

Article

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

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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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Table of Contents Shock Vibration In Linear Systems

1. Understanding the eBook Shock Vibration In Linear Systems
 - The Rise of Digital Reading Shock Vibration In Linear Systems
 - Advantages of eBooks Over Traditional Books
2. Identifying Shock Vibration In Linear Systems
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Shock Vibration In Linear Systems
 - User-Friendly Interface
4. Exploring eBook Recommendations from Shock Vibration In Linear Systems
 - Personalized Recommendations
 - Shock Vibration In Linear Systems User Reviews and Ratings
 - Shock Vibration In Linear Systems and Bestseller Lists
5. Accessing Shock Vibration In Linear Systems Free and Paid eBooks
 - Shock Vibration In Linear Systems Public Domain eBooks
 - Shock Vibration In Linear Systems eBook Subscription Services
 - Shock Vibration In Linear Systems Budget-Friendly Options
6. Navigating Shock Vibration In Linear Systems eBook Formats

- ePub, PDF, MOBI, and More
- Shock Vibration In Linear Systems Compatibility with Devices
- Shock Vibration In Linear Systems Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Shock Vibration In Linear Systems
 - Highlighting and Note-Taking Shock Vibration In Linear Systems
 - Interactive Elements Shock Vibration In Linear Systems
- 8. Staying Engaged with Shock Vibration In Linear Systems
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Shock Vibration In Linear Systems
- 9. Balancing eBooks and Physical Books Shock Vibration In Linear Systems
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Shock Vibration In Linear Systems
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Shock Vibration In Linear Systems
 - Setting Reading Goals Shock Vibration In Linear Systems
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Shock Vibration In Linear Systems
 - Fact-Checking eBook Content of Shock Vibration In Linear Systems
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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