COMET V.5.0 – BENCHMARK MANUAL

CASE LM-1: INFINITELY LONG CYLINDER UNDER EXTERNAL PRESSURE ISSUE: 1

DATE: 12/04/2013.

Summary

Model: Infinitely long cylinder under external pressure

References:

- E. Oñate (1995), *Cálculo de estructuras por el método de los elementos finitos, análisis estático lineal, Ed. CIMNE, 2nd edition, Barcelona. pp. 264-265.*

- NAFEMS, *Workbook of examples,* Published by NAFEMS, Ref: R0019, pp. 29-34

Element type(s) tested

Description	**Designation**	**See in DATA INPUT MANUAL V.5.0**
Linear triangular 2D element - 3 nodes	L-TRIANG3	Secc. 4, pp. 41, 61
Parabolic triangular 2D element – 6 nodes (Not tested in this issue)	Q-TRIANG6	Secc. 4, pp. 41, 61
Quadrilateral 2D element – 4 nodes	L-QUADR4	Secc. 4, pp. 42, 61
Parabolic quadrilateral 2D element – 8 nodes (Not tested in this issue)	Q-QUADR8	Secc. 4, pp. 42, 61
Solid Tetrahedral 3D element – 4 nodes	L-TETRA4	Secc. 4, pp. 42, 61
Solid Parabolic Tetrahedral 3D element – 10 nodes (Not tested in this issue)	Q-TETRA10	Secc. 4, pp. 42, 61
Solid Linear Brick 3D element – 8 nodes	L-HEXA8	Secc. 4, pp. 43, 61
Solid Parabolic Brick 3D element – 20 nodes (Not tested in this issue)	Q-HEXA20	Secc. 4, pp. 43, 61

Solid Parabolic Brick 3D element – 27 nodes (Not tested in this issue)	Q-HEXA27	Secc. 4, pp. 43, 61

Table1: Element type(s) tested and pending to test

Problem definition

Infinitely long cylinder with an inner radius R=a, and outer radius R=2a. The cylinder is subjected to external pressure (P_0) like is shown in figure 1:

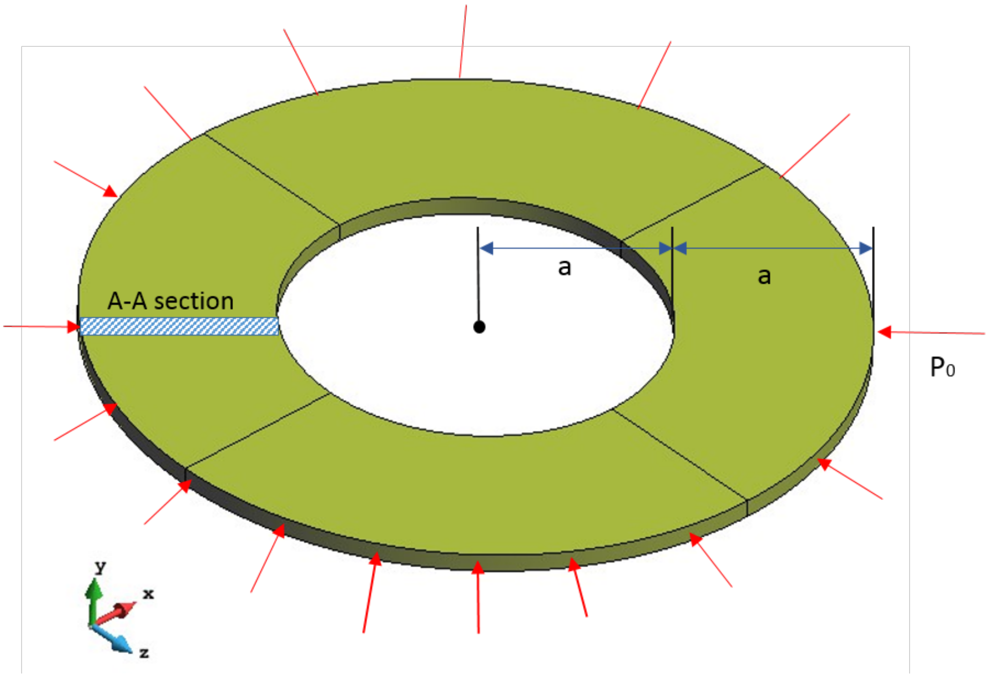

Figure 1: Infinitely long cylinder under external pressure and axisymmetric analysis section (AA).

Data related to the test case can be shown in Table2

Material Properties	Geometric properties	Loading
E = 200 e+9 ν = 0,3	r_0 =a= 2 r_1 =2a= 4	P_0 = 100 e+6

Table 2: Analysis data

Analysis

There are two ways to solve the example. On the one hand, due to symmetry properties of the geometry (Figure 1), the result of a 2D revolution section will represent the result over the whole cylinder only with 2D elements mesh (**¡Error! No se encuentra el origen de la referencia.**). Axisymmetric and plane strain conditions are assumed.

