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RamSeries - Validation Case 17

Thick Plate Pressure (NAFEMS LE10)

RamSeries

Version
15.1.0

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1 Validation Case 17 - NAFEMS LE10

Model Description

This test case is based on the NAFEMS LE10 "Thick plate pressure", described in Ref. [1].

The test consists of a linear elastic anlysis of a thick elliptic plate (shown below) using coarse and fine meshes of solid elements.

The axial stress at point A on the mid-surface is determined.

Dimensions:

Ellipses:

AD: $(x/2)^2 + y^2 = 1$

BC: $(x/3.25)^2 + (y/2.75)^2 = 1$

Geometrical description (dimensions in [m])

Load value:

A pair of forces is applied so it creates the desired moment. The forces value is:

F=6.0e5 N

Material data:

The material is assumed to be lineal elastic.

E = 2.1e5 MPa

μ = 0.3

Mass density = 7.85e-6 kg/mm^3

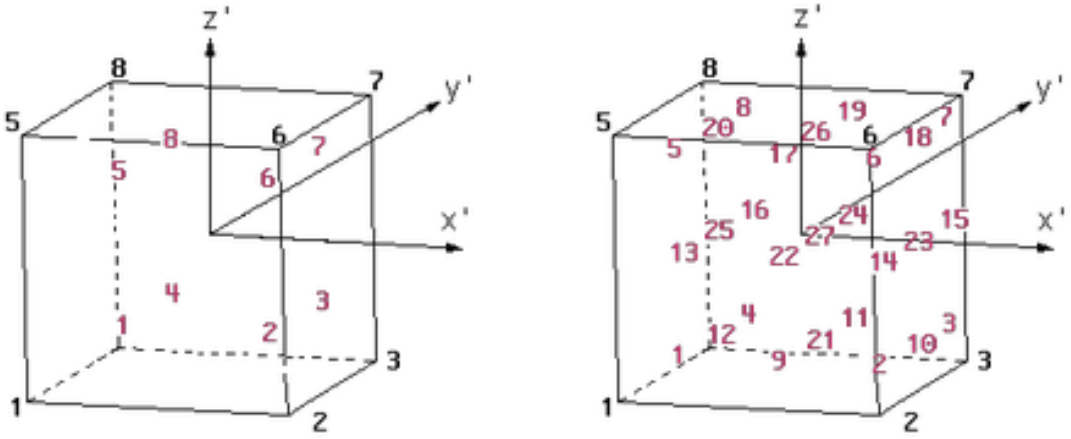
Tensile Yield Strength = 207.0 MPa

Results

For the sake of validation, various simulation were run using the properties described in the previous chapter, with different meshes (hexahedras and tetrahedras, linear and parabolic).

It is necessary to remark some details regarding the obtained results:

- In RamSeries, stresses are computed at the element Gauss points, which are not located in the nodes:



Order of the Internal Gauss points

- In order to get the results in the nodes, a local smoothing is performed (via least squares) inside each element, and then stresses from the elements concurrent at one node are averaged.

Therefore, some of the differences found in the results, are perfectly justified, taking into account that NAFEMS results are given as the direct stress at a certain point/node.

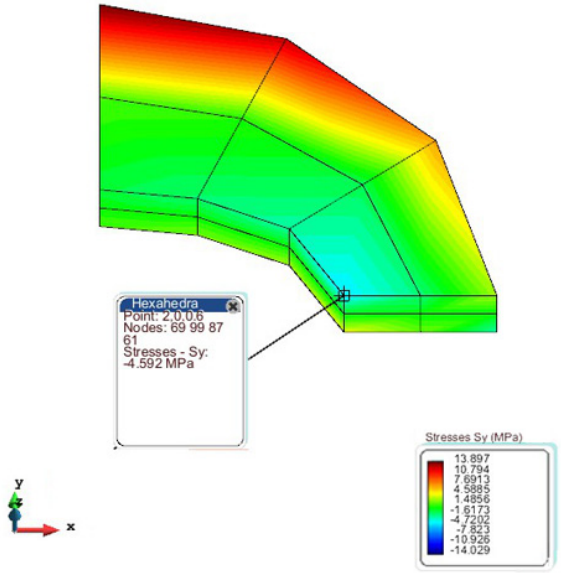
The following summary table shows the difference between the direct stress stress at point D and the reference case (NAFEMS EL10).

