



COMPUtational
ASsessment
Suite

COMPUtational·ASsessment·Suite

STRATOFEM™ ●

Validation V1



STRATOFEM™

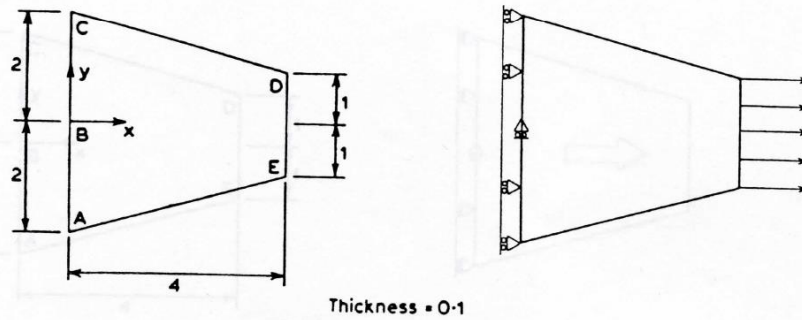
Author : Dr Argiris KAMOULAKOS

Contents

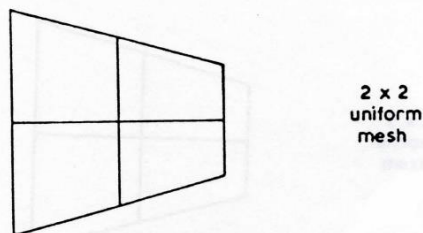
NAFEMS Benchmark B1.1: Tapered Membrane End Load	2
NAFEMS Benchmark B1.1: Tapered Membrane X Gravity Loading	4
NAFEMS Benchmark B1.1: Tapered Membrane Edge Shear	6
NAFEMS Benchmark B1.1: Tapered Membrane Y Gravity Loading	8
NAFEMS Benchmark B1.2: Tapered Plate Z Edge Shear	10
NAFEMS Benchmark B1.2: Tapered Plate Z Gravity Loading	12
NAFEMS Benchmark B2.2: Circular Membrane Point Load	14
NAFEMS Benchmark B3.1: Elliptic Plate Normal Pressure	16
NAFEMS Benchmark B3.2: Skew Plate Normal Pressure	18
NAFEMS Benchmark B4.1: Hemisphere External Pressure	20
NAFEMS Benchmark B4.2: Hemisphere Point Loads.....	22
NAFEMS Benchmark B4.3: Cylindrical Shell Edge Moment	24
NAFEMS Benchmark B4.4: Cylindrical Shell Pressure Load	27
McNeil Hemisphere: Pinch Loads	30
Scordelis-Lo Roof : Cylindrical Shell Under Self-Weight	32

NAFEMS Benchmark B1.1: Tapered Membrane End Load

NAFEMS	TAPERED MEMBRANE END LOAD	TEST No IC 1	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic membrane		
GEOMETRY			



LOADING	Uniformly distributed horizontal load of 10MN/m (pressure of 100MPa) along outer edge DE
BOUNDARY CONDITIONS	Edge AC zero x displacement At B zero y displacement
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3$ MPa, $\nu = 0.3$
ELEMENT TYPES	Plane stress quadrilaterals or triangles
MESHES	



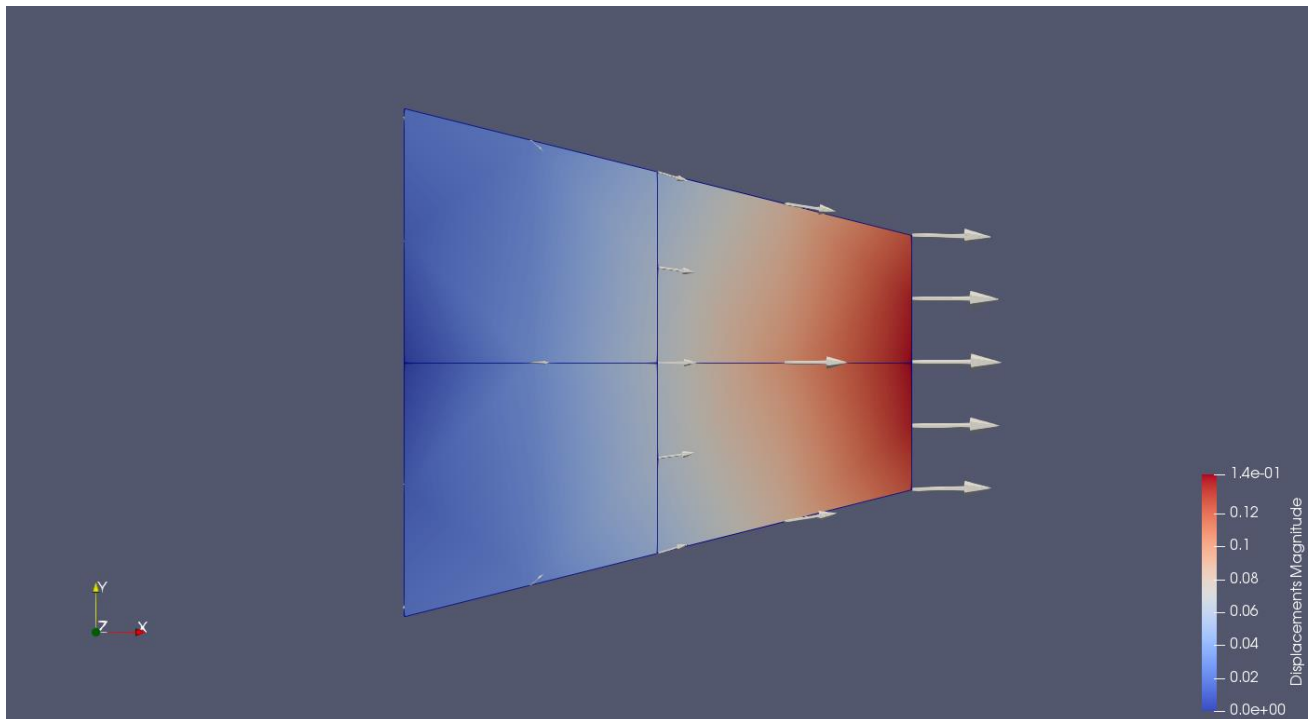
Results

(The Theoretical was obtained by numerical convergence using the FINEL code)

	σ_{xx} at point B (MPa)	σ_{xy} at point B (MPa)
“Theoretical” result	61.3	0
Typical FE result (FINEL)	61.9	0
STRATOFEM	63.6	0

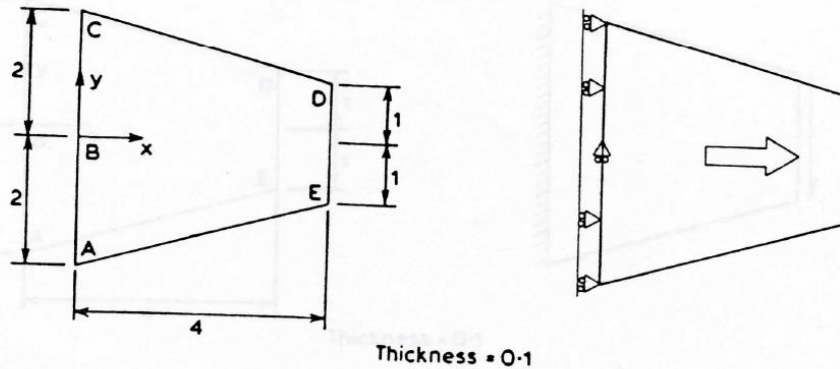
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	2.3D-01	-1.7D+00	0.0D+00	3.92D+07	-2.69D+06	0.00D+00	1.27D+06	0.00D+00	0.00D+00	4.07D+07
1	2	1.0D+00	-1.6D+00	0.0D+00	4.87D+07	-1.22D+05	0.00D+00	7.24D+06	0.00D+00	0.00D+00	5.03D+07
1	3	1.8D+00	-1.4D+00	0.0D+00	5.88D+07	2.87D+06	0.00D+00	1.22D+07	0.00D+00	0.00D+00	6.12D+07
1	4	2.3D-01	-9.7D-01	0.0D+00	5.29D+07	-4.82D+06	0.00D+00	1.06D+06	0.00D+00	0.00D+00	5.55D+07
1	5	1.0D+00	-8.8D-01	0.0D+00	5.93D+07	-2.75D+06	0.00D+00	4.88D+06	0.00D+00	0.00D+00	6.13D+07
1	6	1.8D+00	-7.8D-01	0.0D+00	6.64D+07	-1.75D+05	0.00D+00	7.13D+06	0.00D+00	0.00D+00	6.76D+07
1	7	2.3D-01	2.2D-01	0.0D+00	6.08D+07	-8.65D+06	0.00D+00	7.56D+05	0.00D+00	0.00D+00	6.56D+07
1	8	1.0D+00	-2.0D-01	0.0D+00	6.30D+07	-7.45D+06	0.00D+00	2.46D+06	0.00D+00	0.00D+00	6.72D+07
1	9	1.8D+00	-1.8D-01	0.0D+00	6.55D+07	-5.74D+06	0.00D+00	2.05D+06	0.00D+00	0.00D+00	6.87D+07
4	1	2.3D-01	2.2D-01	0.0D+00	6.08D+07	-8.65D+06	0.00D+00	-7.56D+05	0.00D+00	0.00D+00	6.56D+07
4	2	1.0D+00	2.0D-01	0.0D+00	6.30D+07	-7.45D+06	0.00D+00	-2.46D+06	0.00D+00	0.00D+00	6.72D+07
4	3	1.8D+00	1.8D-01	0.0D+00	6.55D+07	-5.74D+06	0.00D+00	-2.05D+06	0.00D+00	0.00D+00	6.87D+07
4	4	2.3D-01	9.7D-01	0.0D+00	5.29D+07	-4.82D+06	0.00D+00	-1.06D+06	0.00D+00	0.00D+00	5.55D+07
4	5	1.0D+00	8.8D-01	0.0D+00	5.93D+07	-2.75D+06	0.00D+00	-4.88D+06	0.00D+00	0.00D+00	6.13D+07
4	6	1.8D+00	7.8D-01	0.0D+00	6.64D+07	-1.75D+05	0.00D+00	-7.13D+06	0.00D+00	0.00D+00	6.76D+07
4	7	2.3D-01	1.7D+00	0.0D+00	3.92D+07	-2.69D+06	0.00D+00	-1.27D+06	0.00D+00	0.00D+00	4.07D+07
4	8	1.0D+00	1.6D+00	0.0D+00	4.87D+07	-1.22D+05	0.00D+00	-7.24D+06	0.00D+00	0.00D+00	5.03D+07
4	9	1.8D+00	1.4D+00	0.0D+00	5.88D+07	2.87D+06	0.00D+00	-1.22D+07	0.00D+00	0.00D+00	6.12D+07

Displacement Vectors

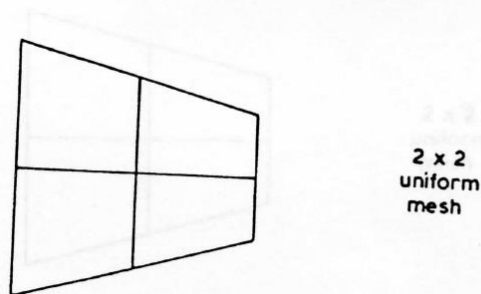


NAFEMS Benchmark B1.1: Tapered Membrane X Gravity Loading

NAFEMS	TAPERED MEMBRANE GRAVITY LOADING	TEST No IC 2	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic membrane		
GEOMETRY			



LOADING	Uniform acceleration 9.81 M/S^2 in global x direction (gravity)
BOUNDARY CONDITIONS	Edge AC zero x displacement At B zero y displacement
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{ MPa}$, $\nu = 0.3$ $p = 7 \text{ MG/m}^3$
ELEMENT TYPES	Plane stress quadrilaterals or triangles
MESHES	



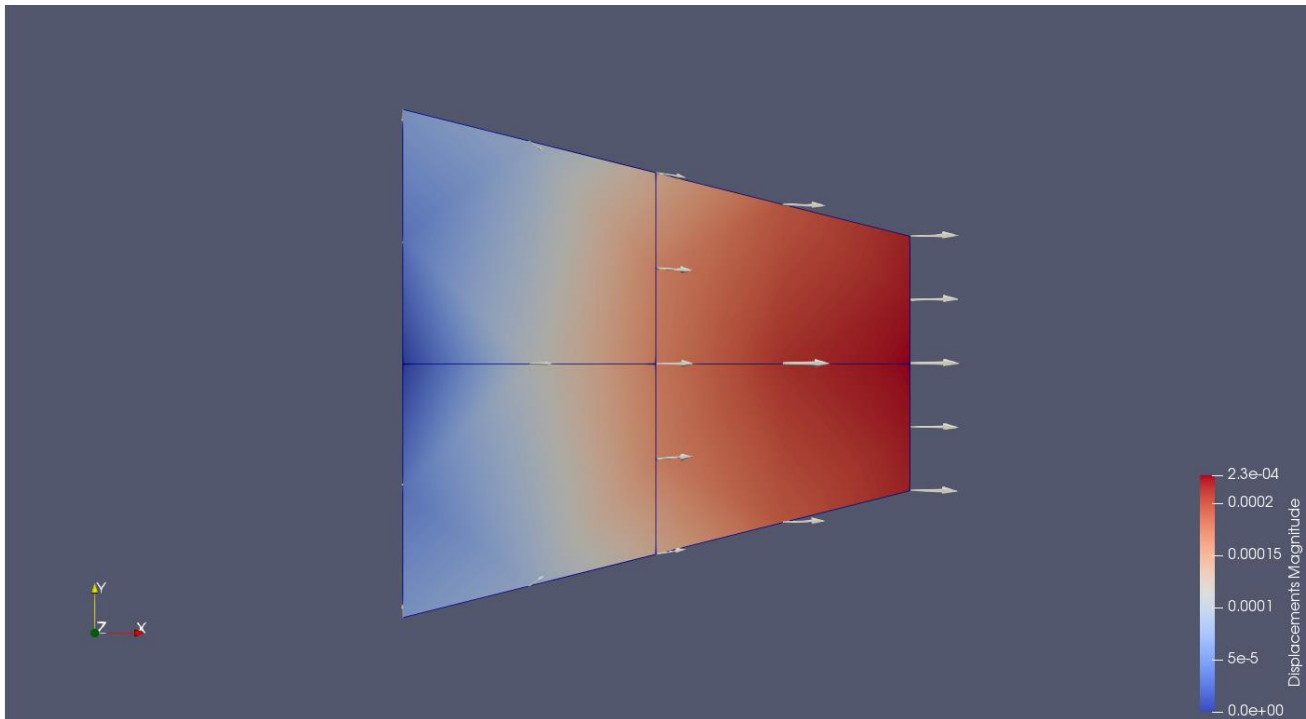
Results

(The Theoretical was obtained by numerical convergence using the FINEL code)

	σ_{xx} at point B (MPa)		σ_{xy} at point B (MPa)
“Theoretical” result	0.247		0
Typical FE result (FINEL)	0.258		0
STRATOFEM	0.263		0

