ZZZZ121 - Adaptation of grid with LOBSTER

Summary

This series of CAS-tests validates by means of computer the adaptation of grid with LOBSTER. On a simple grid, either in 2D, or in 3D, a static calculation of mechanics or thermics is launched, with production of an indicator of errors. From there, a call to the software LOBSTER will involve a modification of the grid. On this new grid, a new calculation is activated, corresponding to the same physical problem.

These CAS-tests are not examples of the interest of the adaptation of grid and do not have any physical meaning. They are used only as tests of not-regression of the functionality in the various possible configurations.

1 General information

1.1 Context

The objective is only to test the not-regression of the future evolutions of *Code_Aster* and LOBSTER. Even if the CAS-tests are realistic from the physical point of view for representing real studies well, one should not attach importance to the value of the results.
In particular, one should not anything deduce some as for the performance indicating couple from adaptation error from grid.

These CAS-tests validate the operation of the two macro-orders `MACR_INFO_MAIL` and `MACR_ADAP_MAIL` who control the whole of the process.

More precisely, the features tested are the following ones:

- readings and writings of grid and fields to the format `MED`. They are the orders `IMPR_RESU`, `LIRE_CHAMP` and `LIRE_MAILLAGE` with the keyword `MED` like format,
- writing of the data file for LOBSTER,
- launching of the procedure managing the LOBSTER execution. It is the order `EXEC_LOGICIEL` ; it calls a script with a variable number of arguments,
- piloting of the whole of the process by the python: `macr_adap_mail_ops.py`.

The process is a priori insensitive with modeling considered. The important points which cause different treatments in the data exchange between LOBSTER and *Code_Aster* are the types of elements, the piloting of the adaptation and the update of fields on the new grid. We thus consider 4 modelings which are distributed as follows:

Modeling	Dimension	Update of fields
With	2D, triangles	Not
C	2D, triangles	Yes
D	2D, quadrangles	Yes
E	3D, hexahedrons	Yes
F	3D, pentahedrons	Not

The not-regression is tested on the value of the field of displacement, constraint or temperature in a free node. The test takes place for several resolutions, those with the grids resulting from the first and at least another adaptation. Indeed, the LOBSTER data transmissions and piloting are not the same ones for the first adaptation and the following ones. At least two passages thus should be tested.

1.2 Material

Two distinct materials are used. This difference makes it possible to make sure that the under-fields are well reconstituted after the adaptation of the grid.

Material 1
$$E=180\,000\,Pa$$
$$\nu=0{,}3\,S.I.$$
$$\alpha=1{,}5\,10^{-5}\,S.I.$$
$$\rho=7\,700\,kg.m^{-3}$$
$$\lambda=400\,W.K^{-1}.m^{-1}$$
$$\rho\,C_p=1.\,S.I.$$

Material 2
$$E=220\,000\mathrm{Pa}$$
$$\nu=0{,}33\,S.I.$$

$$\alpha=1{,}6\,10^{-5}\,S.I.$$
$$\rho=8\,300\,kg.m^{-3}$$
$$\lambda=600\,W.K^{-1}.m^{-1}$$
$$\rho\,C_p=1.\,S.I.$$

In each case of modelings A and C, material 1 is affected with half 1 and material 2 is affected with half 2.

In the case of modeling D, the field is homogeneous and is made up by material 1.
In the case of modeling E, the field is homogeneous and is made up by material 2.

For the case F, volume is subdivided in 4 identified columns *With*, *B*, *C* or *D.* These columns are cut in two parts, identified 0 or 1. One applies material corresponding to the following values:

Material	Young modulus (Pa)	Poisson's ratio
A0	300000	0,3
A1	200000	0,3
B0	500000	0,33
B1	560000	0,33
CD	100000	0,31

1.3 Method of calculating used for the reference solution

These CAS-tests are CAS-tests of nonregression. The reference solution is that obtained with a calculation *Code_Aster*.

