COMET V.5.0 – BM V.1.0

CASE BMNL-2A: PLANE STRAIN RIGID PUNCH (PERFECT PLASTICITY MATERIAL)

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

Summary

Model:

- Rigid, frictionless punch is pressed into a deep plate of finite width supported on a frictionless plane.
- 2D plane strain conditions
- Controlled loading.
- Perfect plasticity material.

References:

Linkens, D., *Selected Benchmarks for Material Non-Linearity,* Published by NAFEMS Committed to Professional Development for Engineering Analysis & Simulation, Ref: R0026, p.20,URL: http://www.nafems.org/publications/browse_buy/nonlinear/r0026/

Element type(s) tested

Description	Designation	COMET model	See in DATA INPUT MANUAL V.5.0
Linear triangular 2D element - 3 nodes	L-TRIANG3-R	BMNL-2A-rigid-punch-and-plate-perfplast-L-triaR.gid	Secc. 4, pp. 41, 61
Parabolic triangular 2D element – 6 nodes	Q-TRIANG6-R	BMNL-2A-rigid-punch-and-plate-perfplast-Q-triaR.gid	Secc. 4, pp. 41, 61
Linear Quadrilateral 2D element – 4 nodes	L-QUADR4-R	BMNL-2A-rigid-punch-and-plate-perfplast-L-quadR.gid	Secc. 4, pp. 42, 61
Parabolic quadrilateral 2D element – 8 nodes (Not included in this issue)	Q-QUADR8	Not included	Secc. 4, pp. 42, 61

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

Table1: Element type(s) tested

Problem definition

A highly rigid, frictionless punch (length 160mm, maximum load 108,8N) transfers pressure to elasto-perfect plastic deep plate. A 2-dimensional strain field, Non-radial material response and plastic collapse are considered. A mechanical frictionless contact is defined between the punch and deep plate like is shown in figure 1:

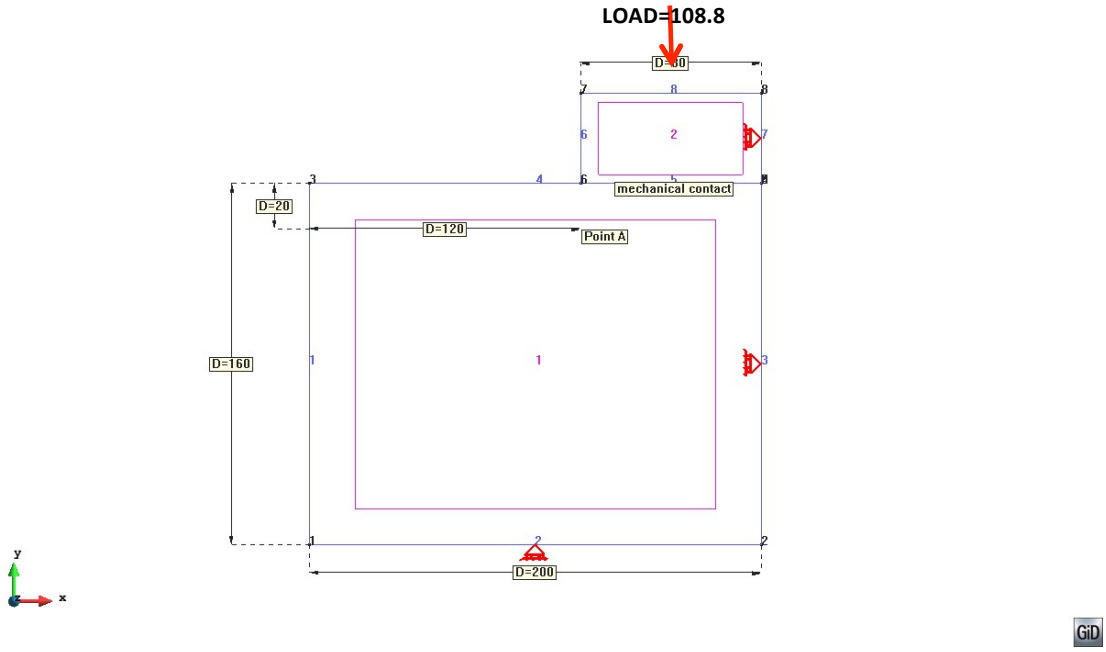

Figure 1: Load applied on punch and constrains in symmetry plane and deep plate base.

