Theme: BRICKS **Axis:** Product **Project code:** B/Pr/3

Title: Damping and functional structures and composites.

Summary

: The optimisation of damping properties of composite materials will be investigated by using innovating multilayer architectures combined with the use of acoustic black hole effect. Maps of mechanical parameters will be obtained by dedicated inverse methods.

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Context:
Vibration and noise are ubiquitous in mechanical engineering. Demanding standards or specifications ensure the proper use, the reliability and the safety of equipments in many key industrial domains: automotive, aerospace, naval and rail. In these areas, composites have been introduced because of their higher specific stiffness as compared to metals; thus they can lighten the structures keeping their static rigidity unchanged. The introduction of composite materials also reduces the contrast of rigidity inside a structure when it is stiffened or strengthened; it calls into question the established design rules. If lightening is nowadays an important issue because of its consequences in terms of saving energy (it is generally accepted that a mass reduction of 10% in a vehicle leads to a reduction of 6 to 8% for consumption and CO_2 emissions), the consequent mechanical changes degrade the acoustic performance of components. Controlling the damping of structures is thus a key element to meet the standards.

Research project:
Two research actions are proposed. The first one concerns the modelling and optimization of damping characteristics of a component, the second one concerns the characterization of materials.

The optimization of a component made of composite material can be made at two levels:
1- In the composite material itself, the choice of the multilayer structure is essential. Innovative strategies can be proposed to integrate layers or patches of elastomers in a sandwich structure. Numerical optimization must be conducted to design new material; and dedicated processes must be developped.
2- The overall shape of components can also be optimized on the vibroacoustic point of view: changes in the geometry can be proposed to create focalization points where the vibration levels are important and where a damping layer is therefore effective. This principle is the one of the Acoustic Black Hole effect. This acoustic wave trap has already successfully been implemented in laboratory for beams and flat panels. The reduction of thickness of the component, in areas called "black hole" creates conditions for a passive damping layer to be much more effective than it would be if it was uniformly distributed over the component. Induced weight gain is substantial.

The mechanical properties of a composite material are related to the manufacturing process. Characterization of the material must then be implemented in situ, directly on the complete component and not on samples: the mechanical parameters are generally non-uniform, anisotropic, and dependent on local pre-stresses which are defined during the manufacturing process of the component. The research project aims to develop dedicated inverse methodology to achieve the local characteristics of the in situ component. One of these inverse methods, called RIFF uses the component itself as a sensor: the combined use of a finite element model (or analytical model for flat parts of components) and a set of vibration measurements allows achieving the target parameters such as residual stress values and mechanical moduli.

For more details and extra references please refer to www.xxx.xxx.fr