Modeling COQUE_3D

Summary:

Modeling COQUE_3D presented here corresponds to a formulation of general kinematics of hulls and plates, of Naghdi-Reissner type, where the generalized constraints are obtained starting from the laws of three-dimensional behavior of constitutive materials [R3.07.04]. Contrary to modelings DKT-DST, Q4G corresponding to the formulations of elements of plate developed by J.L. BATOZ [bib1] which use finite elements plans, modeling COQUE_3D allows to carry out structural analyses hulls of an unspecified form, with a good approximation of the geometry. Moreover this modeling is able to represent great rotations of the structures [R3.07.05] under the assumption of small deformations.

The degrees of freedom are displacements and the rotations, taken with the nodes of the elements.

The nonlinear behavior is discretized by polynomials $P2$, which allows a precise calculation of the constraints.

It is usable for problems of structures three-dimensional hulls in linear and nonlinear mechanical analysis.

This formulation also exists for problems of slices, or revolution. It rests on elements 1D: (see [U3.12.02]).

Thermomechanical calculations are chained starting from the finite elements of thermal hulls (see [U3.22.01]).

1 Discretization

1.1 Degrees of freedom

For modeling hull into three-dimensional the degrees of freedom of discretization are, in each node of the mesh support the six components of displacement (three translations and three rotations) to the nodes tops and mediums on the sides of the mesh support. To the central node of the mesh support the degrees of freedom are reduced to only rotations. These nodes belong to the average layer of the hull.

Modeling	Degrees of freedom (with each node)
COQUE_3D	DX DY DZ DRX DRY MARTINI DRZ DRX DRY MARTINI DRZ only with the central node

1.2 Mesh support of the matrices of rigidity, mass…

The meshs support of the finite elements, in displacement formulation, can be triangles with 7 nodes or quadrangles with 9 nodes. These meshs are not supposed to be plane; they are created starting from grids in TRIA6 and QUAD8 by the order CREA_MAILLAGE (see [U4.23.02]).

Modeling	Mesh	Finite element
COQUE_3D	TRIA7	MEC3TR7H
	QUAD9	MEC3QU9H

1.3 Mesh support of the loadings

All the loadings applicable to the facets of the elements of hull are treated by direct discretization on the mesh support of the element in displacement formulation.

No mesh support of loading is thus necessary for the faces of the elements of hull.

For the applicable loadings on the edges of the elements of hull, a mesh support of the type SEG3 is usable:

Modeling	Mesh	Finite element
COQUE_3D	SEG3	MEBOCQ3

2 Assignment of the characteristics

For these elements of structures $2\mathrm{D}\,1/2$, it is necessary to affect geometrical characteristics which are complementary to the data of grid. The definition of these data is carried out with the order AFFE_CARA_ELEM associated with the keyword following factor:

- HULL
  Allows to define and affect on the meshs, the thickness, the coefficient of shearing, offsetting,…

3 Supported loadings

The mechanical loadings available are the following:

- 'FORCE_ARETE'
  Allows to apply linear forces, with an edge of voluminal element.
- 'FORCE_COQUE'
  Allows to apply surface efforts.
- 'GRAVITY'
  Allows to apply a loading of type gravity.
- 'PRES_REP'
  Allows to apply a pressure to a field of continuous medium.
- 'ROTATION'
  Allows to define the vitesof rotation and the vector of rotation.

The application of a thermal loading of dilation is carried out by defining the keyword factor AFFE_VARC under AFFE_MATERIAU [U4.43.03].

4 Non-linear possibilities

4.1 Law of behaviors

All relations in constraints plane, usable under BEHAVIOR in STAT_NON_LINE, and DYNA_NON_LINE are available (*cf.* [U4.51.11]).

4.2 Deformations

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

/ 'EPTIT'

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

/ 'PETIT_REAC'
The increments of deformations used in the incremental relation of behavior are the linearized deformations of the increment of displacement in the reactualized geometry.

/ 'GROT_GDEP'
Allows to carry out calculations in great displacements and great rotations. The deformations used in the relation of behavior are the deformations of GREEN - LAGRANGE.

Note:

1) *Attention, the calculation of the deformations using ‘PETIT_REAC' is only one approximation of the assumptions of great displacements. It requires to carry out very small increments of loading. To correctly take into account great displacements, and especially great rotations, it is recommended to use DEFORMATION=' GROT_GDEP'.*
2) *It is possible while using under the keyword factor EXCIT (TYPE_CHARGE=' SUIV') to take into account a following pressure.*

5 Examples of implementation: CAS-tests

- Statics linear
  SSLP304C [V3.02.304]: Analysis of an orthotropic square plate subjected to a uniaxial traction out of axes of orthotropism

- Non-linear statics
  HPLA100C [V7.01.100]: Thermoelastic analysis of a heavy hollow roll in uniform rotation.

- Linear dynamics
  SDLS01E [V2.03.01]: Calculation of the frequencies and the modes associated with inflection with a thin square plate into free-free and encastrée on an edge.

6 Bibliography

[1] J.L. BATOZ, G. DHATT: Modeling of the structures by finite elements. Vol.2 - beams and plates - HERMES, PARIS, 1990.