
ZZZZ121 - Mesh adaptation with HOMARD

Summarized

This series of benchmark validates the mesh adaptation with HOMARD by means of computer. On a simple mesh, either in 2D, or in 3D, a static computation of mechanics or thermal is launched, with production of an error indicator. From there, a call to the software HOMARD will involve a modification of the mesh. On this new mesh, a new computation is activated, corresponding to the same physical problem.

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

1 General information

1.1 Context

the purpose is only to test the NON-regression of the future evolutions of *Code_Aster* and HOMARD. Even if the benchmarks 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 mesh adaptation error.

These benchmarks validate the operation of two macro commands `MACR_INFO_MAIL` and `MACR_ADAP_MAIL` which control the group of the process.

More precisely, the features tested are the following ones:

- readings and writings of mesh and fields to med format . They are commands `IMPR_RESU`, `LIRE_CHAMP` and `LIRE_MALLAGE` with the key word `MED` like format,
- writing of the data file for HOMARD,
- launching of the procedure managing the HOMARD execution. It is command `EXEC_LOGICIEL` ; it calls a script with a variable number of arguments,
- control of the group of the process by the python: `macr_adap_mail_ops.py`.

The process is a priori insensitive with the modelization considered. The important points which cause different processing in the data exchange between HOMARD and *Code_Aster* are element types, the control of the adaptation and the update of fields on the new mesh. We thus consider 4 modelizations which are distributed as follows: Modelization

Dimension	Updated	of fields A
2D	, triangles Not	C
2D	, triangles Yes	D
2D	, quadrangles Yes	F
3D	, pentahedrons Not	

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

1.2 Two

distinct materials are used. This difference makes it possible to make sure that the subdomains are well reconstituted after the adaptation of the mesh. Material

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

2 formulates $E = 220\,000 \text{ Pa}$
 $\nu = 0,33 \text{ S.I.}$
 $\alpha = 1,6 \cdot 10^{-5} \text{ S.I.}$

$$\begin{aligned}\rho &= 8\,300 \text{ kg.m}^{-3} \\ \lambda &= 600 \text{ W.K}^{-1} . \text{m}^{-1} \\ \rho C_p &= 1. \text{ S.I.}\end{aligned}$$

In each case of the modelizations and C, material 1 is affected with half 1 and material 2 is affected with half 2. In the case of the modelization D, the field is homogeneous and is made up by material 1. For

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

Modulus	Young (formula <i>Pa</i>	formulates
<i>A0</i>	300000	0.3
<i>A1</i>	200000	0.3
<i>B0</i>	500000	0.33
<i>B1</i>	560000	0.33
<i>CD</i>	100000	0.31

1.3 used for the reference solution These

benchmarks are benchmarks of non regression. The reference solution is that obtained with a computation Code_Aster . *References*

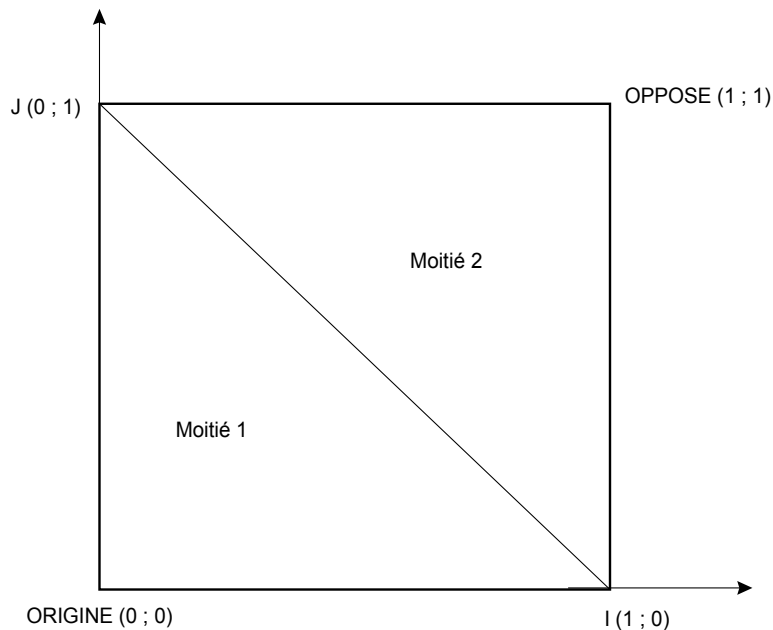
1.4 bibliographical See

the document [V3.04.111] for the analytical solution of modelization D. Modélisation

2 A Geometry

2.1 This

case two-dimensional is a square on side unit. It is divided into two parts according to the diagonal of equation formulates $x + y = 1$