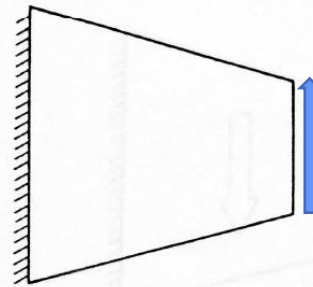
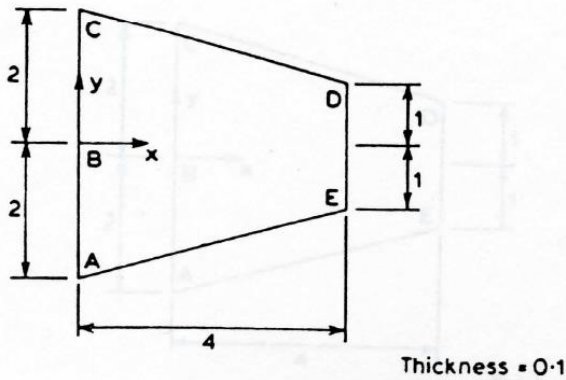
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	2.3D-01	-1.7D+00	0.0D+00	1.54D+05	-1.94D+03	0.00D+00	-1.01D+03	0.00D+00	0.00D+00	1.55D+05
1	2	1.0D+00	-1.6D+00	0.0D+00	1.34D+05	-4.66D+03	0.00D+00	1.42D+04	0.00D+00	0.00D+00	1.39D+05
1	3	1.8D+00	-1.4D+00	0.0D+00	1.22D+05	1.60D+03	0.00D+00	2.13D+04	0.00D+00	0.00D+00	1.26D+05
1	4	2.3D-01	-9.7D-01	0.0D+00	2.03D+05	-4.86D+03	0.00D+00	-4.13D+02	0.00D+00	0.00D+00	2.05D+05
1	5	1.0D+00	-8.8D-01	0.0D+00	1.66D+05	-6.29D+03	0.00D+00	9.25D+03	0.00D+00	0.00D+00	1.70D+05
1	6	1.8D+00	-7.8D-01	0.0D+00	1.35D+05	2.61D+03	0.00D+00	9.24D+03	0.00D+00	0.00D+00	1.35D+05
1	7	2.3D-01	-2.2D-01	0.0D+00	2.34D+05	-1.33D+04	0.00D+00	1.72D+03	0.00D+00	0.00D+00	2.40D+05
1	8	1.0D+00	-2.0D-01	0.0D+00	1.75D+05	-1.46D+04	0.00D+00	6.32D+03	0.00D+00	0.00D+00	1.83D+05
1	9	1.8D+00	-1.8D-01	0.0D+00	1.21D+05	-4.58D+03	0.00D+00	-2.29D+02	0.00D+00	0.00D+00	1.23D+05
4	1	2.3D-01	2.2D-01	0.0D+00	2.34D+05	-1.33D+04	0.00D+00	-1.72D+03	0.00D+00	0.00D+00	2.40D+05
4	2	1.0D+00	2.0D-01	0.0D+00	1.75D+05	-1.46D+04	0.00D+00	-6.32D+03	0.00D+00	0.00D+00	1.83D+05
4	3	1.8D+00	1.8D-01	0.0D+00	1.21D+05	-4.58D+03	0.00D+00	2.29D+02	0.00D+00	0.00D+00	1.23D+05
4	4	2.3D-01	9.7D-01	0.0D+00	2.03D+05	-4.86D+03	0.00D+00	4.13D+02	0.00D+00	0.00D+00	2.05D+05
4	5	1.0D+00	8.8D-01	0.0D+00	1.66D+05	-6.29D+03	0.00D+00	-9.25D+03	0.00D+00	0.00D+00	1.70D+05
4	6	1.8D+00	7.8D-01	0.0D+00	1.35D+05	2.61D+03	0.00D+00	-9.24D+03	0.00D+00	0.00D+00	1.35D+05
4	7	2.3D-01	1.7D+00	0.0D+00	1.54D+05	-1.94D+03	0.00D+00	1.01D+03	0.00D+00	0.00D+00	1.55D+05
4	8	1.0D+00	1.6D+00	0.0D+00	1.34D+05	-4.66D+03	0.00D+00	-1.42D+04	0.00D+00	0.00D+00	1.39D+05
4	9	1.8D+00	1.4D+00	0.0D+00	1.22D+05	1.60D+03	0.00D+00	-2.13D+04	0.00D+00	0.00D+00	1.26D+05

Displacement Vectors

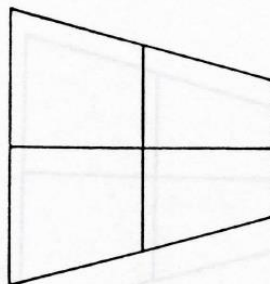


NAFEMS Benchmark B1.1: Tapered Membrane Edge Shear

NAFEMS	TAPERED MEMBRANE EDGE SHEAR	TEST No IC 3	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic membrane		
GEOMETRY			



LOADING	Uniform surface shear traction of 100MPa in the vertical y-direction
BOUNDARY CONDITIONS	Fully fixed along edge AC
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{ MPa}$, $\nu = 0.3$
ELEMENT TYPES	Plane stress quadrilaterals or triangles
MESHES	Plane stress quadrilaterals or triangles



2 x 2
uniform
mesh

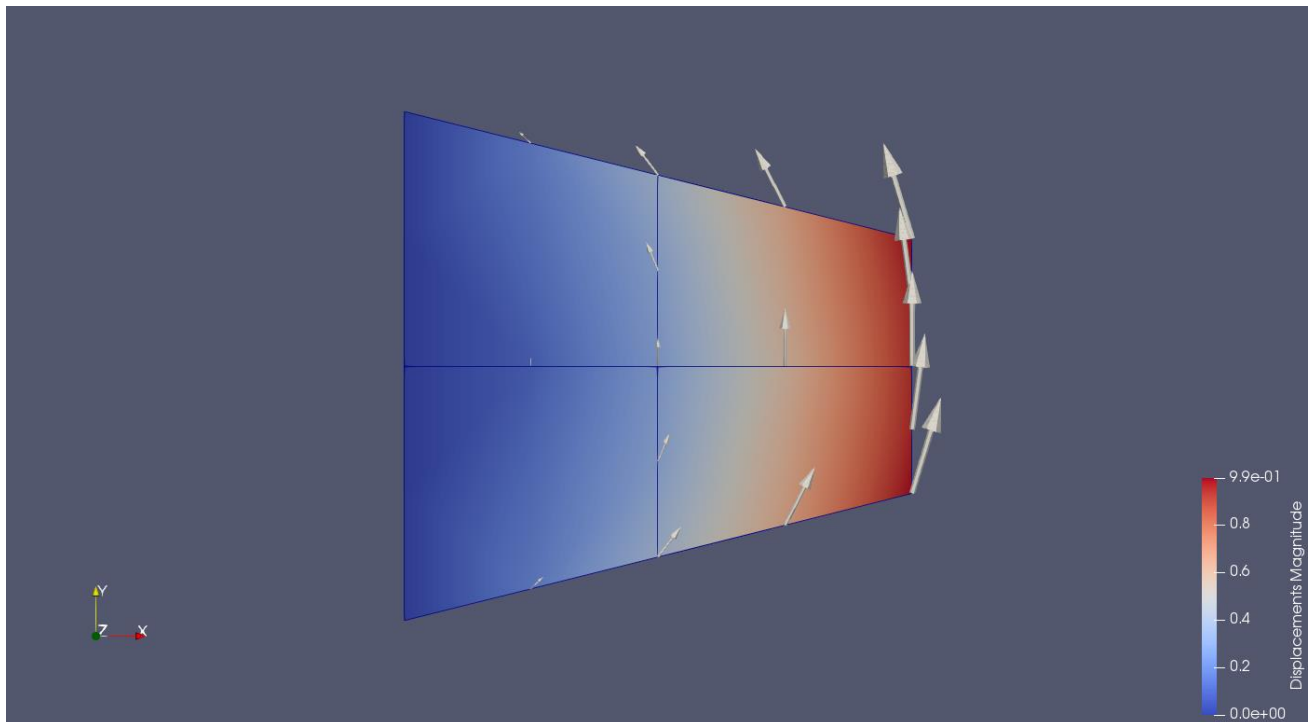
Results

(The Theoretical was obtained by numerical convergence using the FINEL code)

	Displacement v at point D (m)	σ_{xy} at point B (MPa)
“Theoretical” result	0.9430	26.90
Typical FE result	0.9396	28.72
STRATOFEM	0.9515	28,88

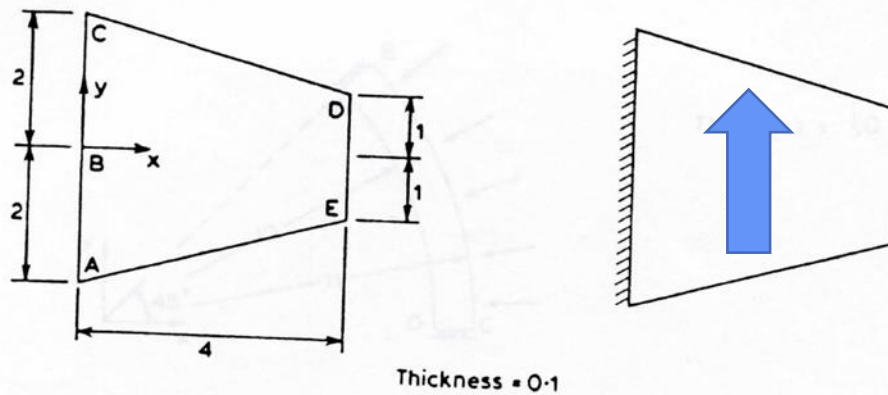
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	2.3D-01	-1.7D+00	0.0D+00	2.72D+08	6.75D+07	0.00D+00	6.44D+07	0.00D+00	0.00D+00	2.69D+08
1	2	1.0D+00	-1.6D+00	0.0D+00	2.54D+08	2.53D+07	0.00D+00	6.69D+07	0.00D+00	0.00D+00	2.69D+08
1	3	1.8D+00	-1.4D+00	0.0D+00	2.47D+08	8.40D+06	0.00D+00	6.29D+07	0.00D+00	0.00D+00	2.66D+08
1	4	2.3D-01	-9.7D-01	0.0D+00	1.54D+08	3.52D+07	0.00D+00	4.88D+07	0.00D+00	0.00D+00	1.63D+08
1	5	1.0D+00	-8.8D-01	0.0D+00	1.43D+08	7.01D+06	0.00D+00	5.78D+07	0.00D+00	0.00D+00	1.72D+08
1	6	1.8D+00	-7.8D-01	0.0D+00	1.42D+08	7.15D+06	0.00D+00	6.07D+07	0.00D+00	0.00D+00	1.74D+08
1	7	2.3D-01	-2.2D-01	0.0D+00	3.32D+07	2.09D+06	0.00D+00	3.74D+07	0.00D+00	0.00D+00	7.24D+07
1	8	1.0D+00	-2.0D-01	0.0D+00	2.85D+07	-1.22D+07	0.00D+00	5.37D+07	0.00D+00	0.00D+00	9.98D+07
1	9	1.8D+00	-1.8D-01	0.0D+00	3.35D+07	4.76D+06	0.00D+00	6.47D+07	0.00D+00	0.00D+00	1.16D+08
4	1	2.3D-01	2.2D-01	0.0D+00	-3.32D+07	-2.09D+06	0.00D+00	3.74D+07	0.00D+00	0.00D+00	7.24D+07
4	2	1.0D+00	2.0D-01	0.0D+00	-2.85D+07	1.22D+07	0.00D+00	5.37D+07	0.00D+00	0.00D+00	9.98D+07
4	3	1.8D+00	1.8D-01	0.0D+00	-3.35D+07	-4.76D+06	0.00D+00	6.47D+07	0.00D+00	0.00D+00	1.16D+08
4	4	2.3D-01	9.7D-01	0.0D+00	-1.54D+08	-3.52D+07	0.00D+00	4.88D+07	0.00D+00	0.00D+00	1.63D+08
4	5	1.0D+00	8.8D-01	0.0D+00	-1.43D+08	-7.01D+06	0.00D+00	5.78D+07	0.00D+00	0.00D+00	1.72D+08
4	6	1.8D+00	7.8D-01	0.0D+00	-1.42D+08	-7.15D+06	0.00D+00	6.07D+07	0.00D+00	0.00D+00	1.74D+08
4	7	2.3D-01	1.7D+00	0.0D+00	-2.72D+08	-6.75D+07	0.00D+00	6.44D+07	0.00D+00	0.00D+00	2.69D+08
4	8	1.0D+00	1.6D+00	0.0D+00	-2.54D+08	-2.53D+07	0.00D+00	6.69D+07	0.00D+00	0.00D+00	2.69D+08
4	9	1.8D+00	1.4D+00	0.0D+00	-2.47D+08	-8.40D+06	0.00D+00	6.29D+07	0.00D+00	0.00D+00	2.66D+08

Displacement Vectors

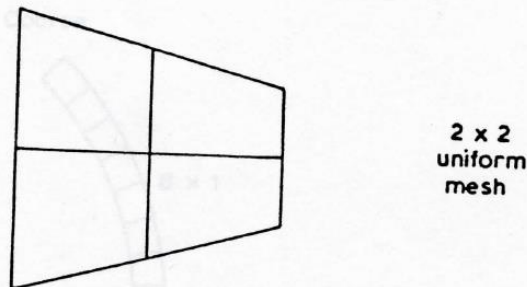


NAFEMS Benchmark B1.1: Tapered Membrane Y Gravity Loading

NAFEMS	TAPERED CANTILEVER GRAVITY LOAD	TEST No IC 4	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic membrane		
GEOMETRY			



LOADING	Acceleration of 9.81M/S^2 in the vertical y-direction (gravity)
BOUNDARY CONDITIONS	Fully fixed along edge AC
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{MPa}$, $\nu = 0.3$, $p = 7\text{MG/m}^3$
ELEMENT TYPES	Plane stress quadrilaterals or triangles
MESHES	



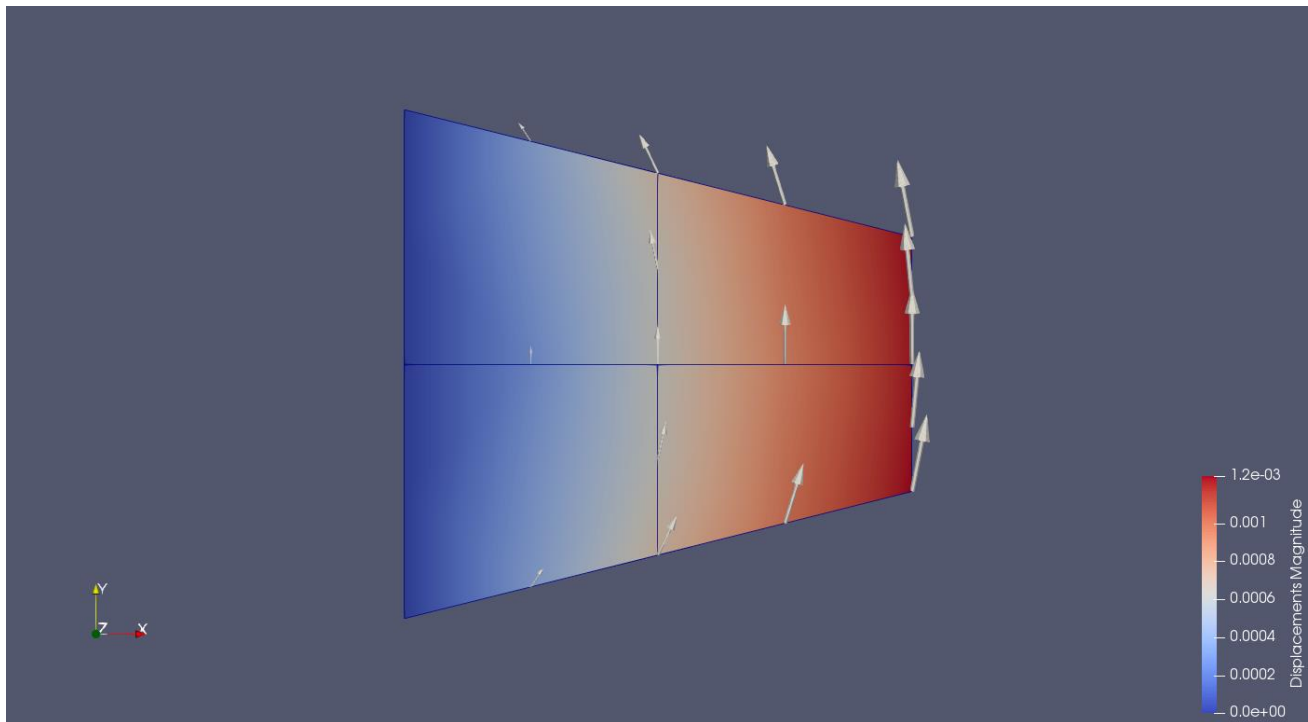
Results

(The Theoretical was obtained by numerical convergence using the FINEL code)

