Decoupling of energy transmission between subsystems of a complex structure

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ABSTRACT

In the industrial engineering field, vibroacoustic analysis is very common as part of study of the comfort in terms of emitted noise and vibration. In particular, the dynamic behaviours of structures subjected to aerodynamic loads (i.e. diffuse fields, Turbulent Boundary Layers (TBL), …) are analysed, in low frequency domain as in medium and high frequency domain. Experimental tests on panels excited by an air flow is a way to obtain information about the vibroacoustic behaviour of structures. Wind tunnels are the best facilities to provide this kind of analysis and it is fundamental to design a structural test bench in which it is possible to allocate a test article and ensure an accurate reproduction of the airflow motion field applied on the panel.

The structural design of the test bench must hold in consideration mostly the contamination effects related to impedance breaks between different subsystems inside a structure. Indeed, these effects can influence the vibration response to an aerodynamic load of a test article and consequently they can alter the experimental measurements, giving wrong information about the structure to be tested. For this reason, the dynamic "decoupling" between test bench and test article is one of the first phases of the structural design process on which must focus.

In this paper, a first analysis in the medium and high frequency domain of the energy transmission between coupled systems is proposed. The methodology applied wants to ensure a fast but efficient process of vibration response analysis, through the description of an aeroacoustic excitation (TBL) as an equivalent "rain on the roof" excitation [1]. Statistical Energy Analysis (SEA) and its hybrid version for the medium frequency (SEA-like) have been used for the calculation of the injected power in the system and the transmitted power between the subsystems [2]. Different cases are studied, varying few characteristics of the involved systems, in particular for different values of damping loss factor (DLF), which can categorize the numerical tests executed as "weakly coupled subsystems" tests and "strongly coupled subsystems" tests.

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