

## SDLS121 – Retiming of the parameters of a dynamic model by modal analysis

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### Summary:

This CAS-test validates the features of retiming in dynamics of the order `MACR_RECAL`. It is in particular about keyword factor `DYNAMICS` but also of the new algorithms of optimization: the algorithm évolutionnaire as well as the hybrid technique based on a combination enters the algorithm évolutionnaire and that of Levenberg-Marquardt.

One considers a plate with a discrete mass placed above and one readjusts, by three different methods, two parameters of the model: the thickness of the plate and the value of the discrete mass. The experimental results are the Eigen frequencies and the modal deformations of the clean modes identified by the measurement and which one stored in a file in format unv.

One also treats the case of a dissipative structure while adding on the plate of discrete depreciation.

## 1 Problem of reference

### 1.1 Geometry

The structure is a plate with following dimensions (see [Figure 1.1-has]):

- length  $L=10\text{ m}$  ;
- width  $b=10\text{ m}$  ;
- thickness  $e=0.5\text{ m}$  .

The origin of the frame of reference is located at the center of the plate and a discrete mass  $M=5\text{E}4\text{ kg}$  is placed at  $X=2\text{ m}$  ,  $Y=3\text{ m}$  .

For the study of the dissipative structure, one adds a discrete damping  $A=2\text{E}4\text{ N}_s/\text{m}$  at the points of coordinates  $(2\text{ m}, 3\text{ m})$  ,  $(1\text{ m}, 1\text{ m})$  ,  $(1\text{ m}, 2\text{ m})$  ,  $(1\text{ m}, 3\text{ m})$  ,  $(1\text{ m}, 4\text{ m})$  ,  $(0\text{ m}, 0\text{ m})$  ,  $(-1\text{ m}, -1\text{ m})$  ,  $(-2\text{ m}, -2\text{ m})$  ,  $(-3\text{ m}, -3\text{ m})$  ,  $(-4\text{ m}, -4\text{ m})$  .

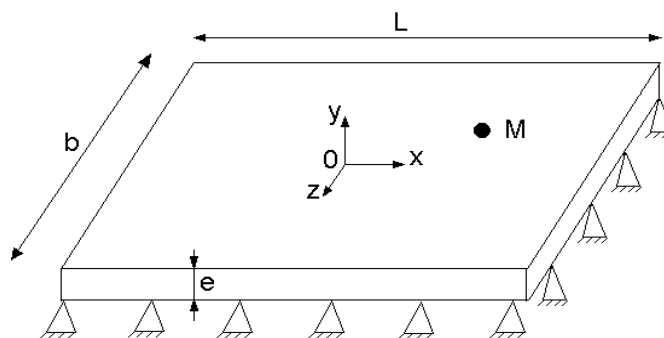


Figure 1.1-a : Geometry of the plate

### 1.2 Properties of material

Young modulus:  $E=2\text{E}11\text{ Pa}$

Poisson's ratio:  $\nu=0.3$

Density:  $\rho=7800\text{ kg}/\text{m}^3$

### 1.3 Boundary conditions and loadings

The plate is embedded on its edges. (see Figure1.1-a).

## 2 Reference solution

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### 2.1 Method of calculating

This calculation is a validation of the option `DYNAMICS` the macro one `MACR_RECAL`. With this intention, the approach is the following one:

- one does a calculation known as “experimental” to obtain the modal base exported in format `unv` as if it would have been provided by measurement, while considering for the parameters of the model to readjust the expected values optimal,
- it is supposed now that the values to be identified preceding are unknown for us. The only information which one has it is the modal base which we will thus regard as an experimental measurement,
- one then launches optimization on this pseudonym measures experimental by taking for each parameter an arbitrary value,
- it is checked that the values identified by the algorithm are well the values to be identified.

This approach is very classical in optimization where it makes it possible to validate the algorithms.

### 2.2 Sizes and results of reference

The reference variables are the values of the parameters with convergence is:

- $e = 0.5 m$
- $M = 5E4 kg$
- $A = 2E4 Ns/m$  (for the study of the dissipative system)

## 3 Modeling A

### 3.1 Characteristics of modeling

In this modeling, of type plates `DST`, the method is considered 'HYBRID' to carry out it retiming of the discrete mass and thickness of the plate. Lbe initial values and the fields acceptable of parameters are:

- mass : 30000 in [20000.,70000.]
- thickness : 0.15 in [0.1,1.]

The discrete mass is introduced using an element `DIS_T`.

### 3.2 Characteristics of the grid

The structure is modelled by a regular grid composed of  $20 \times 20$  `QUAD4`, respectively along the axes  $x, y$  (see [Figure 3.2-has]).

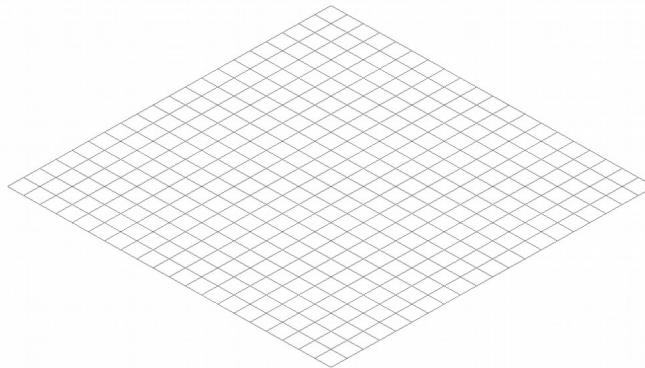


Figure 3.2-a: Grid for modeling A.

