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

Summarized:

The purpose of this case test is to validate command CALC_CORR_SSD and to present a typical example of use of it. One compares here the first 5 eigenfrequencies of a rectangular steel plate of $1\mathrm{m}\times 2\mathrm{m}\times 1\mathrm{cm}$ leaned on his 4 corners. To compare, one considers on the one hand a complete mesh of the rectangular plate, and other of two square meshes, different smoothnesses. One builds a first modele generalized by a method of substructuring, then one evaluates the quality of the results provided by this model by means of command CALC_CORR_SSD. One uses then the terms of enrichment calculated to build new modele generalized, 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 the 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 modelization rests on square shell elements. The plate is discretized by means of 20×40 elements.

2.2 Quantities and results of reference

One considers the first 5 eigenfrequencies 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 dependant on the choices of solvers carried out, and the evolutions of those.

3 Modelization A

3.1 Characteristic of the modelization

One uses a modelization DKT on the basis of element QUAD4 squares. The method of calculating rests on the dynamic substructuring, by means of modes with fixed interface, and modes of interface. Before enrichment, each macro element is built by means of

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

For enrichment, one adds

- 4 modes of interfaces
- 6 modes to interface fixes

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

3.2 Characteristics of the mesh

The mesh of the first plate contains 15x15 elements of the type QUAD4.
The mesh of the first plate contains 14x14 elements of the type QUAD4.

3.3 Quantities tested and results

One tests the first 5 eigenfrequencies of the plate, before and after enrichment of modele generalized.

- Before enrichment

Number of the Standard	mode 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 Standard	mode 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 relevance of the command CALC_CORR_SSD. On the basis of one modele generalized coarse, one shows that the terms of enrichment suggested by CALC_CORR_SSD make it possible 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.