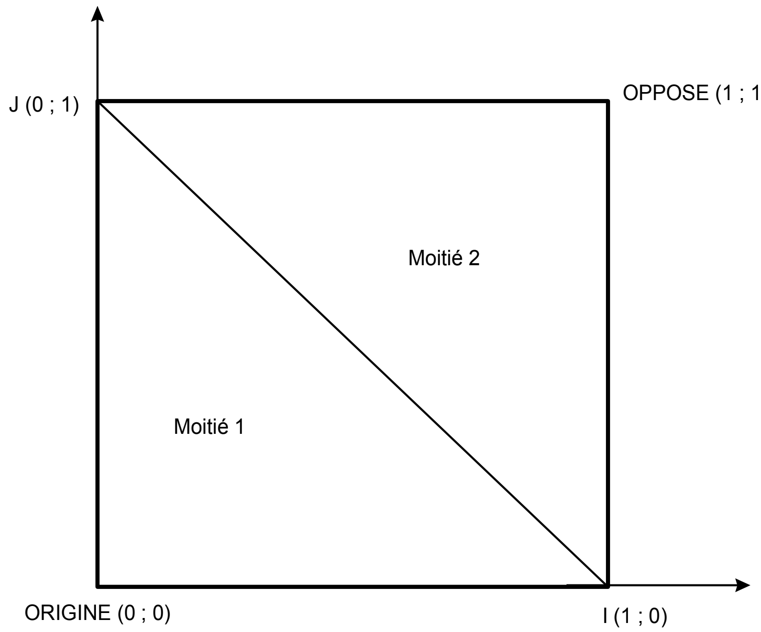
1.4 References bibliographical

See the document [V3.04.111] for the analytical solution of modeling D.

2 Modeling A

2.1 Geometry

This two-dimensional case is a square on side unit.
It is divided into two parts according to the diagonal of equation *X + there = 1*.



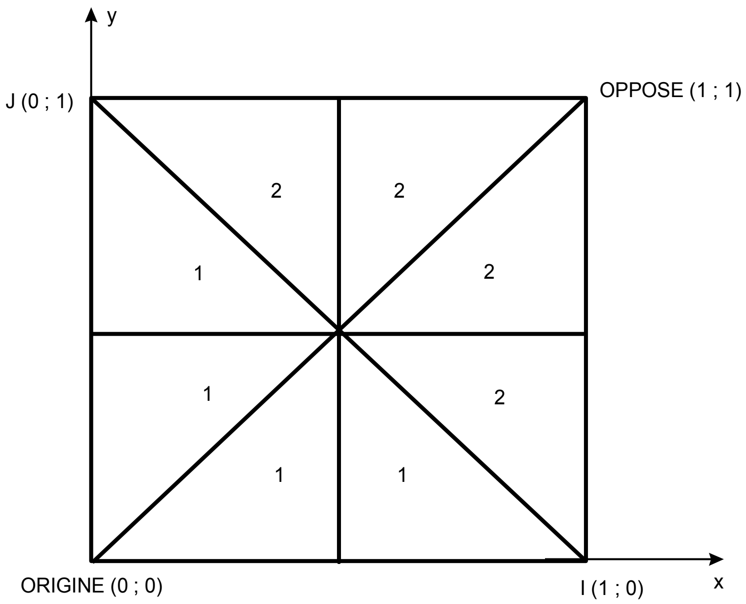
2.2 Boundary conditions and changes

The part is blocked in translation on the left face:
Segment `BORD_GAU` : `DNOR = 0`
It is blocked in rotation around the origin : `DY = 0`

One applies a pressure to the higher edge.
Segment `BORD_SUP` : `CLOSE = 1000`.

The other edges are with worthless constraint.

2.3 Characteristics of the grid



The structure is with a grid in “British flag”, with elements TRIA6. The edges are with a grid in SEG3. One notes on the sketch the number of under-field allotted to each triangle.

2.4 Results of reference

Displacement is tested on the node opposed at the origin.

	After adaptation 4	After adaptation 5
DX	$5.1236224\ 10^{-3}$	$5.1284749\ 10^{-3}$
DY	$-2.7452157\ 10^{-2}$	$-3.1219320\ 10^{-2}$

2.5 Remarks

One can note that total sizes (masses, centre of gravity,…) are well preserved by the process of adjustment.

3 Modeling C

3.1 Geometry

It is identical to modeling A.

3.2 Boundary conditions and loading

For the mechanical problem:

The boundary conditions and the loadings are the same ones as those of modeling A.

For the thermal problem:

The temperature is imposed at the origin: `TEMP = 200`.

One applies a convectif exchange with outside to the flat rim.
Segment `BORD_DRO` : `COEFF_H = 500. TEMP_EXT = 310.`

A voluminal source is applied:
`MOITIE1: SOUR = 18,000`
`MOITIE2: SOUR = 22,000`

The other edges are with null flow.

3.3 Initial conditions

Thermomechanical calculation is transitory, with adaptation of grid all 2 pas de time. Very first thermal calculation is initialized by a stationary calculation. Following thermal calculations are initialized by the field of temperature obtained with the calculation preceding and updated on the new grid.

