# COMET V.5.0 – BENCHMARK MANUAL

# CASE NL1: PLATE WITH A HOLE

**ISSUE: 1** (Publication date: 12/04/2013)

## Summary


**Model:**

- Geometry tested: Plate with a hole
- Reference solution available.
- Controlled displacemets.
- Perfect plasticity material (without hardening).


**References:**


- O.C.Zienkiewicz-R.L.Taylor "El método de los elementos finitos" Mecánica de Sólidos Vol.2, Pag118, Quinta edición, Ed. CIMNE, Barcelona.


**Element type(s) tested**

| Description | Designation | See COMET model | See in DATA INPUT MANUAL V.5.0 |
|---|---|---|---|
| Linear triangular 2D element - 3 nodes | L-TRIANG3-R | plate-with-hole-L-tria-DC.gid | Secc. 4, pp. 41, 61 |
| Parabolic triangular 2D element – 6 nodes | Q-TRIANG6-R | plate-with-hole-Q-tria-DC.gid | Secc. 4, pp. 41, 61 |

NOTE: The designation **-R** indicates the use of reduced integration. See Data Input Manual page. 61.

**Table1: Element type(s) tested**

## Problem definition

Plate with a hole is analyzed. X and Y symmetry planes are considered. The effect of concentration of plastic strain is detected with the consequent constant force applied since this moment (graphics of figures 5 and 6).

