Modelings 3D and 3D_SI mechanics

Summary:

This document describes for mechanical modelings 3D and 3D_SI :

- degrees of freedom carried by the finite elements which support modeling,
- the related meshs supports,
- supported loadings,
- nonlinear possibilities,
- CAS-tests implementing modeling.

Modelings 3D and 3D_SI (phenomene MECHANICS) correspond to finite elements whose meshs supports are voluminal.

The suffix _SI mean Under-Integrated: the integration of the terms relating to the laws of behavior is made in a reduced way (diagram of points of Gauss of a nature less low than modeling with complete integration).

1 Discretization

1.1 Degrees of freedom

Modeling	Degrees of freedom (with each node top)
3D, 3D_SI	DX : following displacement X DY : following displacement Y DZ : following displacement Z

1.2 Mesh support of the matrices of rigidity

The meshs support of the finite elements can be tetrahedrons, pyramids, prisms or hexahedrons. The elements are isoparametric.

Modeling	Mesh	Interpolation	Remarks
3D	TETRA4	Linear	
3D	TETRA10	Quadratic	
3D_SI	TETRA10	Quadratic	reduced integration
3D	PYRAM5	Linear	
3D	PYRAM13	Quadratic	
3D	PENTA6	Bilinear	
3D	PENTA15	Serendip	
3D	HEXA8	Trilinear	
3D_SI	HEXA8	Trilinear	method “assumed strain”
3D	HEXA20	Serendip	
3D_SI	HEXA20	Serendip	reduced integration
3D	HEXA27	Tri-quadratic	

1.3 Mesh support of the loadings

Modeling	Mesh	Interpolation	Remarks
3D, 3D_SI	TRIA3	Linear or Bilinear	
	TRIA6	Quadratic or Serendip	
	QUAD4	Bilinear	
	QUAD8	Serendip	
	QUAD9	Quadratic	

2 Supported loadings

Loadings available are following:

- **'FORCE_ARETE'**

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

  Supported modelings: 3D, 3D_SI

- **'FORCE_FACE'**

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

  Supported modelings: 3D, 3D_SI

- **' FORCE _INTERNE'**

  Allows to apply voluminal forces.

  Supported modelings: 3D, 3D_SI

- **'GRAVITY'**

  Allows to apply a loading of type gravity.

  Supported modelings: 3D, 3D_SI

- **'PRES_REP'**

  Allows ofto apply a pressure with a field of continuous medium.

  Supported modelings: 3D , 3D_SI

- **'PRE_EPSI'**

  Allows to apply a field of predeformation.

  Supported modelings: 3D, 3D_SI

- **'ROTATION'**

  Allows to apply a number of revolutions and a vector of rotation.

  Supported modelings: 3D, 3D_SI

- **'EFFE_FOND'**
  Allows to calculate and apply the basic effect on a branch of piping subjected to an internal pressure.

  Supported modelings: 3D, 3D_SI

3 Non-linear possibilities

3.1 Laws of behaviors

Laws of behaviors (model classics, local models with damage, models for the concrete and grounds, …), usable under BEHAVIOR in STAT_NON_LINE and DYNA_NON_LINE, under the keyword RELATION, are described in details in the document 'Behavior nonlinear' [U4.51.11].

3.2 Deformations

Deformations usable under BEHAVIOR in STAT_NON_LINE and DYNA_NON_LINE, under the keyword DEFORMATION, are described in details in the document 'Behavior nonlinear' [U4.51.11].

4 Examples of implementation: CAS-tests

- **3D**

Linear statics	FORMA01C [V7.15.100]: Quasi-static analysis of a piping comprising an elbow subjected to a specific force, an internal pressure and a thermal transient.
Non-linear statics	HSNV121A: [V7.15.121]: Quasi-static analysis in great deformations of a bar under thermal loading subjected to a force of traction.
Linear dynamics	SDLV100A [V2.04.100]: Research of the frequencies and the modes of inflection associated with a slim beam of variable rectangular section (embed-free).
Non-linear dynamics	SDNV100A [V5.03.100]: Direct transitory analysis of an animated slim beam an initial speed coming to run up against a rigid wall.

- **3D_SI**

Non-linear statics	HSNV125D: Quasi-static analysis of a volume in traction subjected to a variable temperature and a loading in shearing with a law of viscoplastic behavior (case - test n°2 PHI2AS "non-linear Behavior of materials", 2000 – Volume XXIV – N°1).
Non-linear dynamics	SDNV103A [V5.03.103]: Analysis of the impact of an elastoplastic bar of Taylor on a rigid solid mass. Modeling takes into account the contact with friction and a behavior elastoplasticity with great deformations.