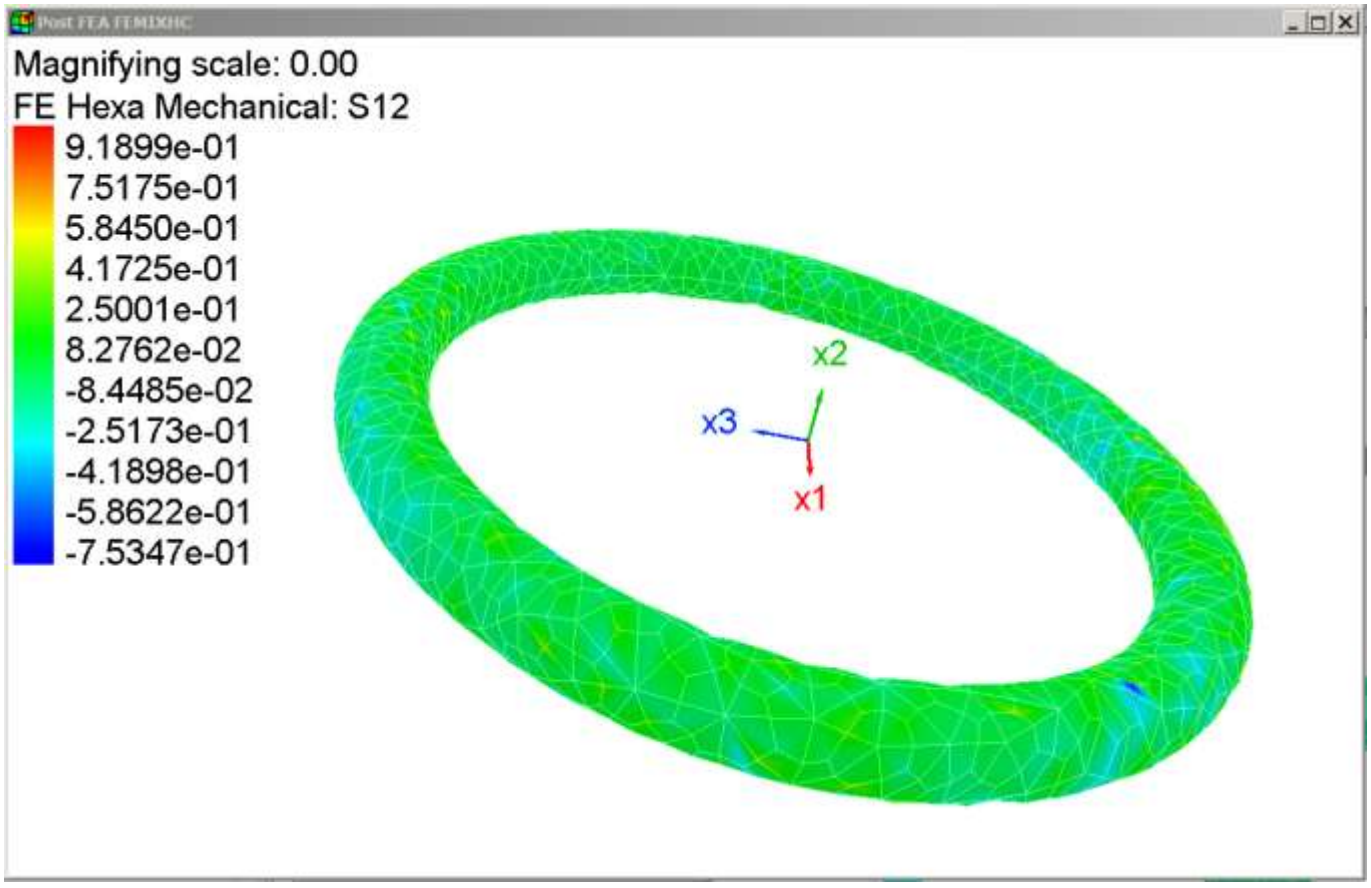
2.2705e+01
1.8492e+01
1.4279e+01
1.0066e+01
5.8526e+00
1.6396e+00
-2.5734e+00
-6.7864e+00
-1.0999e+01
-1.5212e+01
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.00
FE Hexa Mechanical: S12
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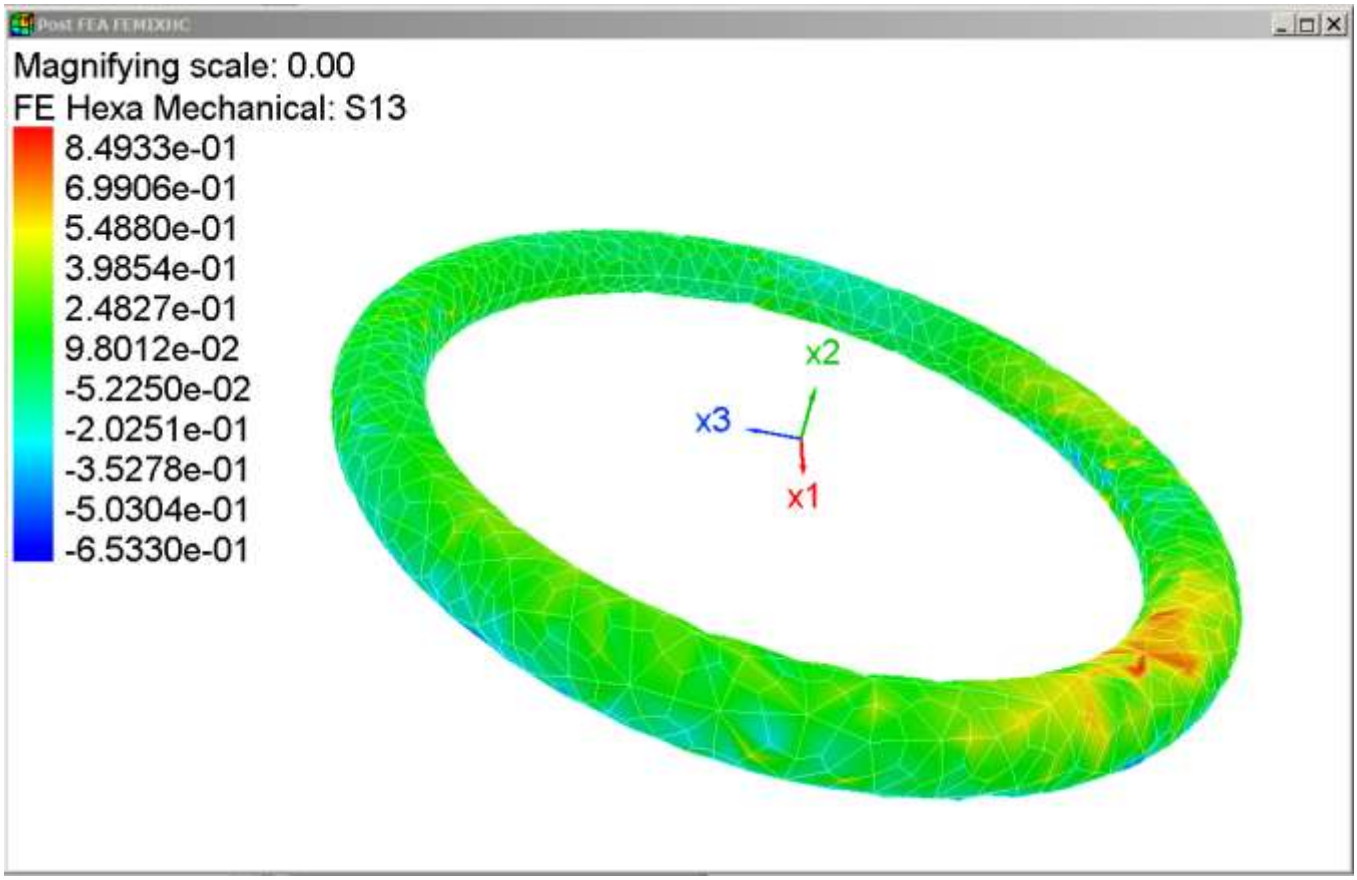