### 3.3 Sizes tested and results

Identification	Reference
Thickness	0.5
Discrete mass	50000

## 4 Modeling B

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### 4.1 Characteristics of modeling

In this modeling, of type plates `DST`, the method is considered 'LEVENBERG' to carry out the retiming of the discrete mass and thickness of the plate. Lbe initial values and the acceptable fields of parameters are:

- mass : 30000 in [20000.,70000.]
- thickness : 0.25 in [0.1,1.]

The discrete mass is introduced using an element `DIS_T`.

### 4.2 Characteristics of the grid

The structure is modelled by a regular grid composed of  $20 \times 20$  `QUAD4`, respectively along the axes  $x, y$  (see [Figure 3.2-has]).

### 4.3 Sizes tested and results

Identification	Reference
Thickness	0.5
Discrete mass	50000

## 5 Modeling C

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### 5.1 Characteristics of modeling

In this modeling, of type plates `DST`, the method is considered 'GENETIC' to carry out the retiming thickness of the plate. initial value and the acceptable field are:

- thickness: 0.35 in [0.3,0.7]

The value of the discrete mass is considered known and fixed at 50000 kg .

### 5.2 Characteristics of the grid

The structure is modelled by a regular grid composed of  $20 \times 20$  `QUAD4`, respectively along the axes  $x, y$  (see [Figure 3.2-has]).

### 5.3 Sizes tested and results

Identification	Reference
Thickness	0.5

## 6 Modeling D

### 6.1 Characteristics of modeling

One uses the same initial characteristics as modeling A or B.

For this modeling D, the technique of modal retiming used consists with diagonaliser the matrices of generalized stiffness and mass obtained with the identified modal deformations extended on the digital model. One also tries to minimize the difference between the identified Eigen frequencies and the Eigen frequencies estimated by carrying out the relationship between the generalized stiffness and masses it generalized of each mode.

The expansion of the identified clean modes "in experiments" is carried out as a preliminary in the master file. The generalized matrices are calculated by the operator `MAC_MODES` in the file slave.

L is not used'option `DYNAMICS` the macro one `MACR_RECAL`. The mode of launching of calculation slave is of type `INCLUSION`.

In this modeling, of type plates `DST`, the method is considered 'LEVENBERG' to carry out the retiming of the discrete mass and thickness of the plate. Lbe initial values and the acceptable fields of parameters are:

- mass : 30000 kg in [20000 kg,70000 kg]
- thickness : 0.25 m in [0.1 m,1.m]

The discrete mass is introduced using an element `DIS_T`.

### 6.2 Characteristics of the grid

The structure is modelled by a regular grid composed of  $20 \times 20$  `QUAD4`, respectively along the axes  $x, y$  (see [Figure 3.2-has]).

### 6.3 Sizes tested and results

Identification	Reference
Thickness	0.5 m
Discrete mass	50000 kg

## 7 Modeling E

### 7.1 Characteristics of modeling

In this modeling, of type plates `DST`, the method is used 'LEVENBERG' to carry out the retiming of the discrete mass, thickness of the plate and discrete depreciation. L be initial values and the acceptable fields of parameters are:

- mass : 30000 kg in [20000 kg, 70000 kg]
- thickness : 0.3 m in [0.1 m, 1. m]
- discrete damping: 5 E6 Ns/m in [1 E3 Ns/m, 1 E8 Ns/m]

The discrete mass and discrete depreciation are introduced using elements `DIS_T`.

The technique of retiming used consists in making check with the wide identified modal deformations, the relations of standard defined on the digital model.

The expansion of the identified clean modes "in experiments" is carried out as a preliminary in the master file.

L is not used'option `DYNAMICS` the macro one `MACR_RECAL`. The mode of launching of calculation slave is of type `INCLUSION`.

### 7.2 Characteristics of the grid

The structure is modelled by a regular grid composed of  $20 \times 20$  `QUAD4`, respectively along the axes  $x, y$  (see [Figure 3.2-has]).

One adds discrete elements at the points of coordinates  $(2 m, 3 m)$ ,  $(1 m, 1 m)$ ,  $(1 m, 2 m)$ ,  $(1 m, 3 m)$ ,  $(1 m, 4 m)$ ,  $(0 m, 0 m)$ ,  $(-1 m, -1 m)$ ,  $(-2 m, -2 m)$ ,  $(-3 m, -3 m)$ ,  $(-4 m, -4 m)$  in order to be able to affect discrete depreciation to it.

### 7.3 Sizes tested and results

Identification	Reference
Thickness	0.5 m
Discrete mass	50000 kg
Discrete damping	20000 Ns/m



## 8 Summary of the results

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This CAS-test allowed the validation of the features of retiming in dynamics with the order `MACR_RECAL` by using experimental data resulting from the modal analysis. Several methods were tested and that which gives the best results is the method `HYBRID` that one advises with the use to readjust the parameters of nature different from a dynamic model.