	Displacement v at point D (m)	σ_{xy} at point B (MPa)
“Theoretical” result	0.1220e-04	0.199
Typical FE result	0.1221e-04	0.197
STRATOFEM	0.1223e-04	0.191

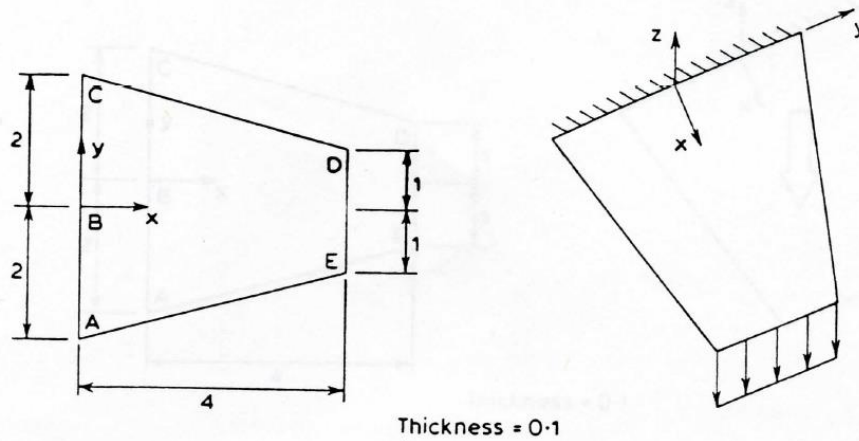
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	2.3D-01	-1.7D+00	0.0D+00	4.67D+05	1.28D+05	0.00D+00	2.08D+05	0.00D+00	0.00D+00	5.51D+05
1	2	1.0D+00	-1.6D+00	0.0D+00	3.54D+05	6.33D+04	0.00D+00	1.45D+05	0.00D+00	0.00D+00	4.13D+05
1	3	1.8D+00	-1.4D+00	0.0D+00	2.44D+05	2.32D+04	0.00D+00	9.02D+04	0.00D+00	0.00D+00	2.80D+05
1	4	2.3D-01	-9.7D-01	0.0D+00	2.39D+05	6.22D+04	0.00D+00	1.98D+05	0.00D+00	0.00D+00	4.05D+05
1	5	1.0D+00	-8.8D-01	0.0D+00	1.70D+05	2.18D+04	0.00D+00	1.57D+05	0.00D+00	0.00D+00	3.15D+05
1	6	1.8D+00	-7.8D-01	0.0D+00	1.05D+05	9.15D+03	0.00D+00	1.27D+05	0.00D+00	0.00D+00	2.43D+05
1	7	2.3D-01	-2.2D-01	0.0D+00	4.73D+04	7.37D+03	0.00D+00	1.92D+05	0.00D+00	0.00D+00	3.35D+05
1	8	1.0D+00	-2.0D-01	0.0D+00	2.92D+04	-6.82D+03	0.00D+00	1.73D+05	0.00D+00	0.00D+00	3.01D+05
1	9	1.8D+00	-1.8D-01	0.0D+00	1.94D+04	1.07D+04	0.00D+00	1.70D+05	0.00D+00	0.00D+00	2.95D+05
4	1	2.3D-01	2.2D-01	0.0D+00	-4.73D+04	-7.37D+03	0.00D+00	1.92D+05	0.00D+00	0.00D+00	3.35D+05
4	2	1.0D+00	2.0D-01	0.0D+00	-2.92D+04	6.82D+03	0.00D+00	1.73D+05	0.00D+00	0.00D+00	3.01D+05
4	3	1.8D+00	1.8D-01	0.0D+00	-1.94D+04	-1.07D+04	0.00D+00	1.70D+05	0.00D+00	0.00D+00	2.95D+05
4	4	2.3D-01	9.7D-01	0.0D+00	-2.39D+05	-6.22D+04	0.00D+00	1.98D+05	0.00D+00	0.00D+00	4.05D+05
4	5	1.0D+00	8.8D-01	0.0D+00	-1.70D+05	-2.18D+04	0.00D+00	1.57D+05	0.00D+00	0.00D+00	3.15D+05
4	6	1.8D+00	7.8D-01	0.0D+00	-1.05D+05	-9.15D+03	0.00D+00	1.27D+05	0.00D+00	0.00D+00	2.43D+05
4	7	2.3D-01	1.7D+00	0.0D+00	-4.67D+05	-1.28D+05	0.00D+00	2.08D+05	0.00D+00	0.00D+00	5.51D+05
4	8	1.0D+00	1.6D+00	0.0D+00	-3.54D+05	-6.33D+04	0.00D+00	1.45D+05	0.00D+00	0.00D+00	4.13D+05
4	9	1.8D+00	1.4D+00	0.0D+00	-2.44D+05	-2.32D+04	0.00D+00	9.02D+04	0.00D+00	0.00D+00	2.80D+05

Displacement Vectors

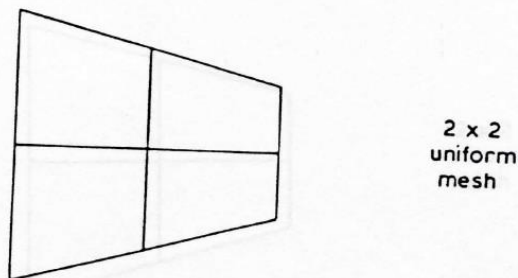


NAFEMS Benchmark B1.2: Tapered Plate Z Edge Shear

NAFEMS	TAPERED PLATE EDGE SHEAR	TEST No IC 10	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic flat plate		
GEOMETRY			



LOADING	Uniform vertical shear 10KN/M in the z-direction along edge DE
BOUNDARY CONDITIONS	Edge ABC fully fixed
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{ MPa}$, $\nu = 0.3$
ELEMENT TYPES	Flat plate-bending quadrilaterals or triangles
MESHES	



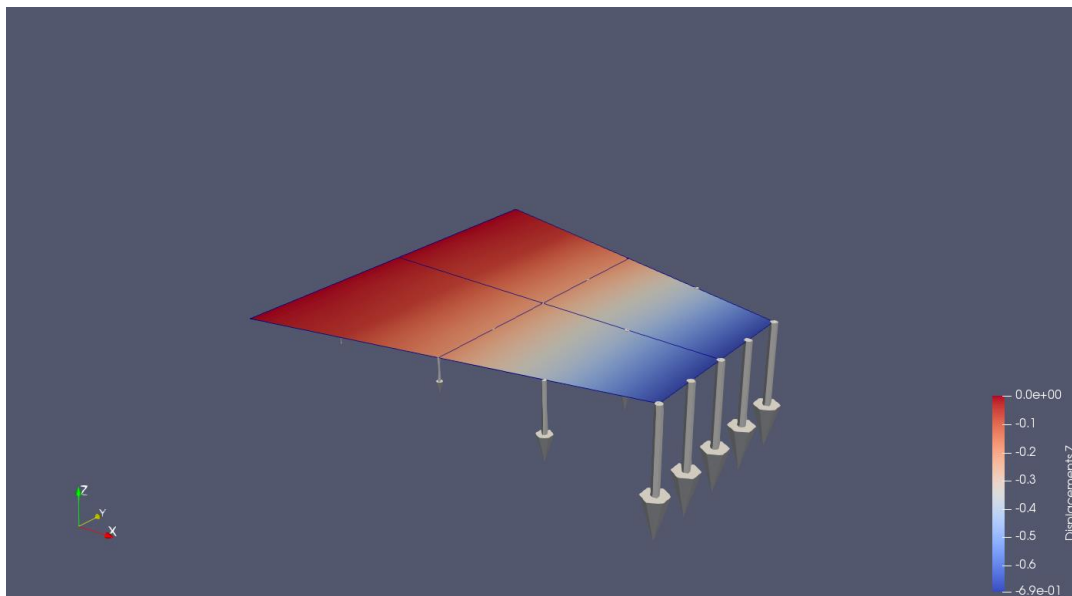
Results

(The Theoretical was obtained by numerical convergence using the FINEL code)

	Displacement w at point D (m)	σ_{xx} at top surface of point B (MPa)
“Theoretical” result	-0.70	14.70
Typical FE result (FINEL)	-0.68	14.68
STRATOFEM	-0.69	14.69

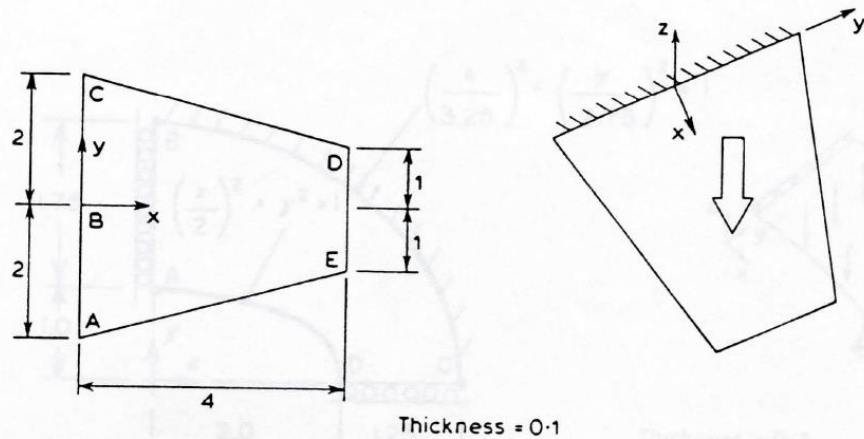
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	4.2D-01	-1.5D+00	0.0D+00	-1.04D+07	-2.59D+06	0.00D+00	-5.73D+05	-1.30D+04	1.18D+05	9.43D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.30D+04	1.18D+05	2.05D+05
					1.04D+07	2.59D+06	0.00D+00	5.73D+05	-1.30D+04	1.18D+05	9.43D+06
1	2	1.6D+00	-1.3D+00	0.0D+00	-9.69D+06	-4.48D+05	0.00D+00	-7.80D+04	-6.95D+04	2.21D+04	9.48D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-6.95D+04	2.21D+04	1.26D+05
					9.69D+06	4.48D+05	0.00D+00	7.80D+04	-6.95D+04	2.21D+04	9.48D+06
1	3	4.2D-01	-4.0D-01	0.0D+00	-1.23D+07	-3.37D+06	0.00D+00	-1.44D+05	-7.40D+04	-7.37D+04	1.11D+07
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-7.40D+04	-7.37D+04	1.81D+05
					1.23D+07	3.37D+06	0.00D+00	1.44D+05	-7.40D+04	-7.37D+04	1.11D+07
1	4	1.6D+00	-3.4D-01	0.0D+00	-8.73D+06	-1.07D+06	0.00D+00	-2.32D+05	-5.32D+04	-1.98D+04	8.25D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-5.32D+04	-1.98D+04	9.84D+04
					8.73D+06	1.07D+06	0.00D+00	2.32D+05	-5.32D+04	-1.98D+04	8.25D+06
4	1	4.2D-01	4.0D-01	0.0D+00	-1.23D+07	-3.37D+06	0.00D+00	1.44D+05	-7.40D+04	7.37D+04	1.11D+07
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-7.40D+04	7.37D+04	1.81D+05
					1.23D+07	3.37D+06	0.00D+00	-1.44D+05	-7.40D+04	7.37D+04	1.11D+07
4	2	1.6D+00	3.4D-01	0.0D+00	-8.73D+06	-1.07D+06	0.00D+00	2.32D+05	-5.32D+04	1.98D+04	8.25D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-5.32D+04	1.98D+04	9.84D+04
					8.73D+06	1.07D+06	0.00D+00	-2.32D+05	-5.32D+04	1.98D+04	8.25D+06
4	3	4.2D-01	1.5D+00	0.0D+00	-1.04D+07	-2.59D+06	0.00D+00	5.73D+05	-1.30D+04	-1.18D+05	9.43D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.30D+04	-1.18D+05	2.05D+05
					1.04D+07	2.59D+06	0.00D+00	-5.73D+05	-1.30D+04	-1.18D+05	9.43D+06
4	4	1.6D+00	1.3D+00	0.0D+00	-9.69D+06	-4.48D+05	0.00D+00	7.80D+04	-6.95D+04	-2.21D+04	9.48D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-6.95D+04	-2.21D+04	1.26D+05
					9.69D+06	4.48D+05	0.00D+00	-7.80D+04	-6.95D+04	-2.21D+04	9.48D+06

Displacement Vectors

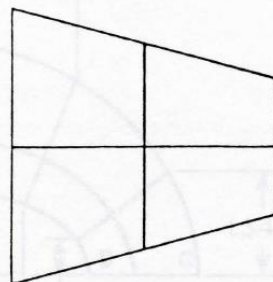


NAFEMS Benchmark B1.2: Tapered Plate Z Gravity Loading

NAFEMS	TAPERED PLATE GRAVITY	TEST No	DATE/ISSUE
		IC 11	
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic flat plate		
GEOMETRY			



LOADING	Vertical acceleration of -9.81M/S^2 in the z-direction
BOUNDARY CONDITIONS	Edge ABC fully fixed
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{MPa}$, $\nu = 0.3$, $p = 7\text{MG/m}^3$
ELEMENT TYPES	Flat plate-bending quadrilaterals or triangles
MESHES	



2 x 2
uniform
mesh

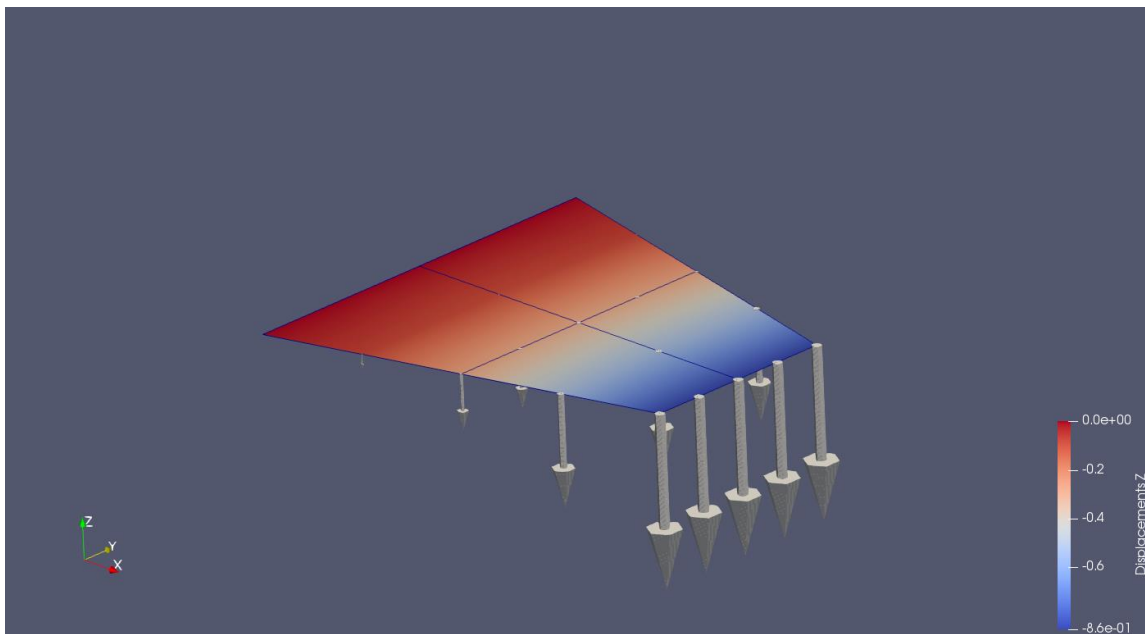
Results

(The Theoretical was obtained by numerical convergence using the FINEL code)

