

SDLS139 - Identification of fluid efforts on a telegraphic structure

Summary:

This CAS-test is used as validation with the macro-order **CALC_ESSAI**, which is an interactive operator of identification of efforts on telegraphic structure. Several methods are proposed by the operator, and are tested here:

- [1] expansion of experimental data on a digital model,
- [2] identification of turbulent efforts by decomposition on modal basis,

The cas-test simulates the data necessary to the use of macro:

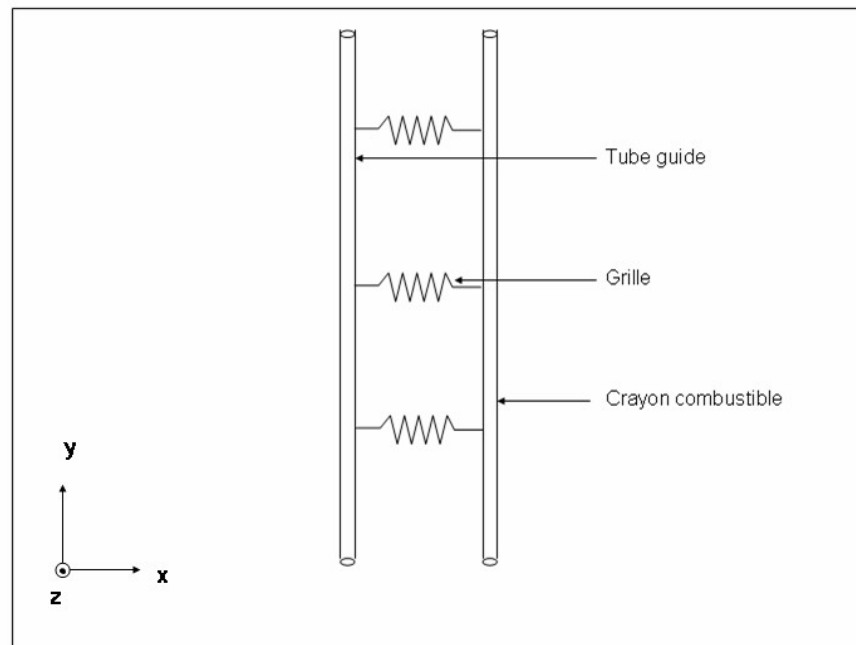
- a grid of fuel pin, stiffened by a tube guides,
- a modal base associated with this structure,
- simulation of efforts fluid-rubber bands, at rest, and in flow,
- simulation of a turbulent inter-spectrum of efforts, according to a model of CORCOS,
- simulation of displacements of the pencil induced by this effort, restitution on 19 "sensors",
- creation of models of observability (grid with 19 sensors) and of order (grid with 3 nodes).

Then, the macro-order uses these data as starter to identify the simulated efforts (turbulent efforts fluid-rubber bands and efforts).

The macro one is normally used in mode **INTERACTIVE**. When it is not the case, as in this CAS-test, the execution of the order is done in the source code of this one, which carries out, instead of the user, the functions of identification.

1 Problem of reference

1.1 Geometry



The geometry is a fuel pin height $4,5\text{ m}$, thickness $0,5\text{ mm}$ and of diameter $0,9\text{ cm}$, regularly attached, via the grids of maintenance, with a tube guides, more rigid, thickness $0,5\text{ mm}$ and of diameter $1,245\text{ cm}$.

1.2 Properties of material

The material is homogeneous, isotropic, elastic linear. The elastic coefficients are:

- 1) $E=98\,400\text{ MPa}$, $\nu=0.3$, and $\rho=6526\text{ kg}\cdot\text{m}^{-3}$ for the guide,
- 2) $E=98\,400\text{ MPa}$, $\nu=0.3$, and $\rho=6526\text{ kg}\cdot\text{m}^{-3}$ for the pencil.

1.3 Mechanical modeling

The grids are of the elements of stiffness of the type `DIS_TR`, the pencils are elements `POU_D_T` of Timoshenko.

1.4 Boundary conditions and loadings

The pencil is embedded at its ends, and only displacements according to DX are authorized.

2 Simulation of the data

2.1 Base in air

The base modal, known as "in air", is calculated with `CALC_MODES`. The modes are then standardized compared to the mass. One recovers this simulation one `sd_resultat mode_meca` called `MODEAIR`.

2.2 Turbulent efforts

The effort is applied to two nodes, according to a inter-spectrum with two components. Each spectrum applied has the form of Gaussian. The two excitations are décorrélées (the inter-spectrum (1,2) is a worthless function).

The operator `DYNA_ALEA_MODAL` calculate modal displacements starting from this effort for the base `MODEAIR`, and `REST_SPEC_PHYS` restore these displacements on physical basis, on 19 points only, which simulate experimental measurement. This result is called `SPECTR19`.

