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 spectrums (SRSs) 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 spectrums (SRSs) 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

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 $td/T0 < 0.25$, 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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Lalanne,2013-03-04 Mechanical Vibration and Shock Analysis Second Edition Volume 4 Fatigue Damage Fatigue damage in a system with one degree of freedom is one of the two criteria applied when comparing the severity of vibratory environments The same criterion is also employed for a specification representing the effects produced by the set of vibrations imposed in a real world environment In this volume which is devoted to the calculation of fatigue damage the author explores the various hypotheses and models used to describe the behavior of material suffering fatigue and the laws of fatigue accumulation He also considers the methods of counting response peaks which are used to establish a histogram when it is impossible to use the probability density of the peaks obtained with a Gaussian signal The expressions for mean damage and its standard deviation are established and other hypotheses are tested The Mechanical Vibration and Shock Analysis five volume series has been written with both the professional engineer and the academic in mind Christian Lalanne explores every aspect of vibration and shock two fundamental and extremely significant areas of mechanical engineering from both a theoretical and practical point of view The five volumes cover all the necessary issues in this area of mechanical engineering The theoretical analyses are placed in the context of both the real world and the laboratory which is essential for the development of specifications *Scientific and Technical Aerospace Reports* ,1988 **Engineering Vibrations** William J. Bottega,2014-12-11 A thorough study of the oscillatory and transient motion of mechanical and structural systems Engineering Vibrations Second Edition presents vibrations from a unified point of view and builds on the first edition with additional chapters and sections that contain more advanced graduate level topics Using numerous examples and case studies the author reviews basic principles incorporates advanced abstract concepts from first principles and weaves together physical interpretation and fundamental principles with applied problem solving This revised version combines the physical and mathematical facets of vibration and emphasizes the connecting ideas concepts and techniques **Applied Mechanics Reviews** ,1973 **The Shock and Vibration Digest** ,1993 **Sinusoidal Vibration** Christi Lalanne,2002-03-29 About the Series This important new series of five volumes has been written with both the professional engineer and the academic in mind Christian Lalanne explores every aspect of vibration and shock two fundamental and crucially important areas of mechanical engineering from both the theoretical and practical standpoints As all products need to be designed to withstand the environmental conditions to which they are likely to be subjected prototypes must be verified by calculation and laboratory tests the latter according to specifications from national or international standards The concept of tailoring the product to its environment has gradually developed whereby from the very start of a design project through the to the standards specifications and testing procedures on the prototype the real environment in which the product being tested will be functioning is taken into account The five volumes of Mechanical Shock and Vibration cover all the issues that need to be addressed in this area of mechanical engineering The theoretical analyses are placed in the context of the real world and of laboratory tests essential for the development of specifications Volume I Sinusoidal Vibration The relative and

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