Vibrations, Shocks and Noise

Optimization of Sheet Steel Thickness for Vibroacoustic Behavior of Enclosures

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Highlights

- In automotive applications, one of the keys to ensure weight reduction is the optimization of the sheet steel thickness. This paper presents an adaptive optimization procedure allowing reduction of the thicknesses under design constraints with the first results illustrated for the modal behavior of an academic structure.

- Keywords : Adaptive optimization procedure, Sheet Steel Thickness

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1. Introduction

The design of novel cars and cabs for urban and peri-urban areas should take into account environmental constraints. Indeed one of the keys in the project is to ensure weight reduction to reduce the energy consumption. An adaptive optimization procedure allowing reduction of the thicknesses has been developed for the modal behavior and can iteratively reduce or increase the sheet steel thicknesses according to the constraints design. An academic structure representing a simplified cab coupled with an acoustic cavity illustrates the procedure.

2. Optimization Procedure

2.1. Optimization strategy

The aim of the optimization procedure is to reduce the weight without deteriorating the dynamic and acoustic behavior of the cab. Thus the different zone thicknesses are ranked according to three indicators representing the strain energy normalized by the volume of the zone, the maximum stress by zone and the maximum displacement

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amplitude of the zone. A first modal analysis is done in order to define the maximum initial values and the thresholds of the indicators. Those initial values allow normalizing the indicators to obtain the same magnitude. The indicators are ranked with Pareto fronts – the first front is computed and saved then the zones represented by those optima are removed and a new front is computed [1]. The thicknesses belonging to the three first Pareto fronts are reduced then an other modal analysis is performed. If the new design fits with the constraints, the procedure goes on, and if not, the thicknesses of the zones where the indicators are greater than the thresholds are increased.

3. Illustrations

3.1. Finite element model

The finite element model of the simplified cab (Fig. 1) is meshed with 500 4-node and 2 3-node shell elements decomposed in 37 zones with the same thickness and the air filled cavity is meshed with 852 8-node six sided solid elements and 6 6-node five sided solid elements. On the figure 1, the different colors represent the 37 zones, one is bigger than the other and its thickness couldn't be reduced as it is considered as the windscreen.

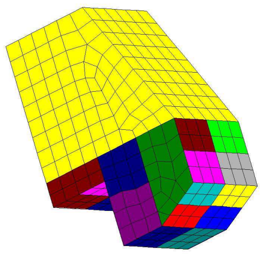

Fig. 1. Finite element model

3.2. First results

The first results of the procedure on the structure part of the model only are illustrated. On the figure 2, one can see the evolution of the relative mass of the cab which is reduced by 13% and of the stress by zone. The increase of the curve at the end is due to a counter that is increased if the design doesn't respect the design constraints and stop the procedure after a chosen value.

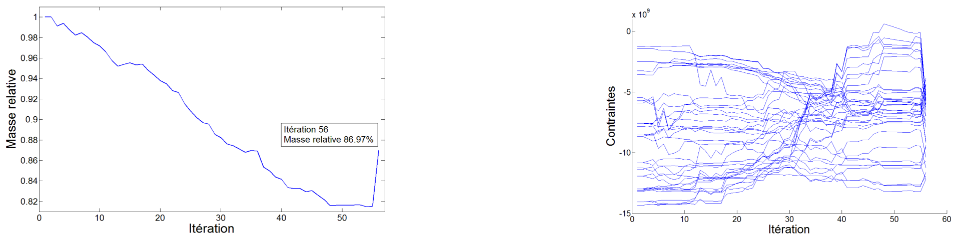

Fig. 2. (a) Mass evolution; (b) stress evolution

References

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