Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Applied Acoustics 67 (2006) 733–742
applied acoustics
www.elsevier.com/locate/apacoust

Effect of viscous damping on power transmissibility for the vibration isolation of building services equipment

Jiancheng Tao [a,b], C.M. Mak [a,*]

[a] Department of Building Services Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, People's Republic of China
[b] State Key Laboratory of Modern Acoustic and Institute of Acoustics, Nanjing University, Nanjing 210093, People's Republic of China

Received 6 September 2005; received in revised form 17 November 2005; accepted 17 November 2005
Available online 7 February 2006

Abstract

Vibration isolation plays an important role in both the vibration and noise control of building services equipment. To evaluate vibration isolation performance, the force transmissibility method is commonly adopted. However, increasing the damping effect in the force transmissibility method reduces both the resonance peak value and the isolation performance in the "isolation region". The limitation of the method is that the transmitted displacement of a floor structure and the interaction of mounting points are neglected. To include the floor displacement and the interaction of mounting points, Mak and Su recently proposed the power transmissibility method to assess the performance of vibration isolation. In this paper, the effect of viscous damping on power transmissibility is investigated. A practical procedure for experimentally determining the damping ratio is also given.

Keywords: Power transmissibility; Viscous damping; Vibration isolation

1. Introduction

Vibration isolation plays an important role in reducing structure-borne sound that is transmitted from building services equipment to floor structures. The force transmissibility

* Corresponding author. Tel.: +852 2766 5856; fax: +852 2765 7198.
E-mail address: becmmak@polyu.edu.hk (C.M. Mak).

0003-682X/$ - see front matter
doi:10.1016/j.apacoust.2005.11.007

[1–3] that is commonly used in practice concerns the force that is transmitted from the equipment to the floor. However, the transmitted displacement from the vibratory equipment to the floor and the interaction of the several contact points are ignored in the force transmissibility method. Hence, the power transmissibility method [4,5], based on the concept of floor effective mobility [6], has been proposed for assessing the performance of vibration isolation.

A number of text books [1,7] have discussed the damping effect in the force transmissibility method. It is known that increasing the damping could constrain the resonance peak value, and as a result the vibration isolation performance in the ‘‘isolation region'' at frequencies larger than $\sqrt{2}\omega_n$ (where ω_n is the natural frequency of the system) would also be reduced. However, the damping effect has not been discussed in relation to the power transmissibility method [4,5].

In this paper, expressions of power transmissibility that consider viscous damping [8] (the damping force is proportional to the amplitude of motion velocity across the damping element, and it is derived from an oil-filled dashpot damper) are deduced for a single contact point system. The damped force transmissibility and damped power transmissibility are derived and analyzed for symmetrically and asymmetrically installed cases. The damping effect in the power transmissibility method is investigated for both the cases. Finally, a procedure [9,10] for experimentally determining the damping ratio is given.

2. Theory

2.1. Force transmissibility with damping

A single-degree-of-freedom vibration model is presented in Fig. 1. The whole system contains a mass M, an isolator that can be described using stiffness k and a viscous damping coefficient c.

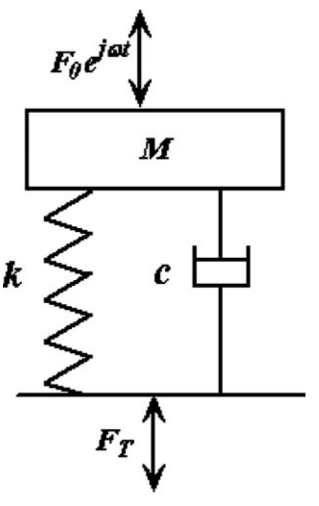

Fig. 1. SDOF vibration isolation system.