

## ZZZZ164 - Validation of the keywords TRANSLATION, ROTATION, MODI\_BASE and SCALE order MODI\_MAILLAGE

---

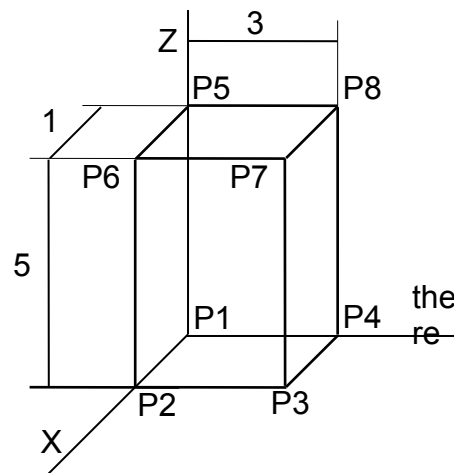
### Summary:

This test validates the keywords TRANSLATION, ROTATION, MODI\_BASE and SCALE of MODI\_MAILLAGE. To this end, one will impose on two grids, one 3D and the other 2D two combinations of these keywords. First is made up of a translation, two unspecified rotations and a scaling. One will thus test the two possibilities of definition of the axis of rotation: either by two points, or by a point and the direction. The second will combine a basic change and a scaling. One will thus have tested thus all the cases authorized by these keywords.

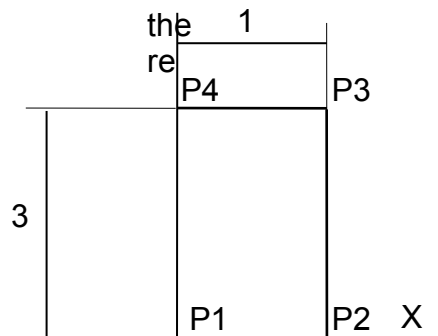
## 1 Problem of reference

### 1.1 Geometry

The problem is 3D, it acts of a right-angled parallelepiped:



One will net this volume with a solid element of type HEXA8.  
A modeling 2D is deduced from it, with a grid with a solid element QUAD4:



### 1.2 Properties of material

Place does not have to be here.

### 1.3 Boundary conditions and loadings

Nondefinite.

### 1.4 Initial conditions

Nondefinite.

## 2 Reference solution

### 2.1 Method of calculating

The reference solution is analytical.

That is to say  $M(x, y, z)$  a point of space, one imposes a translation to him  $T$  of vector  $(tx, ty, tz)$ , and a rotation  $R$  of angle  $\alpha$  (in radians) whose axis passes by  $P(px, py, pz)$  and has as a direction  $D(dx, dy, dz)$ .

Then  $M$  becomes  $M_T$  after the translation:  $M_T(x+tx, y+ty, z+tz)$ .

$M_T$  becomes  $M_{TR}$  after rotation:

$$M_{TR} = P + \cos \alpha \cdot P M_T + (1 - \cos \alpha) \cdot (P M_T \cdot D) \cdot D + \sin \alpha \cdot (D \wedge P M_T)$$

with  $M_T = M + T$

The setting at the level of a factor ech, gives:

$$M_{TRE} = ech \cdot M_{TR}$$

The functionality of basic change expects as starter the data by the user of two orthogonal vectors in 3D (only one vector in 2D). One comes to supplement these data in order to generate a direct orthogonal base, in 3D or 2D. Tests are carried out in order to check if the data input will make it possible to define a direct orthogonal base. A standardisation of the vectors of the base is then carried out.

In 3D, one thus expects the data of  $U$  and  $V$ , the first two vectors of the new base:

$$W(x, y, z) = U(x, y, z) \wedge V(x, y, z)$$
$$\Rightarrow B = (U, V, W) : \text{matrix formed by the basic vectors}$$
$$M(U, V, W) = B^T M(x, y, z)$$

In 2D, one generates the second vector of the base by rotation of  $90^\circ$  of the vector seized by the user. This basic change can be combined with a scaling and a translation, for example.

The programming of these transformations is done differently in 3D and 2D, so as to optimize each one of these two cases.

### 2.2 Sizes and results of reference

One will control the new coordinates of the point  $P1$ ,  $P7$  and  $P8$  in 3D ( $P1$ ,  $P3$  and  $P4$  in 2D).

