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Séminaire du LVA

The vibrational behavior of multi-layer plates: A comparison between experimental and theoretical results

Bert ROOZEN
Guest professor au KU Leuven & Professeur invité au LVA
bert.roozen@kuleuven.be

Kerem EGE & Quentin LECLERE
LVA, INSA de Lyon
kerem.ege@insa-lyon.fr – quentin.leclere@insa-lyon.fr

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25 bis Avenue Jean Capelle, 69621 VILLEURBANNE

In the context of aeronautics, automotive and construction applications the design of lightweight multilayer plates with optimized vibroacoustical damping and isolation performances remains a major industrial challenge and a hot topic of research. This seminar focuses on the analytical modelling and experimental validation of the vibrational behavior of three-layer composites plates.

At LVA a team of people worked on the experimental assessment of the equivalent Young's modulus and loss factor of three-layer composites plates in a broad-band frequency range, up to a frequency of 20kHz. The aim was to validate an equivalent single layer analytical model (MOVISAND) across the full audible frequency range. For this purpose the velocity field of a shaker-excited multi-layer composite plate was measured by means of a scanning laser vibrometer. Two approaches to extract the material properties were considered: CFAT and a complex wavenumber fit. CFAT exploits the plate's equation of equilibrium to estimate the material properties in a force-free plate area. The complex wavenumber fit extracts the material properties by fitting the Green's function of the plate, as function of the complex wavenumber, on to the measurement data. The plate's Green's function is estimated by means of an image source method, in which the source strengths of the image sources (infinite plate Hankel functions) are estimated from the measurement data as well.

The results of both approaches (CFAT and complex wavenumber fit) are in very good agreement with an equivalent single layer analytical modeling based on wave propagation analysis (MOVISAND).The comparison with this model allows identifying the frequency dependent complex modulus of the polymer core layer through an inverse approach.

Dynamical mechanical analysis measurements were also performed on the polymer layer alone (at MATEIS) to compare with the values obtained through inverse method. Again, a good agreement between these two estimations over the broad-band frequency range demonstrates the validity of the approach.