Modelings 3D and 3D_DIAG thermics

Summary:

This document describes for modelings 3D and 3D_DIAG thermics:

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

Modeling 3D (phenomene THERMICS) corresponds to finite elements whose meshs supports are voluminal.

Modeling 3D_DIAG cover the same possibilities as 3D and remotely only for one calculation of thermics where the thermal matrix of mass is then diagonalisée before resolution.

1 Discretization

1.1 Degrees of freedom

Modeling	Degrees of freedom (with each node top)
3D and 3D_DIAG	TEMP : corresponds to the temperature HYDR : corresponds to the hydration

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 and 3D_DIAG	TETRA4	Linear	
3D	TETRA10	Quadratic	
3D	PYRAM5	Linear	
3D	PYRAM13	Quadratic	
3D and 3D_DIAG	PENTA6	Bilinear	
3D	PENTA15	Serendip	
3D and 3D_DIAG	HEXA8	Trilinear	
3D	HEXA20	Serendip	
3D	HEXA27	Tri-quadratic	

1.3 Mesh support of the surface loadings

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

2 Supported loadings

The loadings available are the following:

- **SOURCE**

  Allows to apply voluminal sources to a field 3D.

  Supported modelings: 3D, 3D_DIAG

- **FLUX_REP**

  Allows to apply normal flows to faces of voluminal elements.

  Supported modelings: 3D, 3D_DIAG

- **EXCHANGE**

  Allows to apply conditions of exchange with an outside temperature with faces of voluminal elements.

  Supported modelings: 3D, 3D_DIAG

- **ECHANGE_PAROI**

  Allows to apply conditions of exchange between two walls.

  Supported modelings: 3D, 3D_DIAG

- **GRAD_TEMP_INIT**

  Allows to impose a presumedly uniform variation in temperature in an element

  Supported modelings: 3D, 3D_DIAG

- **CONVECTION**

  Allows to take into account the terms of transport of heat by convection, for THER_NON_LINE_MO only.

  Supported modeling: 3D, 3D_DIAG

- **RADIATION**

  Allows to take into account the flow radiated ad infinitum with faces of voluminal elements

  Supported modelings: 3D, 3D_DIAG

3 Non-linear possibilities

Two operators are available for the study of non-linear behaviors:

- THER_NON_LINE [U4.54.02]: this operator allows, in hover or in transient, to solve the problems of:
  - Standard non-linear thermics: material depend on the temperature, boundary conditions (radiation and nonlinear imposed flow),
  - Nonlinear thermics with calculation of the hydration of the concrete,
  - Drying of the concrete.
- THER_NON_LINE_MO [U4.54.03]: this operator allows to solve the equation of stationary heat in a mobile reference frame related to a loading and moving in a direction and at a given speed.

4 Examples of implementation: CAS-tests

4.1 Standard thermics

- **3D**
  - Stationary linear thermics
    TPLL100A [V4.02.100]: Thermal analysis of an anisotropic wall plan subjected to an imposed temperature and a flow.
  - Transitory linear thermics
    TTLL01C [V4.21.001]: Transitory linear thermal analysis of an infinite wall subjected to a thermal shock.
  - Stationary non-linear thermics
    TPNA01A [V4.41.001]: Thermal analysis of a hollow roll whose internal wall is subjected to a radiation and the external wall with an exchange by convection.
  - Transitory non-linear thermics
    TTNL03A [V4.22.003]: simulation of an adiabatic test: analysis of the hydrating behavior thermo - of freshly-mixed a concrete sample plunged in a calorimeter, the catch being carried out with heat emission.
  - Stationary non-linear thermics with mobile loading
    TPLV105A [V4.04.105]: This test presents thermal simulation by finite elements of the Varestraint test. This test of weldability is employed to characterize resistance to the hot cracking of materials.
- **3D_DIAG**
  - Transitory linear thermics
    TTLL01J [V4.21.001] : Transitory linear thermal analysis of an infinite wall subjected to a thermal shock.

4.2 Hydration

- **3D**
  TTNL03A [V4.22.003]: simulation of an adiabatic test: analysis of the hydrating behavior thermo - of freshly-mixed a concrete sample plunged in a calorimeter, the catch being carried out with heat emission.

4.3 Drying

- **3D**
  HSNA100B [V7.20.100]: Calculation of the drying of a concrete enclosing wall: drying is carried out by exchange with outside, on the walls internal and external of the wall.

- **3D_DIAG**
  HSNA100D [V7.20.100]: Calculation of the drying of a concrete enclosing wall: drying is carried out by exchange with outside, on the walls internal and external of the wall.