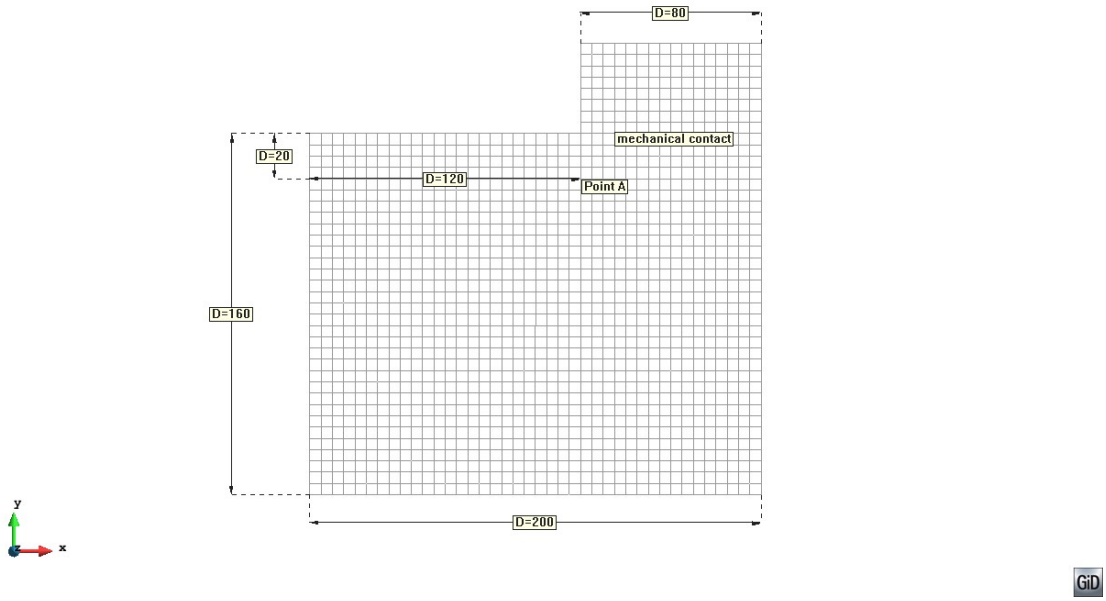

Figure 2: High rigid punch and deep plate, dimensions, contact and test point definitions over 32x40 L-QUADR4-R finite elements mesh.

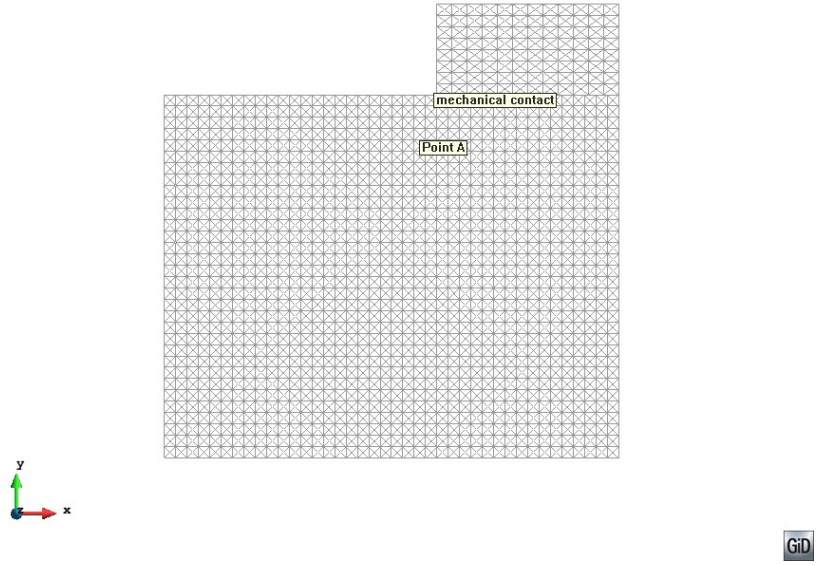

Figure 3: High rigid punch and deep plate, contact and test point definitions over 32x40x4 L-TRIANG3-R finite elements mesh.