7.5175e-01
5.8450e-01
4.1725e-01
2.5001e-01
8.2762e-02
-8.4485e-02
-2.5173e-01
-4.1898e-01
-5.8622e-01
-7.5347e-01
x2
x3
x1


Post FEA FEMIXHC
Magnifying scale: 0.00
FE Hexa Mechanical: S13
8.4933e-01
6.9906e-01
5.4880e-01
3.9854e-01
2.4827e-01
9.8012e-02
-5.2250e-02
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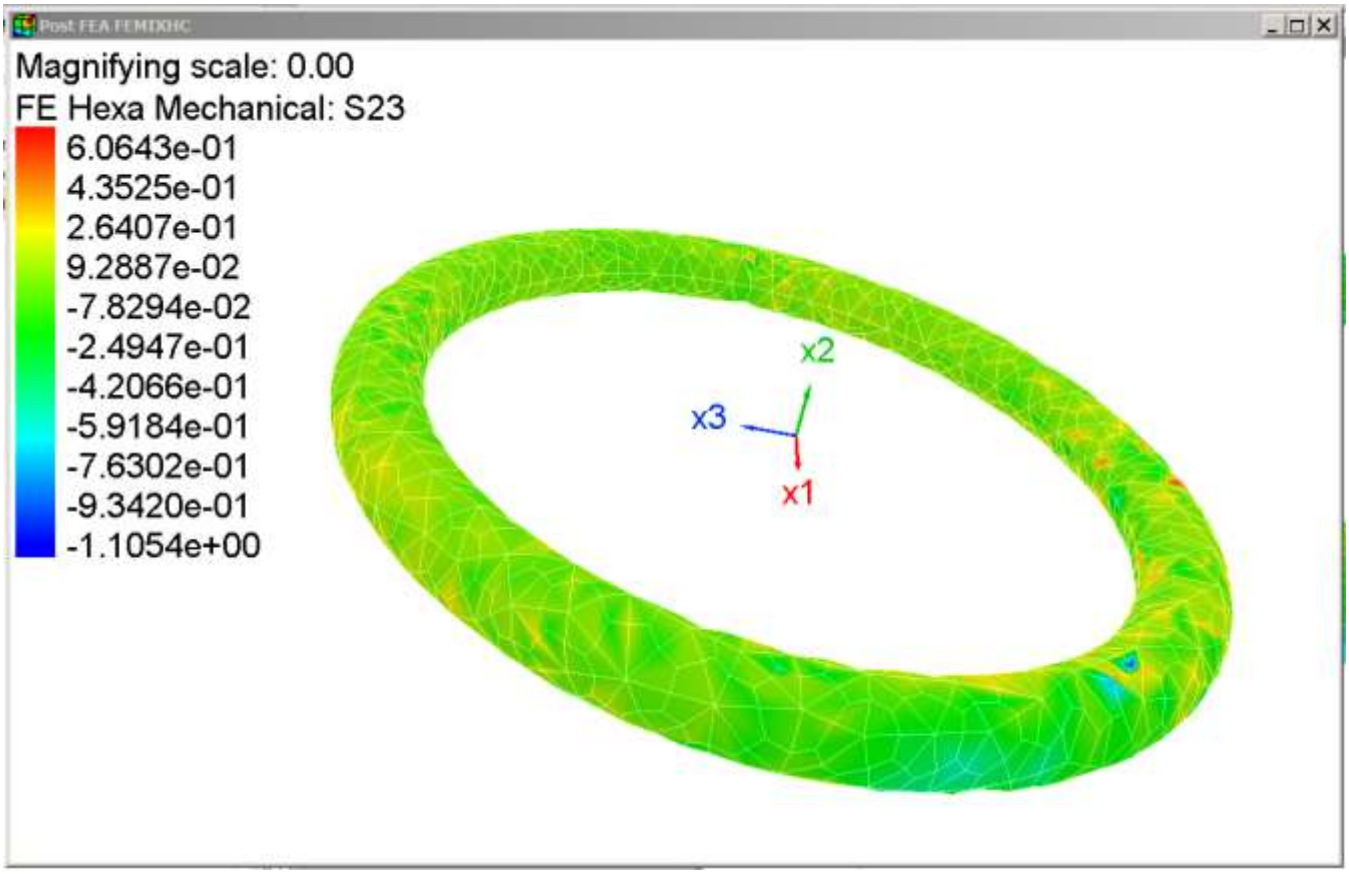
-5.0304e-01
-6.5330e-01
x2
x3
x1


Post FEA FEMXHC
Magnifying scale: 0.00
FE Hexa Mechanical: S23
6.0643e-01
4.3525e-01
2.6407e-01
9.2887e-02
-7.8294e-02
-2.4947e-01
-4.2066e-01
-5.9184e-01
-7.6302e-01
-9.3420e-01
-1.1054e+00
x2
x3
x1