

Article

Shock Vibration Control of SDOF Systems with Tubular Linear Eddy Current Dampers

Yida Pu ^{1,2}, Zhiwen Huang ^{1,2,*}, Hongyi Zhang ^{1,2}, Xugang Hua ^{1,2}  and Yousheng Xu ³

¹ College of Civil Engineering, Hunan University, Changsha 410082, China

² Key Laboratory of Wind and Bridge Engineering of Hunan Province, Hunan University, Changsha 410082, China

³ Shenzhen Municipal Design and Research Institute Co., Ltd., Shenzhen 518029, China

* Correspondence: zw/huang21348@hnu.edu.cn

Featured Application: In this work, the transient response of a single-degree-of-freedom (SDOF) system with a tubular linear eddy current damper (TLECD) under shock excitation is calculated and analyzed. Moreover, to achieve the best design and performance assessment of the structural shock vibration control by the TLECD, this study introduces the shock response spectrum (SRS) and a straightforward design flowchart of the TLECD for its mechanical characteristics.

Abstract: The nonlinear dynamic characteristic of a tubular linear eddy current damper (TLECD) and the transient responses to shock excitations of a single-degree-of-freedom (SDOF) system with the TLECD are studied. First, the nonlinear force-velocity relationship of the TLECD is discussed using the finite element simulation and mathematical model fitting. Next, the influences of three forms of shock excitation and various mechanical parameters of the TLECD on shock vibration control of an SDOF system with the TLECD are investigated. Moreover, for the SDOF systems with the TLECD or the nonlinear fluid viscous dampers (FVD) at the same maximum displacement and maximum damper force, the time to reach the maximum displacement, the time to reach one-third of the maximum displacement, the energy input of the external loading, and the energy dissipation of dampers are analyzed and compared. Finally, the shock response spectrum (SRS) of the SDOF system and the design flowchart for the TLECD are presented to provide a reference for shock vibration control of the SDOF system with the nonlinear TLECD and the design of TLECDs. The results show that there is an optimal dimensionless critical relative velocity that minimizes the dimensionless maximum damping force for reaching the target maximum displacement, and compared to the FVD, the TLECD greatly shortens the time to reach one-third of the maximum displacement.

Keywords: eddy current damper; nonlinear damper; impulsive excitation; vibration control; energy dissipation; shock response spectrum



Citation: Pu, Y.; Huang, Z.; Zhang, H.; Hua, X.; Xu, Y. Shock Vibration Control of SDOF Systems with Tubular Linear Eddy Current Dampers. *Appl. Sci.* **2023**, *13*, 2226. <https://doi.org/10.3390/app13042226>

Academic Editor: Alessandro Ruggiero

Received: 1 November 2022

Revised: 9 January 2023

Accepted: 30 January 2023

Published: 9 February 2023



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1. Introduction

Structural vibration control methods and devices have been well-developed to suppress vibration [1–3]. Unlike force loadings with a relatively long duration, impulse loadings are a special form of loading that can be applied to a structure in a very short period. In general, when the ratio of the duration of loading to the natural period $t_d/T_0 < 0.25$, the loading can be defined as an impulse [4,5]. In reality, impulsive loadings can be generated from many sources, including free-fall impacts, collisions, explosions, short-duration pulse-type seismic excitations, aircraft landing, braking loads, and many more. Although the duration of impulse loadings is relatively short, the peak forces exerted on the structure are usually quite high. As a result, the loadings can generate high responses and damage the structure consequently. This means that the design of the structure or the corresponding measures to prevent shock is crucial. In order to alleviate high responses caused by shock

Shock Vibration In Linear Systems

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