Statistical Energy Analysis limits for car acoustic radiation : an alternative approach

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G. Borello[a], A. Borello[a], J. Primus[a] and L. Gagliardini[b]

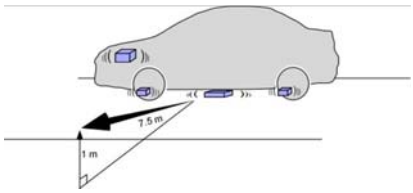
[a]InterAC, 10 impasse Borde Basse, Z.A. La Violette, 31240 L'Union, France

[b]PSA Peugeot Citroën, 4 Route de Gisy, 78943 Vélizy-Villacoublay Cedex, France

REBECA Réduction du Bruit Extérieur dans la Conception Automobile

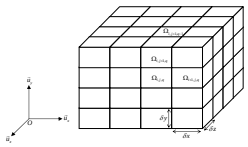
***External Noise Reduction in Automotive Design* - ADEME Research Program, leader PSA**

Vehicle exterior noise has to be reduced to satisfy a new pass-by noise regulation (ISO 362). An optimization of screening apertures, underbody and underhood absorption is therefore necessary, and numerical techniques must be able to predict the related sound reduction.
Two theories have first been tested on straightforward benchmarks.

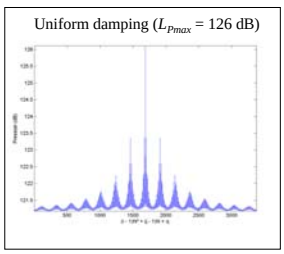


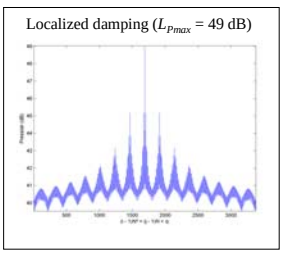
Energy Flow Analysis (EFA)

$$-\Delta e + \eta^2 k^2 e = \eta k^2 e'$$



3D cavity model

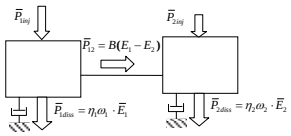




The acoustic pressure level (dB) of a meshed parallelepipedic cavity collapses when damping is localized on the edges. Energy conservation is then not respected and the energy levels do not have any physical meaning.

Analytical Statistical Energy Analysis (ASEA)

$$\eta_i \omega E_i + \sum_j P_{ij} = P_i$$



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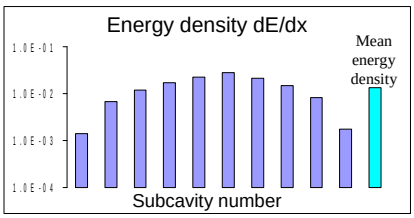
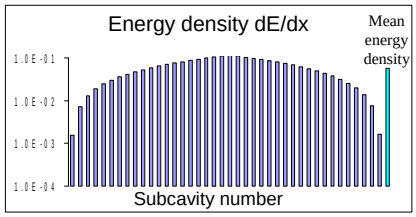
1D cavity model (10 and 40 subcavities)



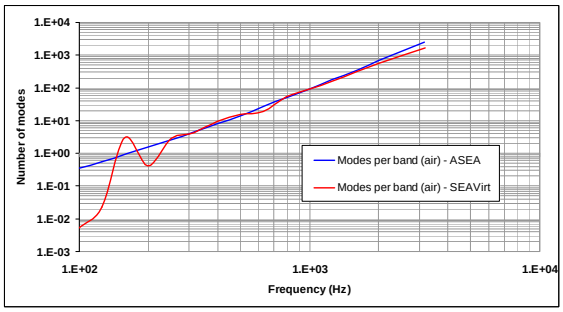


Energy density of a 1D acoustic cavity divided into 10 and 40 subcavities, for a localized Damping Loss Factor. The predicted mean energy density varies with the mesh size.

Neither EFA nor ASEA suits the establishment of a model of acoustic cavities which fulfil the optimization requirements such as damping localization. With ASEA the evolution of the energy levels depends on the mesh size. Techniques more representative of the physical problem are thus investigated.

Candidate Method : Virtual SEA (VSEA)

VSEA, initially conceived for vibratory calculation, turns out to be fitted to acoustic prediction. This technique allows the creation of a numerical energy based model of coupled acoustic cavities from the finite element global modes.



Comparison of the number of modes per band calculated by ASEA and VSEA for a cubic acoustic cavity. The SEAVirt software developed by InterAC has been validated for acoustic prediction.

Global modes of the acoustic cavities will be calculated by an internal finite element solver based on a Craig-Bampton coupling, where the energy exchange model rests on 3 degrees of freedom (DOF) : the interface DOF and the blocked modes of the two blocked subsystems. The projection then permits to predict indirect energy coupling between subsystems.

Virtual SEA provides an automatic substructuration of the underhood volume for a set of observation nodes. Power flow can be displayed for an excitation of any subsystem.