Modelings AXIS, PLAN, AXIS_DIAG and PLAN_DIAG – Phenomenon THERMICS

Summary:

This document describes for modelings of thermics of the axisymmetric elements and plans:

- 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.

Axisymmetric and plane modelings (Phenomenon: THERMICS) correspond to finite elements whose meshs supports are surface.

Modelings AXIS_DIAG and PLAN_DIAG the same possibilities cover as AXIS and PLAN and differ from it only for one calculation from thermics where the thermal matrix of mass is then diagonalisée.

1 Discretization

1.1 Degrees of freedom

Modeling	Degrees of freedom (with each node top)
AXIS, AXIS_DIAG, PLAN, PLAN_DIAG	TEMP : corresponds to the temperature

1.2 Mesh support of the matrices of rigidity

The meshs support of the finite elements can be triangles or quadrilaterals. The elements are isoparametric.

Modeling	Mesh	Interpolation	Remarks
AXIS (_DIAG) - PLAN (_DIAG)	TRIA3	Linear	
AXIS (_DIAG) - PLAN (_DIAG)	QUAD4	Linear	
AXIS (_DIAG) - PLAN (_DIAG)	TRIA6	Quadratic	
AXIS - PLAN	QUAD8	Serendip	
AXIS (_DIAG) - PLAN (_DIAG)	QUAD9	Quadratic	

1.3 Mesh support of the loadings

Modeling	Mesh	Interpolation	Remarks
AXIS (_DIAG) - PLAN (_DIAG)	SEG2	Linear	
AXIS (_DIAG) - PLAN (_DIAG)	SEG3	Quadratic	

2 Supported loadings

The loadings available are the following:

- **SOURCE**

  Allows to apply voluminal sources to a 2D field.

  Supported modelings: AXIS (_DIAG), PLAN (_DIAG)

- **FLUX_REP**

  Allows to apply normal flows to sides of elements 2D.

  Supported modelings: AXIS (_DIAG), PLAN (_DIAG)

- **EXCHANGE**

  Allows to apply conditions of exchange with an outside temperature at sides of elements 2D.

  Supported modelings: AXIS (_DIAG), PLAN (_DIAG)

- **ECHANGE_PAROI**

  Allows to apply conditions of exchange between two walls.

Supported modelings: AXIS (_DIAG), PLAN (_DIAG)

- **GRAD_TEMP_EPSI**

  Allows to apply a presumedly uniform variation in temperature “initial” in the element.

  Supported modelings: AXIS (_DIAG), PLAN (_DIAG)

- **CONVECTION**

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

  Supported modelings: AXIS, PLAN

- **RADIATION**

  Allows to take into account ad infinitum radiated flow.

  Supported modelings: AXIS (_DIAG), PLAN (_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),
  - Non-linear 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 Thermics

- **AXIS**
  - Stationary linear thermics
    TPLA07A [V4.01.007]: Thermal analysis of an orthotropic hollow roll subjected to various boundary conditions (imposed flow, convection, linear variation of the outside temperatures).
  - Stationary non-linear thermics
    TPNA01A [V4.41.001]: Thermal analysis of a hollow roll subjected to a convectif exchange on the interior wall and to a radiation ad infinitum on the external wall.
  - Transitory linear thermics
    TTLV01B [V4.25.001]: Transitory linear thermal analysis of a full sphere subjected to a heat transfer by convection.
  - Transitory non-linear thermics
    TTNA200A: CAS-test of not-regression
- **PLAN**
  - Stationary linear thermics
    TPLL100B [V4.02.100]: Thermal analysis of an anisotropic wall plan subjected to an imposed temperature and a flow.
  - Stationary non-linear thermics
    TPNL300A [V4.42.300]: Unidimensional thermal analysis of a wall subjected to a temperature imposed on the internal wall and to an exchange by radiation on the external wall (Test NAFEMS).

- Transitory linear thermics

TTLP100B [V4.23.100]: Calculate linear transitory thermal answer of two plates separated by a game in which a transfer of heat between the walls is carried out.

- Transitory non-linear thermics
  TTNL02A [V4.22.002]: Simulation of a liquid/solid phase shift by introducing via the voluminal enthalpy the latent heat of fusion.
- Nonlinear stationary thermics with mobile loading
  TPLV102A [V4.04.102]: Transport of heat by convection and conduction in a square cavity.

- **AXIS_DIAG**
  - Transitory linear thermics
    TTLV100A [V4.25.100]: Transitory linear thermal analysis of a presumedly infinite pipe in which one imposes a cold thermal shock using a limiting condition of exchange.
- **PLAN_DIAG**
  - Transitory linear thermics
    TTLL100A [V4.21.100]: Transitory linear thermal analysis of a wall infinite plan on which one imposes a cold thermal shock using a limiting condition of exchange.
  - Transitory non-linear thermics
    TTNL02C [V4.22.002]: Simulation of a liquid/solid phase shift by introducing via the voluminal enthalpy the latent heat of fusion.

4.2 Hydration

- **AXIS**
  TTNL03B [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

- **AXIS**
  HSNA102A [V7.20.102]: Validation of the calculation of the drying of the concrete, it acts of an axisymmetric case test where the water concentration is applied directly to the external wall.

- **AXIS_DIAG**
  HSNA102D [V7.20.102]: Validation of the calculation of the drying of the concrete, it acts of an axisymmetric case test where the water concentration is applied directly to the external wall.