Sound Radiation Analysis of a Guitar Cover by the Finite Element Method

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Abstract

This project of scientific initiation had the goal of an evaluation by finite element method (FEM) of the sound radiation of a guitar cover. It consists in one analysis of a simple cover (isotropic) followed by one analysis with orthotropic material. ABAQUS® and ANSYS® were the programs used for this.

Key words: Finite Element Method, Vibro-Acoustics, Vibration Modes.

Introduction

The basic concepts of vibro-acoustics were studied¹, as well as the definition of natural frequencies on thin boards. Analytics equations of natural frequencies for thin boards with different boundary conditions were get from Blevins². The beginning of the study was about the simple case of an isotropic board (steel). Then, the material was changed to an orthotropic (white fir) that is commonly used at guitar's covering.

Results and Discussion

The board with the dimensions of 0.5 x 0.75 x 0.002 m was modeled on ABAQUS and ANSYS. The results were compared with those obtained with analytics equations from Blevins. The Chart 1 shows the orthotropic case with errors lower than 0.5% between the MEF and the analytic equation. Figure 1 shows the second mode of the board.

Chart 1. Orthotropic board: clamped.

Modo	i	j	Bordas Engastadas - Frequência [Hz]				
			Blevins			ANSYS	
			Análítica	Eng. Const	Erro[%]	Ortotrópica	Erro[%]
1	1	1	27,552	27,480	0,260	27,479	0,263
2	1	2	41,742	41,604	0,330	41,606	0,325
3	1	3	67,187	66,915	0,410	66,948	0,356
4	2	1	68,357	68,148	0,310	68,150	0,302
5	2	2	79,831	79,520	0,390	79,543	0,360
6	2	3	101,351	100,944	0,400	101,030	0,317
7	1	4	102,989	102,479	0,490	102,650	0,329
8	3	1	130,514	130,078	0,330	130,100	0,317
9	2	4	133,841	133,162	0,510	133,440	0,299
10	3	2	140,931	140,305	0,440	140,380	0,391

Figure 1. Second mode of the clamped orthotropic board

Figure 2 shows the first four vibration modes of linked system (structure-fluid) calculated by MEF (ANSYS) to the isotropic (steel) thin board linked to a layer of fluid (air) of 0.5m. The results are consistent with those found in the literature but still require a qualitative comparison.

Figure 2. Vibration modes of the linked system: (A) Structural and (B) Acoustic.

Conclusions

A study of an actual engineering problem in the coupling areas (vibro-acoustics) was done. In this case was learned modeling by MEF which is very important to the learning process and initiation of the current research engineer.

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¹ Barron, R., "Industrial Noise Control and Acoustics", Marcel Dekker, New York, 2003.
² Blevins, R., "Formulas for Natural Frequency and Mode Shape", Krieger Publishing Company, Florida, 2001.
³Bergman, R, et al , "Wood Handbook-Wood as an Engineering Material", General Technical Report FPL-GTR-190, Madison, WI, 508 p., 2010.