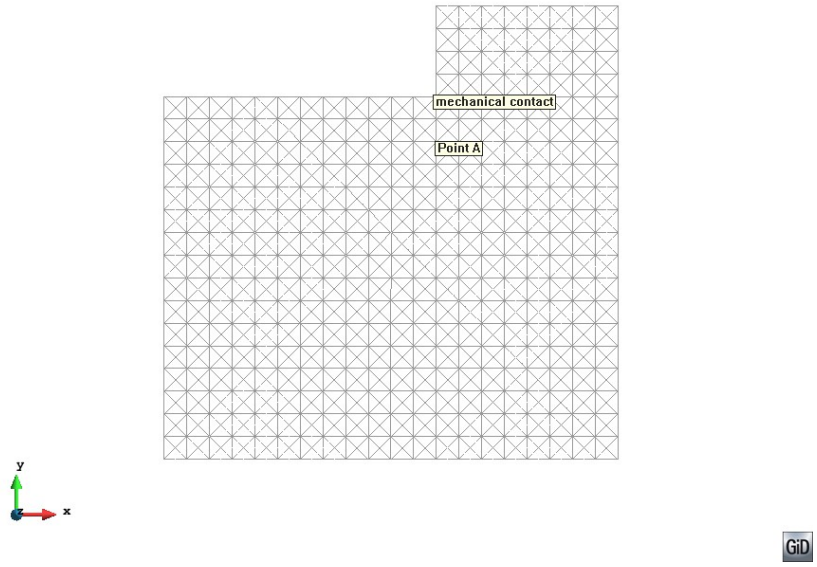

Figure 4: High rigid punch and deep plate, contact and test point definitions over 16x20x4 Q-TRIANG6-R finite elements mesh.

Data related to the test case can be shown in Table2

Material Properties	Geometric and mesh properties	Loading
Punch: E=1000000 v = 0,3 Elastic model **Deep plate:** E = 1000 v = 0,3 Yield stress= 1.0 Von Mises yield, associated flow rule H: 0 (Perfect plasticity)	**Geometry dimensions:** See fig. 1 **Meshes characteristics:** For **L-QUADR4-R elems.:** Punch mesh: 8x16 Plate mesh: 32x40 For **L-TRIANG3-R elems.:** Punch mesh: 16x32 Plate mesh: 32x40x4 (each Quadrilateral element is divided en 4 triangles). For **Q-TRIANG6-R elems.:** Punch mesh: 4x8 Plate mesh: 16x20x4 (each Quadrilateral element is divided en 4 triangles).	P_0 = 108.8 (applied on superior punch surface).

Table 2: Analysis data

Analysis

Symmetry properties of the geometry (**¡Error! No se encuentra el origen de la referencia.**1, represent the result over the whole plate only with 2D elements mesh (Figure). Plane strain conditions are assumed.

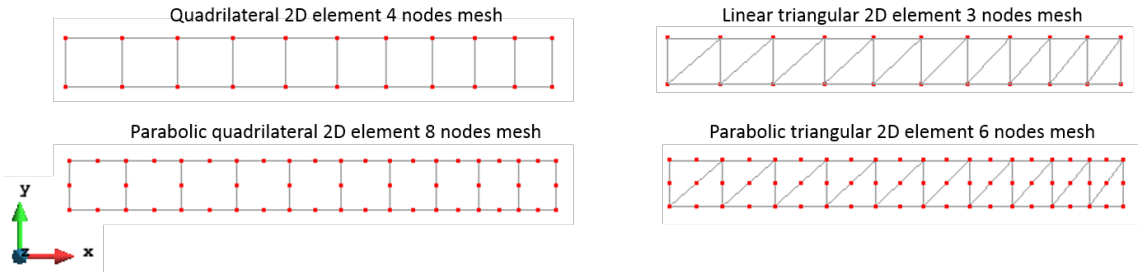

Figure 4: 2D test case mesh and elements type tested (Q-QUADR8 elem. is not tested at this issue)

