

## SDLV128 - Modal expansion on a cylindrical tube 3D starting from extensiometric measurements

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### Summary:

The objective of this test is to validate the approach of expansion of modes identified with extensiometric gauges on a digital model.

## 1 Problem of reference

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### 1.1 Geometry

One considers a cylindrical tube length  $2.17\text{ m}$ , of external diameter  $10\text{ mm}$  and thickness  $1\text{ mm}$

### 1.2 Properties of material

The material is elastic isotropic whose properties are:

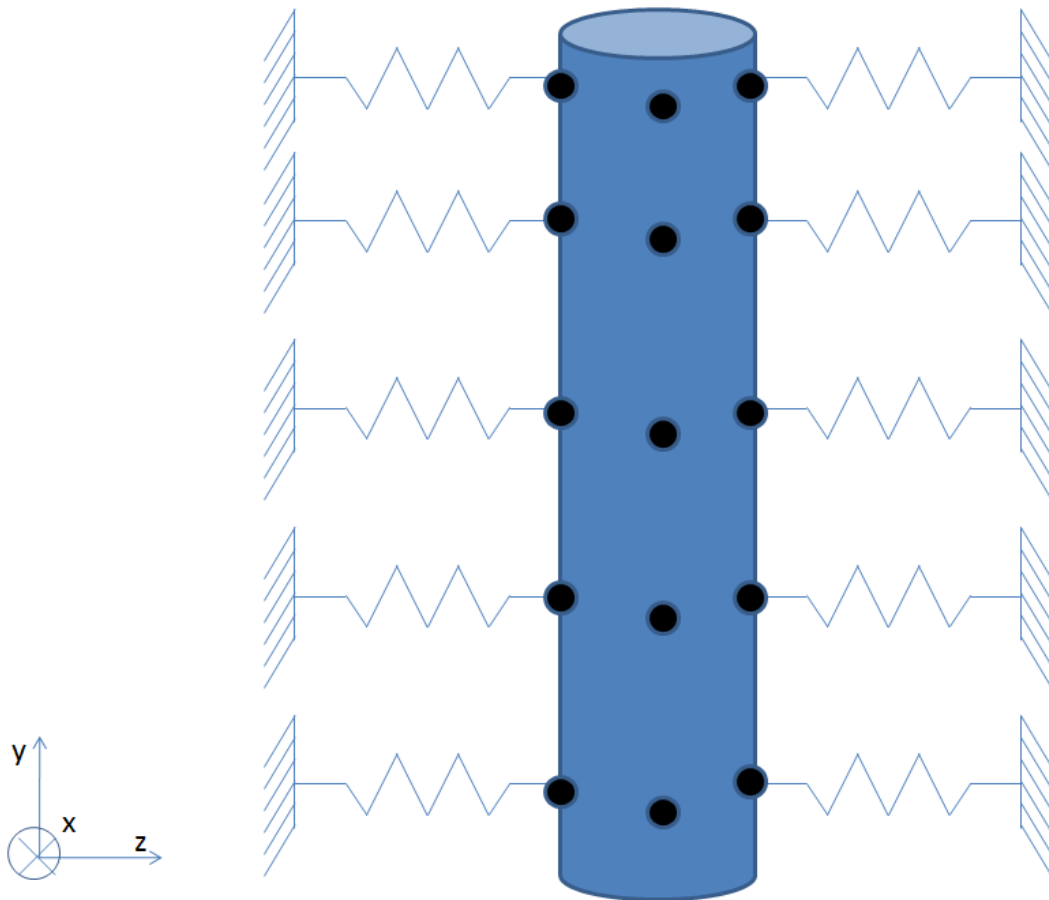
- $E = 210\,000\text{ MPa}$
- $\nu = 0.3$
- $\rho = 7800\text{ kg/m}^3$

### 1.3 Boundary conditions and loadings

The tube is supported by supports in several points according to the diagram below.  
The mechanical characteristics of these supports are:

- $K_x = K_z = \frac{1.8 \cdot 10^6}{4}\text{ N/m}$
- $K_y = \frac{2.1 \cdot 10^7}{4}\text{ N/m}$

To break the axisymetry of the model which generates double modes, one adds a specific mass of  $10^{-4}\text{ kg}$ , in a point of the lower support. One also multiplies in this point, rigidity according to X per 1.05. Moreover, at another point of the lower support, one multiplies rigidity according to Z by 0.95. That allows on the one hand, to obtain a well defined order of the modes according to the increasing frequency without too disturbed the model, and on the other hand, to have static deformations step too colinéaires (bases linearly independent expansion) for modeling A.



The dimensions of the something to lean on are: 0.3 m, 0.8 m, 1.29 m, 1.88 m and 2.09 m  
Not to overload the illustration, the supports (springs) which are in the xOy plan are not presented.

Gauges were stuck inside the tube on two generators. Eight gauges were stuck on each generator.  
The first generator is in the plan xOy and the second generator is in the yOz plan.  
The dimensions of the points of measurement are: 0.2 m, 0.4 m, 0.63 m, 0.92 m, 1.22 m, 1.51 m, 1.80 m and 2.09m.

## 1.4 Initial conditions

Nothing

## 2 Reference solution

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### 2.1 Method of calculating

It is a question here of estimating the field of deformation on all the structure, starting from the deformations measured in some points of the tube.

For that, one carries out an expansion of measurement by using the technique of modal expansion. The experimental modes "were simulated" by projection of the digital modes on the gauges, in the form of field of deformation to the node.

### 2.2 Sizes and results of reference

It is considered that the technique used is robust if one arrives, after expansion of measurement, to find the field of deformation on all the nodes of the initial digital model.

The reference variable is the scalar product between the wide field and the computed field on the initial digital model. This scalar product is obtained by carrying out a calculation of MAC.

### 2.3 Uncertainties on the solution

The solution obtained is considered correct if the scalar product between the wide field and the computed field directly with the digital model is close to 1.

## 3 Modeling A

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### 3.1 Characteristics of modeling

One carries out an expansion of measurement by using a base of expansion made up of raised static at the points of measurement.

A modeling is used `3D` for the tube and a modeling `DIS_T` for the supports.

### 3.2 Characteristics of the grid

The grid contains 8680 elements of the type `HEXA8` and 20 elements of the type `POI1`.

### 3.3 Sizes tested and results

One tests the not-regression, for the first four modes of the tube, the scalar product between the field of modal deformation wide and the field of modal deformation calculated with the initial digital model.

The got results are considered to be correct here in spite of the fact that the base of expansion made up only of is raised static.

## 4 Modeling B

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### 4.1 Characteristics of modeling

One carries out an expansion of measurement by using a base of expansion made up of the first six clean modes calculated on the initial digital model.

A modeling is used 3D for the tube and a modeling DIS\_T for the supports.

### 4.2 Characteristics of the grid

The grid contains 8680 elements of the type HEXA8 and 20 elements of the type POI1.

### 4.3 Sizes tested and results

One tests, for the first six modes of the tube, the scalar product between the field of modal deformation wide and the field of modal deformation calculated with the initial digital model.

Identification	Type of reference	Value of reference
Mode 1	'ANALYTICAL'	1
Mode 2	'ANALYTICAL'	1
Mode 3	'ANALYTICAL'	1
Mode 4	'ANALYTICAL'	1
Mode 5	'ANALYTICAL'	1
Mode 6	'ANALYTICAL'	1

## 5 Summary of the results

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The got results show that one can estimate the field of deformation from a base made up of clean modes or the raised static ones with the points of measurements.

The results got with a base made up of clean modes obviously better than those obtained by are raised static.