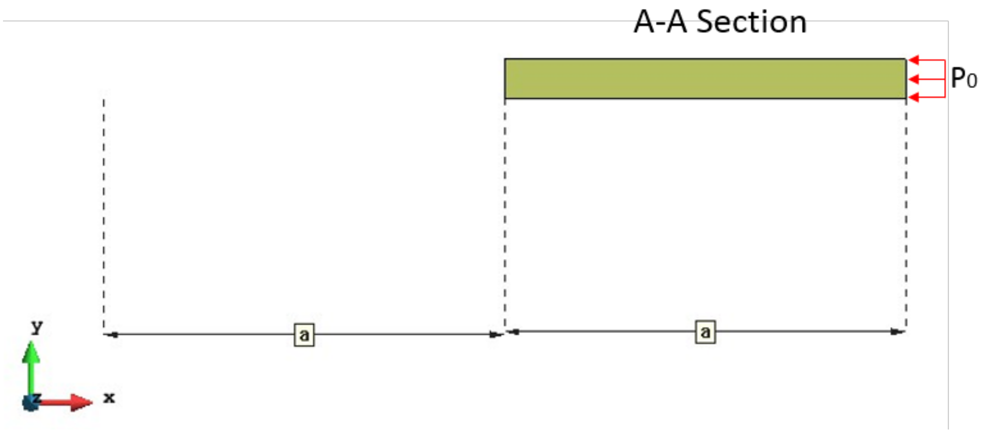

Figure 2: 2D axisymmetric test case geometry

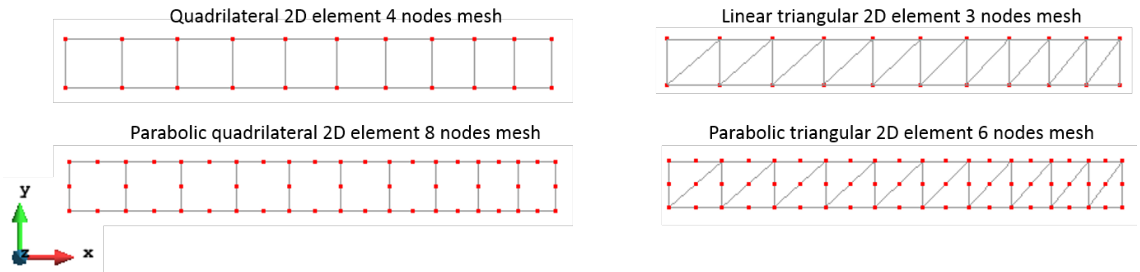

Figure 3: 2D axisymmetric test case mesh and elements type tested (Parabolic elements not tested in this issue)

On the other hand, to solve the 3D case, only a quarter of the total cylinder has been tested as can be shown in Figure 4 (because of the symmetric properties of a cylinder) applying the corresponding symmetry boundary conditions.

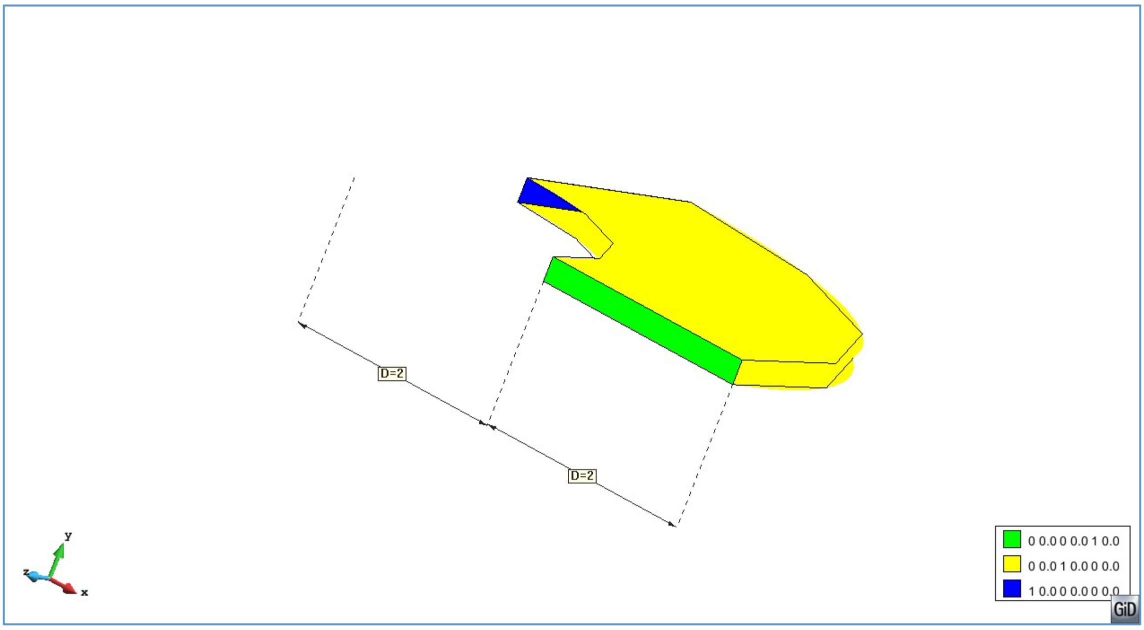

Figure 4: 3D geometry test case and boundary conditions applied.

