LE5: Z-section cantilever

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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:

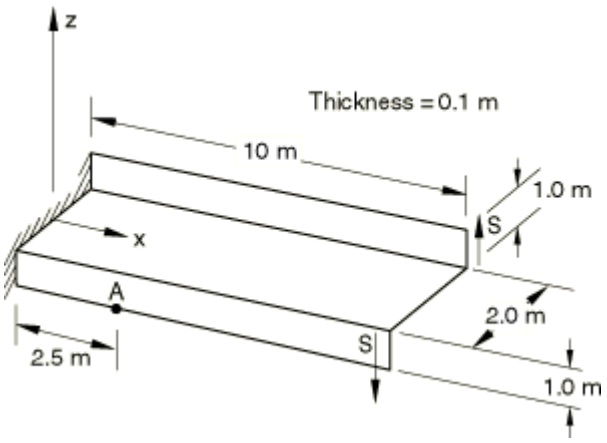
ProductsAbaqus/StandardAbaqus/Explicit

Elements tested

- S3
- S3R
- S4R
- S4R5
- S4RS
- S4RSW
- S8R
- S8R5
- S9R5
- STRI3
- STRI65

- B31OS
- B32OS

Problem description



Model:

Z-section cantilever under torsional loading.

Material:

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

Boundary conditions:

All displacements are zero along the edge at x= 0.

Loading:

Torque of 1.2 MN-m applied at x= 10. The torque is applied by two uniformly distributed edge shears of 0.6 MN at each flange when shell elements are used. In the explicit dynamic analysis the loading rate 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 LE5 from NAFEMS publication TNSB, Rev. 3, “The Standard NAFEMS Benchmarks,” October 1990.

Target solution: Axial stress, σxx= −108 MPa at midsurface, point A.

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. Slow convergence toward the target solution is seen as the mesh is refined.

Table 1. Abaqus/Standard analysis.

Element	σxx, Coarse Mesh	σxx, Refined Mesh
S3/S3R	−24.266 MPa (−78%)	−92.166 MPa (−15%)
S4	−110.36 MPa (2.2%)	−110.38 MPa (2.2%)
S4R	−50.480 MPa (−53%)	−96.732 MPa (−10%)
S4R5	−50.116 MPa (−54%)	−96.378 MPa (−11%)
S8R	−109.85 MPa (1.7%)	—
S8R5	−109.72 MPa (1.6%)	—
S9R5	−109.72 MPa (1.6%)	—
STRI3	−30.389 MPa (−72%)	−94.532 MPa (−12%)
STRI65	−107.32 MPa (−0.63%)	—
B31OS	−108.09 MPa (0.08%)	—
B32OS	−107.34 MPa (−0.61%)	—

Table 2. Abaqus/Explicit analysis.

Element	σxx, Coarse Mesh	σxx, Refined Mesh
S4R	−49.5 MPa (−54%)	−100.3 MPa (−7.1%)
S4RS	−87.5 MPa (−19%)	−100.3 MPa (−7.1%)
S4RSW	−87.7 MPa (−19%)	−100.3 MPa (−7.1%)

Input files

Abaqus/Standard input files

Coarse mesh tests:

nle5xf3c.inp

S3/S3R elements.

nle5xe4c.inp

S4 elements.

nle5xf4c.inp

S4R elements.

nle5x54c.inp

S4R5 elements.

nle5x68c.inp

S8R elements.

nle5x58c.inp

S8R5 elements.

nle5x59c.inp

S9R5 elements.

nle5x63c.inp

STRI3 elements.

nle5x56c.inp

STRI65 elements.

nle5xb2c.inp

B31OS elements.

nle5xb3c.inp

B32OS elements.

Fine mesh tests:

nle5xf3f.inp

S3/S3R elements.

nle5xe4f.inp

S4 elements.

nle5xf4f.inp

S4R elements.

nle5x54f.inp

S4R5 elements.

nle5x63f.inp

STRI3 elements.

Abaqus/Explicit input files

Coarse mesh tests:

le5_c.inp

S4R elements.

le5_c_s4rs.inp

S4RS elements.

le5_c_s4rsw.inp

S4RSW elements.

Fine mesh tests:

le5_f.inp

S4R elements.

le5_f_s4rs.inp

S4RS elements.

le5_f_s4rs_subcyc.inp

S4RS elements and subcycling.

le5_f_s4rsw.inp

S4RSW elements.