	Displacement w at point D (m)	σ_{xx} at top surface of point B (MPa)
“Theoretical” result	-0.86	26
Typical FE result (FINEL)	-0.86	24
STRATOFEM	-0.86	25

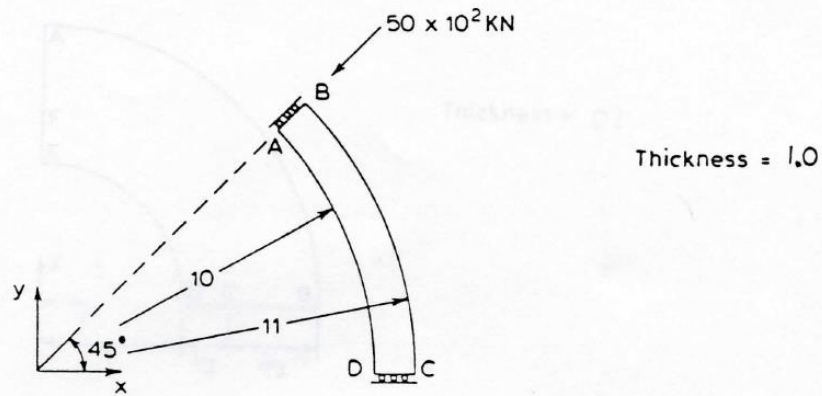
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	4.2D-01	-1.5D+00	0.0D+00	-1.69D+07	-4.68D+06	0.00D+00	-1.33D+06	-1.44D+05	2.09D+05	1.53D+07
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.44D+05	2.09D+05	4.39D+05
					1.69D+07	4.68D+06	0.00D+00	1.33D+06	-1.44D+05	2.09D+05	1.53D+07
1	2	1.6D+00	-1.3D+00	0.0D+00	-9.92D+06	-4.35D+05	0.00D+00	-3.05D+04	-1.38D+05	5.04D+04	9.72D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.38D+05	5.04D+04	2.54D+05
					9.92D+06	4.35D+05	0.00D+00	3.05D+04	-1.38D+05	5.04D+04	9.72D+06
1	3	4.2D-01	-4.0D-01	0.0D+00	-1.93D+07	-5.38D+06	0.00D+00	-3.24D+05	-2.03D+05	-1.62D+05	1.72D+07
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-2.03D+05	-1.62D+05	4.50D+05
					1.93D+07	5.38D+06	0.00D+00	3.24D+05	-2.03D+05	-1.62D+05	1.72D+07
1	4	1.6D+00	-3.4D-01	0.0D+00	-8.44D+06	-7.17D+05	0.00D+00	-2.13D+05	-1.29D+05	-7.36D+04	8.11D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.29D+05	-7.36D+04	2.58D+05
					8.44D+06	7.17D+05	0.00D+00	2.13D+05	-1.29D+05	-7.36D+04	8.11D+06
4	1	4.2D-01	4.0D-01	0.0D+00	-1.93D+07	-5.38D+06	0.00D+00	3.24D+05	-2.03D+05	1.62D+05	1.72D+07
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-2.03D+05	1.62D+05	4.50D+05
					1.93D+07	5.38D+06	0.00D+00	-3.24D+05	-2.03D+05	1.62D+05	1.72D+07
4	2	1.6D+00	3.4D-01	0.0D+00	-8.44D+06	-7.17D+05	0.00D+00	2.13D+05	-1.29D+05	7.36D+04	8.11D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.29D+05	7.36D+04	2.58D+05
					8.44D+06	7.17D+05	0.00D+00	2.13D+05	-1.29D+05	7.36D+04	8.11D+06
4	3	4.2D-01	1.5D+00	0.0D+00	-1.69D+07	-4.68D+06	0.00D+00	1.33D+06	-1.44D+05	-2.09D+05	1.53D+07
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.44D+05	-2.09D+05	4.39D+05
					1.69D+07	4.68D+06	0.00D+00	-1.33D+06	-1.44D+05	-2.09D+05	1.53D+07
4	4	1.6D+00	1.3D+00	0.0D+00	-9.92D+06	-4.35D+05	0.00D+00	3.05D+04	-1.38D+05	-5.04D+04	9.72D+06
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-1.38D+05	-5.04D+04	2.54D+05
					9.92D+06	4.35D+05	0.00D+00	-3.05D+04	-1.38D+05	-5.04D+04	9.72D+06

Displacement Vectors

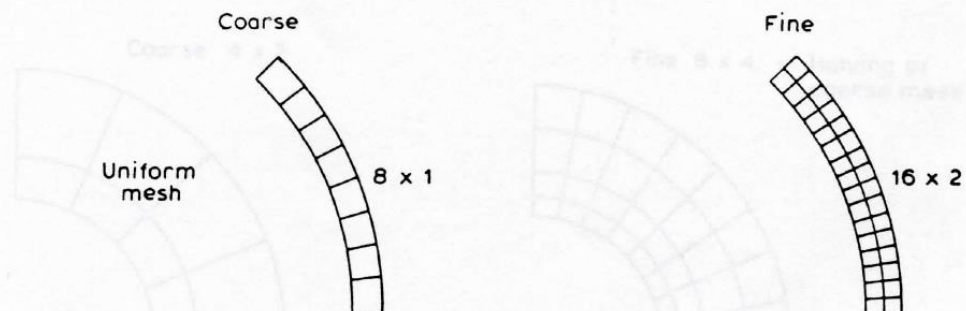


NAFEMS Benchmark B2.2: Circular Membrane Point Load

NAFEMS	CIRCULAR MEMBRANE POINT LOAD	TEST No IC 6	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic membrane		
GEOMETRY			



LOADING	Point load of 50×10^2 KN radially inward at point B
BOUNDARY CONDITIONS	Edge AB on rollers with zero hoop displacement. Edge CD zero y displacement
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3$ MPa, $\nu = 0.3$
ELEMENT TYPES	Plane stress quadrilaterals or triangles
MESHES	Plane stress quadrilaterals or triangles

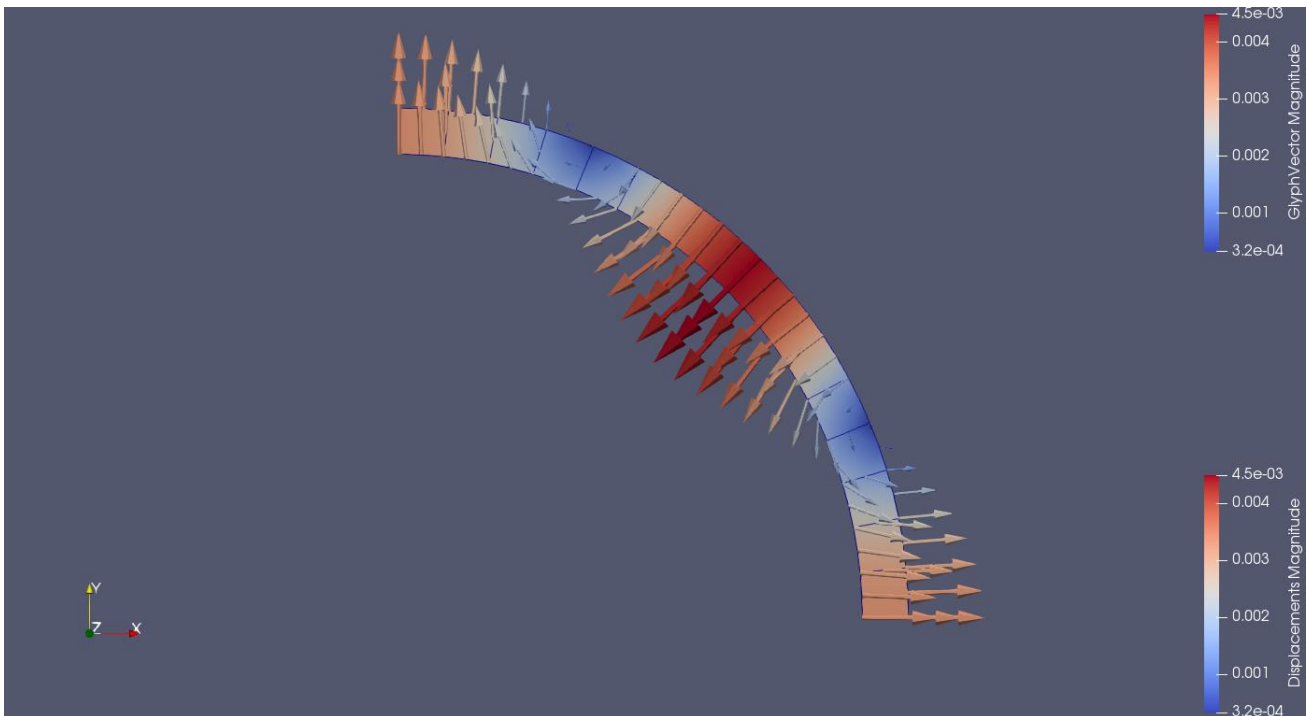


Results

	σ_{yy} at point D (MPa)
Theoretical result	-51.60
Typical FE result (FINEL)	53.20
STRATOFEM (Coarse)	-52.16

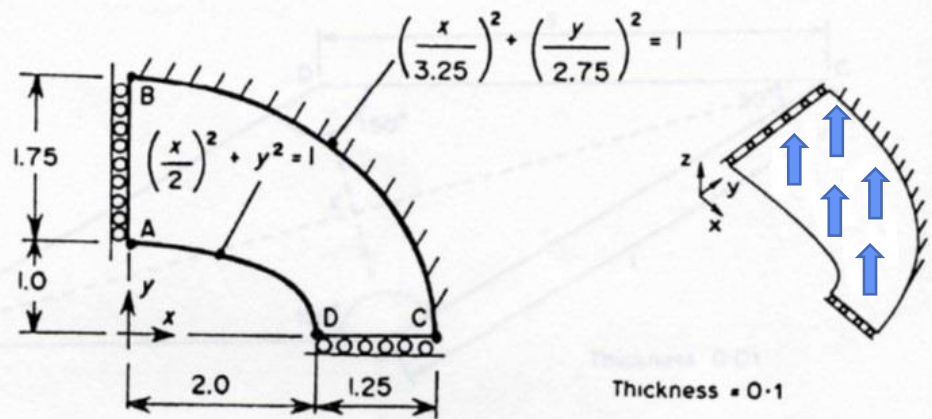
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	1.0D+01	1.1D-01	0.0D+00	-8.34D+05	-4.18D+07	0.00D+00	2.08D+05	0.00D+00	0.00D+00	4.14D+07
1	2	1.0D+01	1.2D-01	0.0D+00	-3.07D+05	-5.55D+06	0.00D+00	-1.17D+05	0.00D+00	0.00D+00	5.41D+06
1	3	1.1D+01	1.2D-01	0.0D+00	-7.46D+05	2.75D+07	0.00D+00	-3.47D+05	0.00D+00	0.00D+00	2.79D+07
1	4	1.0D+01	5.0D-01	0.0D+00	-1.19D+06	-4.25D+07	0.00D+00	1.74D+06	0.00D+00	0.00D+00	4.20D+07
1	5	1.0D+01	5.2D-01	0.0D+00	-5.71D+05	-6.99D+06	0.00D+00	1.43D+04	0.00D+00	0.00D+00	6.72D+06
1	6	1.1D+01	5.3D-01	0.0D+00	-9.12D+05	2.54D+07	0.00D+00	-1.54D+06	0.00D+00	0.00D+00	2.60D+07
1	7	1.0D+01	8.8D-01	0.0D+00	-1.01D+06	-4.03D+07	0.00D+00	2.90D+06	0.00D+00	0.00D+00	4.02D+07
1	8	1.0D+01	9.1D-01	0.0D+00	-1.93D+05	-5.61D+06	0.00D+00	-1.97D+05	0.00D+00	0.00D+00	5.53D+06
1	9	1.1D+01	9.5D-01	0.0D+00	-3.40D+05	2.60D+07	0.00D+00	-3.03D+06	0.00D+00	0.00D+00	2.67D+07

Displacement Vectors



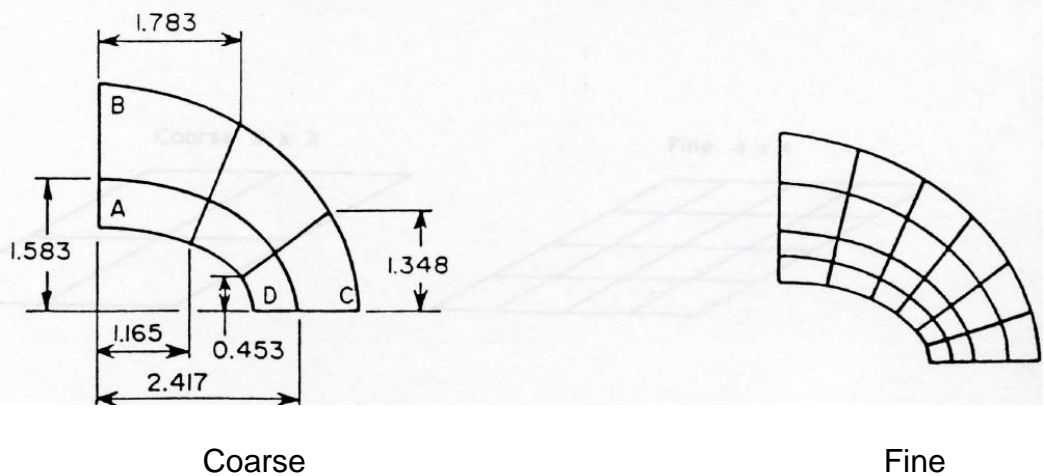
NAFEMS Benchmark B3.1: Elliptic Plate Normal Pressure

NAFEMS	ELLIPTIC PLATE NORMAL PRESSURE	TEST No IC 12	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic flat plate		
GEOMETRY			



LOADING	Pressure on the upper surface of 1MPa.
BOUNDARY CONDITIONS	Edge AB symmetry about yz plane (no x-disp or rotations about y and z-axes). Edge BC fully fixed. Edge CD symmetry about xz plane (no y-disp or rotations about x and z-axes).
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{ MPa}$, $\nu = 0.3$
ELEMENT TYPES	Flat plate-bending quadrilaterals or triangles

MESHES



Results

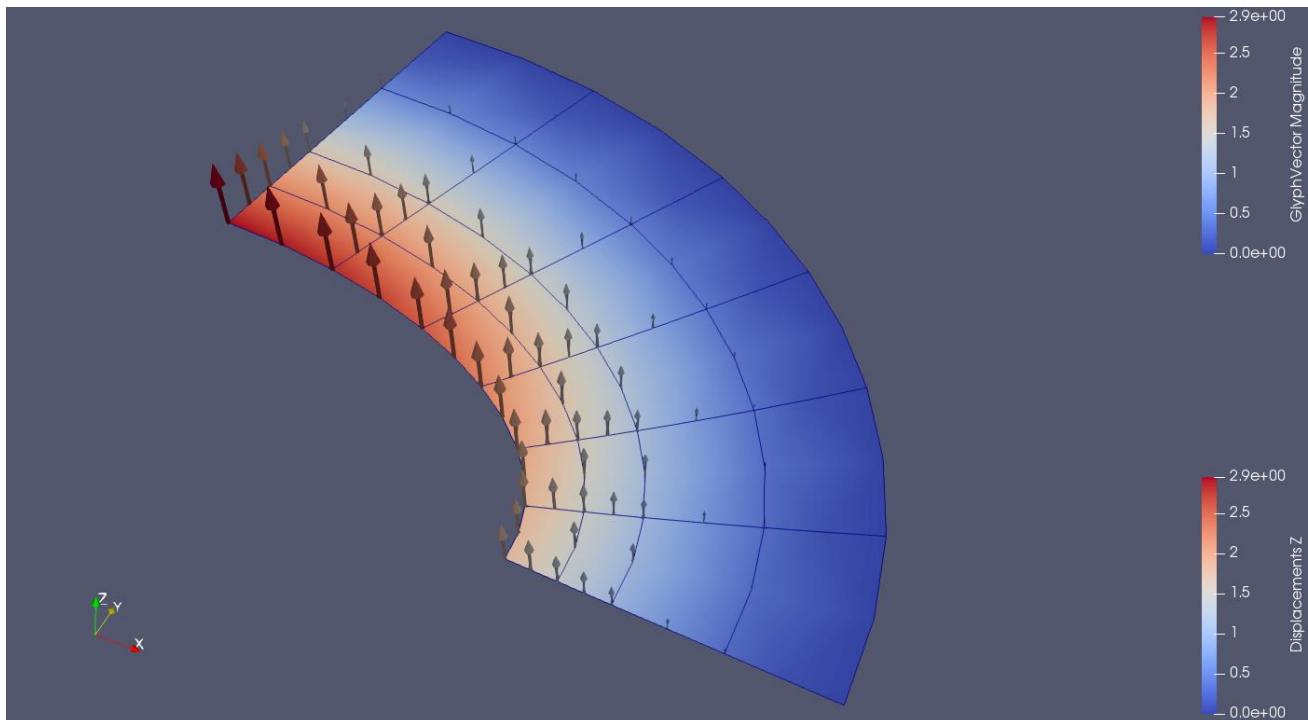
(Fine mesh, upper surface)