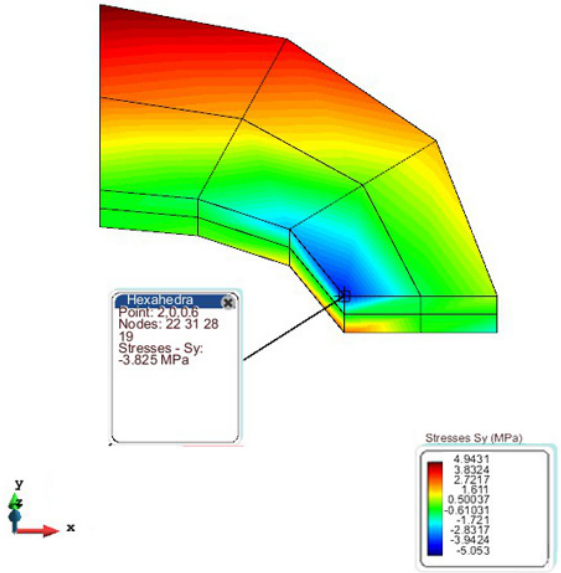
Sy NAFEMS EL10 = -5.5 MPa

	Ramseries Sy (MPa)	Difference (%)
Coarse Linear Hexa.	-3.825	30.45
Coarse Parab. Hexa.	-4.592	16.51
Fine Linear Hexa.	-5.195	5.55
Fine Parab. Hexa.	-5.217	5.15
Coarse Linear Tetra.	-2.132	61.24
Coarse Parab. Tetra	-5.227	4.96
Fine Linear Tetra.	-3.177	42.24
Fine Parab. Tetra	-5.08	7.64

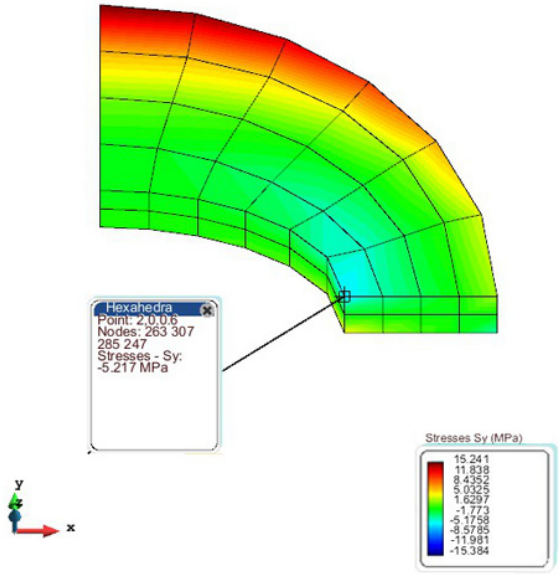
The results obtained for both meshes are shown next:

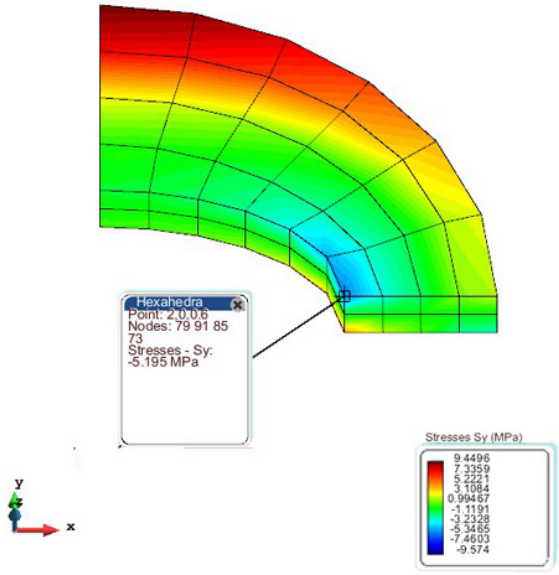
- Coarse hexahedra meshes. Linear at the right (36 nodes, 12 elems.) and parabolic at the left (111 nodes, 12 elems.):



