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EXPERIMENTAL STATISTICAL ENERGY ANALYSIS : INTERNAL AND COUPLING LOSS FACTOR MATRIX VALIDATION

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1. INTRODUCTION

Over the last few years, experimental Statistical Energy Analysis (ESEA), the counterpart of analytical SEA, has been shown to be an effective predictive tool for complicated vibro-acoustic structures like trains, cars, engines, ..., exhibiting a high modal density and overlap in the medium and high frequency range. Based on partitioning the test structure into subsystems and conducting 'in-situ' measurements, the internal and coupling loss factor matrix can be derived. This paper gives a brief overview of some approaches to calculate the loss factors and describes how the quality of the experimentally derived loss factors can be assessed.

2. DERIVING THE LOSS FACTORS

Balancing the time-averaged power input to each subsystem with the power dissipated in the subsystem and the net power flows to coupled subsystems gives rise to the SEA power balance equations. According to the Power Injection Method (PIM) [1], a response energy matrix can be composed whereby each element $<\bar{E}_{ij}>$ represents the subsystem response energy for subsystem i due to injected power $<\bar{P}_j>$ in subsystem j. The brackets < > and the bar ¯ denote respectively the space and time averaging. This gives the following equation :

$$\begin{bmatrix} \sum_{i=1}^{n}\eta_{1i} & -\eta_{21} & \cdots & -\eta_{n1} \\ -\eta_{12} & \sum_{i=1}^{n}\eta_{22} & \cdots & -\eta_{n2} \\ \vdots & & & \\ -\eta_{1n} & & & \sum_{i=1}^{n}\eta_{ni} \end{bmatrix} \begin{bmatrix} \langle\overline{E_{11}}\rangle & \langle\overline{E_{12}}\rangle & \cdots & \langle\overline{E_{1n}}\rangle \\ \langle\overline{E_{21}}\rangle & & & \vdots \\ \vdots & & & \\ \langle\overline{E_{n1}}\rangle & & & \langle\overline{E_{nn}}\rangle \end{bmatrix} = \frac{1}{\omega} \begin{bmatrix} \langle\overline{P_1}\rangle & 0 & \cdots & 0 \\ 0 & & \cdots & 0 \\ \vdots & & & \vdots \\ 0 & & & \langle\overline{P_n}\rangle \end{bmatrix} \quad or\ [L][E] = \frac{1}{\omega}[P] \qquad (1)$$

where n is the number of subsystems, ω the center band frequency, η_{ii} the internal loss factor of subsystem i and η_{ij} the coupling loss factor between subsystems i and j.