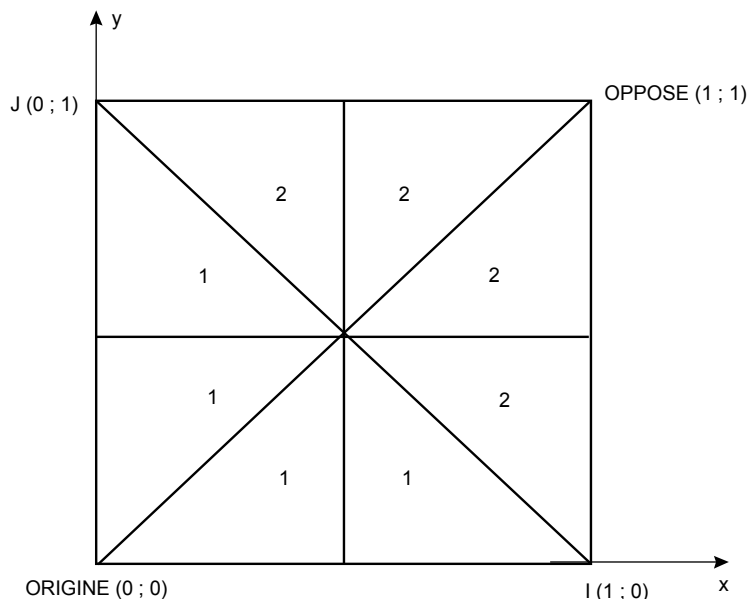
2.2 and changes

the part is blocked in translation on the left face: Segment
EDGE_GAU: DNOR = 0 It
is blocked in rotation around the origin: DY = 0 One

apply a pressure to higher edge. Segment
EDGE_SUP: NEAR = 1000.

The other edges are with stress null. Characteristics

2.3 of the mesh



the structure is with a grid in "British flag", with elements SORTED 6. The edges are with a grid in SEG3. One notes on the sketch the number of subdomain allotted to each triangle. Results

2.4 of reference

displacement is tested on the node opposed at the origin. After

	adaptation 4 After	adaptation 5 DX
	5,093375	10-3 ^{DY}
	10-3 ^{5.0939774}	10-3 ^{DY}
	2,763497 10-2 ⁻	3,158715 10-2 ^{Remarks}

2.5 One

can note that total quantities (masses, center of gravity,...) are well preserved by the process of adjustment. Modelization

3 C Geometry

3.1 It

is identical to modelization A. Conditionsaux limites

3.2 and loading For

the mechanical problem:

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

the thermal problem:

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

applies a convective exchange with outside to flat rim. Segment
EDGE_DRO: COEFF_H = 500. TEMP_EXT = 310.

A volumic source is applied: HALF

1: SOUR = 18.000 HALF

2: SOUR = the 22.000

other edges are with null flux. Initial conditions

3.3 The computation

thermomechanical is transitory, with mesh adaptation all the 2 time step. Very first thermal computation is initialized by a steady computation. Following thermal computations are initialized by the field of temperature obtained with the computation preceding and updated on the new mesh. Results

3.4 of reference After

	adaptation 1 After	adaptation 2 After	adaptation 3 TEMP
3,025 71345	102 3,03305718	102 3,0303801408	102 DX
1,241 50129	10-2 ^{1,23762443}	10-2 ^{DY}	
-	2,54077755 10-2	2,56470180 10-2	Remarks

3.5 In

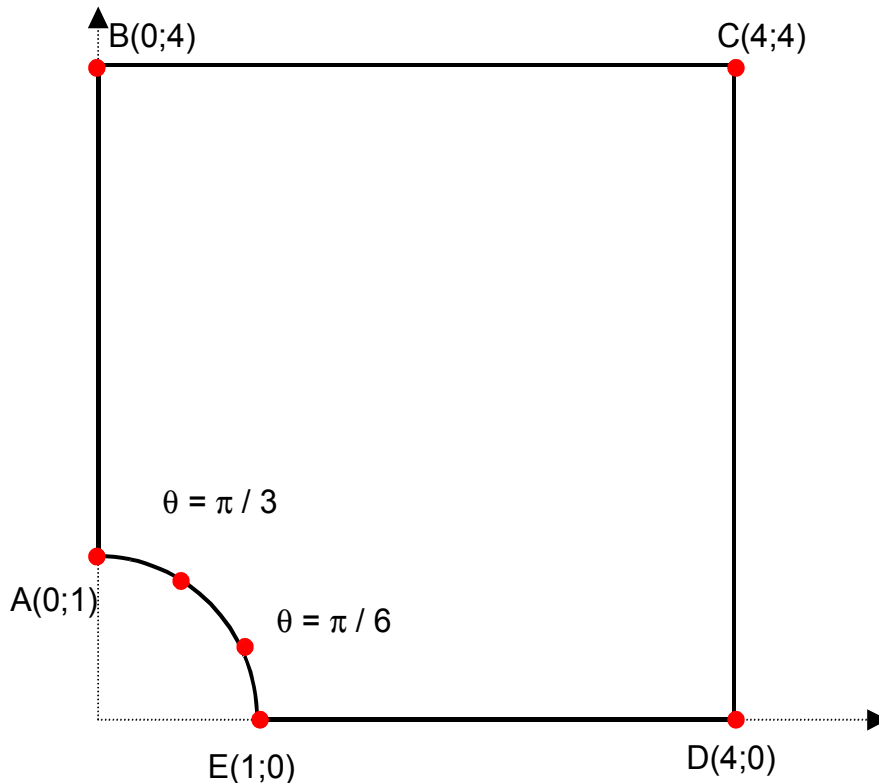
this series of adaptations, one produce at the same time the meshes of degree 1 and degree 2 necessary to thermal computation and mechanics.