2.3 Models of efforts and commandability

The user must define the experimental grid used during the experiment, as well as the positions of the specific points on which it wishes to project the identified efforts (commandability), with the associated degrees of freedom:

- 1) translation if one wishes to identify only specific efforts,
- 2) translation and rotation if one wishes to identify specific efforts and moments.

3 Launching of `CALC_ESSAI`

The order used for the launching of macro is the following one:

```
CALC_ESSAI (INTERACTIVE = 'NOT',
            EXPANSION = _F (CALCULATION = MODEAIR,
                            NUME_MODE_CALCUL = (1,2,3,4,5,6,7,8),
                            MEASUREMENT = MODCRA,
                            NUME_MODE_MESURE = (1,2,3,4,5,6,7,8)),
            IDENTIFICATION = _F (ALPHA = 0.0, EPS = 0.0,
                                 INTE_SPEC = SPECTR19,
                                 OBSERVABILITY = OBS,
                                 COMMANDABILITE = COM,
                                 BASE = MODEAIR),
            RESU_IDENTIFICATION = (_F (TABLE = CO ("EFFORTS")),
                                   _F (TABLE = CO ("DEPL_PHY")),
                                   _F (TABLE = CO ("DEPL_SYN"))),
            );
```

3.1 Significance of the keywords

3.1.1 Module “ EXPANSION ”

The module “ **EXPANSION** ” allows to launch the macro one **MACRO_EXPANS**, who carries out the modal expansion of experimental data on a digital model. It uses the operators **EXTR_MODE**, **PROJ_MESU_MODAL**, **REST_GENE_PHYS** and **PROJ_CHAMP**.

In this CAS-test, one extends modes 1,2,3,4,5 and 6 of **MODCRA** while using as expansion bases modes 1,3,4,5,6,7 of the base **MODEAIR**.

One creates in continuation the new concepts aster **RESU_NX**, **RESU_EX**, **RESU_ET** and **RESU_RD** in the macro-order. In interactive, the naming can be done in an interactive way.

Lastly, one prepares the MACS between modes the concepts created (operator **MAC_MODE**) and the visualization of the deformations with gmsh (operator **IMPR_RESU**, **FORMAT=' GMSH '**).

3.1.2 Module “ FLUDELA ”

The module fludela was removed in version 9 of Code_Aster. It was about a functionality making it possible to identify the coefficients of mass, stiffness and damping added by comparison between them of the modal bases of the structures identified in air, water and flow.

NB: at the end of the command file, one shows how to simulate the setting in water and under flow of the base of calculated mode, with the operators **DEFI_FLUI_STRU** and **CALC_FLUI_STRU** (assumption of axial flow).

3.1.3 Module “ IDENTIFICATION ”

The principle of the mitre “ **IDENTIFICATION** ” is to identify a inter-spectrum of efforts starting from the data of the inter-spectrum of displacements measured on a structure.

- inter-spectrum: keyword **INTE_SPEC**, one takes **SPEC19**,
- base modal: keyword **BASE**, one takes **RESU_ET**, obtained in the mitre “correlation”,
- grid of observability: keyword **MODELE_MESURE**, one takes **MODPROJ1**,
- grid of commandability: keyword **MODELE_COMMANDE**, one takes **MODPROJ2**,
- parameters of regularization: they are worthless within the framework of this CAS-test, but have authority to be adjusted when one uses data of real measurements (made sound effects for).

In noninteractive mode, the exit of the module of identification is by default:

- the inter-spectrum of the identified efforts (called “ **EFFORTS** ”),
- the inter-spectrum of displacements as starter (called “ **DEPL_PHY** ”),
- the inter-spectrum of Re-synthesized displacements (called “ **DEPL_SYNT** ”, to compare with the precedent).

The inter-spectra are structures of data **sd_table_fonction**. Caution: this structure of data is reserved for the inter-spectra of small, ideally for measured data (about a few tens of points of measurement max). They are not adapted to the numerical data of big size. The inter-spectral matrices are indeed square matrices full with size nb_{ddl}^2 .

4 Checking of the quality of the results

One checks the quality of the identification carried out by calculating value RMS of the difference between measured displacements and Re-synthesized displacements.

The value of reference to be reached is zero, with a precision of 10^{-3} , to compare with the value of the RMS of measured displacement (about 10^1).

This checking can be realized in the real case where one does not know the efforts applied (since one wishes to identify them), and that the only quality standard of the result of problem reverse, is the capacity of the efforts to find measured displacements. But it should not be forgotten that several different inputs can lead to the same measured displacement. The choice of the localization a priori of the efforts is important. It is pointed out that so that the problem reverses is on-given, it is necessary to respect the double-inequality $nb_{mes} > nb_{modes} > nb_{act}$, or nb_{mes} is the number of points of measurement, nb_{modes} is the number of modes used in the modal decomposition, and nb_{act} is the number of points of localization of the efforts chosen a priori.

If one seeks to identify a fluid effort applied to a linear structure, one is in general satisfied to identify an "equivalent" effort applied to a point of the structure.