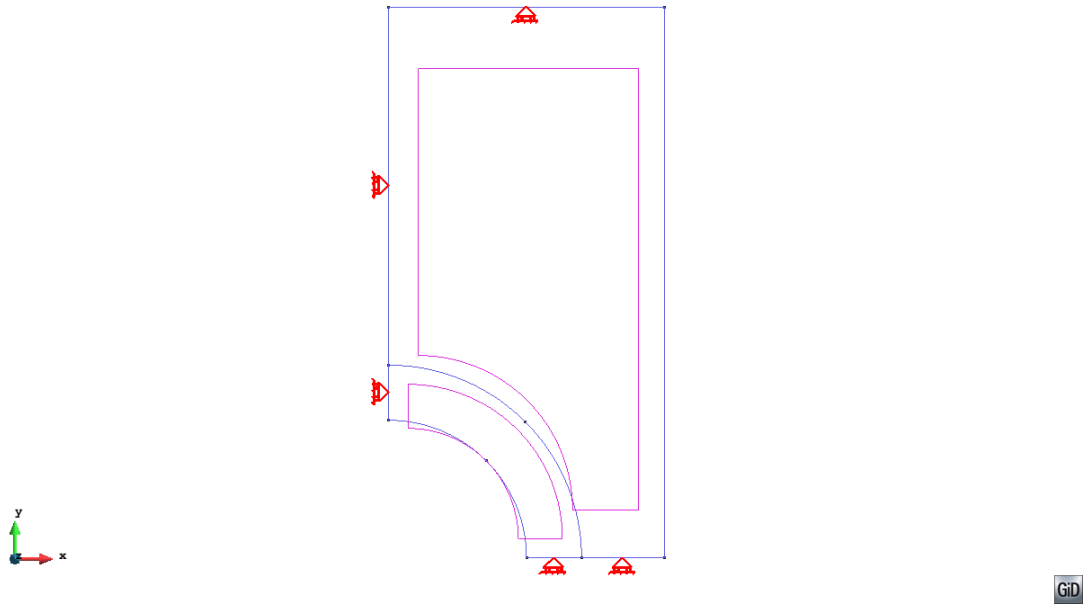


**Figure 0: Symmetry and imposed displacement constrains**

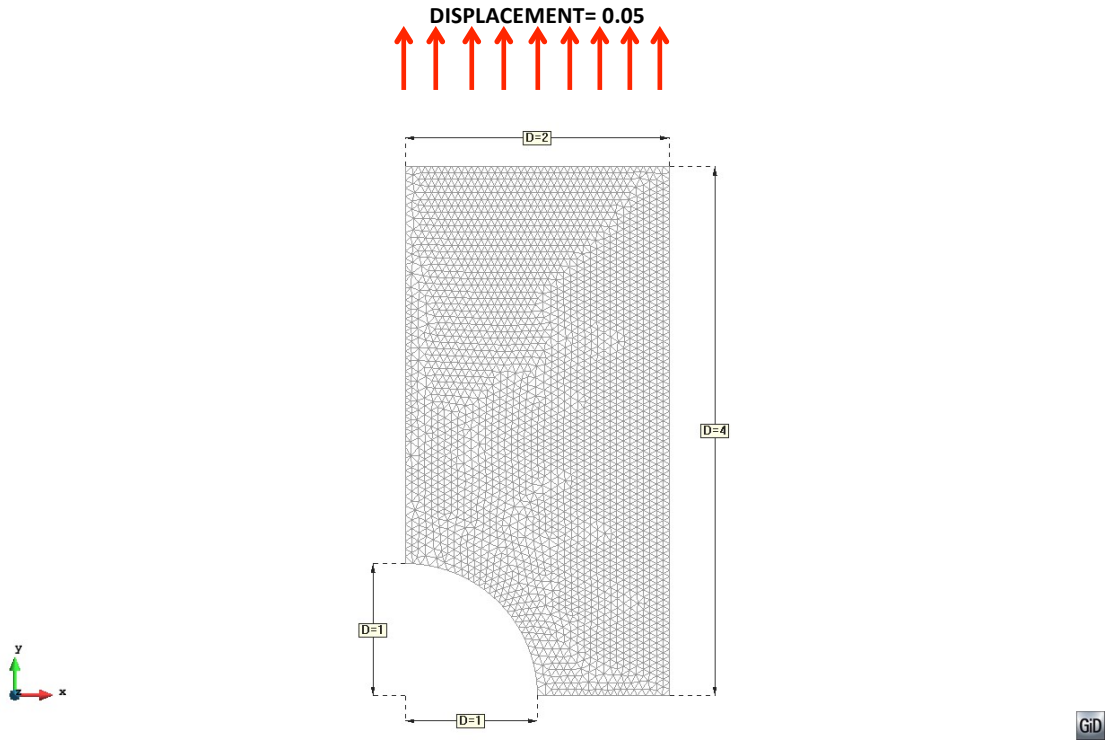


**Figure 1: ¼ of Plate with a hole**

Data related to the test case are shown in Table2

| Material Properties | Geometry and mesh properties | Loading |
|---|---|---|
| E = 100000<br>v = 0.3<br>Elastic Limit $\sigma_y$ =1000<br>Perfect Plasticity (H=0) | **Geometry dimensions**: See fig. 1. Thickness= 0.6 (only used to calculate the applied force).<br><br>**Mesh characteristics**: Non-structured triangles mesh. Size=0.05 | Control of Displacement= 0.05 ( Linear evolution) |

**Table 2: Analysis data**

## Analysis

There are two ways to solve the example. On the one hand, the 2D plane stress simplification is applicable because the thickness is only 0.6 in relation to width (4+4=8). The 2D plane stress analysis is possible using available 2D elements set in COMET (see Figure ).

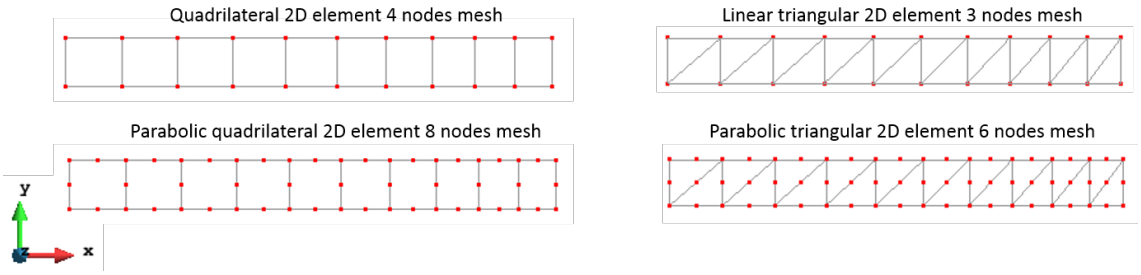


**Figure 2: 2D axisymmetric test case mesh and elements type tested**

On the other hand, the 3D analysis is possible with 3D solid elements. At this issue only 2D plane stress analysis will be included.

