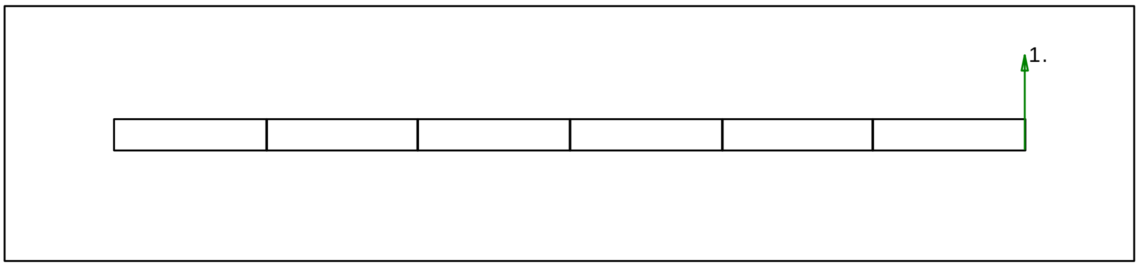
Problem Straight Cantilever Beam modeled with regular shape elements.

Reference R.H. Macneal and R.L.Harder, "A Proposed Standard Set of Problems To Test Finite Element Accuracy," Finite Elements in Analysis and Design, 1, pp 3-20, 1985.

Data Length = 6.0, Width = 0.2, Depth = 0.1
Young's Modulus =10.0E6, Poisson's ratio = 0.3, Mass Density=2.53881E-4
Loading: Unit force at free end.
Constraints: Fixed at one end and all out-of plane translations and rotations are fixed.

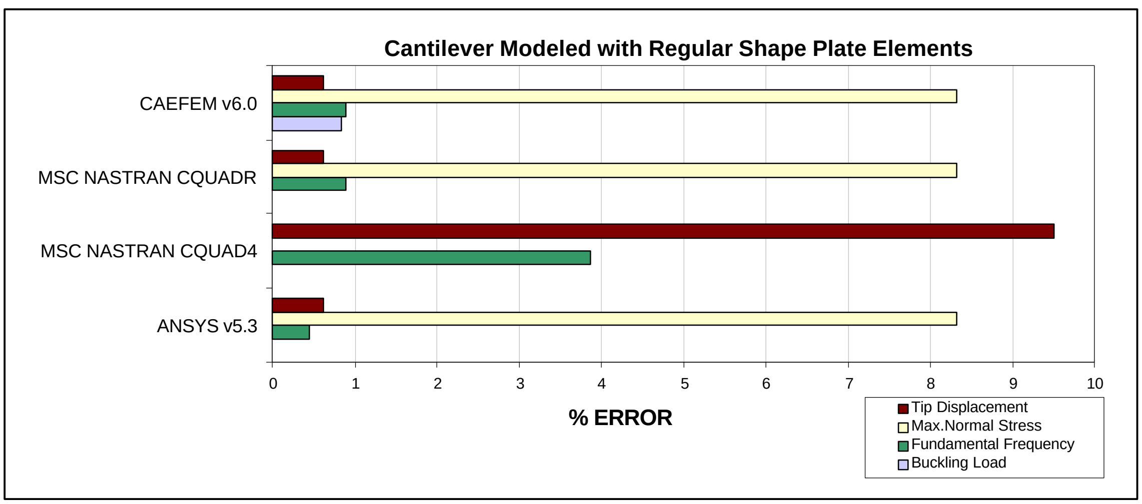
Comments This is a cantilever beam subjected to in-plane loading. The aspect ratio of the elements of this problem is 5.0. Hence this problem demonstrates the performance of various elements with such a high aspect ratio.

CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated from FEMAP)



Analytical Solution:

Tip Deflection	Max. Normal Stress at fixed end	Fundamental frequency	Buckling Load due to axial load
0.1081	9000	178.0 Hz	45.69



Bar charts currently not shown: Buckling load for MSC NASTRAN and ANSYS, and Max. Normal Stress for MSC NASTRAN CQUAD4

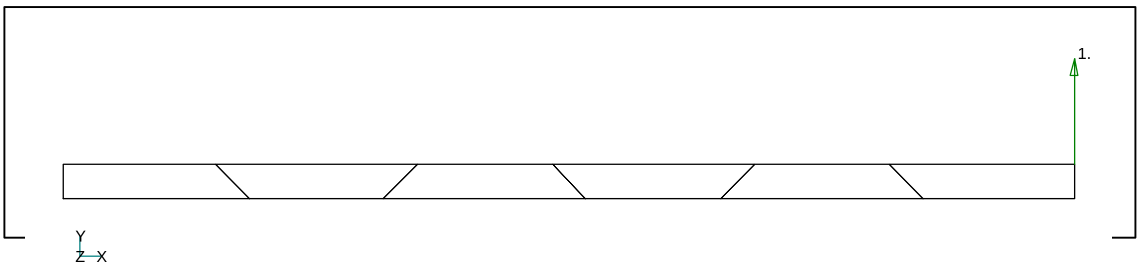
Problem Straight Cantilever Beam modeled with trapezoidal shape elements.