	σ_{xx} at point D (MPa)	σ_{yy} at point D (MPa)
Theoretical result	0.0	156
Typical FE result (FINEL)	45.4	238
STRATOFEM	1.85	196

ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	2.0D+00	5.3D-02	0.0D+00	1.62D+05	-1.79D+08	0.00D+00	-1.58D+06	-3.45D+05	-1.88D+06	1.79D+08
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	-3.45D+05	-1.88D+06	3.31D+06
1	2	2.2D+00	6.2D-02	0.0D+00	-1.62D+05	1.79D+08	0.00D+00	1.58D+06	-3.45D+05	-1.88D+06	1.79D+08
					3.68D+06	-1.61D+08	0.00D+00	6.34D+06	9.16D+05	5.22D+06	1.63D+08
1	3	2.0D+00	2.0D-01	0.0D+00	0.00D+00	0.00D+00	0.00D+00	0.00D+00	9.16D+05	5.22D+06	9.18D+06
					-3.68D+06	1.61D+08	0.00D+00	-6.34D+06	9.16D+05	5.22D+06	1.63D+08
1	4	2.1D+00	2.3D-01	0.0D+00	5.87D+06	-1.60D+08	0.00D+00	3.59D+07	1.16D+06	1.91D+06	1.75D+08
					0.00D+00	0.00D+00	0.00D+00	0.00D+00	1.16D+06	1.91D+06	3.87D+06
1	4	2.1D+00	2.3D-01	0.0D+00	-5.87D+06	1.60D+08	0.00D+00	-3.59D+07	1.16D+06	1.91D+06	1.75D+08
					2.19D+06	-1.57D+08	0.00D+00	2.66D+07	-3.46D+06	-5.20D+06	1.65D+08
1	4	2.1D+00	2.3D-01	0.0D+00	0.00D+00	0.00D+00	0.00D+00	0.00D+00	-3.46D+06	-5.20D+06	1.08D+07
					-2.19D+06	1.57D+08	0.00D+00	-2.66D+07	-3.46D+06	-5.20D+06	1.65D+08

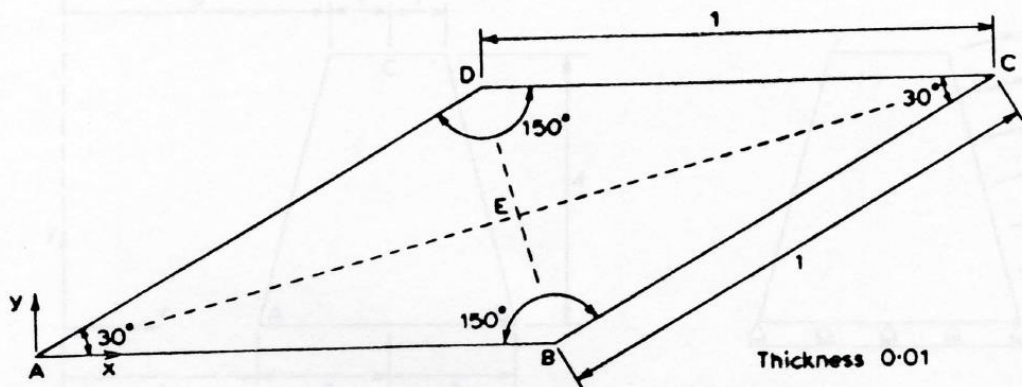
Displacement Vectors

(maximum w displacement at point A)



NAFEMS Benchmark B3.2: Skew Plate Normal Pressure

NAFEMS	SKEW PLATE NORMAL PRESSURE	TEST No IC 13	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic plate bending		
GEOMETRY			



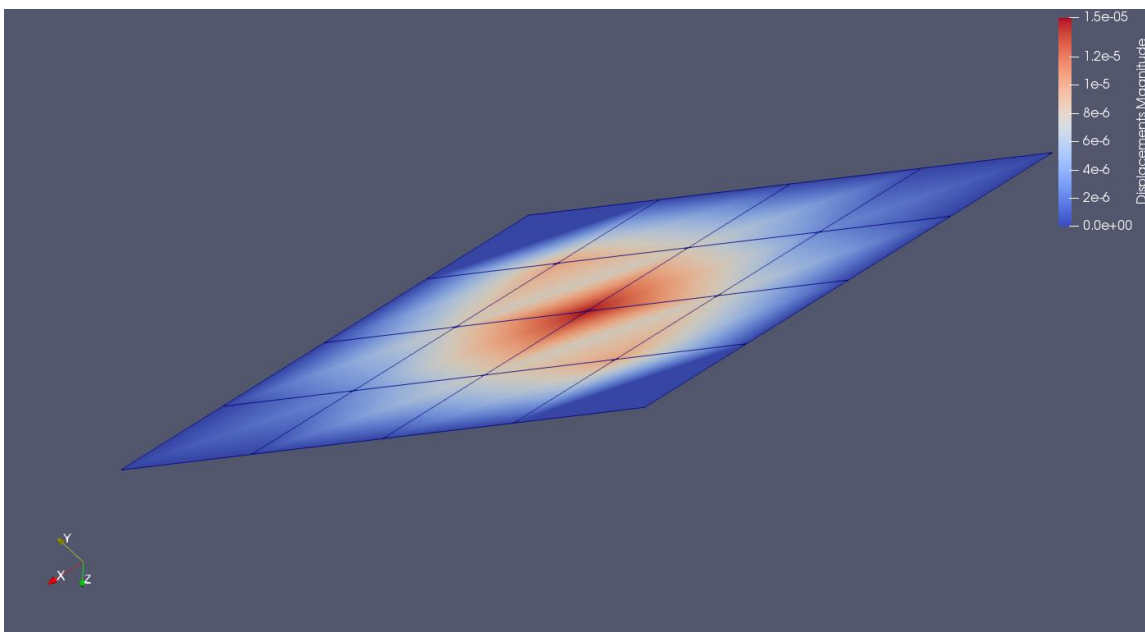
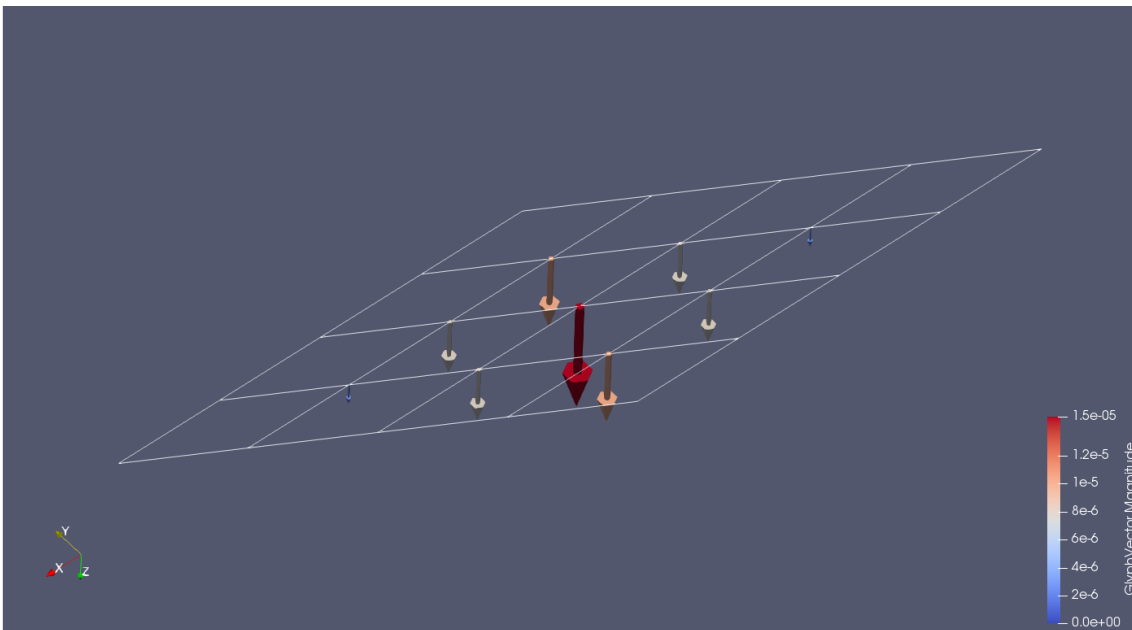
LOADING	Normal pressure -0.7 KPa in the vertical z-direction
BOUNDARY CONDITIONS	Simple supports (no z-displacement) for all edges AB, BC, CD, DA.
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3$ MPa, $\nu = 0.3$
ELEMENT TYPES	Flat plate-bending quadrilaterals or triangles
MESHES	



Results

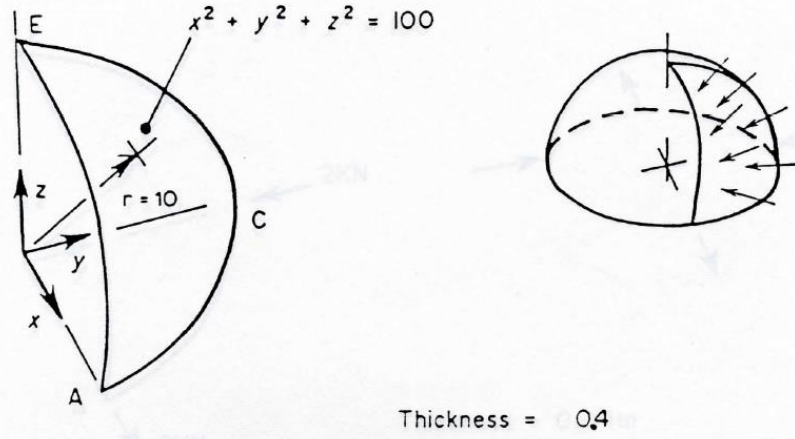
	Vertical Displacement w at point E (10e-06 m)
“Theoretical” result	-14.85
Typical FE result (FINEL)	---
STRATOFEM (Fine)	-14.74

Displacement Vectors

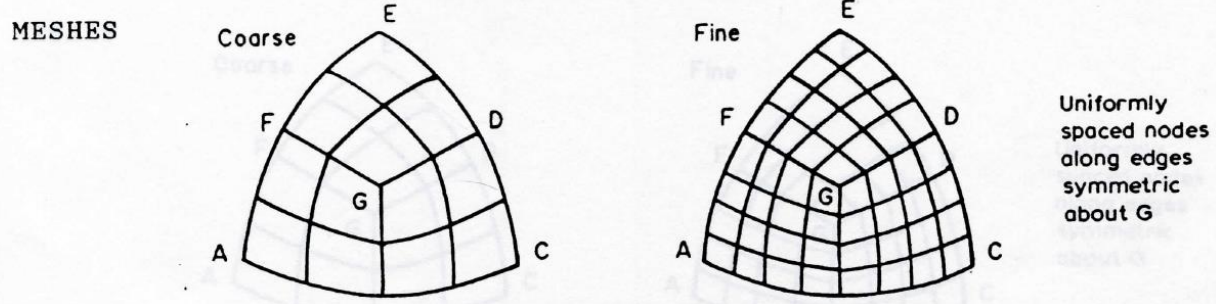


NAFEMS Benchmark B4.1: Hemisphere External Pressure

NAFEMS HEMISPHERE EXTERNAL PRESSURE **TEST No** DATE/ISSUE
 IC 17
ORIGIN NAFEMS report LSB2 **Units** M,KN
ANALYSIS TYPE Linear elastic thin shell
GEOMETRY



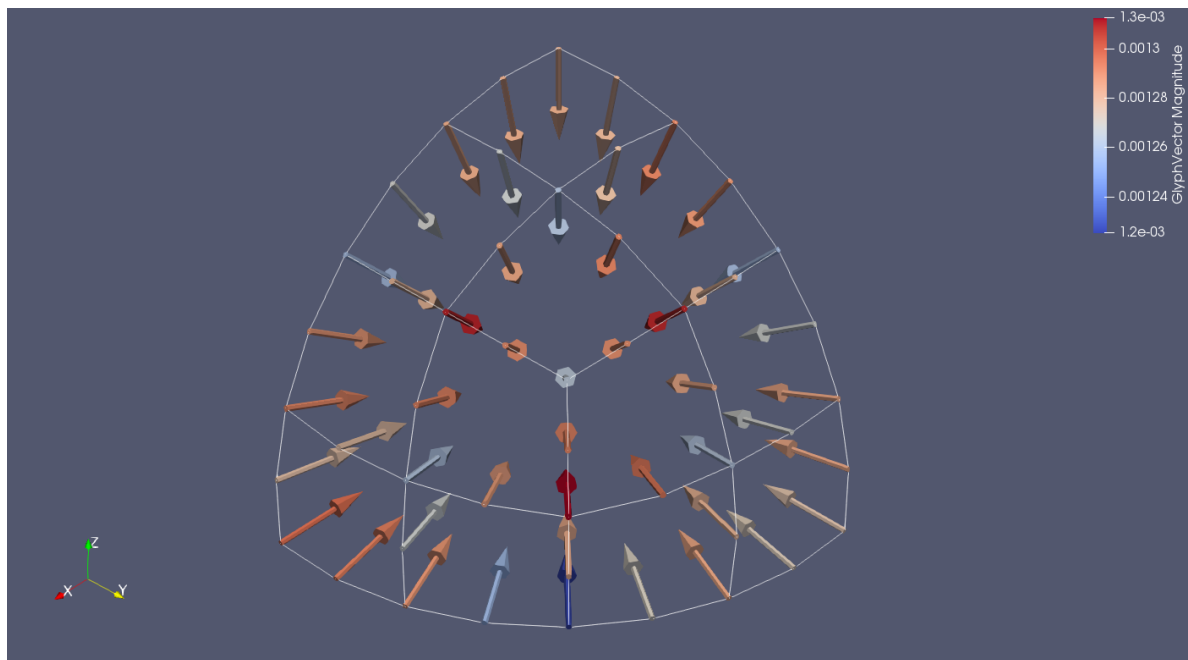
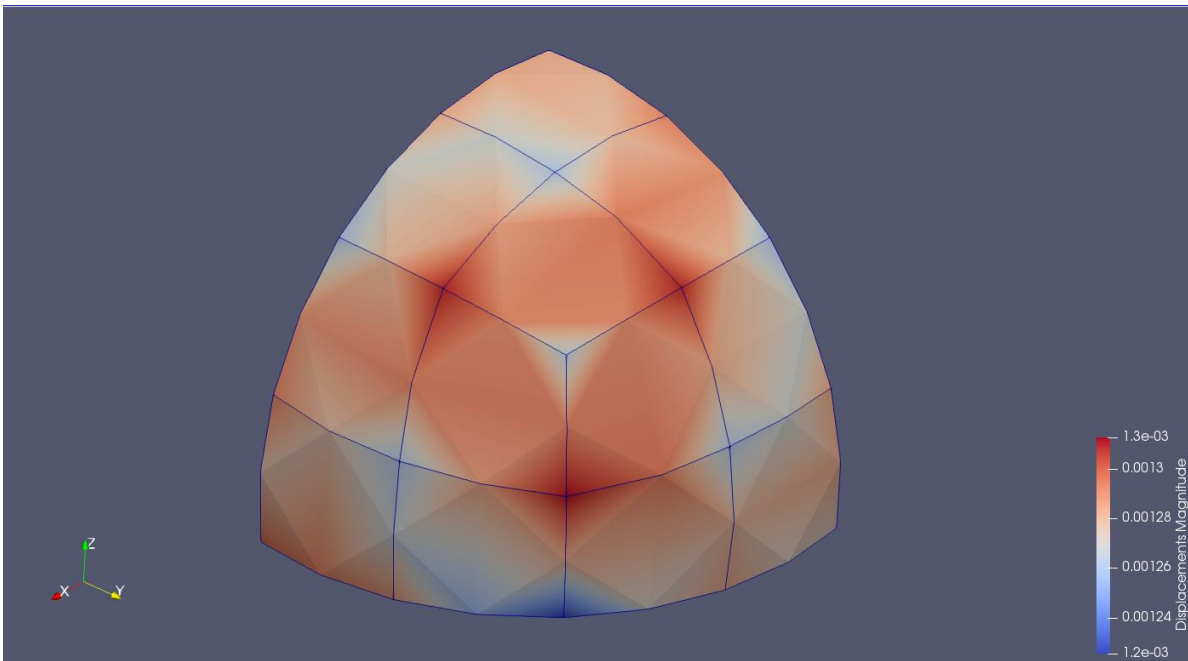
LOADING Uniform pressure of .001MPa directed radially inwards.
BOUNDARY CONDITIONS Edge ABC, zero z-displacements
 Edge CDE, symmetry, e.g. no x-displacements or rotations about y and z-axes
 Edge AFE, symmetry, e.g. no y-displacements or rotations about x and z-axes
MATERIAL PROPERTIES Isotropic, $E = 68.25 \times 10^3 \text{MPa}$, $\nu = 0.3$
ELEMENT TYPES General thin shell quadrilaterals or triangles



