LE6: Skew plate under normal 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/StandardAbaqus/Explicit

Elements tested

S4R

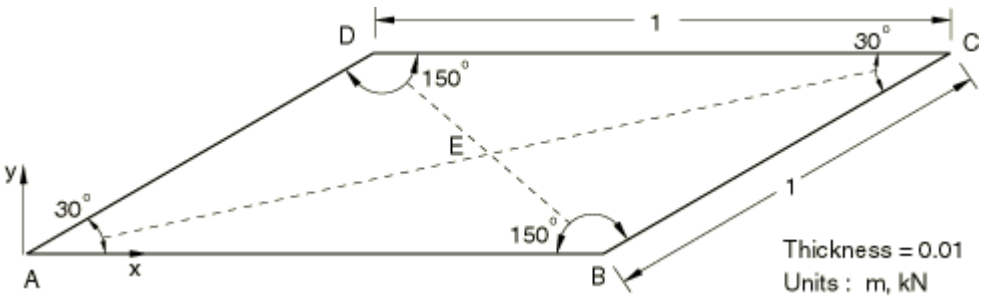
S4RS

S4RSW

S8R5

S9R5

Problem description



Model:

Skew plate under normal pressure.

Mesh:

A coarse (2 × 2) and a fine (4 × 4) are tested for each element. In addition, a very fine (8 × 8) mesh is tested for each element in the explicit dynamic analysis.

Material:

Linear elastic, Young's modulus = 210 GPa, Poisson's ratio = 0.3, density = 7800 kg/m^3.

Boundary conditions:

uz=0 along edges AB, BC, CD, and AD. ux=uy= 0 at point A and uy=0 at point B to prevent rigid body motion.

Loading:

Uniform pressure of −7.0 kPa in the vertical z-direction. In the explicit dynamic analysis the loading is applied such that a quasi-static solution is obtained.

Reference solution

This is a test recommended by the National Agency for Finite Element Methods and Standards (U.K.): Test LE6 from NAFEMS Publication TNSB, Rev. 3, “The Standard NAFEMS Benchmarks,” October 1990.

Target solution: Maximum principal stress = 0.802 MPa on the lower surface at point E.

Results and discussion

The results are shown in Table 1 and Table 2. The values enclosed in parentheses are percentage differences with respect to the reference solution.

Table 1. Abaqus/Standard analysis.

Element	Coarse Mesh	Fine Mesh
S8R5	1.156 MPa (+44.1%)	0.862 MPa (+7.5%)
S9R5	1.156 MPa (+44.1%)	0.862 MPa (+7.5%)

Table 2. Abaqus/Explicit analysis.

Element	Coarse Mesh	Fine Mesh	Very Fine Mesh
S4R	0.338 MPa (−58%)	0.703 MPa (−12.3%)	0.765 MPa (−4.61%)
S4RS	0.343 MPa (−57%)	0.745 MPa (−7.11%)	0.8021 MPa (+0.01%)
S4RSW	0.341 MPa (−57%)	0.674 MPa (−16.0%)	0.8034 MPa (+0.17%)

Remarks

The skew sensitivity of shell elements is discussed in Skew sensitivity of shell elements.

Input files

Abaqus/Standard input files

Coarse mesh tests:

nle6x58c.inp

S8R5 elements.

nle6x59c.inp

S9R5 elements.

Fine mesh tests:

nle6x58f.inp

S8R5 elements.

nle6x59f.inp

S9R5 elements.

Abaqus/Explicit input files

Coarse mesh tests:

le6_c.inp

S4R elements.

le6_c_s4rs.inp

S4RS elements.

le6_c_s4rsw.inp

S4RSW elements.

Refined mesh tests:

le6_f.inp

S4R elements.

le6_f_s4rs.inp

S4RS elements.

le6_f_s4rsw.inp

S4RSW elements.

Very refined mesh tests:

le6_vf.inp

S4R elements.

le6_vf_s4rs.inp

S4RS elements.

le6_vf_s4rsw.inp

S4RSW elements.