Reference R.H. Macneal and R.L.Harder, “A Proposed Standard Set of Problems To Test Finite Element Accuracy,” Finite Elements in Analysis and Design, 1, pp 3-20, 1985.

Data Length = 6.0, Width = 0.2, Depth = 0.1
Young’s Modulus =10.0E6, Poisson’s ratio = 0.3, Mass Density=2.53881E-4
Loading: Unit force at free end.
Constraints: Fixed at one end and all out-of plane translations and rotations are fixed.

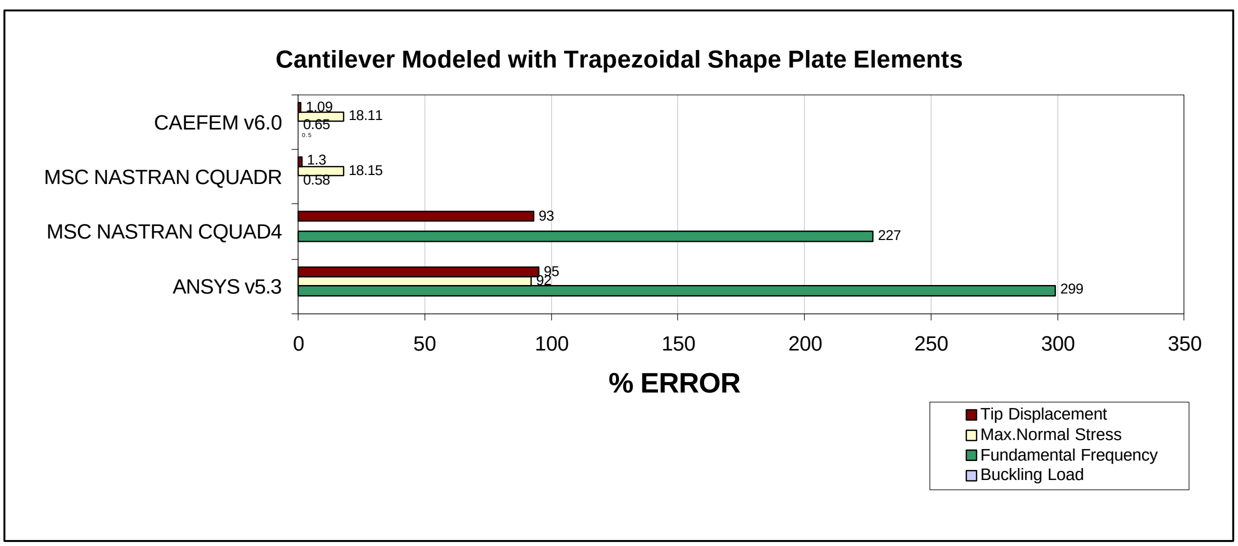
Comments This is a cantilever beam subjected to in-plane loading. The aspect ratio of very distorted elements of this problem is 5.0. Hence this problem demonstrates the performance of distorted elements with high aspect ratio.

CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated using FEMAP)



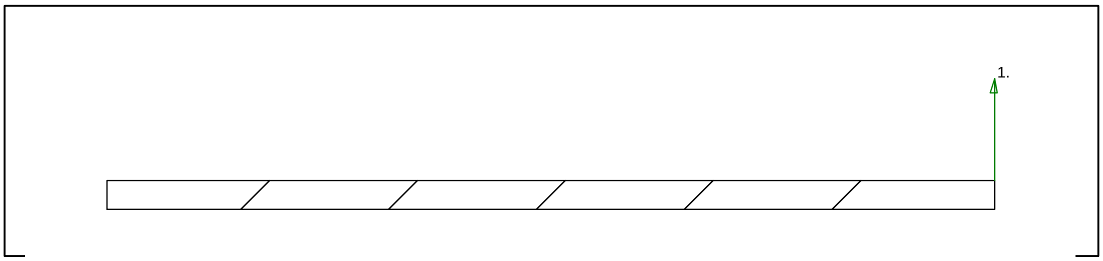
Analytical Solution:

Tip Deflection	Max. Normal Stress at fixed end	Fundamental frequency	Buckling Load due to axial load
0.1081	9000	178.0 Hz	45.69



