Accepted Manuscript

Sound radiation of a beam with a wedge-shaped edge embedding acoustic black hole feature

Xi Li, Qian Ding

PII:	S0022-460X(18)30676-X
DOI:	10.1016/j.jsv.2018.10.009
Reference:	YJSVI 14425
To appear in:	*Journal of Sound and Vibration*
Received Date:	10 February 2018
Accepted Date:	05 October 2018

Please cite this article as: Xi Li, Qian Ding, Sound radiation of a beam with a wedge-shaped edge embedding acoustic black hole feature, *Journal of Sound and Vibration* (2018), doi: 10.1016/j.jsv.2018.10.009

Sound radiation of a beam with a wedge-shaped edge embedding acoustic black hole feature

Xi Li [a, b], Qian Ding [a, b,*]

[a] *School of Mechanical Engineering, Tianjin University, Tianjin 300350, PR China*

[b] *Tianjin Key Laboratory of Nonlinear Dynamics and Control, Tianjin 300350, PR China*

ABSTRACT

As a potential intelligent structure which is capable of concentrating energy into local area, the Acoustic Black Hole (ABH) structure has high potential of application for sound radiation control. The ABH effect is caused by the infinitely small material attenuation in an inhomogeneous medium, such as the wedge-shaped beam with a diminishing thickness, giving rise to the reduction in the bending wave speed and no wave reflections in the tip. Therefore, the waves will be trapped in the edge portion. This paper investigates sound radiation problems of a beam embedding an ABH feature, focusing on characterizing and improving the low frequency performance of the beam on sound radiation reduction. The ABH beam is modeled and solved by transfer matrix method (TMM). Analytical solutions of vibration, wavenumber domain analysis and acoustic radiation phenomena are presented. A critical mode with very high order of the ABH beam is found, resulting in that its radiation efficiency is lower than that of the uniform beam in a specified range of frequencies. Generally, the low frequency performance will be improved effectively by enhancing the interaction between the bending waves and ABH element.

Keywords: Acoustic Black Hole, Transfer matrix method, Sound radiation, Low frequency.

1. Introduction

Structural noise, which is usually defined as unwanted sound produced by vibrating objects, is an important aspect of environmental pollution. The amplitude of it radiated from a thin-wall structure is directly linked to the amplitude of flexural vibration of noise producing members [1, 2]. To address the demand for light-weighted and quiet structures with high damping and transmission loss performances, the Acoustic Black Hole (ABH) effect has become the research focus of many scholars in the last decade. For instance, as documented in Ref. [3], seven years ago, the ABH effect was being evaluated for noise reduction in structures of large dimensions, like plate-like components of ship structures, or other machinery to reduce vibration and noise emission. The applications of ABHs in engine covers [4] and floorboards [5] of vehicles can effectively reduce their sound radiation. In Ref. [6], the ABH effect was introduced in turbofan blades to reduce their flexural vibrations associated with noise. Another example was the use of the ABH effect in an artificial

* Corresponding author.
E-mail address: qding@tju.edu.cn (Q. Ding).