ZZZZ110 - Validation of order PROJ_CHAMP/ELEM (in 2D and telegraphic)

Summary:

This CAS-test makes it possible to validate the order PROJ_CHAMP/ELEM in the following cases:

Projection of a field of temperature (modelings A and B) :

- Projection of a grid $2D$ on another grid $2D$
- Projection of a grid $2D$ on a telegraphic grid $1D$
- Projection of a grid $1D$ telegraphic on a grid $2D$
- Projection of a grid $2D\,axis$ on a solid $3D$

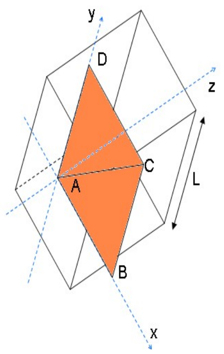
Projection of a stress field (modelings A and B) :

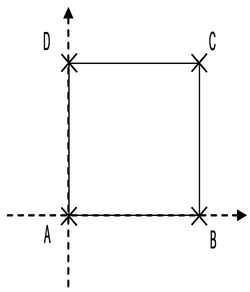
- Projection of a grid $2D\,axis$ on a solid $3D$
- Projection of a grid $3D$ on a solid $3D$

1 Problem of reference

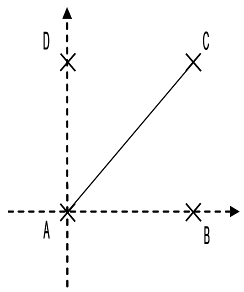
1.1 Modeling A

1.1.1 Geometry

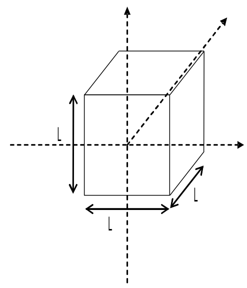




Carre1/carre2



AC



cube1

Coordinates of the points (m) :

$A:(0.,0.)$
$B:(1.,0.)$
$C:(0.,0.)$
$D:(0.,1.)$

Geometry of the cube:
Center: $(0.,0.,-0.5)$
Side: $L=1$

Group of meshs:
$carre1$ surface A,B,C,D
$carre2$ surface A,B,C,D
AC segment AC
$cube1$ volume

1.1.2 Properties of material

Without object

1.1.3 Boundary conditions and loadings

Without object

1.2 Reference solution

1.2.1 Method of calculating

Calculation of the reference for the field of temperature

The field which one projects of a model on the other is an analytical field of temperature whose evolution is the following one:

$$T=3.+X+Y$$

The reference solution is identical to the analytical field project.

Calculation of the reference for the stress field

The objective is to carry out a change of reference mark, after having carried out a projection of a stress field known on a grid towards a grid 3D.

Passage d' a cylindrical reference mark (XOY) towards a Cartesian reference mark $3\mathrm{D}$ (XYZ).

The stress field (N/m^2) in the axisymmetric reference mark (axis OY) is the following:

- $SIXX=2$
- $SIYY=y$
- $SIZZ=1$
- $SIXY=0.$

The stress field in the Cartesian reference mark ($3\mathrm{D}$) is obtained while carrying out:

- A projection of the tensor of the constraints evaluated on the grid $2\mathrm{D}\,axis$ on the grid 3D.
- Change of reference mark of the tensor of the constraints $[\sigma_{3\mathrm{D}}]=[P][\sigma_{cyl}][P]^T$ or $[P]$ represent the matrix of change of reference mark.

The digital results are the following:

NODE	X	Y	Z	$SIXX$	$SIYY$	$SIZZ$
N258	-1/3	-1/3	1/6	1.5	1.5	1/6
N33	-1/3	0.	1.	2.	1.	1.
N108	0.	1/2	2/3	1.	2.	2/3.