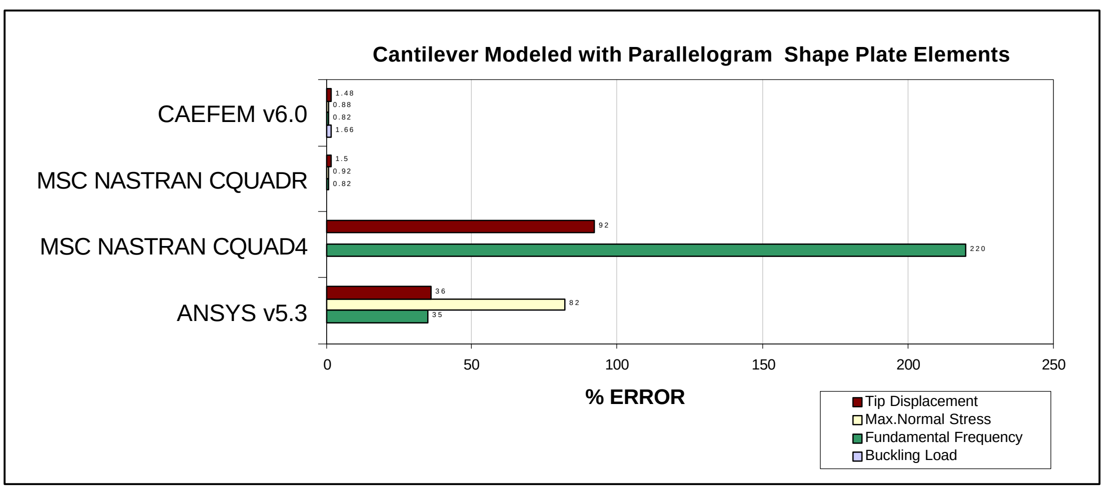
Note: Bar charts currently not shown: Buckling load for MSC NASTRAN and ANSYS, and Max. Normal Stress for MSC NASTRAN CQUAD4

Problem	Straight Cantilever Beam modeled with parallelogram shape elements.
Reference	R.H. Macneal and R.L.Harder, “A Proposed Standard Set of Problems To Test Finite Element Accuracy,” Finite Elements in Analysis and Design, 1, pp 3-20, 1985.
Data	Length = 6.0, Width = 0.2, Depth = 0.1 Young’s Modulus =10.0E6, Poisson’s ratio = 0.3, Mass Density=2.53881E-4 Loading: Unit force at free end. Constraints: Fixed at one end and all out-of plane translations and rotations are fixed.
Comments	This is a cantilever beam subjected to in-plane loading. The aspect ratio of very distorted elements of this problem is 5.0. Hence this problem demonstrates the performance of distorted elements with high aspect ratio. CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated using FEMAP)



Analytical Solution:

Tip Deflection	Max. Normal Stress at fixed end	Fundamental frequency	Buckling Load due to axial load
0.1081	9000	178.0 Hz	45.69



Bar Charts currently not shown: Buckling load for MSC NASTRAN and ANSYS, and Max. Normal Stress for MSC NASTRAN CQUAD4

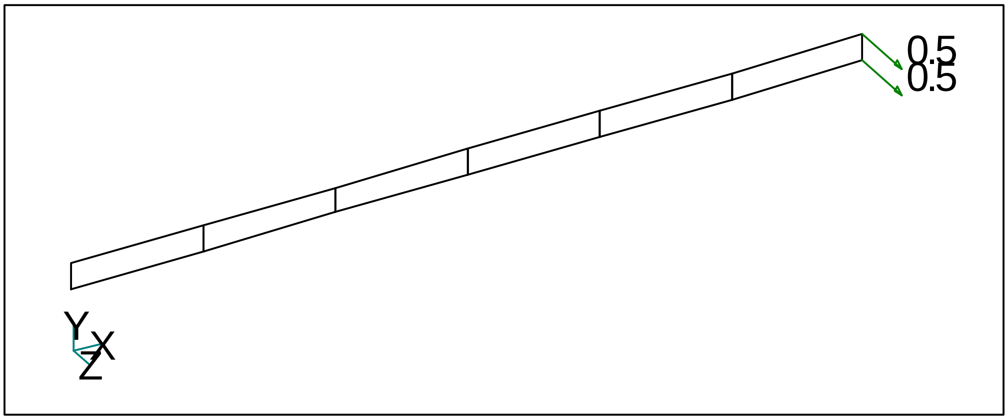
Problem Straight Cantilever Beam modeled by regular shape elements.

Reference R.H. Macneal and R.L.Harder, "A Proposed Standard Set of Problems To Test Finite Element Accuracy," Finite Elements in Analysis and Design, 1, pp 3-20, 1985.

Data Length = 6.0, Width = 0.2, Depth = 0.1
Young's Modulus =10.0E6, Poisson's ratio = 0.3, Mass Density=2.53881E-4
Loading: Unit force at free end.
Constraints: Fixed at one end.

