A Study Into the Acoustic and Vibrational Effects of Carbon Fiber Reinforced Plastic As a Sole Manufacturing Material for Acoustic Guitars

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Abstract

This study will evaluate a modern design of acoustic guitar by the analysis of the vibrational modes. The guitar that will undergo testing has been provided by Emerald Guitars and is solely constructed using Carbon Fiber Reinforced Plastic (CFRP). With the use of COMSOL Multiphysics the guitar will be simulated and analysis will be carried out to determine the first 10 Eigenfrequencies and the modal shapes these create. This paper will include the preliminary results obtained using the physical data collected through experimental testings in a previous study. The paper will demonstrate an application of the finite element method in the field of musical acoustics. The structural mechanics module within COMSOL Multiphysics has been used to simulate the first 10 Eigenfrequencies of the guitar structure provided by Emerald Guitars. The results gathered will be compared to those obtained through previous work, when necessary changes shall be made to sub-domain settings in order to minimize error. A 3D model of the acoustic guitar provided to the author has been constructed using Auto-Cad [Figure 1]. The model has been imported into COMSOL. The guitar model has been fixed at all sides [boundary conditions] and the sub-domain settings applied are:

• Young's Modulus: 2.0e9[Pa]
• Poisson's Ratio: 0.28
• Density: 1500[kg/m³]
• Damping [Loss Factor]: 0.02

The mesh detail of the back plate of the guitar can be seen in Figure 2. An Eigenfrequency analysis has been carried out and the results are presented and discussed in comparison with those obtained previously. The results have shown that there is a consistent match between early and current studies for each individual Eigenmode. The data gives the author full confidence to carry out further research in this area and to develop and refine techniques. Further work in this area will include a study of the modal shapes and frequencies at which these occur with the use of holographic interferometry. A detailed frequency response of the guitar will be carried out, analyzed and compared with empirical data of the radiation field of the guitar.

Reference

1. O'Donnell, J.; McRobbie, G. A Study of the Acoustic Response of Carbon Fiber Reinforced Plastic Plates. Proceedings of the COMSOL conference, Stuttgart. (2011).

Figures used in the abstract

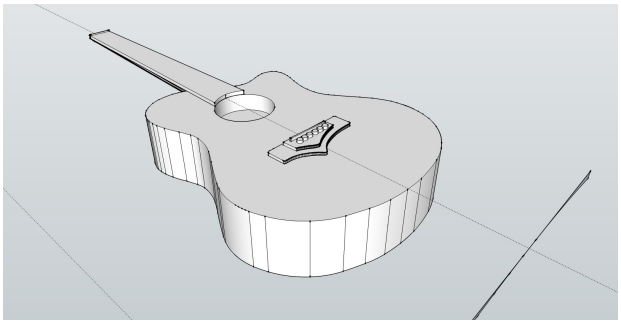

Figure 1: Auto Cad Design - Acoustic Guitar.

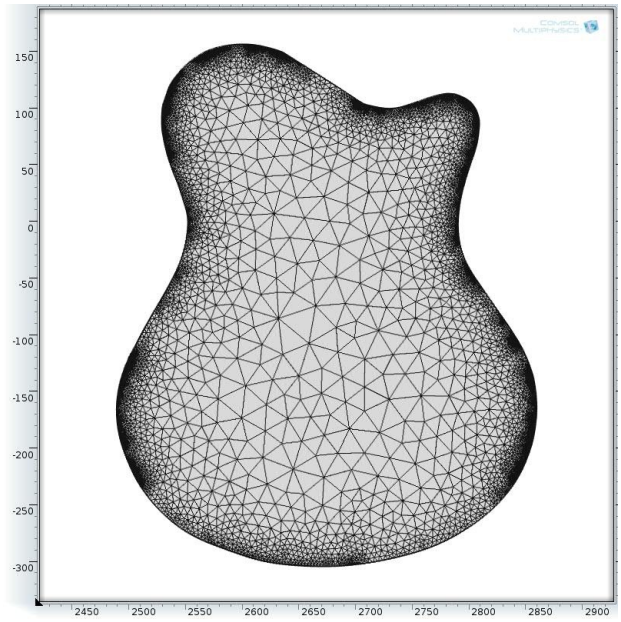

Figure 2: Mesh detail - Guitar back plate.