### 2.3 Uncertainties on the solution

Uncertainties come from the digital precision in *Code\_Aster* (dependence of the platform) and in the calculation of the analytical solution of reference. One can thus consider a relative criterion of precision about  $1.E-13$  in the tests.

### 2.4 Bibliographical references

Without use.

## 3 Modeling A

---

### 3.1 Characteristics of modeling

One places oneself within a framework massive 3D. One will impose successively:

- a translation of vector  $(2.5; 3.9; -12.3)$ ,
- a rotation of angle 33 degrees and axis passing by the points  $(10; 0.5; 3.8)$  and  $(0; 10; 0)$ ,
- the second rotation of angle  $-161$  degrees and of axis passing by  $(-3.; 0.5; 3.8)$  and of direction  $(0; 1; 0)$ ,
- a setting at the level of a factor 5.

One thus tests all the cases authorized by the syntax of the keywords TRANSLATION, ROTATION and SCALE.

Then, one sets out again of the initial grid and one imposes to him successively:

- a basic change of vectors  $(1.23; 0.23; 0)$  and  $(-2.3; 12.3; 0)$ ,
- a setting at the level of a factor 5.

One tests together thus the keywords MODI\_BASE and SCALE.

### 3.2 Characteristics of the grid

The grid comprises only one element of the type HEXA8.

### 3.3 Sizes tested and results

For the first part, with TRANSLATION, ROTATION and SCALE :

Points observed	Coordinates	Reference
<i>P1</i>	<i>X</i>	5.2501368890123E+00
	<i>Y</i>	- 2.1551486020681E+00
	<i>Z</i>	7.8600118786924E+01
<i>P7</i>	<i>X</i>	- 1.3714414455621E+01
	<i>Y</i>	1.9199906921638E+01
	<i>Z</i>	7.0898989267417E+01
<i>P8</i>	<i>X</i>	- 9.9168576521849E+00
	<i>Y</i>	2.0297577804345E+01
	<i>Z</i>	6.7837342495183E+01

For the second part, with `MODI_BASE` and `SCALE` :

Points observed	Coordinates	Reference
<i>P1</i>	<i>X</i>	4.9148126952461E+00
	<i>Y</i>	- 9.1903001618423E-01
	<i>Z</i>	0.0000000000000E+00
<i>P7</i>	<i>X</i>	7.6719027437988E+00
	<i>Y</i>	1.3825408069554E+01
	<i>Z</i>	2.5000000000000E+01
<i>P8</i>	<i>X</i>	2.7570900485527E+00
	<i>Y</i>	1.4744438085738E+01
	<i>Z</i>	2.5000000000000E+01

## 4 Modeling B

One places oneself within a framework 2D. One will impose successively:

- a translation of vector  $(2.5; 3.9)$ ,
- a rotation of angle 33 degrees and axis passing by the point  $(10.; 0.5)$ ,
- the second rotation of angle  $-161$  degrees and of axis passing by the point  $(-3; 0.5)$ ,
- a setting at the level of a factor 5.

One thus tests all the cases authorized by the syntax of the keywords `TRANSLATION`, `ROTATION` and `SCALE`.

Then, one sets out again of the initial grid and one imposes to him successively:

- a change of reference mark of vectors  $(1.23; 0.23)$ ,
- a setting at the level of a factor 5.

The keywords thus together are tested `MODI_BASE` and `SCALE`.

### 4.1 Characteristics of the grid

The grid comprises only one element of the type `QUAD4`.

### 4.2 Sizes tested and results

For the first part, with `TRANSLATION`, `ROTATION` and `SCALE` :

Points observed	Coordinates	Reference
<i>P1</i>	<i>X</i>	- 3.9975219277929E+01
	<i>Y</i>	4.2222814000070E-01
<i>P3</i>	<i>X</i>	- 3.1233365350457E+01
	<i>Y</i>	- 1.2752747757918E+01
<i>P4</i>	<i>X</i>	- 2.8155057973828E+01
	<i>Y</i>	- 8.8126939898842E+00

For the second part, with `MODI_BASE` and `SCALE` :

Points observed	Coordinates	Reference
P1	X	0.0000000000000E+00
	Y	0.0000000000000E+00
P3	X	7.6719027437988E+00
	Y	1.3825408069554E+01
P4	X	2.7570900485527E+00
	Y	1.4744438085738E+01

## 5 Summary of the results

The digital results for the translation, rotation, the change of reference mark and the setting at the level of the grid are identical to the analytical results of reference, in 3D or 2D, except for the digital precision.