ZZZZ336 – Validation of the taking into account of the command variables at the subpoints

Summarized:

The purpose of this test is to the key word validate the taking into account of the command variables at the subpoints by providing AFFE_VARC of the command AFFE_MATERIAU a field or result created by method SOUS_POINT of the command PROJ_CHAMP.

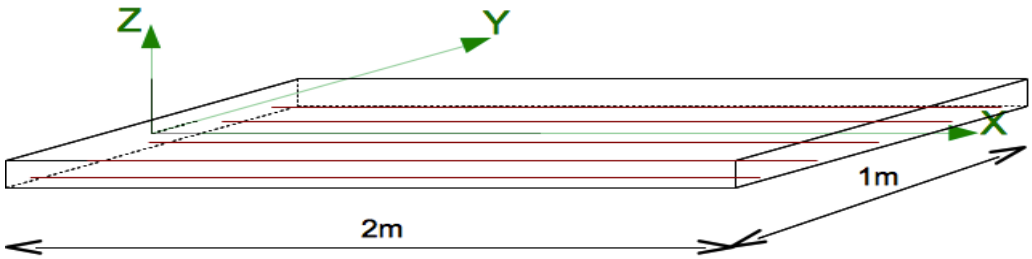
The modelizations considered are elements DKT and GRILLE_EXCENTREE.
The checking consists in 3D projecting a field of temperatures resulting from a linear thermal computation on a slab made up of multi-layer elements DKT and from an offset grid. The deflection of slab due to the heat gradient is calculated in linear thermoelasticity.

The reference solution is resulting from an identical computation with method CREA_RESU option PREP_VRC1 .

1 Problem of reference

1.1 Geometry and meshes

One considers a concrete slab length $2\,m$, of width $1\,m$ and of thickness $10\,cm$. It comprises a steel three-dimensions function directed according to the axis X, composed of bars of diameter $8\,mm$ spaced of $20\,cm$ whose axis is located at $2.5\,cm$ below average plane.



1.2 Properties of the materials

For linear thermal computation 3D (on the concrete only) the properties are:
$\rho C_p = 0$
$\lambda = 2\,W/m^2/K$

For mechanical computation the materials are elastic linear:

Concrete:	$E = 30\,GPa$	:	$E = 200\,GPa$
	$\nu = 0.2$		$\nu = 0.3$
	$\alpha = 10^{-5} K^{-1}$		$\alpha = 2.10^{-5} K^{-1}$

1.3 Boundary conditions and loading

For thermal computation, the temperature is imposed on the lower face and the upper face:
$T_{inf} = 20\,°C$ and $T_{\sup} = 50\,°C$
the initial temperature is $T_{ini} = 20\,°C$

For mechanical computation, the slab is simply leaned on its two bearings parallel with Y :
- on edge $X = 0$: $DX = DZ = 0$
- on edge $X = 1\mathrm{m}$: $DZ = 0$
- for the corner $Y = -0.5\mathrm{m}$: $DY = 0$

the loading consists in 3D imposing the temperature resulting from thermal computation.

2 Reference solution

2.1 Méthode de calcul

In the reference solution, the thermal field is imposed using command CREA_RESU option PREP_VRC1 for the multi-layer shells and the offset grids. The field of temperature, linear in the thickness, varies from $20\,°C$ opposite lower than $50\,°C$ opposite higher.

Field EVOL_THER (with under points) is transmitted to mechanical computation by the key word AFFE_VARC of AFFE_MATERIAU.

2.2 Quantities and results of reference

the heat gradient in the thickness imposes a mechanical strain of bending in slab. The coefficients of thermal expansion of the material steel and of concrete material one be voluntarily selected very different to generate stresses due to the differential expansion and to thus test the good performance of the elements roasts at the same time as that of the multi-layer shells.

The generated stresses are uniform in the planes parallel with the plane XY
the quantities tested are:

- the vertical displacement of the node $C5$ in the middle of edge $Y=-0.5\mathrm{m}$
- the stress σ_{xx} opposite lower concrete
- the stress σ_{xx} opposite superior the concrete
- the stress σ_{xx} in the layer of steel

2.3 Uncertainties on the solution

Nothing.

3 Modelization A

3.1 Characteristic of the modelization

The computation thermal 3D uses a lumped modelization (3D_DIAG). However, as the temperature is imposed on the two sides of the element, it is everywhere given. The thermal solver is used here only to generate field EVOL_THER to be projected. The computation mechanical uses multi-layer elements DKT for the concrete and GRILLE_EXCENTRE for steel. The number of layers in the DKT is 10. The temperature resulting from thermal computation 3D is projected on the layers of elements DKT and elements GRILL using method SOUS_POINT of the command PROJ_CHAMP.

3.2 Characteristics of the mesh

For thermal computation the mesh 3D is composed of only one mesh HEXA8.

For mechanical computation the mesh of the average plane is carried out with 30 elements QUAD4. The elements for the grids are generated in the command file with CREA_MAILLAGE.

3.3 Quantities tested and results

the deflection of the point $C5$ is tested:

Not	Component	**Value of reference**	**Tolerance**
C5	DZ	-2.82212559380283E-03	1.E-6

the stress in an element DKT (M27) is tested opposite lower (item 1, low of layer 1) and opposite higher (item 30, high of layer 10). The stress in an element GRILL (AM27) is tested in the single layer (subpoint 1).

Do not net		Subpoint	Component	**Value of reference**	**Tolerance**
M27	1	1	SIXX	7.074958252E+06	1.E-6
M27	1	30	SIXX	-1.524877428E+06	1.E-6
AM27	1	1	SIXX	-1.154105353E+07	1.E-6

4 Summary of the results

the taking into account of the command variables at the subpoints by providing to AFFE_VARC a field or one result created by method SOUS_POINT of the command PROJ_CHAMP is validated for multi-layer elements DKT and of elements GRILL.