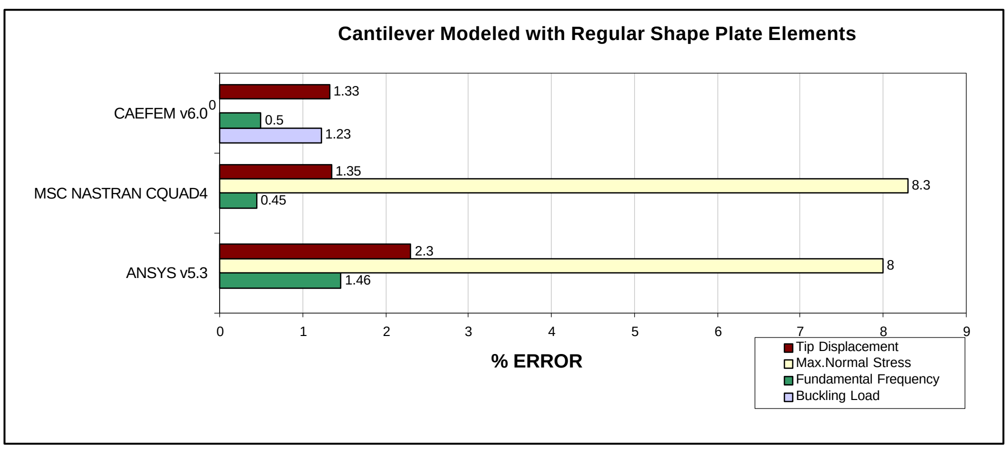
Comments This is a cantilever beam subjected to out-of-plane loading. The aspect ratio of the elements of this problem is 5.0. Hence this problem demonstrates the performance of various elements with such a high aspect ratio. Neglect Shear Deformation

CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3



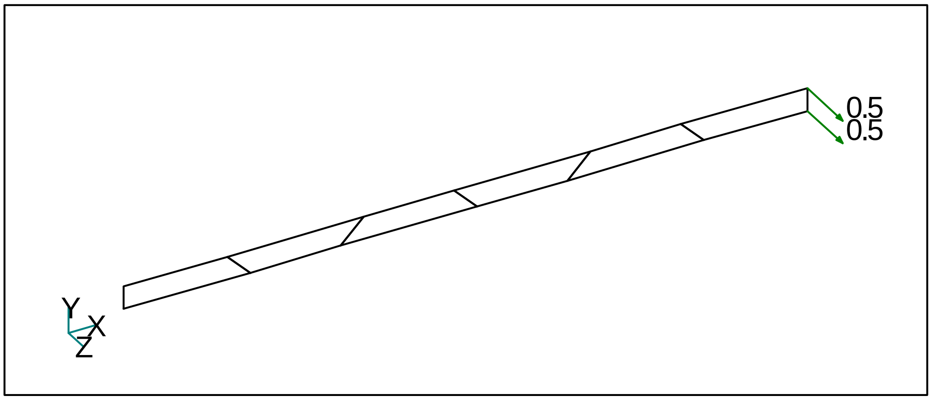
Analytical Solution:

Tip Deflection	Max. Normal Stress at fixed end	Fundamental frequency	Buckling Load due to axial load
0.432	18000		11.42



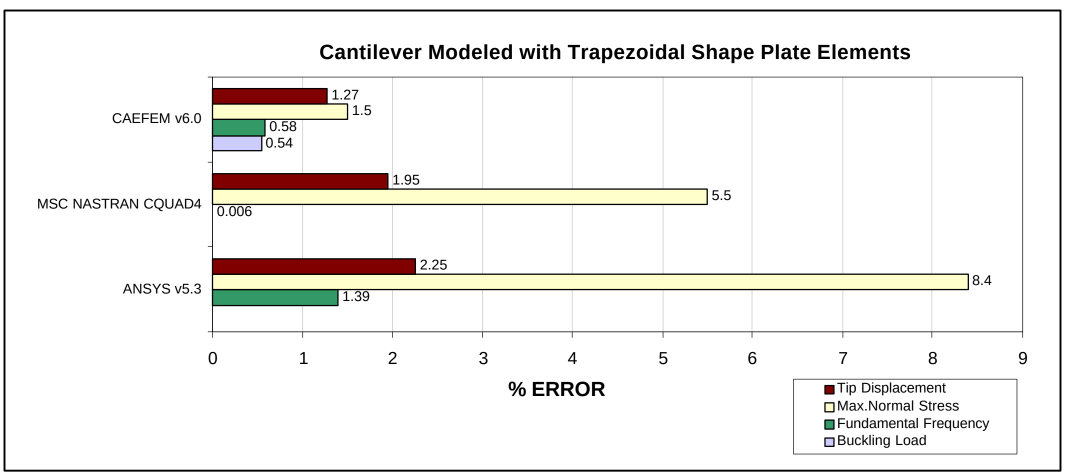
Note: Bar charts currently not shown: Buckling loads for MSC NASTRAN and ANSYS