3.4 Results of reference

	After adaptation 1	After adaptation 2	After adaptation 3	After adaptation 4
TEMP	$3.02571345\ 10^{2}$	$3.03305718\ 10^{2}$	$3.0303801408\ 10^{2}$	$3.0887294988051\ 10^{2}$
DX	$1.24150129\ 10^{-2}$	$1.23762443\ 10^{-2}$		
DY	$-2.54077755\ 10^{-2}$	$-2.56470180\ 10^{-2}$		

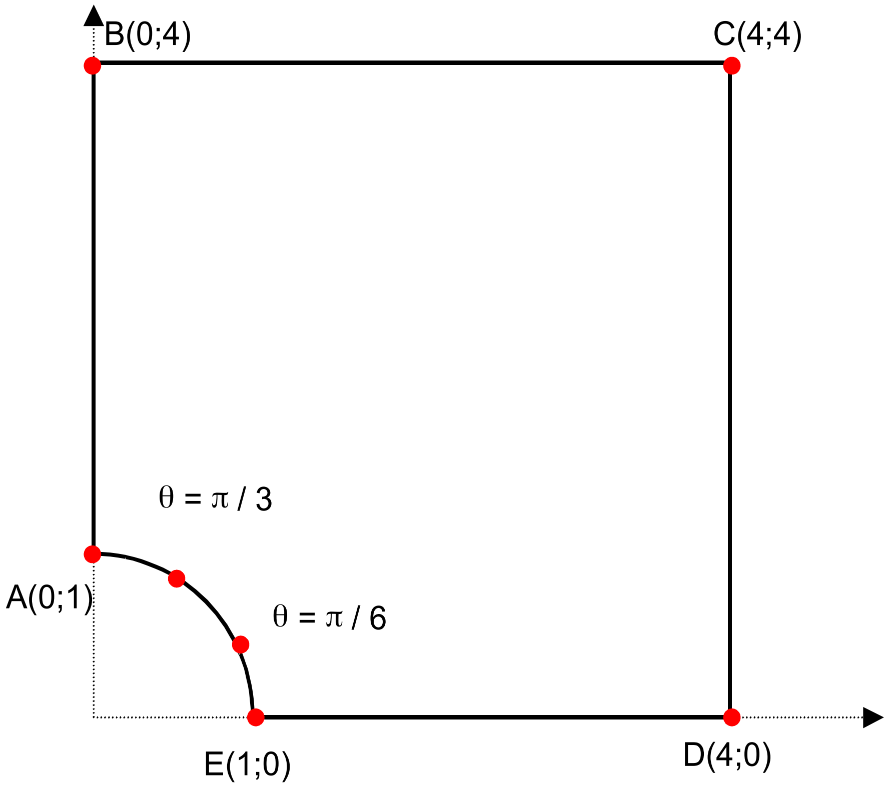
3.5 Remarks

In this series of adaptations, one produces at the same time the grids of degree 1 and degree 2 necessary to thermal and mechanical calculation.
The adaptation is controlled by indicators of error, zones geometrical or by the jump of displacement.

4 Modeling D

4.1 Geometry

This case is a copy of CAS-test SSLV111.



4.2 Boundary conditions and loading

To represent symmetries, the part is blocked in normal translation on the edges of cut:
Left vertical edge *AB* (group *GMP4*) : *DX = 0*
Lower horizontal edge *ED* (group *GMP1*) : *DY = 0*

Mechanical loading:

Vertical edge right CD (group $GMP2$) : tractions $\begin{cases} F_x = \sigma_{xx}(x=4.) \\ F_y = \sigma_{xy}(x=4.) \end{cases}$

Higher horizontal edge BC (group $GMP3$) : tractions $\begin{cases} F_x = \sigma_{xy}(x=4.) \\ F_y = \sigma_{yy}(x=4.) \end{cases}$

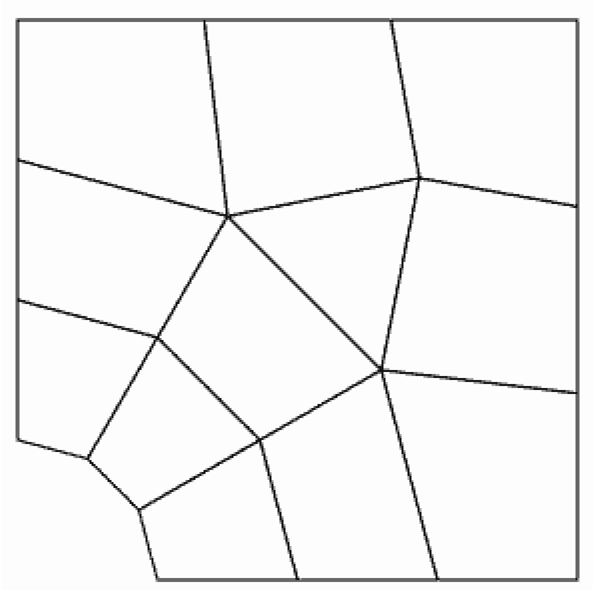
These constraints are calculated by the analytical solution, described in the document [V3.04.111].