Results

	Displacement u at point G (mm)	Displacement v at point G (mm)	Displacement w at point G (mm)
Theoretical result	-0.740	-0.740	-0.740
Typical FE result (FINEL)	-0.709	-0.709	-0.709
STRATOFEM (Coarse)	-0.729	-0.729	-0.729

Displacement Vectors



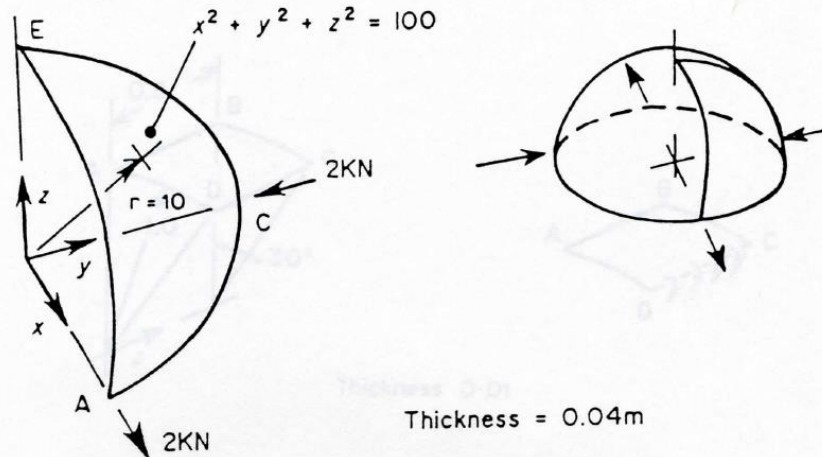
NAFEMS Benchmark B4.2: Hemisphere Point Loads

NAFEMS HEMISPHERE POINT LOADS TEST No IC 18 DATE/ISSUE

ORIGIN NAFEMS report LSB2 Units M,KN

ANALYSIS TYPE Linear elastic thin shell

GEOMETRY



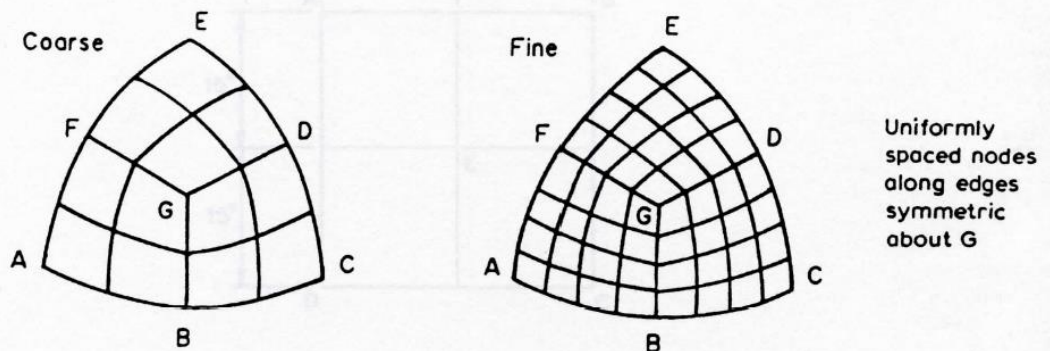
LOADING Concentrated radial loads of 2KN outwards at A, inwards at C

BOUNDARY CONDITIONS Point E fully fixed.
Edge CDE, symmetry, e.g. no x-displacements or rotations about y and z-axes
Edge AFE, symmetry, e.g. no y-displacements or rotations about x and z-axes

MATERIAL PROPERTIES Isotropic, $E = 68.25 \times 10^3 \text{MPa}$, $\nu = 0.3$

ELEMENT TYPES General thin shell quadrilaterals or triangles

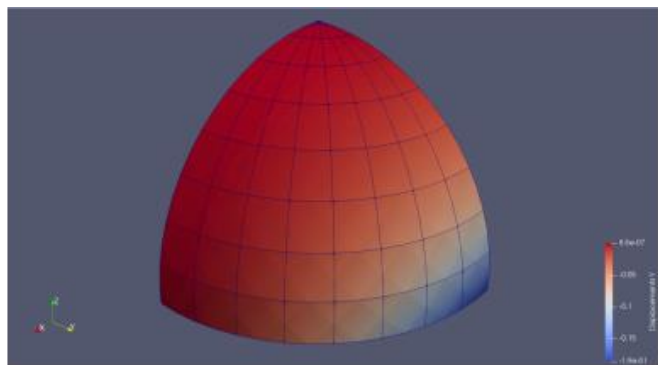
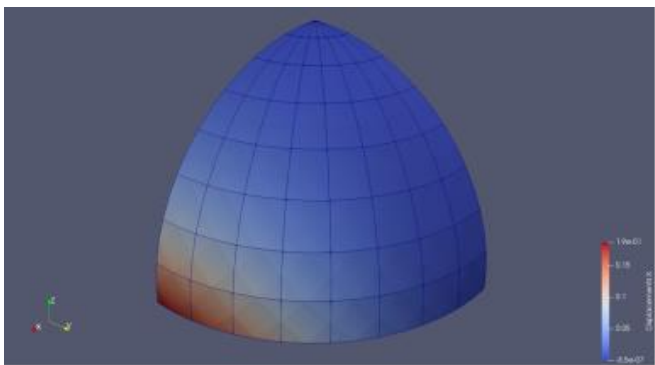
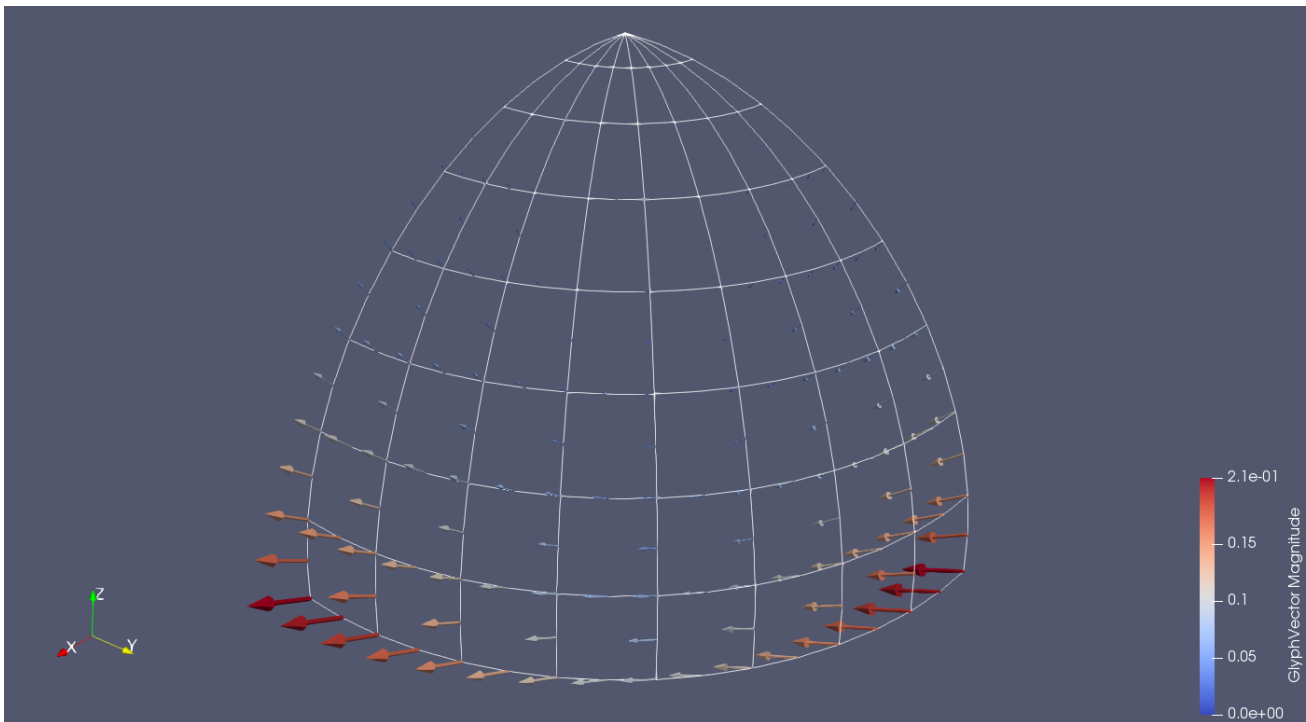
MESHES



Results

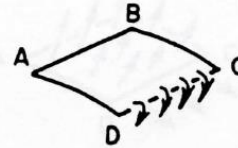
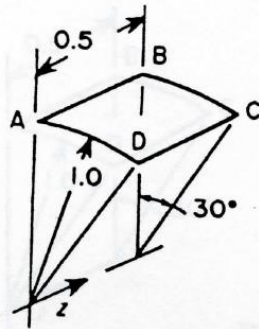
	Displacement u at point A (m)	Displacement v at point C (m)
Theoretical result	0.185	-0.185
Typical FE result (FINEL)	0.181	-0.181
STRATOFEM (Fine)	0.186	-0.186

Displacement Vectors



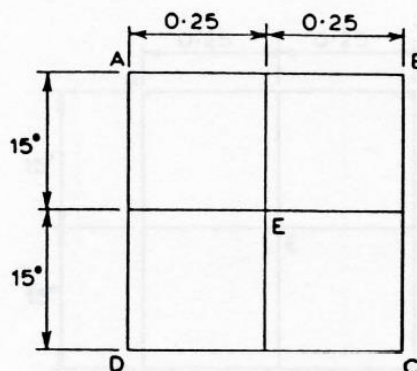
NAFEMS Benchmark B4.3: Cylindrical Shell Edge Moment

NAFEMS	CYLINDRICAL SHELL EDGE MOMENT	TEST No IC 19	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic thin shell		
GEOMETRY			



Thickness 0.01

LOADING	Uniform normal edge moment on DC of 1.0KNM/M
BOUNDARY CONDITIONS	Edge AB, all translations and rotations zero Edge AD and edge BC, symmetry e.g. z translation and rotations about the edges are zero
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{ MPa}$, $\nu = 0.3$
ELEMENT TYPES	General thin shell quadrilaterals or triangles
MESHES	

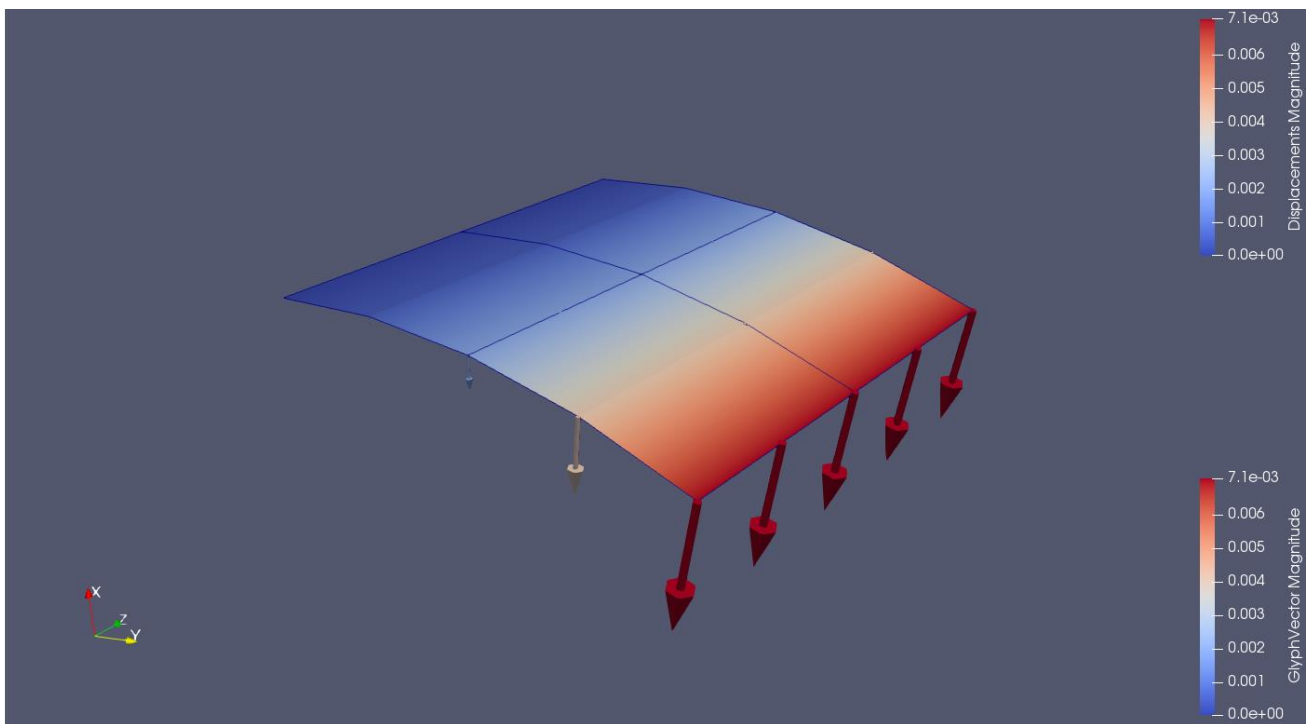
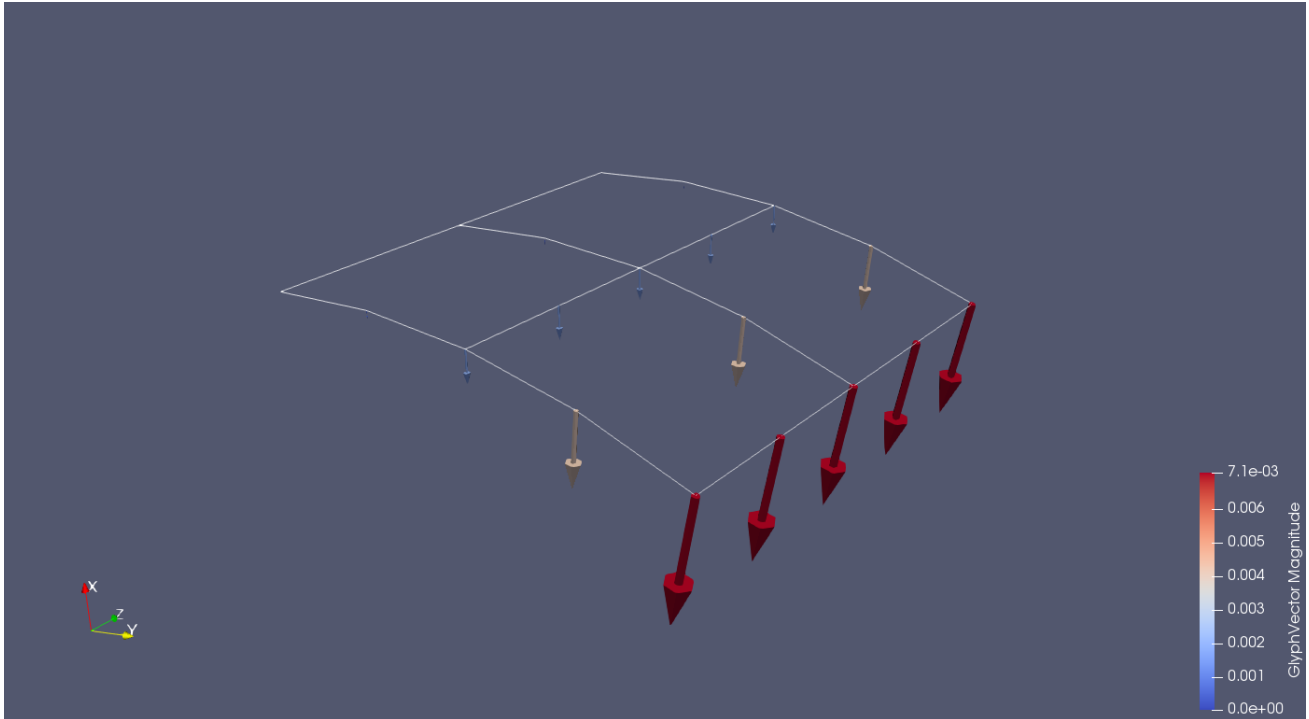


