

## SDLS122 - Modal analysis of a plate pressed on its corners – Under structuring

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### Summary:

The objective of this case test is to validate the order `CALC_CORR_SSD` and to present a typical example of use of it. One compares here the first 5 Eigen frequencies of a rectangular steel plate of  $1\text{m} \times 2\text{m} \times 1\text{cm}$  pressed on its 4 corners. To compare, one considers on the one hand a complete grid of the rectangular plate, and other of two square grids, different smoothnesses. One builds a first model generalized by a method of under-structuring, then one evaluates the quality of the results provided by this model by means of the order `CALC_CORR_SSD`. One uses then the terms of enrichment calculated to build a new generalized model, and to check the relevance of enrichment.

## 1 Problem of reference

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### 1.1 Geometry

One considers a rectangular steel plate of  $2\text{m} \times 1\text{m} \times 1\text{cm}$  .

### 1.2 Properties of material

The material is elastic isotropic whose properties are:

- $E = 210\,000\text{MPa}$
- $\nu = 0.3$

### 1.3 Boundary conditions and loadings

The plate is simply supported on its 4 corners: the translations are blocked, rotations are free.

### 1.4 Initial conditions

Without object for the modal analysis.

## 2 Reference solution

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### 2.1 Method of calculating

One is pressed here on a model finite element of the rectangular plate to build the reference solution. This modeling rests on square elements of hull. The plate is discretized while using  $20 \times 40$  elements.

### 2.2 Sizes and results of reference

One considers the first 5 Eigen frequencies of the supported plate:

- 5,806 Hz
- 17,175 Hz
- 20,516 Hz
- 32,422 Hz
- 39,845 Hz

### 2.3 Uncertainties on the solution

The suggested solution is slightly dependent on the choices of solveurs carried out, and the evolutions of those.

## 3 Modeling A

### 3.1 Characteristics of modeling

A model is used based on the basis of element QUAD4 squares. The method of calculating rests on the dynamic under-structuring, by using modes with fixed interface, and modes of interface. Before enrichment, each macro element is built while using

- 1 dynamic mode with fixed interface
- 6 modes of interfaces

For enrichment, one adds

- 4 modes of interfaces
- 6 modes with fixed interface

The details on the methods of calculating of these enrichment are given in U2 documentation.

### 3.2 Characteristics of the grid

The grid of the first plate contains 15x15 elements of the type QUAD4.

The grid of the first plate contains 14x14 elements of the type QUAD4.

### 3.3 Sizes tested and results

One tests the first 5 Eigen frequencies of the plate, before and after enrichment of the generalized model.

- Before enrichment

Number of the mode	Type of reference	Value of reference ( Hz )	Tolerance
1	'AUTRE_ASTER'	5.806	5.1%
2	'AUTRE_ASTER'	17.175	11%
3	'AUTRE_ASTER'	20.516	5.1%
4	'AUTRE_ASTER'	32.422	11%
5	'AUTRE_ASTER'	39.845	160%

- After enrichment

Number of the mode	Type of reference	Value of reference ( Hz )	Tolerance
1	'AUTRE_ASTER'	5.806	0.51%
2	'AUTRE_ASTER'	17.175	0.11%
3	'AUTRE_ASTER'	20.516	0.21%
4	'AUTRE_ASTER'	32.422	0.51%
5	'AUTRE_ASTER'	39.845	5.1%

## 4 Summary of the results

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One illustrates in this case test the use and the relevance of the order `CALC_CORR_SSD`. On the basis of a coarse generalized model, one shows that the terms of enrichment suggested by `CALC_CORR_SSD` allow to appreciably improve quality of the scale model. On the basis of a model presenting up to 70% of error, one arrives, in an iteration, with less than 3% of error.