ANALYSIS OF THE STIFFNESS CONTRAST OF A MECHANICAL STRUCTURE MADE OF COMPOSITE MATERIALS

M. Nobou Dassi[1,2] , A. Gaudin[1], Z. Abbadi[1], L. Gagliardini[1], C. Pézerat[2] and F. Gautier[2]

[1]PSA Peugeot Citroën, Direction de la Recherche et de l'Ingénierie Avancée
Route de Gisy, 78140 Vlizy-Villacoublay - France
Email: martial.noboudassi@mpsa.com

[2]Laboratoire d'Acoustique de l'Université du Maine
Rue Aristote, 72085 Le Mans cedex 9 - France

ABSTRACT

In the context of lightening automotive vehicles to reduce the greenhouse gas emissions, one solution considered is to use composite materials. The introduction of such orthotropic materials can yet significantly modify the automotive design due to the new distribution of local stiffness. These modifications may result in very different vibro-acoustic behaviours and therefore different NVH performances. Indeed, the panels can participate more greatly to the overall stiffness of the car, reducing the ratio of frame in the architecture and therefore the number of assemblies. The objective of this work is to bring out the concept of structural contrast and define the associated indicator. This indicator suitable to any kind of material ensures the level of performance requested by the stakeholders.
Several strategies can be used to highlight the vibrational contrast of a mechanical structure made of frame and panels. In this work, this concept is investigated by using an analytical model made of a plate and five rectangular section beams. This model allows an easy introduction of the detailed coupling expressions at the interface between a frame and panels. The system is studied using a modal approach. The computations of point mobilities allow building maps which are representative of the vibrational behaviour of the structure. On such a map, the areas corresponding to the presence of stiffeners (frame) can be identified. A histogram containing the values of point mobilities is then build and allows the definition of different classes of behaviour. The latter define the stiffness contrast of the structure, which is evaluated by a contrast indicator.
An extension of this approach is presented on two industrial cases of roof panels. The first case is based on a steel roof, with conventional design architecture (frame and panels). The second case is based on an innovative roof, made of composite materials. The developed approach allows to locate the stiffeners and to highlight their contribution to the overall stiffness of the structure. Moreover, the contrast indicator identifies the areas requiring an addition of stiffeners to ensure the required level of performance. Thus, for several frequency ranges the calculated contrast allows one to assess the vibrational performance of a mechanical structure, whatever the used material.