Modeling 3D_INCO_UPG

Summary:

This document describes for modeling 3D_INCO_UPG :

- degrees of freedom carried by the finite elements which support modeling,
- the related meshs supports,
- laws of behavior and loadings supported,
- non-linear possibilities,
- CAS-tests implementing modeling.

This modeling is based on finite elements adapted to the treatment of the incompressible problems quasi -. It is essential to carry out calculations of limiting analysis with the law of Norton - Hoff and is also useful for the studies presenting of strong plastic deformations for which the classical formulation in displacement appears insufficient (oscillation of the constraints). The formulation used is a formulation with 3 fields: displacement-pressure-swelling [R6.03.05], usable with all the behaviors written in incremental form and in elasticity. Modeling 3D_INCO_UPG has voluminal meshs supports and accepts them TETRA10, them HEXA20, and them PENTA15.

1 Discretization

1.1 Degrees of freedom

Modeling	Degree of freedom to all the nodes	Degree of freedom only to the nodes tops
3D	DX, DY, DZ	CLOSE (*), GONF

* no kinematic condition can be imposed on the degree of freedom NEAR.

1.2 Mesh support of the matrices of rigidity

For modeling 3D, the meshs support of the finite elements can be tetrahedrons, hexahedrons or prisms.

Modeling	Mesh	Interpolation in displacements	Interpolation in pressure and swelling
3D	TETRA10	Quadratic	Linear
	HEXA20	Quadratic	Linear
	PENTA15	Quadratic	Linear

1.3 Mesh support of the surface loadings

Modeling	Mesh	Interpolation in displacements
3D	TRIA6	Quadratic
	QUAD8	Quadratic

2 Supported loadings

Loadings available under AFFE_CHAR_MECA_ are the following:

- 'FORCE_ARETE'

  Allows to apply forces linear, with one edge of element voluminal.

- 'FORCE_FACE'

  Allows to apply surface forces on one face of voluminal element.

- 'FORCE _INTERNE'

  Allows to apply voluminal forces.

- 'GRAVITY'

  Allows to apply a loading of type gravity.

- 'PRES_REP'

  Allows to apply a pressure to a field of continuous medium.

3 Non-linear possibilities

3.1 Laws of behavior

All the laws of behavior usable on meshs of continuous mediums have a physical direction for these modelings and are easily affected as from the moment when they are accessible from BEHAVIOR in STAT_NON_LINE (Cf [U4.51.11]). Or in MECA_STATIQUE (linear rubber band in small deformations)

Let us announce that a law of behavior is specific to this modeling (dedicated to the calculation of limiting load, cf [R7.07.01]):

/ ' NORTON_HOFF '

3.2 Deformations

Deformations available, used in the relations of behavior under the keyword DEFORMATION for the operators STAT_NON_LINE, DYNA_NON_LINE and CALCULATION are (cf [U4.51.11]):

/ 'SMALL'

The deformations used for the relation of behavior are the linearized deformations.

/ 'SIMO_MIEHE'
'GDEF_LOG'
Allows to carry out calculations in great plastic deformations.

In MECA_STATIQUE, one is in elasticity small deformations.

3.3 Method of Newton

For the resolution of the problem by the method of Newton-Raphson in the non-linear oéprateurs, the elastic matrix is not available. It is thus necessary to use under the keyword NEWTON for the operators STAT_NON_LINE and DYNA_NON_LINE (Cf [U4.51.11]):

/ PREDICTION = 'TANGENT'

The phase of prediction is carried out with the tangent matrix.

/ MATRIX = 'TANGENT'

The matrix used for the iterations total is the tangent matrix

Note:

The formulation used leads to nonpositive matrices and the current solveurs cannot solve always well the linear systems which are associated for them. In the event of difficulty of convergence, it can thus be useful to test the other solveurs available in the code or the other methods of renumérotations (cf [U4.50.01]).

4 Examples of implementation: CAS-tests

- Small deformations:
  - SSLV130A [V3.04.130]: Analysis of a hollow roll into incompressible, subjected to an internal pressure.
- Great deformations:
  - SSNV112A [V6.04.112]: Analysis of a hollow roll into incompressible in great deformations, subjected to an internal radial displacement.

- Analysis limit:
  - SSNV124B [V6.04.124]: Determination of the load limits of a cube subjected to loadings on its edges.