SDLS129 - MODAL CALCULATION OF A STAR WITH 3 BRANCHES

Summary:

The objective of this test is to validate the good taking into account of the orientations of under structure in DEFI_MODELE_GENE, as well as the restitution of the complex modes generalized on physical basis . One builds a model plan of star with three branches, made up by two macros distinct elements: a macro element for the central part of star, and a macro element for the branch of star.

Two modelings are carried out:
•Modeling a: calculation of the real modes, without damping;
•Modeling b: introduction of a damping of the Rayleigh type for the calculation of complex modes.

1 Problem of reference

1.1 Geometry

One considers a star with three connects as represented on figure 1.1-1. The figure also gives dimensions (in meters) of the structure. The thickness is homogeneous, and is worth 5mm.

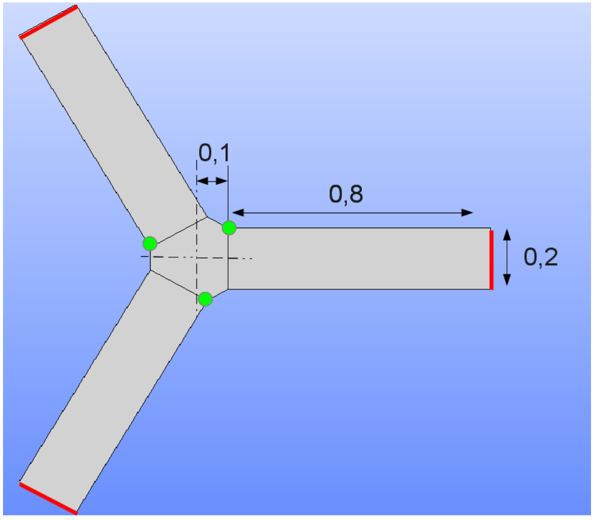

Figure 1.1-1: Geometry of star.

1.2 Properties of materials

The material constitutive of each one of under structure is a standard, elastic steel isotropic. Its properties are:

- Young modulus $E=210\,000\,MPa$
- Poisson's ratio $\nu=0{,}3$
- density $\rho=7800\,kg/m^3$

For modeling B, one introduces coefficients of Rayleigh to obtain a modal damping of 15 % for the frequencies located at 10 Hz and 50 Hz, is

$$\begin{cases}\alpha = 2(\xi_1\omega_1-\xi_2\omega_2)/(\omega_1^2-\omega_2^2)\\ \beta = 2\xi_1\omega_1-\alpha\omega_1^2\end{cases}, \text{ with } \begin{cases}\xi_1=0.15 \;/\; f_1=10\,Hz \;/\; \omega_1=2\pi f_1\\ \xi_2=0.15 \;/\; f_2=50\,Hz \;/\; \omega_2=2\pi f_2\end{cases}.$$

1.3 Boundary conditions and loadings

The structure is embedded on stop represented in red on figure 1.1-1, and is not charged (modal calculation without prestressed).

2 Modeling A

2.1 Geometry and grid

The geometry of figure 1.1-1 is represented by two pennies structures. Under structure representing the central part, and under structure representing one of the branch of star. The central part is with a grid using 45 triangular elements, and the arm is with a grid using 104 quadrangular elements. The grids are compatible on the level of the interfaces between the center and each arm.

2.2 Properties of materials

For modeling A, one does not consider the damping of Rayleigh. One poses $\alpha=\beta=0$.

2.3 Sizes tested and results

In this test, one compares, for the first three clean modes of the assembly, the relative displacement of nodes located in opposite, one pertaining to under central structure, the other pertaining to the arm. The three nodes for which the tests are carried out are represented by green points on figure 1.1-1. This relative displacement must be null for each node.

3 Modeling B

3.1 Geometry and grid

The geometry and the grid are identical to those of modeling A.

3.2 Properties of materials

For modeling B, one introduces damping by the means of the coefficients of Rayleigh defined in section 1.2.

3.3 Sizes tested and results

In this test, one compares, for the clean modes 2 and 3 of the assembly, dephasing between the real and imaginary parts of displacements of the three nodes represented by green points on figure 1.1-1. One tests the value of the report of the imaginary and real parts of displacement. The results are synthesized in table 3.3-1

	Im (N1)/Re (N1)	Im (N2)/Re (N2)	Im (N3)/Re (N3)
Mode 2	5.20615470017E-08	-1.76935137026E-08	Not tested (| 0)
Mode 3	-6.32045219166E-08	Not tested (| 0)	-7.86254989276E-0

Table 3.3-1: Summary of the results tested for modeling B