The adaptation is controlled by error indicators or geometrical zones. Modelization

4 D Geometry

4.1 This

case is a copy of benchmark SSLV111. Boundary conditions



4.2 and loading

to represent symmetries, the part is blocked in normal translation on edges of cut: Left vertical edge formulates AB formulates $GMP4$ formulates $DX=0$
horizontal Edge formulates ED formulates $GMP1$ formulates $DY=0$

Loading: Vertical

edge right formulates CD formulates $GMP2$ tensions formulates $\begin{cases} F_x = \sigma_{xx}(x=4.) \\ F_y = \sigma_{xy}(x=4.) \end{cases}$
horizontal Edge formulates BC formulates $GMP3$ tensions formulates $\begin{cases} F_x = \sigma_{xy}(x=4.) \\ F_y = \sigma_{yy}(x=4.) \end{cases}$

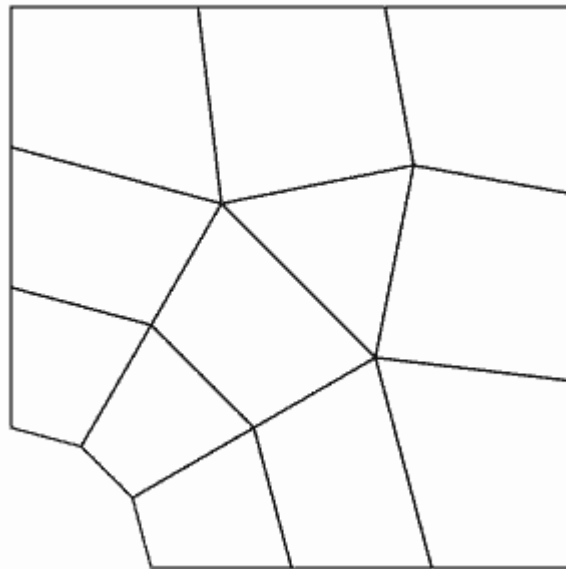
stresses are calculated by the analytical solution, described in the document [V3.04.111].

The last edge, formulates AE formulates $GMP5$ is with stress null. Characteristics

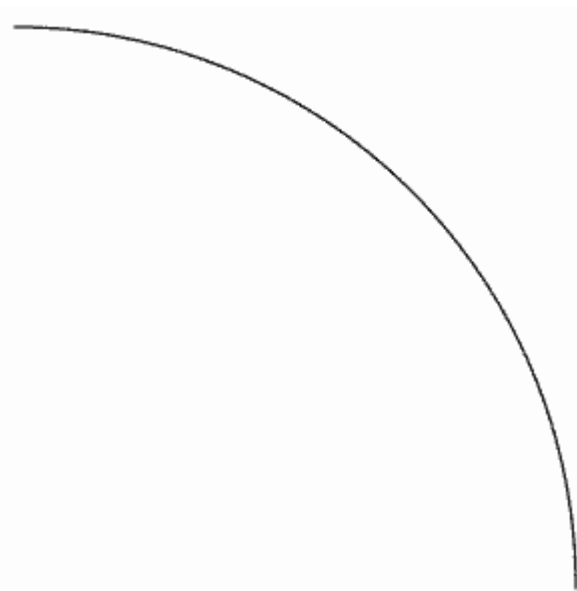
4.3 of the mesh

the field is with a grid with 11 quadrangles QUAD4 and 1 triangle SORTED 3 .