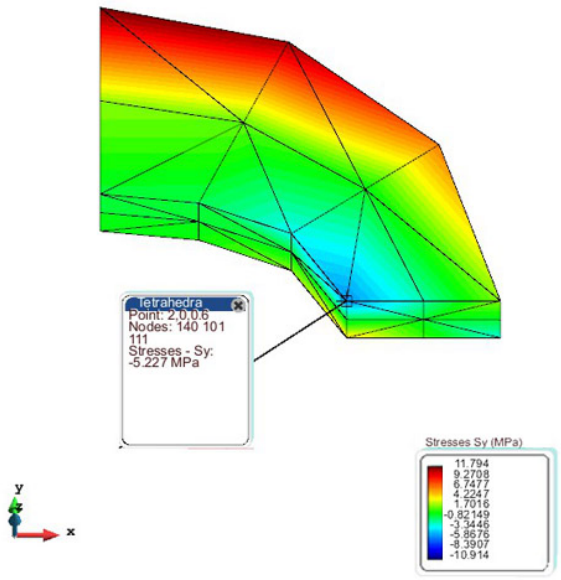


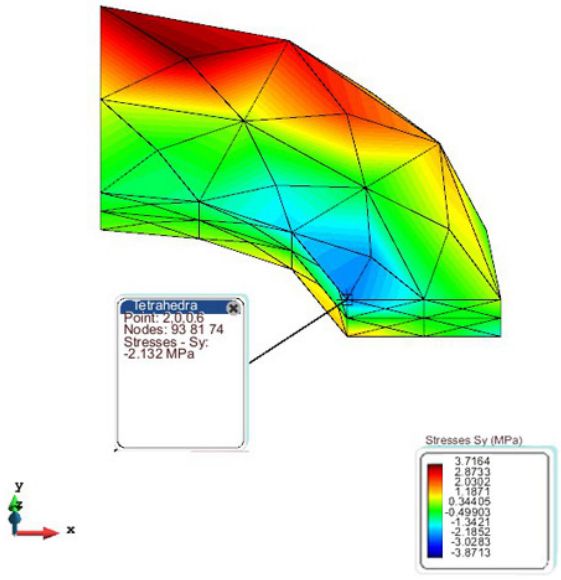
- Fine hexahedra meshes. Linear at the right (105 nodes, 48 elems.) and parabolic at the left (349 nodes, 48 elems.):


Hexahedra
Point: 2,0,0.6
Nodes: 263 307
285 247
Stresses - Sy:
-5.217 MPa
Stresses Sy (MPa)
15.241
11.838
8.4352
5.0325
1.6297
-1.773
-5.1758
-8.5785
-11.981
-15.384
y
x

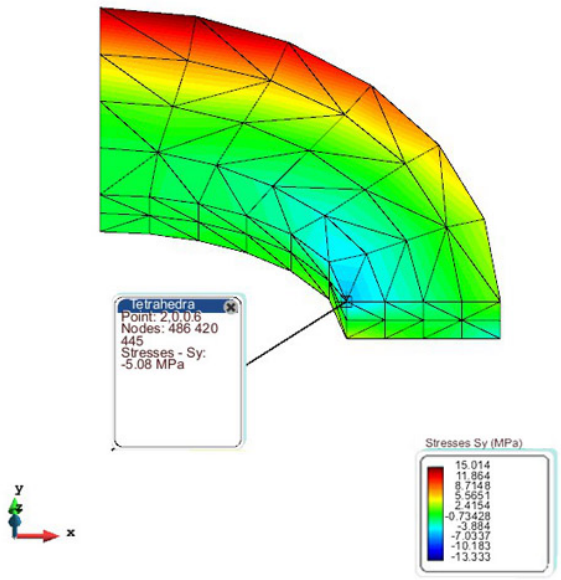

Hexahedra
Point: 2,0,0.6
Nodes: 79 91 85
73
Stresses - Sy:
-5.195 MPa
Stresses Sy (MPa)
9.4496
7.3359
5.2221
3.1084
0.9947
-1.1191
-3.2328
-5.3465
-7.4603
-9.574
y
x

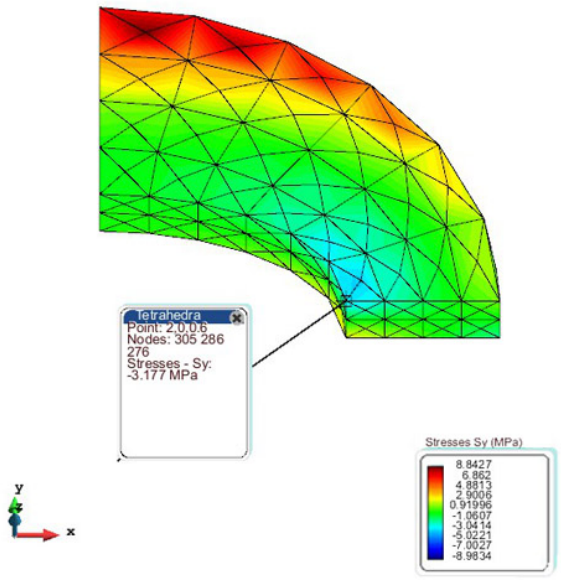
- Coarse tetrahedra meshes. Linear at the right (100 nodes, 288 elems.) and parabolic at the left (175 nodes, 72 elems.):





- Fine tetrahedra meshes. Linear at the right (341 nodes, 1152 elems.) and parabolic at the left (585 nodes, 288 elems.):


Tetrahedra
Point: 2,0,0.6
Nodes: 486 420
445
Stresses - Sy:
-5.08 MPa
Stresses Sy (MPa)
15.014
11.864
8.7148
5.5651
2.4154
-0.73428
-3.884
-7.0337
-10.183
-13.333
y
x


Tetrahedra
Point: 2,0,0.6
Nodes: 305 286
276
Stresses - Sy:
-3.177 MPa
Stresses Sy (MPa)
8.8427
6.862
4.8813
2.9006
0.91996
-1.0607
-3.0414
-5.0221
-7.0027
-8.9834
y
x

References

[1] NAFEMS Finite Element Methods & Standards.The Standard NAFEMS Benchmarks, Test No.LE10. Glasgow: NAFEMS, Rev.3, 1990.

Validation Summary

CompassFEM version	15.1.0
Tdyn solver version	15.1.0
RamSeries solver version	15.1.0
Benchmark status	Successfull
Last validation date	27/11/2018