SSNA111 - Indentation of a solid mass by a Summarized

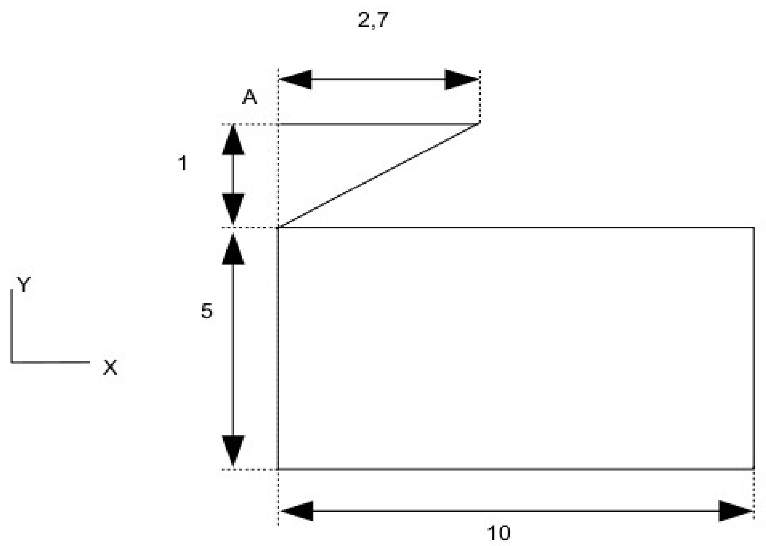
punch:

This test relates to the study of a conical punch deforming an elastoplastic massive structure.

The group is modelled with elements axisymmetric and subjected to an imposed displacement and of the contact.

1 Problem of reference

1.1 Geometry



the problem is axisymmetric (of axis Y). The punch consists of only one triangular element. It is supposed in initial contact with the solid mass at the point A , this point is thus topologically confused between the punch and the solid mass.

1.2 Material properties

the solid mass consists of an elastoplastic material with linear isotropic hardening:

$$E=2{,}0\times 10^{5}\,\mathrm{MPa}$$

$$\nu=0{,}3$$

$$\sigma_y=300\,\mathrm{MPa}$$

$$E_T=5000$$

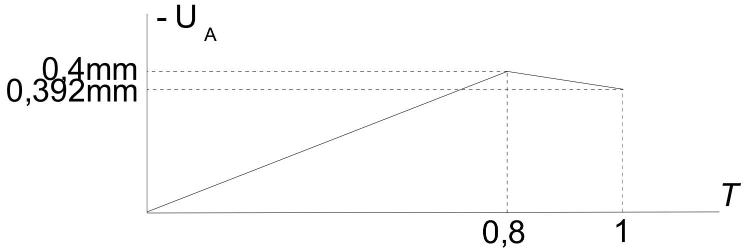
The punch is supposed to be rigid and one approximates it by an elastic material with a large Young's modulus:

$$E=2{,}0\times 10^{9}\,\mathrm{MPa}$$

$$\nu=0{,}3$$

1.3 Boundary conditions and loadings

the base of the solid mass is embedded and its left side is imposed on $DX=0$. Horizontal displacement is imposed on 0. The vertical displacement of the punch is imposed on $u_A=-0,4\ \mathrm{mm}$, then gone up $0,008\ \mathrm{mm}$ (elastic return) according to the following graph:



2 Reference solution

2.1 Results of reference

the results calculated in this benchmark are displacements and rotations of the node A (DEPL). It result from a former execution of *Code_Aster*. It is a case test of non regression, except for the point A .

3 Modelization A

3.1 Characteristic of the modelization

Modelization AXIS.

3.2 Characteristics of the mesh

The mesh consists of 1803 nodes and 1852 meshes of which a mesh TRIA3 for the rigid punch, and 1715 meshes QUAD4 for the solid mass (the rest of meshes being meshes SEG2 for surface slave of the contact).

3.3 Characteristics of the incremental

behavior Behavior elastic for punch (COMP_INCR/ELAS).
Behavior elasto_plastic in large deformations with linear isotropic hardening for solid mass (COMP_INCR/VMIS_ISOT_LINE/SIMO_MIEHE).

3.4 Characteristics of the contact

Method of discrete contact with algorithm of the active stresses, pairing MAIT_ESCL and normal MAIT_ESCL.

3.5 Quantities tested and Value

results tested	Urgent	Standard	Reference	*Tolerance*
Analytical DY Displacement A	into	0,5	-0,25	-0.80%
	0,5	-0,24798	NON-regression	1.0x10- $^{8\%}$
Reaction force DX in A	0,5	3,2482	NON-regression	1.0x10- $^{8\%}$
Reaction force DY into A	0,5	-8,7703	NON-regression	1.0x10- $^{8\%}$
Analytical DY Displacement A	into	1,0	-0,392	-0.60%
	1,0	-0,38944	NON-regression	1.0x10- $^{8\%}$
Reaction force DX in A	1,0	1,81357	NON-regression	1.0x10- $^{8\%}$
Reaction force DY in A	1,0	-4.8966	NON-regression	1.0x10- $^{8\%}$

3.6 Remarks

the nodal reaction force is in $\mathrm{N/rad}$ since the problem is axisymmetric. The difference on the analytical values of displacement come owing to the fact that the rigid punch is modelled by a material with an Young's modulus of finished stiffness.

4 Modelization B

4.1 Characteristic of the modelization

Modelization AXIS.

4.2 Characteristics of the mesh

The mesh consists of 1803 nodes and 1852 meshes of which a mesh TRIA3 for the rigid punch, and 1715 meshes QUAD4 for the solid mass (the rest of meshes being meshes SEG2 for surface slave of the contact).

4.3 Characteristics of the incremental

behavior Behavior elastic for punch (COMP_INCR/ELAS).
Behavior elasto_plastic in large deformations with linear isotropic hardening for solid mass (COMP_INCR/VMIS_ISOT_LINE/SIMO_MIEHE).

4.4 Characteristics of the contact

Method of contact continues, pairing MAIT_ESCL, normal MAIT_ESCL and pairing is fixed, of norm $(0,-1,0)$. Integration with the nodes and coefficient of regularization of Lagrangian increased being worth 1000.

4.5 Quantities tested and Value

results tested	Urgent	Standard	Reference	*Tolerance*
Analytical DY Displacement A	into	0,5	-0,25	-0.80%
	0,5	-0,24798	NON-regression	1.0x10- 8%
Reaction force DX in A	0,5	3,2482	NON-regression	1.0x10- 8%
Reaction force DY into A	0,5	-8,7703	NON-regression	1.0x10- 8%
Analytical DY Displacement A	into	1,0	-0,392	-0.60%
	1,0	-0,38944	NON-regression	1.0x10- 8%
Reaction force DX in A	1,0	1,81343	NON-regression	1.0x10- 8%
Reaction force DY in A	1,0	-4.8962	NON-regression	1.0x10- 8%

4.6 Remarks

the nodal reaction force is in $\mathrm{N/rad}$ since the problem is axisymmetric. The difference on the analytical values of displacement come owing to the fact that the rigid punch is modelled by a material with an Young's modulus of finished stiffness.

5 Summary of the results

This example of non regression watch a nonlinear computation with contact. The nodal forces are slightly different ($0{,}007\%$) between the two modelizations (discrete contact or continues), during the elastic return.