# Results analysis

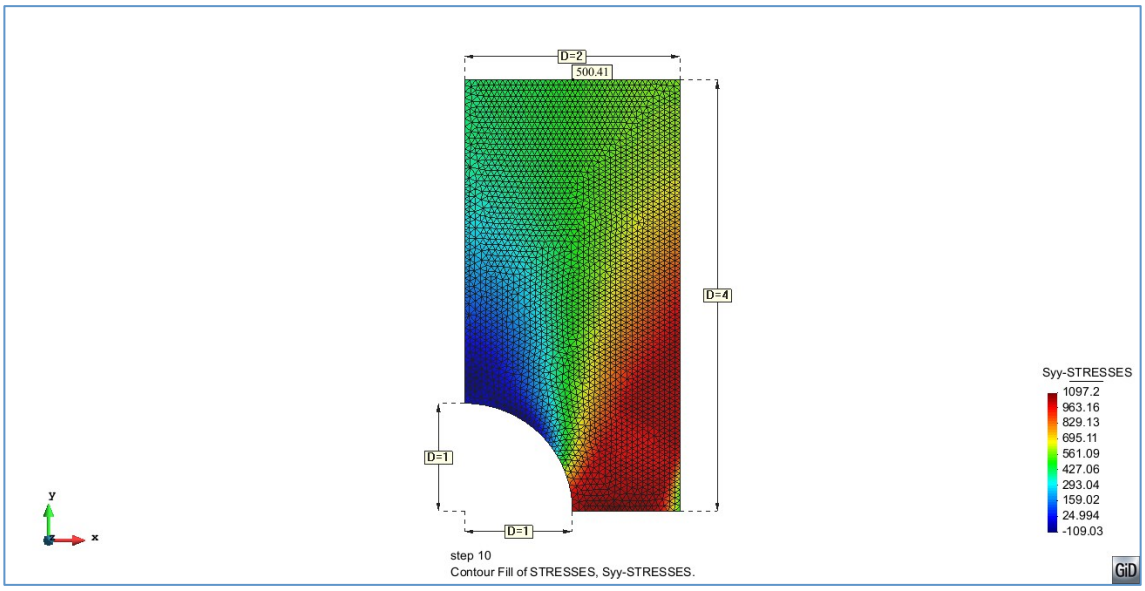


**Figure 3 : Stress YY. Simulation with L-TRIANG3-R elems.**

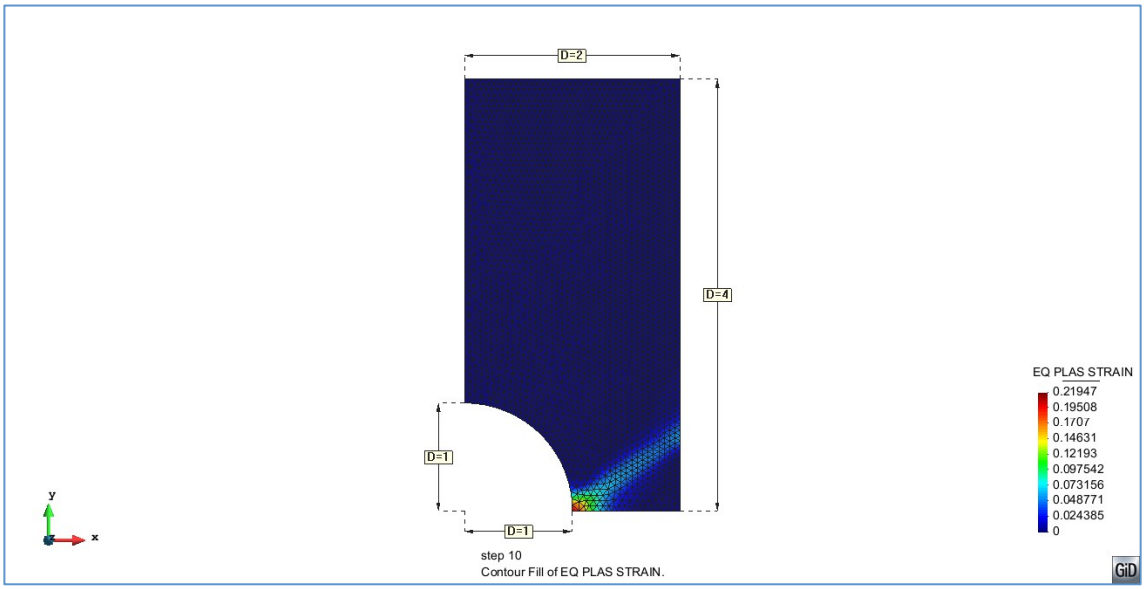


**Figure 4.: Effective Plastic Strain. Simulation with L-TRIANG3-R elems.**

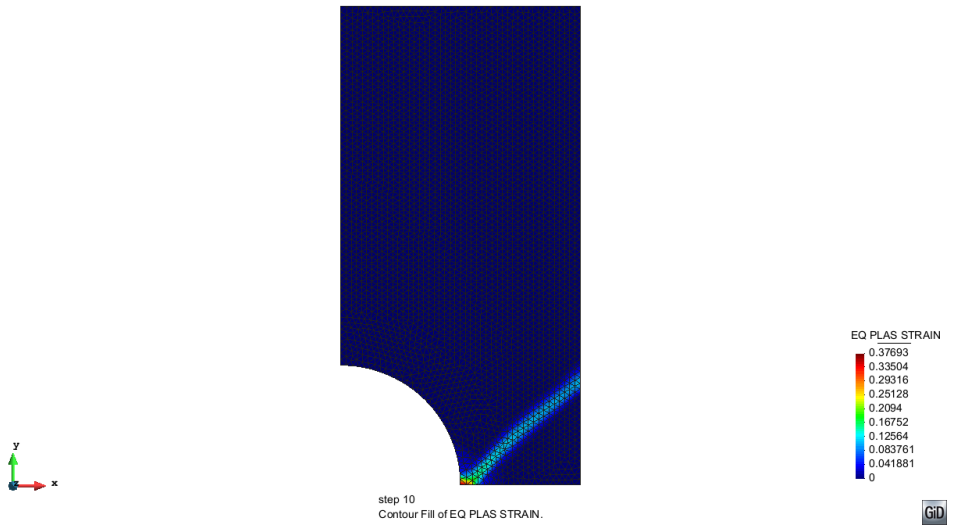


**Figure 5.: Effective Plastic Strain. Simulation with Q-TRIANG6-R elems.