Problem	Straight Cantilever Beam modeled by trapezoidal shape elements.
Reference	R.H. Macneal and R.L.Harder, “A Proposed Standard Set of Problems To Test Finite Element Accuracy,” Finite Elements in Analysis and Design, 1, pp 3-20, 1985.
Data	Length = 6.0, Width = 0.2, Depth = 0.1 Young’s Modulus =10.0E6, Poisson’s ratio = 0.3, Mass Density=2.53881E-4 Loading: Unit force at free end. Constraints: Fixed at one end.
Comments	This is a cantilever beam subjected to out-of-plane loading. The aspect ratio of very distorted elements of this problem is 5.0. Hence this problem demonstrates the performance of distorted elements with high aspect ratio. Neglect Shear Deformation. CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3



Analytical Solution:

Tip Deflection	Max. Normal Stress at fixed end	Fundamental frequency	Buckling Load due to axial load
0.432	18000	89.096 Hz	11.42



Note: Bar charts currently not shown: Buckling loads for MSC NASTRAN and ANSYS

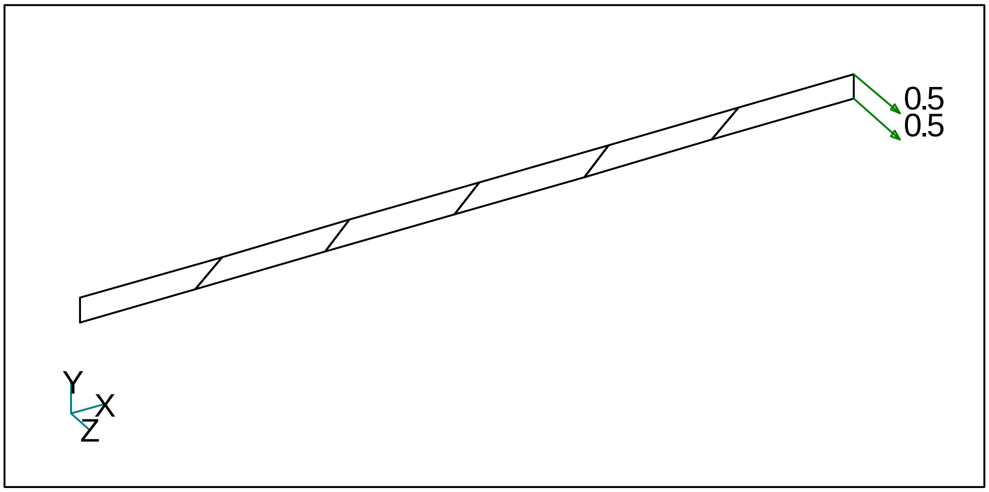
Problem — Straight Cantilever Beam modeled by parallelogram shape elements.

Reference — R.H. Macneal and R.L.Harder, "A Proposed Standard Set of Problems To Test Finite Element Accuracy," Finite Elements in Analysis and Design, 1, pp 3-20, 1985.

Data — Length = 6.0, Width = 0.2, Depth = 0.1
Young's Modulus =10.0E6, Poisson's ratio = 0.3, Mass Density=2.53881E-4
Loading: Unit force at free end.
Constraints: Fixed at one end.

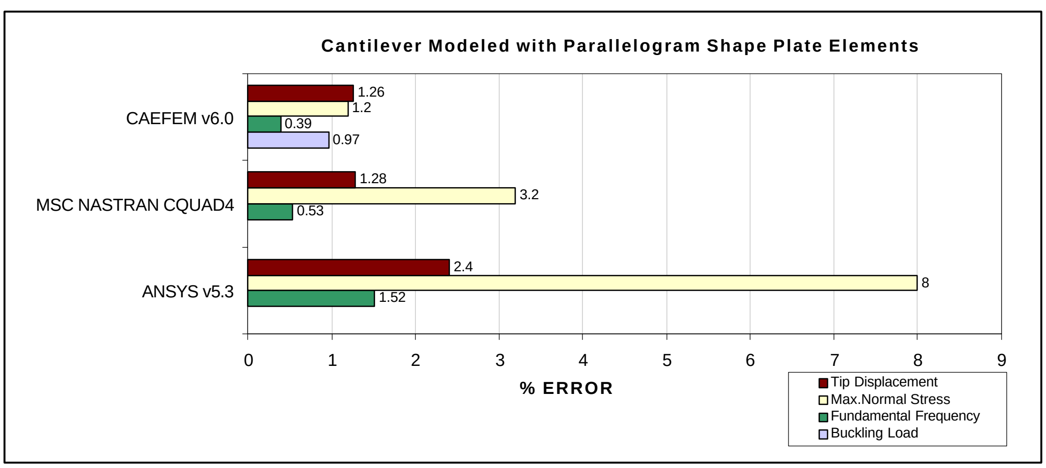
Comments — This is a cantilever beam subjected to out-of-plane loading. The aspect ratio of very distorted elements of this problem is 5.0. Hence this problem demonstrates the performance of distorted elements with high aspect ratio. Neglect Shear Deformation

CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3



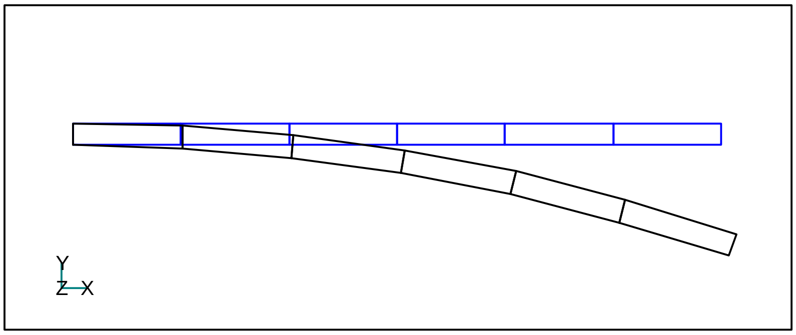
Analytical Solution:

Tip Deflection	Max. Normal Stress at fixed end	Fundamental frequency	Buckling Load due to axial load
0.432	18000	89.096 Hz	11.42



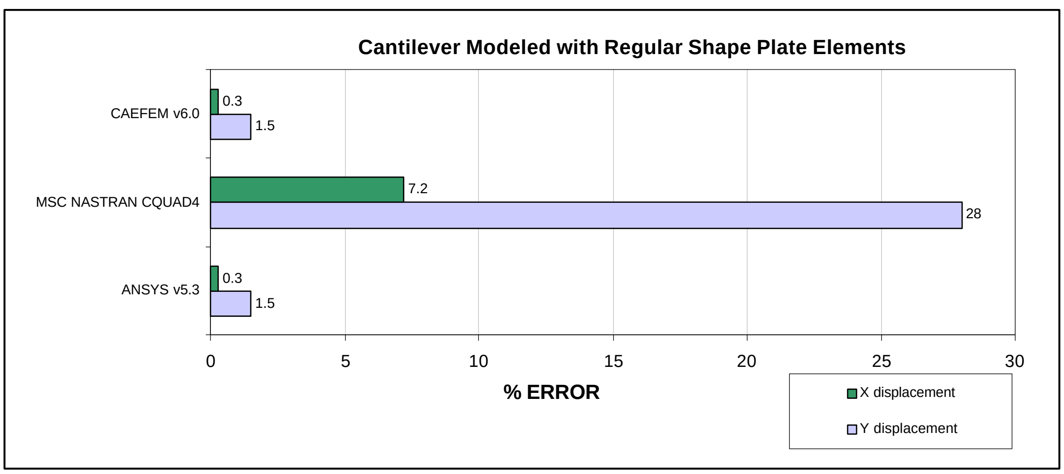
Note: Bar charts currently not shown: Buckling load for MSC NASTRAN and ANSYS

Problem	Straight Cantilever Beam modeled with regular shape elements subjected to temperatures
Reference	Bruno A. Boley and Jerome H. Weiner, “Theory of Thermal Stresses,” page 279, Dover Publications Inc., Mineola, New York 1997.
Data	Length = 6.0, Width = 0.2, Depth = 0.1 Young’s Modulus =10.0E6, Poisson’s ratio = 0.3 Coefficient of thermal expansion=1.265E-5, Reference temperature = 0^0F Loading: Top surface is maintained at 200^0F and bottom surface is maintained at 100^0F Constraints: Fixed at one end.
Comments	Deformation due to temperature loading is considered in this problem. The aspect ratio of the elements of this problem is 5.0. Hence this problem demonstrates the performance of various elements with such a high aspect ratio. Both undeformed and deformed shapes are shown in the figure. CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated from FEMAP)



Analytical Solution:

Deflection of node located at top right corner
X displacement: 0.015225, Y displacement: -0.1152



Problem: Curved Beam modeled with regular shape elements.

Reference: R.H. Macneal and R.L.Harder, “A Proposed Standard Set of Problems To Test Finite Element Accuracy,” Finite Elements in Analysis and Design, 1, pp 3-20, 1985.