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. Results



4.4 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 into non regression 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

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2 0,50229053	1,5904140	Adaptation
3 0,51272201	1,7902384	One

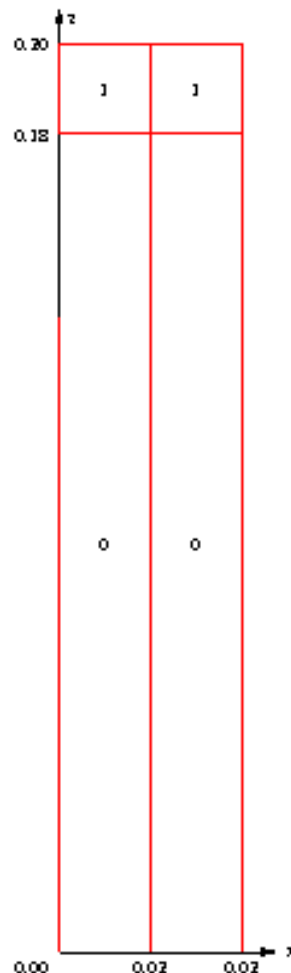
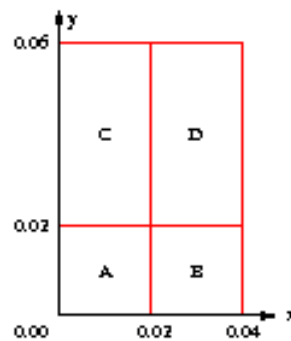
also tests on the node with 30 degrees, the projection of the field of displacement between 1st^{and} the 2nd^{adaptation} : formulate $U_x = 7,733 \cdot 10^{-6}$

5

6 F Geometry

6.1

the field is a parallelepiped, separate in four columns formulates A formula B formula C formula D the axis formulates Oz separate in two parts 0 and 1 according to a plane perpendicular to the axis formulates Oz Boundary conditions



6.2 and loading

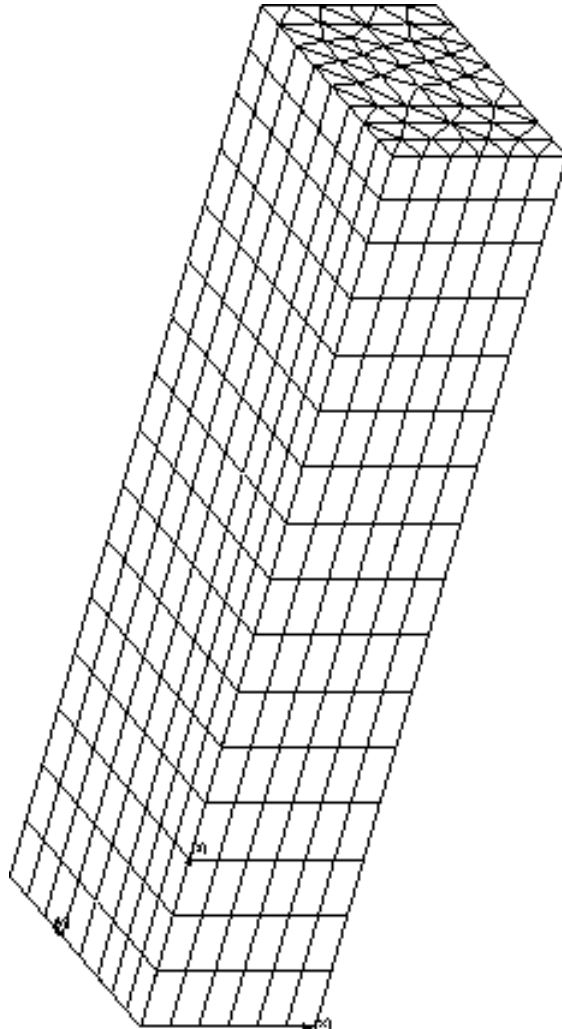
the part is blocked in translation in the three directions formulates x formula y formula z the column formulates B the basis formulates $Z=0$ formulates CL_1 Pressure is put on the

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trail of the column formulates C the side 1, on the plane formulates $Y=0.06$ formulates
 CL_2
The other edges are with stress null. Characteristics

6.3 of the mesh

the field is with a grid in extrusion from a base with a grid in triangles. That produced 1408 pentahedrons PENTA 15. The edges of the field are with a grid in sides QUAD 8 and SORTED 6. Results



6.4 of reference

the reference is established on the value of the component formulates DX field of displacement on a node in the center of one of the external sides. The test is made into non regression after the last adaptation. Summary

7 of the results This

benchmark having for simple purpose the control of non regression, no remark is to be made on the value of the results. The reference is that of computation 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 distributed pressure in 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 nodes groups or of meshes and not on the nodes or and the meshes. Indeed after adaptation of the mesh, the groups are reconstituted. The ordering of loading is thus the same one, whatever the mesh. By

complying with these two rules on the loadings, the mesh adaptation is possible.