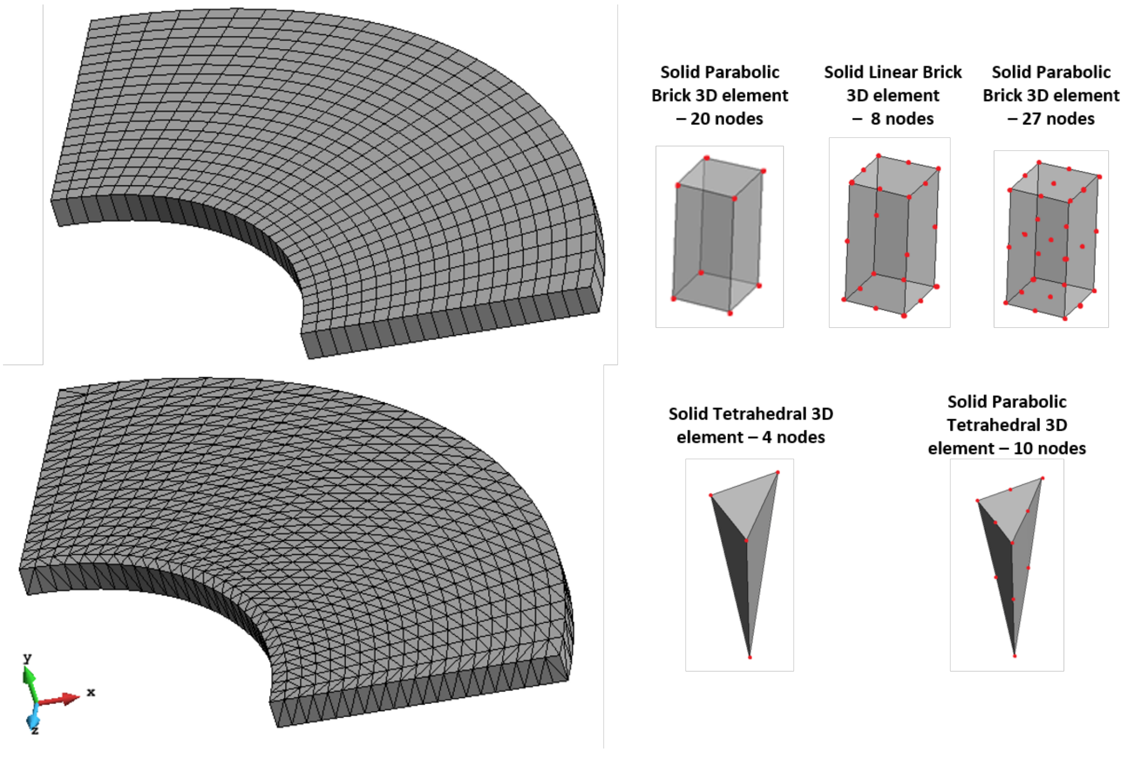

Figure 5: 3D case mesh and element type(s) tested (parabolic elements not tested in this issue)

Results analysis

Dimension	Element type	Theorical result	COMET result	Relative error
2D (Axisymmetric)	Linear triangular 2D element (for r= 1.454a)	$\sigma r/P_0$=0.72 $\sigma\theta/P_0$=2 $\sigma z/P_0$=0.8	$\sigma r/P_0$=0.7077 $\sigma\theta/P_0$=1.9416 $\sigma z/P_0$=0.87428	=1.7% =2.92% =9.3%
	Quadrilateral 2D element(for r= 1.454a)	$\sigma r/P_0$=0.72 $\sigma\theta/P_0$=2 $\sigma z/P_0$=0.8	$\sigma r/P_0$=0.697 $\sigma\theta/P_0$=1.96 $\sigma z/P_0$=0.878	=3.2% =2.0% =9.75%
3D	Solid Tetrahedral 3D element (for r= 1.5a)	$\sigma r/P_0$=0.76 $\sigma\theta/P_0$=1.96 $\sigma z/P_0$=0.8	$\sigma r/P_0$=0.732 $\sigma\theta/P_0$=1.9 $\sigma z/P_0$=0.872	=3.7% =3.1% =9.0%
	Solid Linear Brick 3D element (for r= 1.5a)	$\sigma r/P_0$=0.76 $\sigma\theta/P_0$=1.96 $\sigma z/P_0$=0.8	$\sigma r/P_0$=0.74 $\sigma\theta/P_0$=1.9255 $\sigma z/P_0$=0.879	=2.6% =1.76% =9.87%

Table 3: Results analysis summary