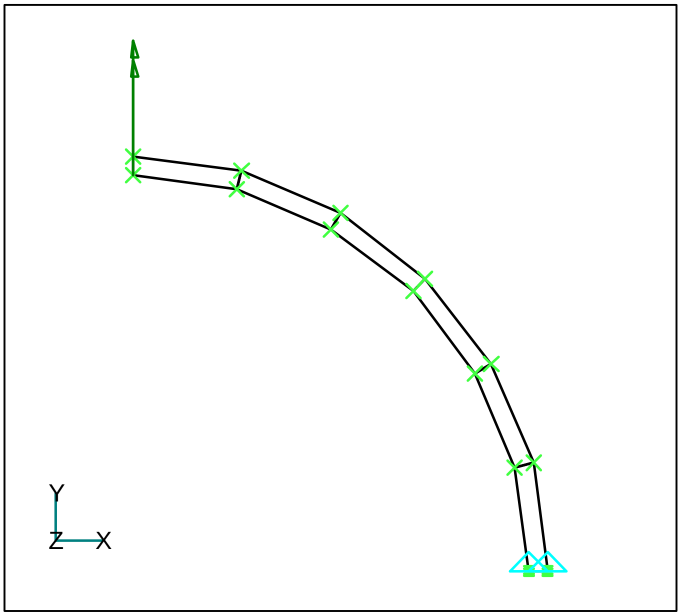
Data: Inner radius = 4.12, Outer radius = 4.32, Thickness = 0.1, arc = 90^0
Young’s Modulus =10.0E6, Poisson’s ratio = 0.25, Mass Density=2.53881E-4
Loading: Unit force at free end.
Constraints: Fixed at one end and all out-of plane translations and rotations are fixed.

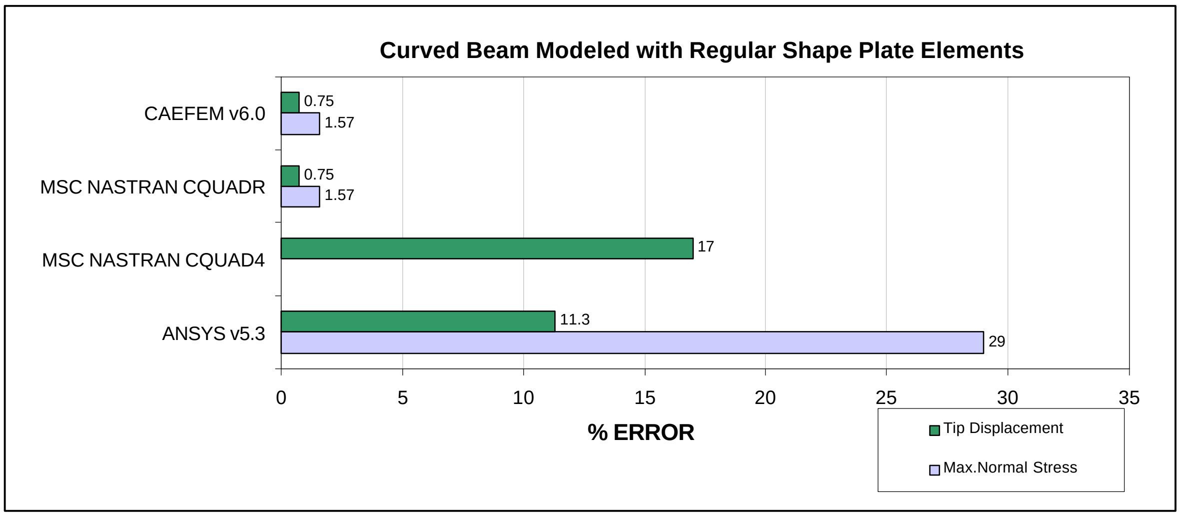
Comments: This is a curved beam subjected to in-plane shear. The aspect ratio of very distorted elements of this problem is 5.0. Hence this problem demonstrates the performance of distorted elements with high aspect ratio.

CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated using FEMAP)

Analytical Solution:

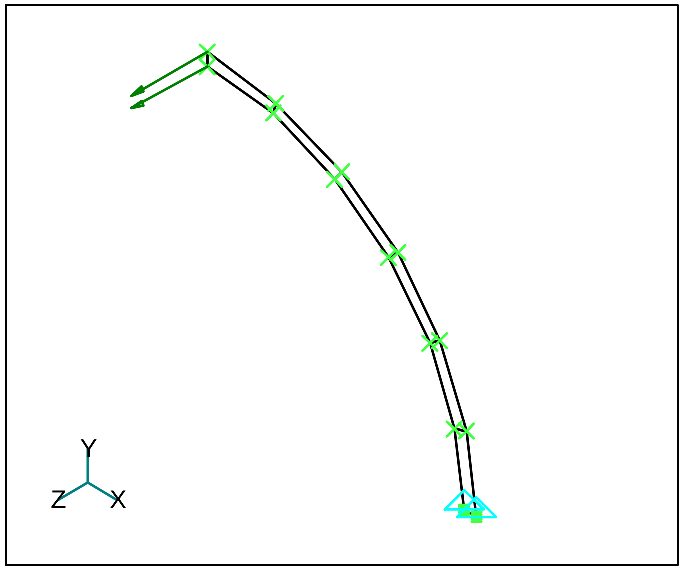
Tip Deflection	Max. Normal Stress at fixed end at r=4.12
0.08734	6180