Results (Bending stresses)

	Circumferential $\sigma_{\theta\theta}$ at point E (MPa)	Lateral $\sigma_{\phi\phi}$ at point E (MPa)
“Theoretical” result	60.0	18.0
Typical FE result (FINEL)	60.2	18.1
STRATOFEM	60.0	18.0

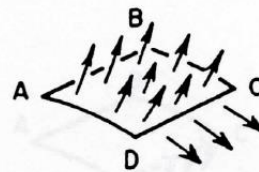
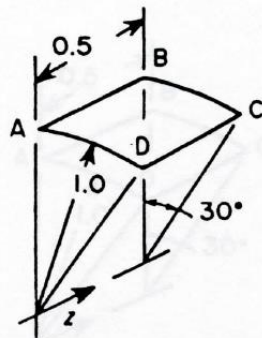
ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	1.0D+00	5.5D-02	5.3D-02	1.80D+07	6.00D+07	0.00D+00	1.60D+01	1.45D+01	1.99D+00	5.33D+07
					3.99D-01	1.78D+00	0.00D+00	-1.27D+00	1.45D+01	1.99D+00	2.55D+01
1	2	1.0D+00	5.5D-02	2.0D-01	-1.80D+07	-6.00D+07	0.00D+00	-1.86D+01	1.45D+01	1.99D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	-1.99D+01	1.45D+01	-1.99D+00	5.33D+07
1	3	9.8D-01	2.0D-01	5.3D-02	-3.99D-01	-1.78D+00	0.00D+00	-1.27D+00	1.45D+01	-1.99D+00	2.55D+01
					-1.80D+07	-6.00D+07	0.00D+00	1.74D+01	1.45D+01	-1.99D+00	5.33D+07
1	4	9.8D-01	2.0D-01	2.0D-01	1.80D+07	6.00D+07	0.00D+00	7.14D+01	-1.08D+01	-2.23D+00	5.33D+07
					-1.03D+00	-1.76D+00	0.00D+00	2.64D+00	-1.08D+01	-2.23D+00	1.96D+01
2	1	9.5D-01	3.1D-01	5.3D-02	-1.80D+07	-6.00D+07	0.00D+00	-6.61D+01	-1.08D+01	-2.23D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	-6.28D+01	-1.08D+01	2.23D+00	5.33D+07
2	2	9.5D-01	3.1D-01	2.0D-01	1.03D+00	1.76D+00	0.00D+00	2.64D+00	-1.08D+01	-2.23D+00	1.96D+01
					-1.80D+07	-6.00D+07	0.00D+00	6.80D+01	-1.08D+01	2.23D+00	5.33D+07
2	3	8.9D-01	4.5D-01	5.3D-02	1.80D+07	6.00D+07	0.00D+00	-7.03D+00	7.76D+00	2.61D+00	5.33D+07
					-3.11D-01	-3.10D-01	0.00D+00	-3.40D+00	7.76D+00	2.61D+00	1.54D+01
2	4	8.9D-01	4.5D-01	2.0D-01	-1.80D+07	-6.00D+07	0.00D+00	2.36D-01	7.76D+00	2.61D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	2.61D+00	7.76D+00	-2.61D+00	5.33D+07
3	1	1.0D+00	5.5D-02	3.0D-01	3.11D-01	-3.10D-01	0.00D+00	-3.40D+00	7.76D+00	2.61D+00	1.54D+01
					-1.80D+07	-6.00D+07	0.00D+00	-9.40D+00	7.76D+00	-2.61D+00	5.33D+07
3	2	1.0D+00	5.5D-02	4.5D-01	1.80D+07	6.00D+07	0.00D+00	-2.32D+02	-2.50D+00	-3.41D+00	5.33D+07
					6.84D-01	1.54D+00	0.00D+00	1.53D+00	-2.50D+00	-3.41D+00	7.91D+00
3	3	9.8D-01	2.0D-01	3.0D-01	-1.80D+07	-6.00D+07	0.00D+00	2.35D+02	-2.50D+00	-3.41D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	2.69D+02	-2.50D+00	3.41D+00	5.33D+07
3	4	9.8D-01	2.0D-01	4.5D-01	-6.84D-01	-1.54D+00	0.00D+00	1.53D+00	-2.50D+00	3.41D+00	7.91D+00
					-1.80D+07	-6.00D+07	0.00D+00	-2.66D+02	-2.50D+00	3.41D+00	5.33D+07
4	1	9.5D-01	3.1D-01	3.0D-01	1.80D+07	6.00D+07	0.00D+00	1.99D+01	-1.45D+01	-1.99D+00	5.33D+07
					-3.99D-01	-1.78D+00	0.00D+00	1.27D+00	-1.45D+01	-1.99D+00	2.55D+01
4	2	9.5D-01	3.1D-01	4.5D-01	-1.80D+07	-6.00D+07	0.00D+00	-1.74D+01	-1.45D+01	-1.99D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	-1.60D+01	-1.45D+01	1.99D+00	5.33D+07
4	3	8.9D-01	4.5D-01	3.0D-01	3.99D-01	1.78D+00	0.00D+00	1.27D+00	-1.45D+01	1.99D+00	2.55D+01
					-1.80D+07	-6.00D+07	0.00D+00	1.86D+01	-1.45D+01	1.99D+00	5.33D+07
4	4	8.9D-01	4.5D-01	4.5D-01	1.80D+07	6.00D+07	0.00D+00	6.28D+01	1.08D+01	2.23D+00	5.33D+07
					1.03D+00	1.76D+00	0.00D+00	-2.64D+00	1.08D+01	2.23D+00	1.96D+01
4	1	9.5D-01	3.1D-01	3.0D-01	-1.80D+07	-6.00D+07	0.00D+00	-6.80D+01	1.08D+01	2.23D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	-7.14D+01	1.08D+01	-2.23D+00	5.33D+07
4	2	9.5D-01	3.1D-01	4.5D-01	-1.03D+00	-1.76D+00	0.00D+00	-2.64D+00	1.08D+01	-2.23D+00	1.96D+01
					-1.80D+07	-6.00D+07	0.00D+00	6.61D+01	1.08D+01	-2.23D+00	5.33D+07
4	3	8.9D-01	4.5D-01	3.0D-01	1.80D+07	6.00D+07	0.00D+00	-2.61D+00	-7.76D+00	-2.61D+00	5.33D+07
					-3.11D-01	-3.10D-01	0.00D+00	3.40D+00	-7.76D+00	-2.61D+00	1.54D+01
4	4	8.9D-01	4.5D-01	4.5D-01	-1.80D+07	-6.00D+07	0.00D+00	9.40D+00	-7.76D+00	-2.61D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	7.03D+00	-7.76D+00	2.61D+00	5.33D+07
4	1	9.5D-01	3.1D-01	3.0D-01	-3.11D-01	-3.10D-01	0.00D+00	3.40D+00	-7.76D+00	2.61D+00	1.54D+01
					-1.80D+07	-6.00D+07	0.00D+00	-2.36D-01	-7.76D+00	2.61D+00	5.33D+07
4	2	9.5D-01	3.1D-01	4.5D-01	1.80D+07	6.00D+07	0.00D+00	-2.69D+02	2.50D+00	3.41D+00	5.33D+07
					-6.84D-01	-1.54D+00	0.00D+00	-1.53D+00	2.50D+00	3.41D+00	7.91D+00
4	3	8.9D-01	4.5D-01	3.0D-01	-1.80D+07	-6.00D+07	0.00D+00	2.66D+02	2.50D+00	3.41D+00	5.33D+07
					1.80D+07	6.00D+07	0.00D+00	2.32D+02	2.50D+00	-3.41D+00	5.33D+07
4	4	8.9D-01	4.5D-01	4.5D-01	6.84D-01	1.54D+00	0.00D+00	-1.53D+00	2.50D+00	-3.41D+00	7.91D+00
					-1.80D+07	-6.00D+07	0.00D+00	-2.35D+02	2.50D+00	-3.41D+00	5.33D+07

Displacement Vectors



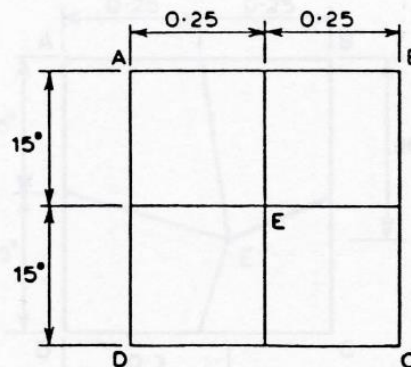
NAFEMS Benchmark B4.4: Cylindrical Shell Pressure Load

NAFEMS	CYLINDRICAL SHELL PRESSURE LOAD	TEST No IC 20	DATE/ISSUE
ORIGIN	NAFEMS report LSB2		Units M,KN
ANALYSIS TYPE	Linear elastic thin shell		
GEOMETRY			



Thickness 0.01

LOADING	Uniform outward normal pressure at mid surface ABCD, of 0.6MPa. Tangential outward normal pressure on edge DC, of 60.0MPa
BOUNDARY CONDITIONS	Edge AB, all translations and rotations zero Edge AD and edge BC, symmetry eg z translations and rotations about the edges are zero
MATERIAL PROPERTIES	Isotropic, $E = 210 \times 10^3 \text{ MPa}$, $\nu = 0.3$
ELEMENT TYPES	General thin shell quadrilaterals or triangles
MESHES	

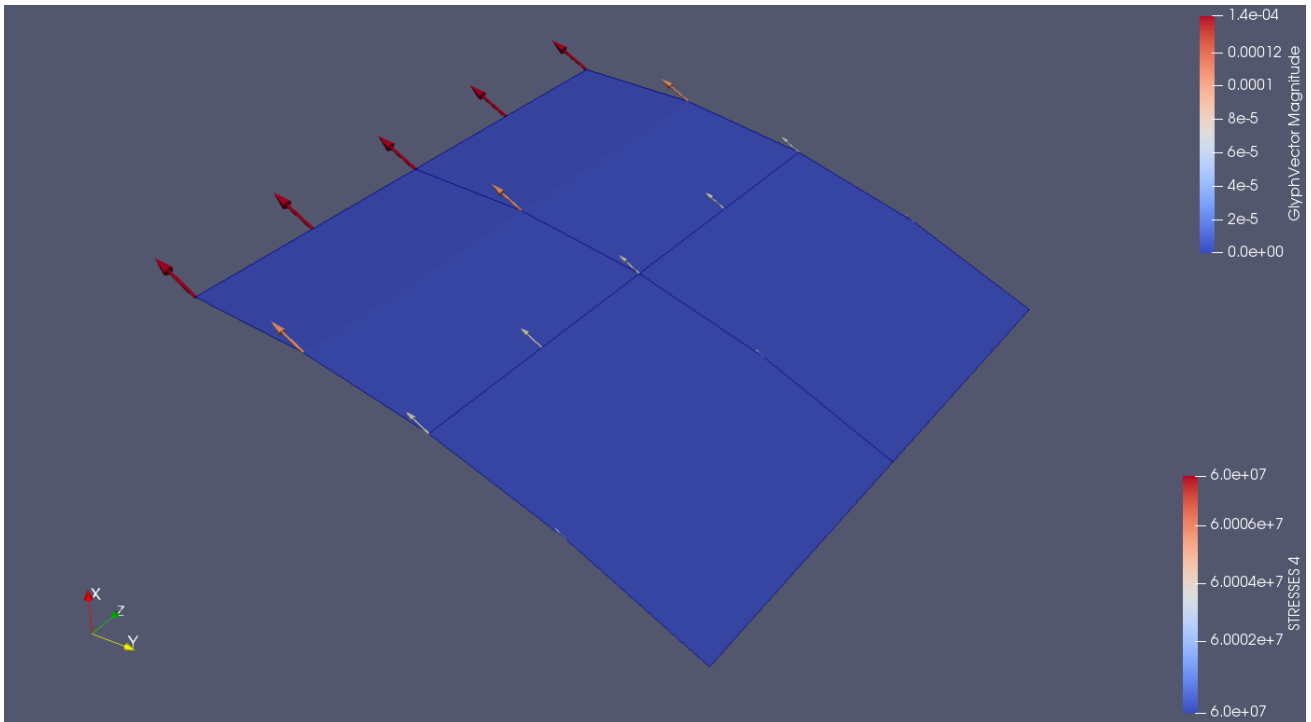


Results (Membrane stresses)

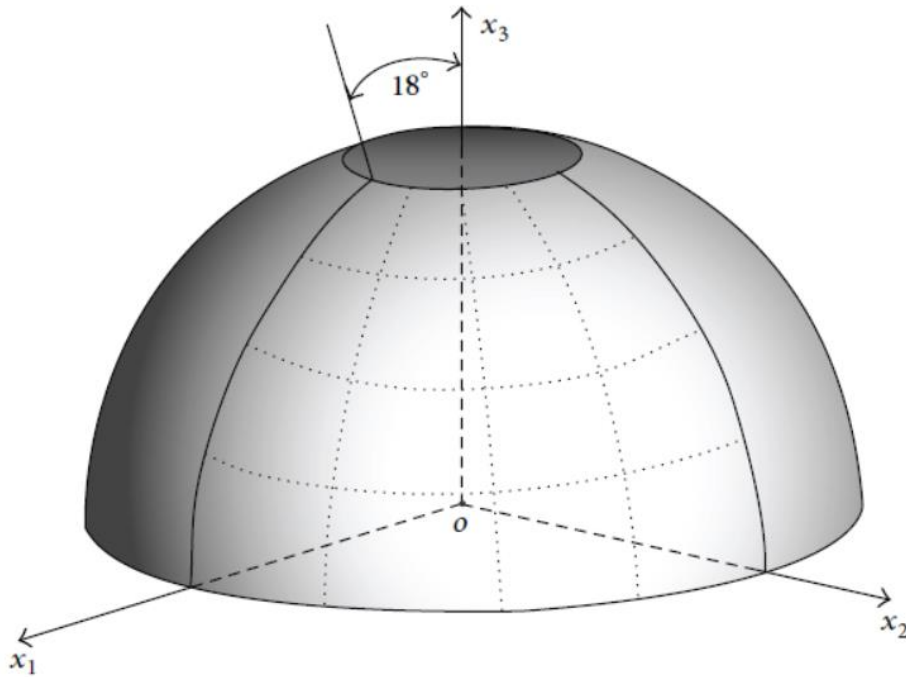
	Circumferential $\sigma_{\theta\theta}$ at point E (MPa)	Lateral $\sigma_{\phi\phi}$ at point E (MPa)
“Theoretical” result	60.0	18.0
Typical FE result (FINEL)	---	---
STRATOFEM	60.0	18.0

