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

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 $1\mathrm{m}\times 2\mathrm{m}\times 1\mathrm{cm}$ 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

1.1 Geometry

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

1.2 Properties of material

The material is elastic isotropic whose properties are:

- $E=210\,000\,MPa$
- $\nu=0.3$

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

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 20×40 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 modéli is usedsation DKT 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

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.