Results analysis

Dimension	Element type	Reference solution	COMET result	Relative error
2D (Plane strain)	Linear triangular 2D element (at A point for P=108.8 and Deflection of punch=0.18)	$\sigma_{xx} = -0.203$ $\sigma_{yy} = -0.944$ $\sigma_{xy} = -0.441$	$\sigma_{xx} = 0.202$ $\sigma_{yy} = 0.891$ $\sigma_{xy} = 0.457$	0.1% 5.6% 3.8%
	Parabolic triangular 2D element (at A point for P=108.8 and deflection of punch=0.18)	$\sigma_{xx} = -0.203$ $\sigma_{yy} = -0.944$ $\sigma_{xy} = -0.441$	$\sigma_{xx} = 0.199$ $\sigma_{yy} = 0.963$ $\sigma_{xy} = 0.412$	1.97% 2.01% 6.6%
	Linear Quadrilateral 2D element (at A point for P=108.8 and deflection of punch = 0.18)	$\sigma_{xx} = -0.203$ $\sigma_{yy} = -0.944$ $\sigma_{xy} = -0.44$	$\sigma_{xx} = -0.187$ $\sigma_{yy} = -0.917$ $\sigma_{xy} = -0.446$	7.9 % 2.8 % 1.36 %

Table 3: Results analysis summary

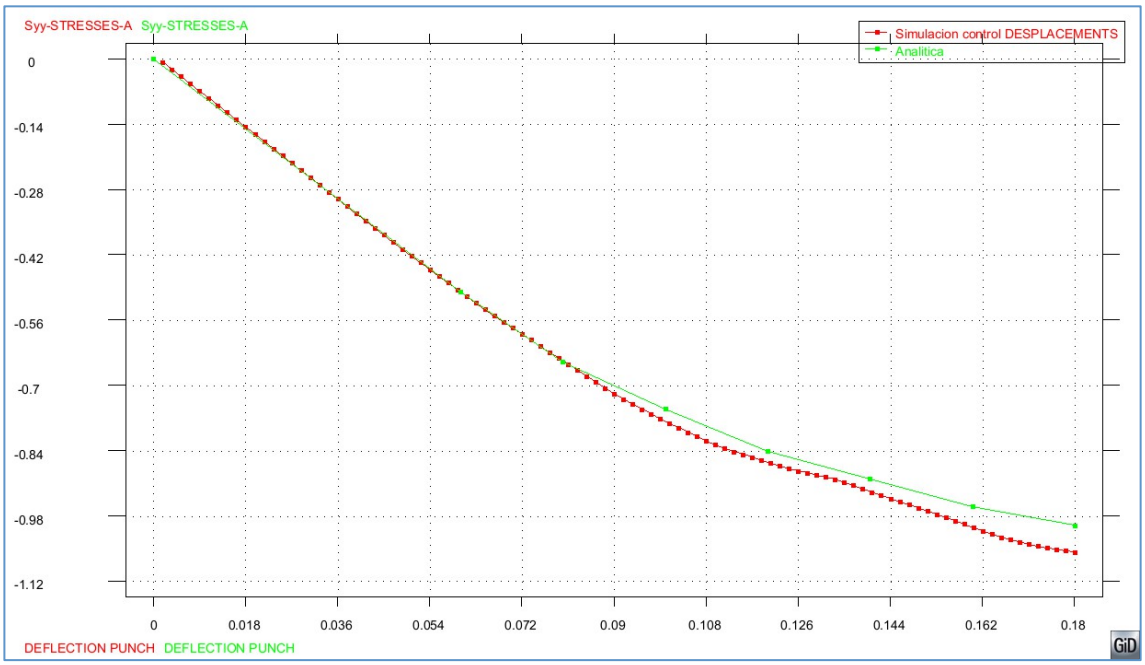

Figure 5 : Applied deflection of Punch evrsus STRESSYY at point A with control DISPLACEMENTS