SSNV218 – Computation of the energy parameter Gp in 3D

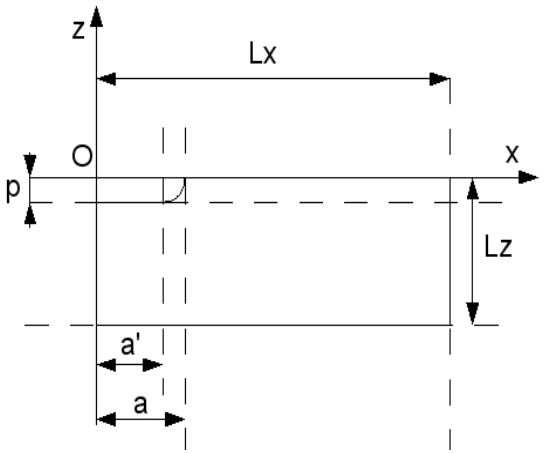
Summarized

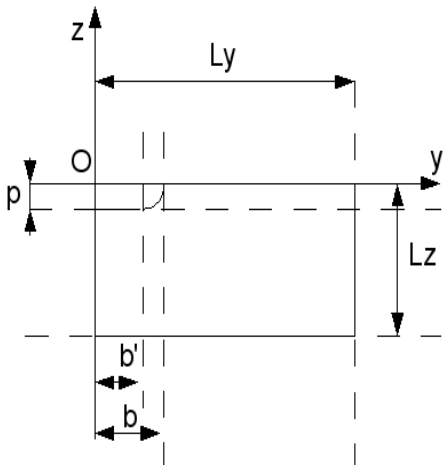
This test of nonlinear static mechanics presents the computation of the parameter G_p in $3\mathrm{D}$ for a structure of the shape quarter of block ellipse using the macro one of postprocessing CALC_GP. The structure is subjected to a tension in mode I with constant temperature.

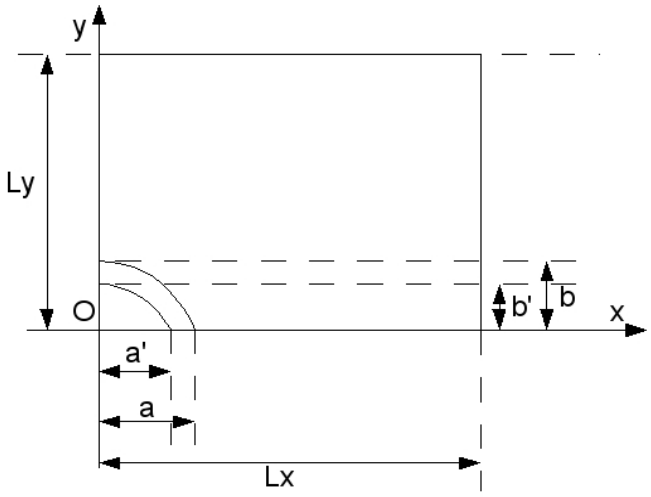
The computation carried out upstream is a nonlinear computation with isotropic hardening (VMIS_ISOT_TRAC) in large deformations.

1 Problem of reference

1.1 Geometry







Values	Measurements (mm)
Lx	22.2
Ly	15
Lz	4
a	9
a'	8.94
b	6
b'	5.94
p	the 0.1

structure considered is a block with an elliptic notch of form. In the frame of this modelization and for reasons of symmetry, only a quarter of the block is taken into account.

1.2 Properties of the material

Modulus Young: $223\,194\,\mathrm{MPa}$.

Poisson's ratio: $\nu = 0.3$.