ELEMENT	GAUSS POINT	X-GPT COORD	Y-GPT COORD	Z-GPT COORD	SIGMA 11	SIGMA 22	SIGMA 33	SIGMA 12	SIGMA 13	SIGMA 23	VON MISES
1	1	1.0D+00	5.5D-02	5.3D-02	1.79D+07	5.97D+07	0.00D+00	2.69D-08	-1.17D-08	6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-1.84D-08	-1.17D-08	6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-6.37D-08	-1.17D-08	6.48D+03	5.36D+07
1	2	1.0D+00	5.5D-02	2.0D-01	1.79D+07	5.97D+07	0.00D+00	2.64D-07	-2.56D-09	6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-7.42D-08	-2.56D-09	6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-4.13D-07	-2.56D-09	6.48D+03	5.36D+07
1	3	9.8D-01	2.0D-01	5.3D-02	1.79D+07	5.97D+07	0.00D+00	1.96D-07	-3.59D-08	-6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-4.24D-08	-3.59D-08	-6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-2.81D-07	-3.59D-08	-6.48D+03	5.36D+07
1	4	9.8D-01	2.0D-01	2.0D-01	1.79D+07	5.97D+07	0.00D+00	1.03D-07	3.34D-08	-6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-1.08D-07	3.34D-08	-6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-3.19D-07	3.34D-08	-6.48D+03	5.36D+07
2	1	9.5D-01	3.1D-01	5.3D-02	1.79D+07	5.97D+07	0.00D+00	1.75D-07	-1.81D-09	6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	5.12D-08	-1.81D-09	6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-7.23D-08	-1.81D-09	6.44D+03	5.36D+07
2	2	9.5D-01	3.1D-01	2.0D-01	1.79D+07	5.97D+07	0.00D+00	-7.11D-08	-3.71D-09	6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	1.31D-08	-3.71D-09	6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	9.74D-08	-3.71D-09	6.44D+03	5.36D+07
2	3	8.9D-01	4.5D-01	5.3D-02	1.79D+07	5.97D+07	0.00D+00	-3.15D-09	-1.14D-07	-6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-9.85D-09	-1.14D-07	-6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-1.66D-08	-1.14D-07	-6.44D+03	5.36D+07
2	4	8.9D-01	4.5D-01	2.0D-01	1.79D+07	5.97D+07	0.00D+00	-8.85D-09	6.82D-08	-6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	3.59D-08	6.82D-08	-6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	8.06D-08	6.82D-08	-6.44D+03	5.36D+07
3	1	1.0D+00	5.5D-02	3.0D-01	1.79D+07	5.97D+07	0.00D+00	-5.82D-08	1.26D-08	6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-1.99D-07	1.26D-08	6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-3.40D-07	1.26D-08	6.48D+03	5.36D+07
3	2	1.0D+00	5.5D-02	4.5D-01	1.79D+07	5.97D+07	0.00D+00	2.52D-07	5.42D-08	6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-6.80D-08	5.42D-08	6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-3.88D-07	5.42D-08	6.48D+03	5.36D+07
3	3	9.8D-01	2.0D-01	3.0D-01	1.79D+07	5.97D+07	0.00D+00	3.09D-07	-5.63D-08	-6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-1.04D-07	-5.63D-08	-6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-5.16D-07	-5.63D-08	-6.48D+03	5.36D+07
3	4	9.8D-01	2.0D-01	4.5D-01	1.79D+07	5.97D+07	0.00D+00	-3.71D-08	-2.26D-08	-6.48D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-9.87D-08	-2.26D-08	-6.48D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-1.60D-07	-2.26D-08	-6.48D+03	5.36D+07
4	1	9.5D-01	3.1D-01	3.0D-01	1.79D+07	5.97D+07	0.00D+00	3.46D-07	-2.31D-08	6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	1.03D-07	-2.31D-08	6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	-1.39D-07	-2.31D-08	6.44D+03	5.36D+07
4	2	9.5D-01	3.1D-01	4.5D-01	1.79D+07	5.97D+07	0.00D+00	-7.26D-08	9.62D-08	6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	2.13D-08	9.62D-08	6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	1.15D-07	9.62D-08	6.44D+03	5.36D+07
4	3	8.9D-01	4.5D-01	3.0D-01	1.79D+07	5.97D+07	0.00D+00	1.17D-07	-2.45D-09	-6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	6.94D-08	-2.45D-09	-6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	2.21D-08	-2.45D-09	-6.44D+03	5.36D+07
4	4	8.9D-01	4.5D-01	4.5D-01	1.79D+07	5.97D+07	0.00D+00	-9.26D-08	-1.49D-07	-6.44D+03	5.31D+07
					1.80D+07	6.00D+07	0.00D+00	-4.53D-08	-1.49D-07	-6.44D+03	5.33D+07
					1.81D+07	6.03D+07	0.00D+00	1.88D-09	-1.49D-07	-6.44D+03	5.36D+07

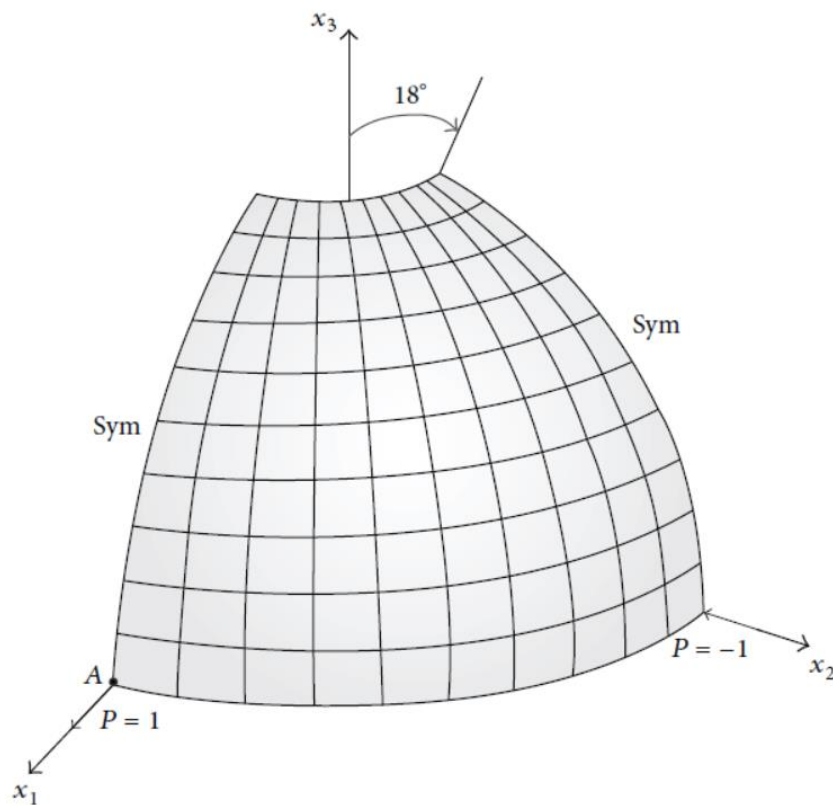
Displacement Vectors



McNeil Hemisphere: Pinch Loads



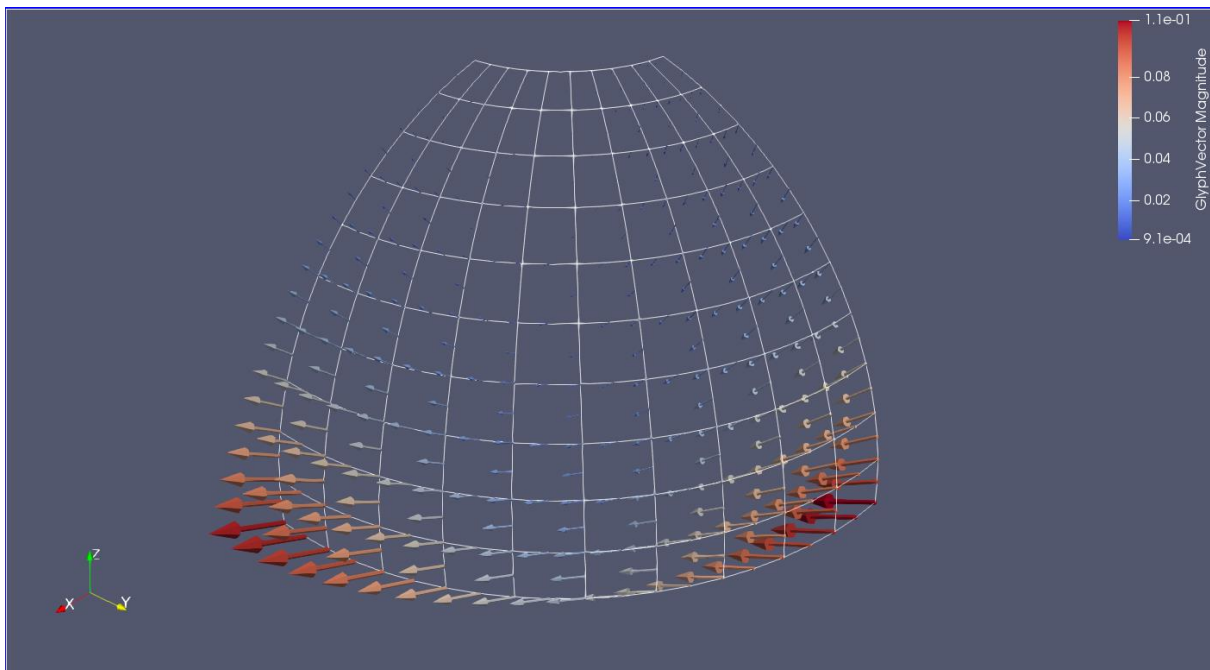
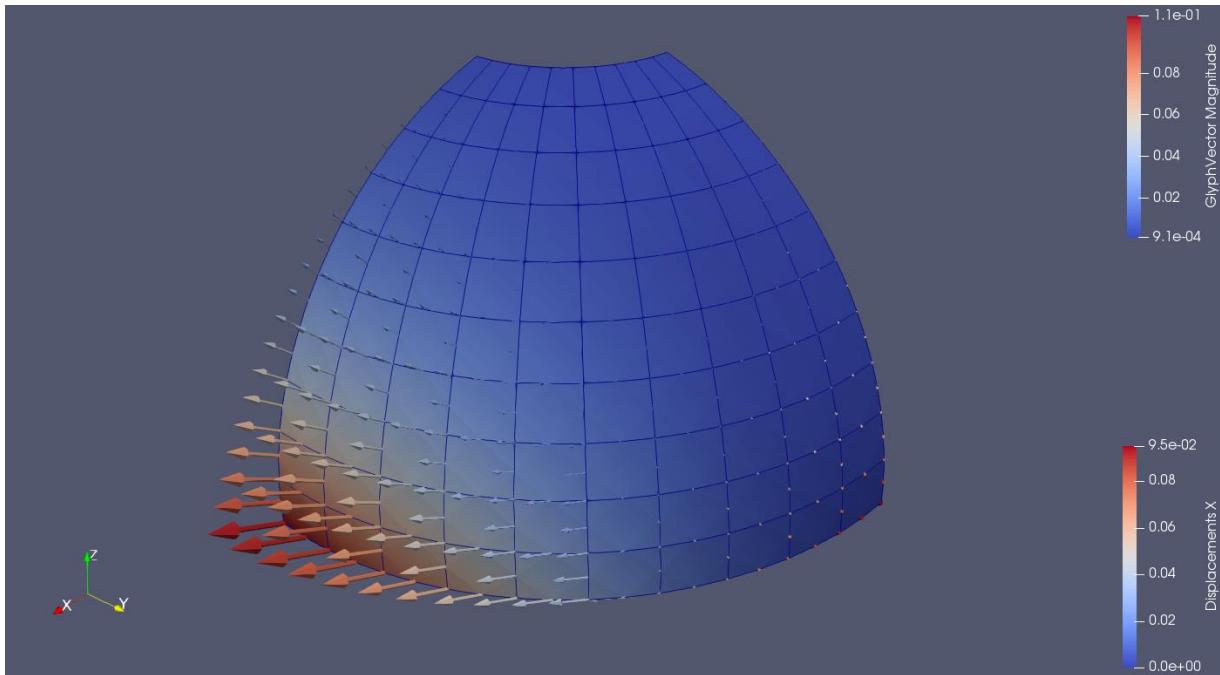
The radius of the shell is 10 m, thickness is 0.04m, Young's modulus is 68.25 MPa, and Poisson's ratio is 0.3.



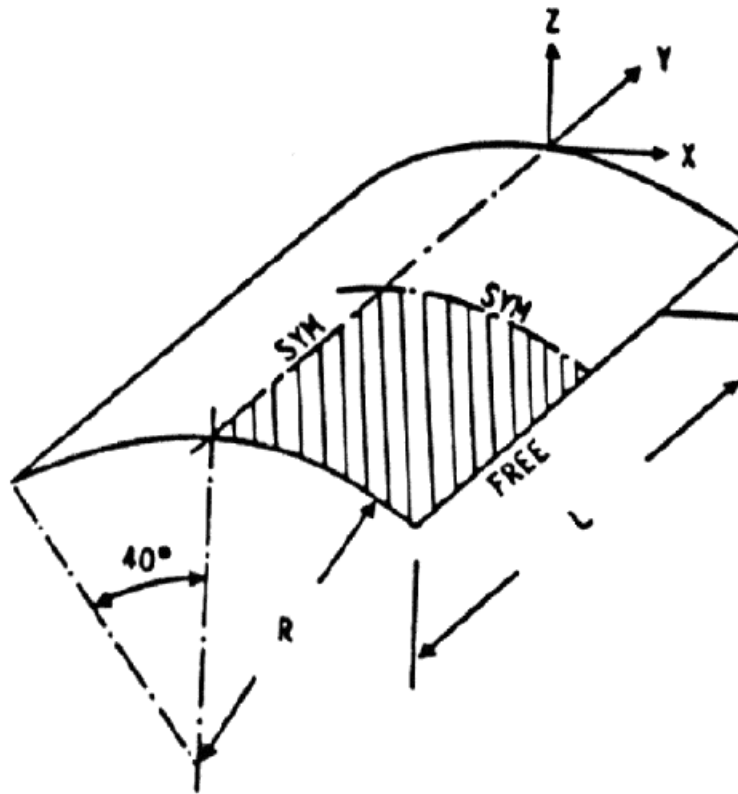
Results

	Displacement u at point A (m)	Displacement v at point C (m)
Theoretical result	0.094	-0.094
Typical FE result (FINEL)	---	---
STRATOFEM (Fine)	0.094886	-0.094886

Displacement Vectors



Scordelis-Lo Roof : Cylindrical Shell Under Self-Weight



Radius R : 25.0
 Length L : 50.0
 Thickness t : 0.25
 Young's modulus : 4.32×10^8
 Poisson's ratio : 0.0;
 Vertical Gravity Loading : 90.0 per unit area in - Z direction

Rigid Diaphragms at both curved sides : $U = W = 0$ on curved edges

Results

	Maximal Vertical Displacement w
Theoretical result	-0.3086
Typical FE result	---
STRATOFEM	-0.3093

Displacement Vectors