**

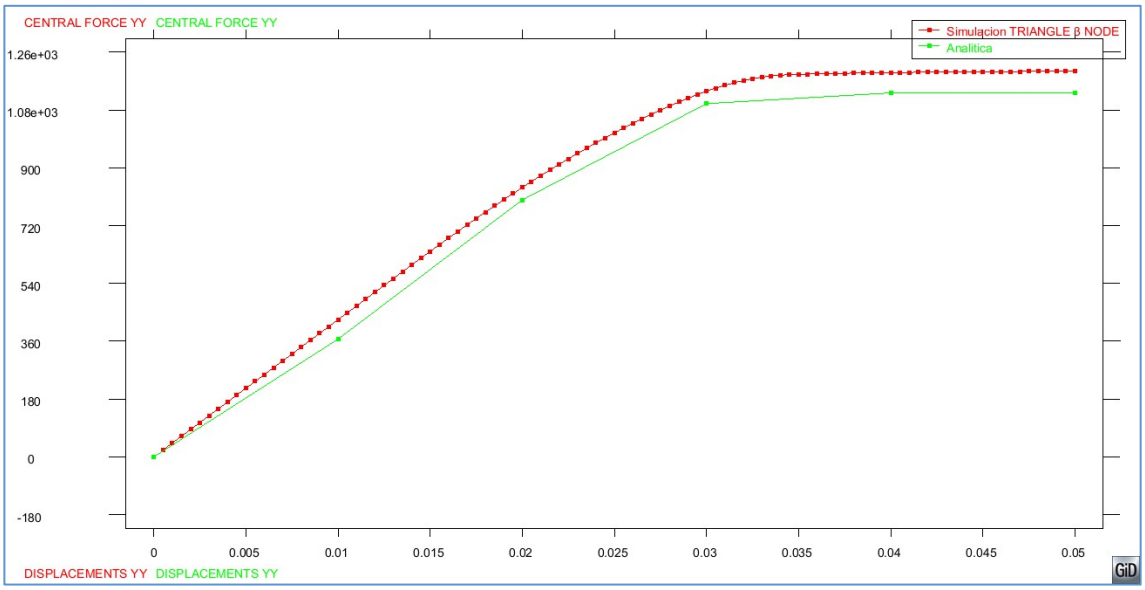


**Figure 6: Comparison FORCE vs. DISPLACEMENT Simulation with L-TRIANG3-R elems. And reference curves**

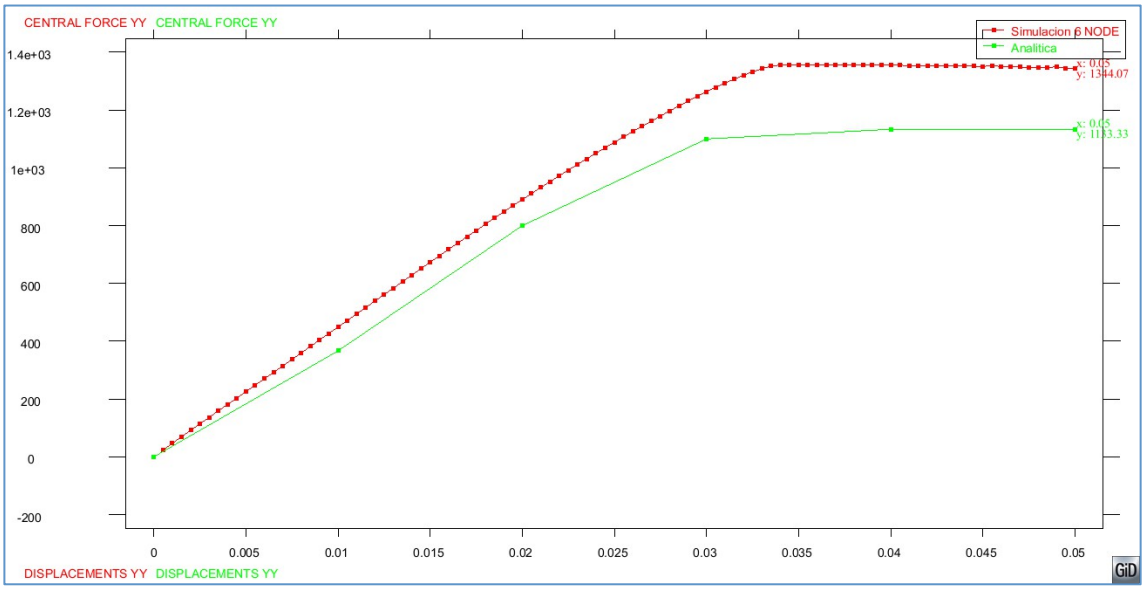


**Figure 6: Comparison FORCE vs. DISPLACEMENT Simulation with Q-TRIANG6-R elems. and reference curves**

| Dimension | Result description | Element type | Theorical result | COMET result | Relative error |
|---|---|---|---|---|---|
| **2D** | Reaction on superior border | L-TRIANG3-R | $F = 1133.33$ | $F = 1200.98$ | =5.9% |
| | Reaction on superior border | Q-TRIANG6-R | $F = 1133.33$ | $F = 1344.07$ | =18% |
| | | | | | |

Table 3: Results analysis summary