LE4: Axisymmetric hyperbolic shell under uniform internal pressure

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This problem provides evidence that Abaqus can reproduce the result from the benchmark defined by NAFEMS and cited as the reference solution.

This page discusses:

ProductsAbaqus/Standard

Elements tested

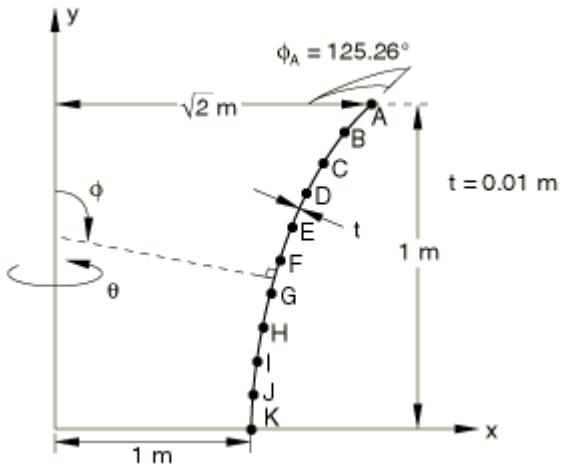
SAX1

SAX2

SAXA11

SAXA21

Problem description



Mesh:

A coarse and a fine mesh are tested for each element.

Material:

Linear elastic, Young's modulus = 210 GPa, Poisson's ratio = 0.3.

Boundary conditions:

At point B, uz=0.

Loading:

Uniform internal pressure of 1 MPa.

General:

Gauss integration is used for the shell cross-section for the SAXA11 elements.

Reference solution

This is a test recommended by the National Agency for Finite Element Methods and Standards (U.K.): Test LE4 from NAFEMS publication TNSB, Rev. 3, “The Standard NAFEMS Benchmarks,” October 1990.

Target solution: On the midsurface at point K the meridional stress, $\sigma\phi\phi$, is -50.0 MPa and the hoop stress, $\sigma\theta\theta$, is 50.0 MPa.

Results and discussion

The results are shown in the following table. The values enclosed in parentheses are percentage differences with respect to the reference solution.

Element Type	σϕϕ	σθθ
SAX1 (Coarse)	−49.69 (−0.62%)	49.99 (−0.02%)
SAX1 (Fine)	−49.99 (−0.02%)	49.92 (−0.16%)
SAX2 (Coarse)	−50.09 (0.18%)	48.33 (−3.3%)
SAX2 (Fine)	−50.02 (0.04%)	48.34 (−3.3%)
SAXA11 (Coarse)	−49.69 (−0.62%)	49.92 (−0.16%)
SAXA11 (Fine)	−49.99 (−0.02%)	49.20 (−1.6%)
SAXA21 (Coarse)	−50.09 (0.18%)	48.33 (−3.3%)
SAXA21 (Fine)	−50.02 (0.04%)	48.34 (−3.3%)

Input files

Coarse mesh tests:

esa2smsf.inp

: SAX1 elements.

esa3smsf.inp

: SAX2 elements.

esnssmsf.inp

: SAXA11 elements.

esnwsmsf.inp

: SAXA21 elements.

Fine mesh tests:

esa2sfsf.inp

: SAX1 elements.

esa3sfsf.inp

: SAX2 elements.

esnssfsf.inp

: SAXA11 elements.

esnwsfsf.inp

SAXA21 elements.