Design for structural vibration suppression in laminate acoustic metamaterials

†Z.C. He[1], †Eric. Li[2], *X. Xiao[1]

[1] State Key Laboratory of Advanced Design and Manufacturing for Vehicle Body, Hunan University, Changsha, 410082 P. R. China.
[2] Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Shatin, NT, Hong Kong, China.

*Presenting author: xiaoxiaostc@163.com.
†Corresponding author: hezhicheng815@hnu.edu.cn， ericsg2012@gmail.com.

Abstract

This paper investigates the stopband of laminate acoustic metamaterials, which is composed of carbon-fiber-reinforced polymer (CFRP) and a periodic array of mass-spring-damper subsystems integrated with the laminates to act as vibration absorbers. Based on the mathematical model derived in this work, a wide stopband is observed by dispersion analysis. The frequency response analysis is performed to confirm its stopband behavior for a finite laminate acoustic metamaterial. Due to the superior strength to weight ratio of CFRP, the laminate acoustic metamaterials are able to have a much wider stopband than the conventional metamaterial plates proposed in recent years. In addition, the effects of the relevant parameters on the stopband of laminate acoustic metamaterial are discussed in this work. The excellent performance of laminate acoustic metamaterials has been applied to design the vehicle door, and the vibration of the vehicle door is suppressed significantly.

Keywords: laminate acoustic metamaterials; stop-band; local resonance; CFRP.

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