The last edge, AE (group $GMP5$), is with worthless constraint.

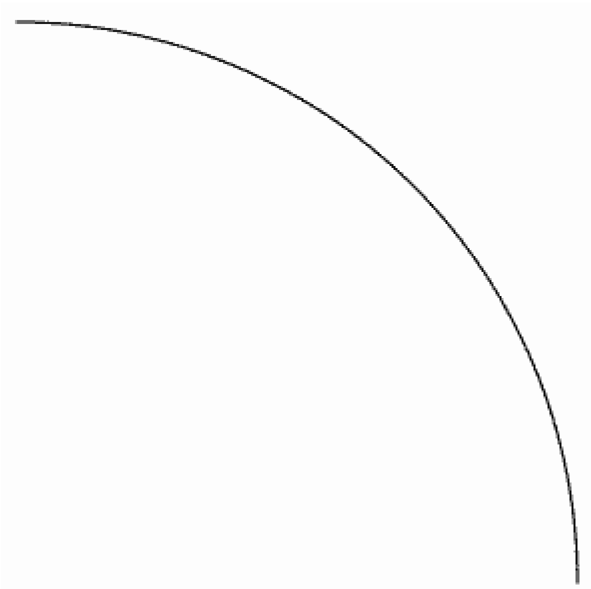
4.3 Characteristics of the grid

The field is with a grid with 11 quadrangles QUAD4 and 1 triangle TRIA3.

The edges of the field are with a grid in segments SEG2.



The arc of a circle of the curved border is with a grid with 300 SEG2. Since they are rectilinear, the other edges are not represented.



4.4 Results of reference

The reference is established on the value of the stress field on the two nodes placed on the interior arc, with the angles 30 and 60 degrees. The test is made in nonregression after the first and the second adaptation. One compared to the analytical solution after the third adaptation.

	Node 30 degrees	Node 60 degrees

Adaptation 1	0.8364656	1.5763891
Adaptation 2	0.50491074	1.5891275
Adaptation 3	0.50830985	1.8640630

One also tests on the node with 30 degrees, the projection of the field of displacement between the 1era and 2ème adaptation: $Ux=7{,}733\,10^{-6}$

5 Modeling E

5.1 Geometry

It is about a parallelepiped cut out in 9 hexahedrons.

5.2 Boundary conditions and loading

The face $x=0$ is embedded.

One presses, towards the interior, on the face $x=6$.

One is in the presence of gravity.

Notice :

Revolves is tilted compared to the axes to break the symmetry of the problem. That makes it possible to ensure a single extremum for the indicator of error and thus an identical selection of the mesh to be refined, whatever the object computer.

5.3 Characteristics of the grid

The field is with a grid with 9 hexahedrons HEXA8.

The edges of the field are with a grid in quadrangles QUAD4.

Many groups of Nœuds: 2
B : $NO4(6.,0.,0.)$
A : $NO32(6.,6.,2.)$

Many groups of meshs: 5
X_0 : quadrangles of the face x=0
X_MAX : quadrangles of the face x=6
Z_MI_MA : quadrangles of the lower face, z=0, and of the higher face, z=2
Y_MI_MA : quadrangles of the front face, y=0, and of the back face, y=6
VOLUME : hexahedrons of volume

5.4 Results of reference

On the result of calculation:

	After adaptation 2
DZ	-17.3329132
ERREST	51818.753

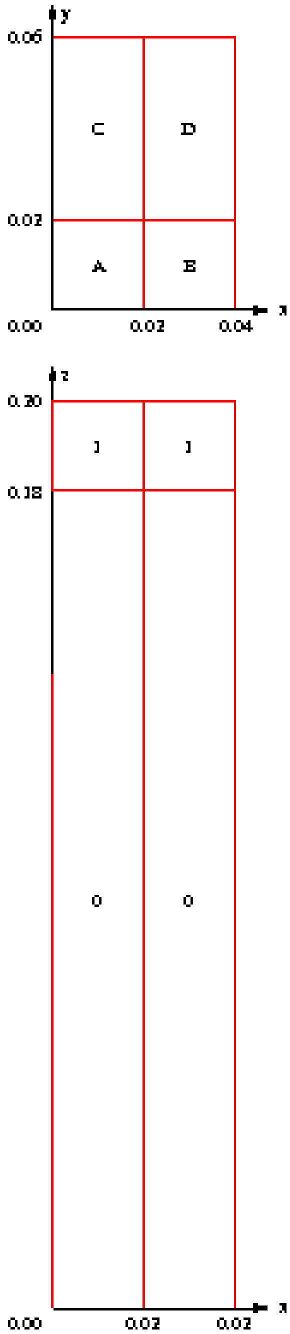
On the field of displacement interpolated with the second adaptation; the two nodes are created in the center of the cut hexahedrons. That makes it possible to be freed from possible changes of classification of the nodes in LOBSTER and to perennialize the CAS-test.

	Interpolated values
DX	6.036338
DZ	-14.0615426

6 Modeling F

6.1 Geometry

The field is a parallelepiped, subdivided in 4 identified columns *With*, *B*, *C* or D according to axis OZ. These columns are cut in two parts according to a plan perpendicular to axis OZ, identified 0 or 1.

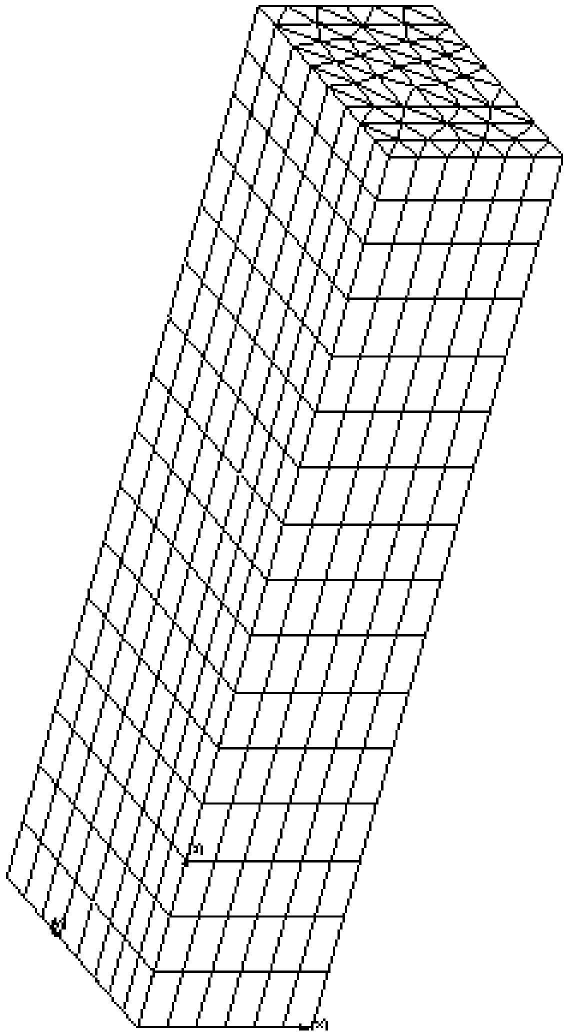


6.2 Boundary conditions and loading

The part is blocked in translation in three directions X, there and Z on the trail of the column *B* on the basis *Z=0* (group *CL1*). Pressure is put on the trail of the column *C*, side 1, on the plan *Y=0.06* (group *CL2*).
The other edges are with worthless constraint.

6.3 Characteristics of the grid

The field is with a grid in extrusion starting from a base with a grid in triangles. That produced 1408 pentahedrons PENTA15. The edges of the field are with a grid in faces QUAD8 and TRIA6.



6.4 Results of reference

The reference is established on the value of the component *DX* field of displacement on a node in the center of one of the external faces. The test is made in nonregression after the last adaptation.

	After last adaptation
DX	0.0633925584439

7 Summary of the results

This CAS-test having for simple objective the control of nonthe regression, no remark is to be made on the value of the results. The reference is that of calculation *Code_Aster* at the day of the first restitution and must be found thereafter.

By examining the files orders, one will note that the loadings must be done on entities with suitable dimension.

- a node for a specific loading; for example a displacement imposed on a corner,
- a segment for a linear loading; for example, a pressure divided into 2D,
- a triangle for a surface loading; for example, a force in 3D.

In addition, it will be noted that these loadings must be expressed on groups of nodes or meshs and not on the nodes or and meshs. Indeed after adaptation of the grid, the groups are reconstituted. The ordering of loading is thus the same one, whatever the grid.

By complying with these two rules on the loadings, the adaptation of grid is possible.