Modelings TUYAU_3M and TUYAU_6M

Summary:

This document describes for modelings TUYAU_3M and TUYAU_6M :
- •degrees of freedom carried by the finite elements which support modeling,
- •the related meshs supports,
- •supported loadings,
- •non-linear possibilities,
- •CAS-tests implementing modelings.

Modelings TUYAU_3M and TUYAU_6M correspond to a formulation of linear elements of right piping or curve, which are based on a kinematics of beam of Timoshenko for displacements and rotations of average fibre and on a kinematics of hull for the deformations of the transverse section (ovalization, warping, swelling). These transverse deformations are broken up into Fourier series. Modeling TUYAU_3M takes into account 3 modes to the maximum, while modeling TUYAU_6M takes into account 6 modes of Fourier.

These modelings are usable for problems of three-dimensional pipings in linear mechanical analysis or not linear and small displacements.

Contents

1 Discretization

1.1 Degrees of freedom

The degrees of freedom are, in each node of the mesh support:

- six components of displacement of average fibre (three translations and three rotations),
- three degrees of freedom corresponding to modes 0 and 1,
- for each mode of Fourier 6 degrees of freedom (U corresponds to warping, V with orthoradial displacement, W with radial displacement).

Finite element	Degrees of freedom (with each node top)						Remarks
TUYAU_3M	DX	DY	DZ	DRX	DRY MARTINI	DRZ	
	W0	WI1	WO1				
	UI2	VI2	WI2	UO2	VO2	WO2	mode 2
	UI3	VI3	WI3	UO3	VO3	WO3	mode 3
TUYAU_6M	DX	DY	DZ	DRX	DRY MARTINI	DRZ	
	W0	WI1	WO1				
	UI2	VI2	WI2	UO2	VO2	WO2	mode 2
	UI3	VI3	WI3	UO3	VO3	WO3	mode 3
	UI4	VI4	WI4	UO4	VO4	WO4	mode 4
	UI5	VI5	WI5	UO5	VO5	WO5	mode 5
	UI6	VI6	WI6	UO6	VO6	WO6	mode 6

1.2 Mesh support of the matrices of rigidity

The meshs support of the finite elements, in displacement formulation, are segments with 3 or 4 nodes.

Modeling	Mesh	Finite element	Remarks
TUYAU_3M	SEG3	MET3SEG3	
	SEG4	MET3SEG4	
TUYAU_6M	SEG3	MET6SEG3	

2 Assignment of the characteristics

For these elements of structures 1D, 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 keywords following factors:

•BEAM
Allows to define and affect the characteristics of the cross section.
Supported modelings: TUYAU_3M, TUYAU_6M

•ORIENTATION
Allows to define and affect a generator.
Supported modelings: TUYAU_3M, TUYAU_6M

•SOLID MASS
Optional, allows to only in the case of define and affect a direction of growth (necessary a law of behavior ASSE_COMBU).
Supported modelings: TUYAU_3M, TUYAU_6M

3 Supported loadings

The loadings available are the following:

•'FORCE_POUTRE'
Allows to apply linear forces

Supported modelings: TUYAU_3M, TUYAU_6M

- 'FORCE_TUYAU'
  Allows to apply a pressure in the pipe.
  Supported modelings: TUYAU_3M, TUYAU_6M
- 'GRAVITY'
  Allows to apply a loading of type gravity.
  Supported modelings: TUYAU_3M, TUYAU_6M

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 laws of behaviors available in C_PLAN are usable under BEHAVIOR in STAT_NON_LINE and DYNA_NON_LINE (Cf [U4.51.11]).

4.2 Deformations

Only linearized deformations keyword 'SMALL' under DEFORMATION are available in the relations of behavior (cf [U4.51.11]).

5 Examples of implementation: CAS-tests

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- Linear statics
  - FORMA01E [V7.15.100]: Analysis of a piping comprising an elbow embedded at an end and subjected to a force at the other end.
  - SSLL106A [V3.01.106]: Analysis quasi-static of a pipe right embedded at an end and subjected to a traction, 2 efforts cutting-edges, 2 bending moments and a torsion at the other end. One applies moreover one internal pressure, a linear force distributed and a thermal dilation.
- Non-linear statics
  - SSNL117A [V6.02.117]: Elastoplastic analysis of an elbow embedded at an end and subjected to a loading of inflection in its plan at the other end.
- Linear dynamics
  - SDLL14A [V2.02.014]: Research of the Eigen frequencies and the modes associated with a bent piping.
- Non-linear dynamics
  - SDNL113A: Elastoplastic dynamic response of a piping in the shape of quadrant subjected to a seismic loading.

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- Linear statics
  - SSLL106C [V3.01.106]: Analysis quasi-static of a pipe right embedded at an end and subjected to a traction, 2 efforts cutting-edges, 2 bending moments and a torsion at the other end. One applies moreover one internal pressure, a linear force distributed and a thermal dilation.
- Non-linear statics
  - HSNV100D [V7.22.100]: Thermoplastic analysis in simple traction of a right pipe.
- Linear dynamics
  - SDLL14B [V2.02.014]: Research of the Eigen frequencies and the modes associated with a bent piping.