Curve of tension (isotropic plasticity of Von Mises):

Strain applied	Threshold of stress raised $[\mathrm{MPa}]$
0.00379042	846
0.00579042	849.2
0.01179042	840.9
0.01479042	842.4
0.01879042	849.7
0.02179042	855.9
0.02979042	894.2
0.04679042	951.2
0.07179042	1012.9
0.10379042	1067.1
0.13479042	1106.6
0.20379042	1165.7
0.30379042	1228.4
0.40379042	1275.3
0.50379042	1313
0.60379042	1344.8
0.70379042	1372.4
0.80379042	1396.8
0.90379042	1418.7
1.0037904	1438.7

Table 1.1

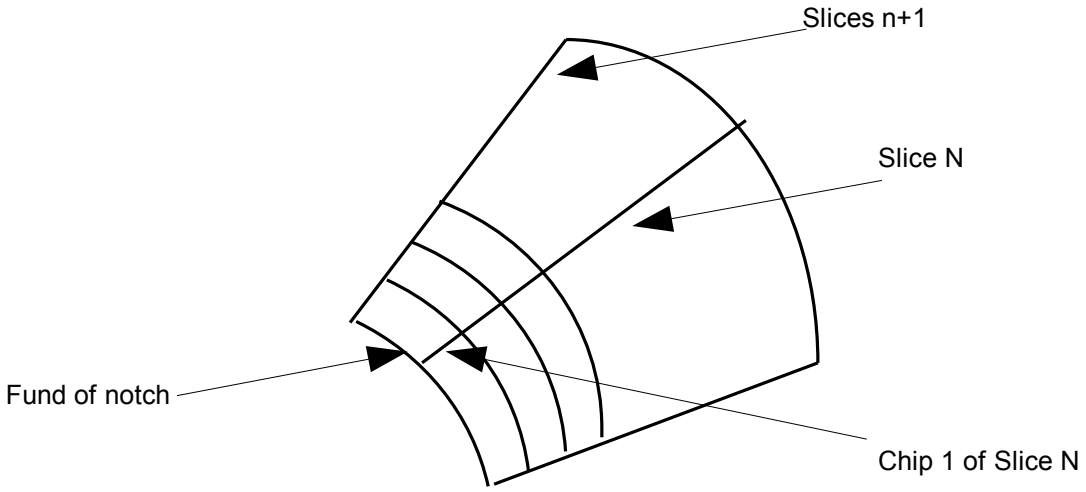
1.3 Boundary conditions and loadings

the face located has $x = 0$ of it a displacement imposed along the axis of x no one.
The face located has $y = Ly$ of it a displacement imposed along the axis of y no one.
The face located has $z = 0$ of it a displacement imposed along the axis of z no one.

A force with linear growth in time is applied to the face located at an altitude of Lz .
This force is worth $2000\mathrm{N}$ at time $\mathrm{INST} = 20\mathrm{s}$.

2 Reference solution

This case test is a case of non regression. The solution with which one compares oneself here is obtained by means of a version of development python of the command, which made it possible to develop the approach G_p .
The bottom of notch is of form elliptic. This one is described by slices. Each slice consists of chips. This total zone of chips corresponds to the virtual propagation of the notch.



One determines in each chip and at every moment the evolution of the quantity $G_p(\Delta S)$ defined by:

$$G_p(\Delta S)=2[W_{elas}(\Delta S)]/\Delta S$$

where $W_{elas}(\Delta S)$ is the elastic strain energy calculated on the zone cumulated of chip according to a slice.

3 Modelization A

3.1 Characteristic of the modelization

the crack is modelled by a notch of radius 100 microns. The zone $Ze\ \ 2\,mm$ length is divided into 20 microns thickness zones (also called “chips”). The selected modelization is 3D.

3.2 Characteristics of the mesh

Many nodes: 7598
Number of meshes and types: 2 POI1, 231 SEG3, 185 TRIA6, 532 QUAD8, 1368 PENTA15, 704 HEXA20

3.3 Quantities tested and results

One tests the values of G_p given by the macro CALC_GP.

3.3.1 Values tested of Gp

Instant	Slices	Chip	G_p	Tolerance $(\%)$
1.0	1	1	0.438815	2.0E-03
1.0	1	2	0.780974	2.0E-03
1.0	4	1	0.445910	2.0E-03
1.0	4	2	0.495423	2.0E-03
3.0	1	1	0.678008	2.0E-03
3.0	1	2	0.732731	2.0E-03
3.0	4	1	0.729344	2.0E-03
3.0	4	2	0.816681	2.0E-03

Table 3.1

In all the cases, the difference between the computed values by the two versions of CALC_GP is minimal, which validates them mutually.

4 Summary of the results

For all the data tested, the variation is lower than $2\mathrm{E}\text{-}04\,\%$.