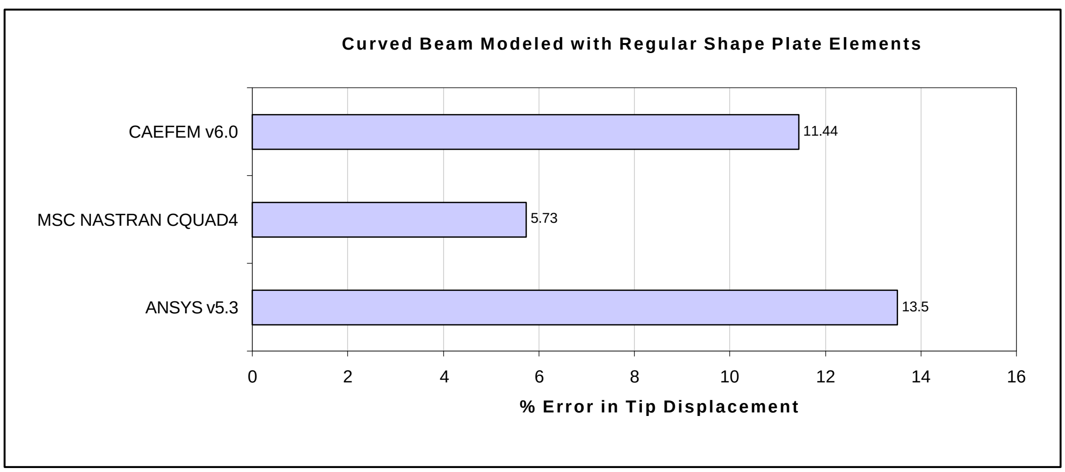
Note: Bar chart currently not shown for Max. Normal Stress for MSC NASTRAN CQUAD4

Problem	Curved Beam modeled with regular shape elements.
Reference	R.H. Macneal and R.L.Harder, “A Proposed Standard Set of Problems To Test Finite Element Accuracy,” Finite Elements in Analysis and Design, 1, pp 3-20, 1985.
Data	Inner radius = 4.12, Outer radius = 4.32, Thickness = 0.1, arc = 90^0 Young’s Modulus =10.0E6, Poisson’s ratio = 0.25, Mass Density=2.53881E-4 Loading: Unit force at free end. Constraints: Fixed at one end.
Comments	This is a curved beam subjected to out-of-plane shear. The aspect ratio of very distorted elements of this problem is 5.0. Hence this problem demonstrates the performance of distorted elements with high aspect ratio. CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated from FEMAP)



Analytical Solution:

Tip Deflection
0.5022



Problem Morley's Spherical Shell.

Reference R.H. Macneal and R.L.Harder, "A Proposed Standard Set of Problems To Test Finite Element Accuracy," Finite Elements in Analysis and Design, 1, pp 3-20, 1985.

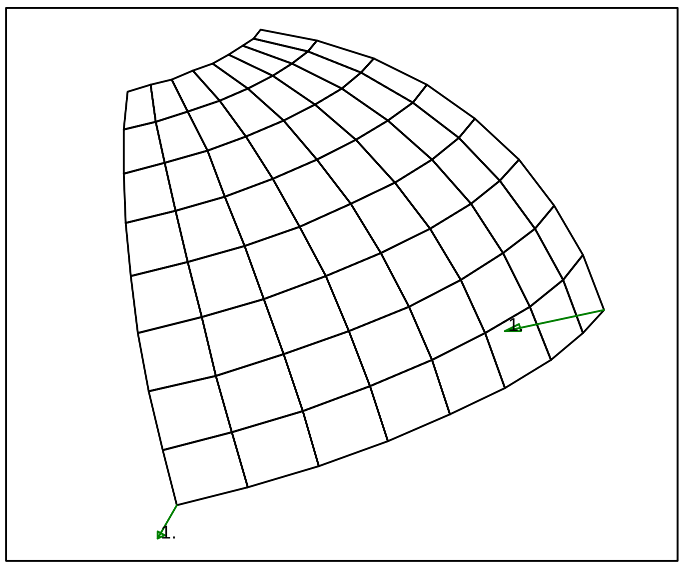
Also

Morley, L.S.D. and A.J. Morris, Conflict between Finite Elements and Shell Theory, Royal Aircraft Establishment Report, London, 1978.

Data Radius of Shell = 10.0, Thickness=0.04
Young's Modulus =6.825E7, Poisson's ratio = 0.3
Loading: Unit forces as shown.
Constraints: Symmetric boundary conditions along vertical edges.

Comments It is a doubly-curved shell problem. The equator is a free edge so that this problem represents a hemisphere with four point loads alternating in sign at 90 degree intervals on the equator. **Both membrane and bending strains contribute significantly to the radial displacement at the load point**.

CAEFEM v6.0, MSC NASTRAN for Windows v1.0, ANSYS v5.3 (generated using FEMAP)



Reference Solution:

Deflection under load: 0.094