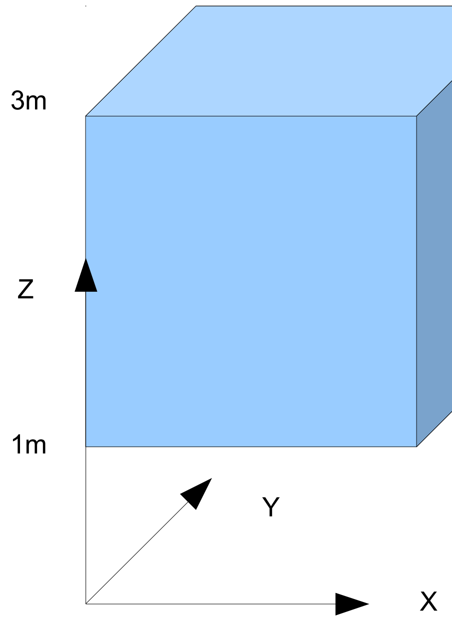
1.2.2 Results of reference

Type of projection	Not	Size $(°C)$	Reference
$carre1 \rightarrow carre2$	A	$TEMP$	3
	B	$TEMP$	4
	C	$TEMP$	5
	$N364$	$TEMP$	4.66
$carre2 \rightarrow carre1$	A	$TEMP$	3
	B	$TEMP$	4
	C	$TEMP$	5
	$N355$	$TEMP$	3.75
$carre2 \rightarrow AC$	A	$TEMP$	3
	C	$TEMP$	5
	$N356$	$TEMP$	4
$AC \rightarrow carre2$	A	$TEMP$	3
	B	$TEMP$	4
$carre2 \rightarrow cube1$	C	$TEMP$	5
	$N363$	$TEMP$	3.33
	$N341$	$TEMP$	3.69371

Type of projection	Not	Size (N/m^2)	Reference
$carre2 \rightarrow cube1$	$N258$	$SIXX$	1.5
	$N258$	$SIYY$	1.5
	$N258$	$SIZZ$	0.16
	$N33$	$SIXX$	2
	$N33$	$SIYY$	1
	$N33$	$SIZZ$	1
	$N108$	$SIXX$	1
	$N108$	$SIYY$	2
	$N108$	$SIZZ$	0.66

1.3 Modeling B

1.3.1 Geometry



Cubic on side: $L=2$

1.3.2 Properties of material

- $E=2\,N/m^2$
- $\nu=0.$

1.3.3 Boundary conditions and loadings

Imposed displacements

- plan $z=1\text{m}$ $DX=0.=DY=0.=DZ=0.$
- plan $z=3\,m$ $DZ=2.\text{m}$

1.4 Reference solution

1.4.1 Method of calculating

The Poisson's ratio is null $\nu=0$ what gives us

$$\sigma_{xx}=\sigma_{yy}=\sigma_{xy}=\sigma_{xz}=\sigma_{yz}=0$$

$$\sigma_{zz}=E\epsilon=E\frac{DZ}{L}$$

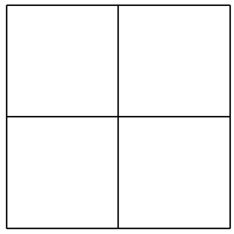
1.4.2 Results of reference

$SIZZ=2\,N/m^2$ In any point of the cube

2 Modeling A

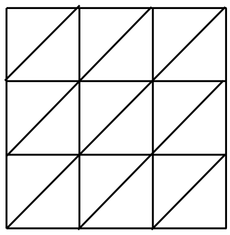
2.1 Characteristics

Modeling `PLAN` for $carre1$:



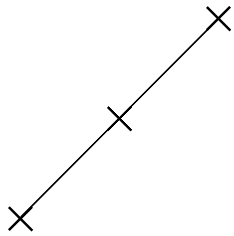
Many nodes 9
Many meshs 4 That is to say:
`QUAD8` 4

Modeling `PLAN` for $carre2$:



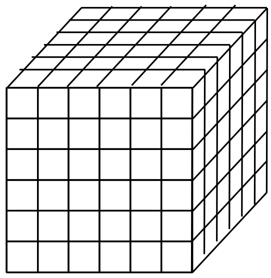
Many nodes 16
Many meshs 18 That is to say:
`TRIA3` 18

Modeling `COQUE_PLAN` for AC :



Many nodes 3
Many meshs 1 That is to say:
`SEG3` 1

Modeling `3D` for $cube1$:



Many nodes 341
Many meshs 252 That is to say:
`QUAD4` 36
`HEXA8` 216

2.2 Results

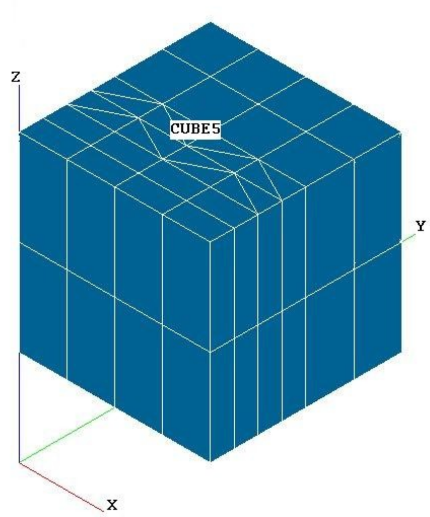
Projection	Not	Size $(°C)$	Reference	Tolerance (%)
$carre1 \rightarrow carre2$	A	$TEMP$	3	0.1
	B	$TEMP$	4	0.1
	C	$TEMP$	5	0.1
	$N364$	$TEMP$	4.66	0.1
$carre2 \rightarrow carre1$	A	$TEMP$	3	0.1
	B	$TEMP$	4	0.1
	C	$TEMP$	5	0.1
	$N355$	$TEMP$	3.75	0.1
$carre2 \rightarrow AC$	A	$TEMP$	3	0.1
	C	$TEMP$	5	0.1
	$N356$	$TEMP$	4	0.1
$AC \rightarrow carre2$	A	$TEMP$	3	0.1
	B	$TEMP$	4	0.1
	C	$TEMP$	5	0.1
	$N363$	$TEMP$	3.33	0.1
$carre2 \rightarrow cube1$	$N341$	$TEMP$	3.69371	0.1

Projection	Not	Size (N/m^2)	Reference	Tolerance (%)
$carre2 \rightarrow cube1$	$N258$	$SIXX$	1.5	0.1
	$N258$	$SIYY$	1.5	0.1
	$N258$	$SIZZ$	0.16	0.1
	$N33$	$SIXX$	2	0.1
	$N33$	$SIYY$	1	0.1
	$N33$	$SIZZ$	1	0.1
	$N108$	$SIXX$	1	0.1
	$N108$	$SIYY$	2	0.1
	$N108$	$SIZZ$	0.66	0.1

3 Modeling B

3.1 Characteristics of modeling B

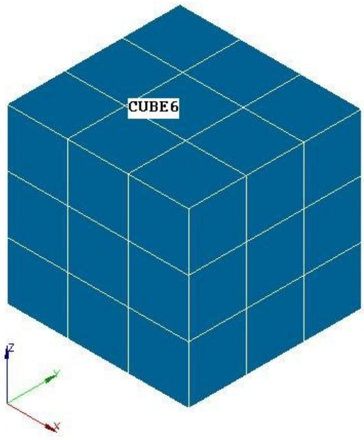
Grid MA1:



Modeling 3D:

Many nodes	361			
Many meshs	204	That is to say:		
			SEG2	38
			TRIA3	8
			QUAD4	28
			TETRA4	22
			TETRA10	22
			PENTA6	16
			PENTA15	16
			PYRAM5	14
			PYRAM13	14
			HEXA8	13
			HEXA20	13

Grid MA2:



Modeling 3D:

Many nodes	64			
Many meshs	39	That is to say:		
			SEG2	3
			QUAD4	9
			HEXA8	27

3.2 Results

Projection	Moment	Mesh	Not Gauss n°	Size (N/m^2)	Reference	Tolerance (%)
$MA1 \rightarrow MA2$	3.2	M3	1	$SIXX$	0.	0.1
		M3	1	$SIYY$	2.	1.
		M7	1	$SIXX$	0.	0.1
		M7	1	$SIYY$	2.	1.

4 Summary of the results

The got results are very satisfactory, they made it possible to check in the following situations:

The projection of a field of temperature:

- Projection of a grid $2D$ on another grid $2D$
- Projection of a grid $2D$ on a telegraphic grid $1D$
- Projection of a grid $1D$ telegraphic on a grid $2D$
- Projection of a grid $2D\,axis$ on a solid $3D$

The projection of a stress field :

- Projection of a grid $2D\,axis$ on a solid $3D$
- Projection of a grid $3D$ on a solid $3D$