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PII: S0020-7403(16)30116-3
DOI: http://dx.doi.org/10.1016/j.ijmecsci.2016.07.004
Reference: MS3341

To appear in: *International Journal of Mechanical Sciences*

Received date: 19 November 2015
Revised date: 30 June 2016
Accepted date: 3 July 2016

Cite this article as: Krzysztof Czolczynski, Barbara Blazejczyk-Okolewska an Andrzej Okolewski, Analytical and numerical investigations of stable periodi solutions of the impacting oscillator with a moving base, *International Journal o Mechanical Sciences,* http://dx.doi.org/10.1016/j.ijmecsci.2016.07.004

Analytical and numerical investigations of stable periodic solutions of the impacting oscillator with a moving base

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Summary

A vibrating system with impacts that can be used as a model of the cantilever beam with a mass at its end impacting against a harmonically moving frame is investigated. An analytical method, based on Peterka's approach, to obtain stable periodic solutions to the equations of motion is presented. The results of analytical investigations have been compared to the results of numerical simulations conducted for two different, equivalent as far as the impact energy dissipation extent is concerned, ways of modelling of impacts. The ranges of existence of stable periodic solutions, determined analytically and numerically with bifurcation diagrams of spectra of Lyapunov exponents, show excellent conformity.

Keywords: impact oscillator, time-varying amplitude constraint, stable periodic solutions, Lyapunov exponents, hard versus soft impact

1. Introduction

Mechanical systems whose elements impact on one another during operation have been extensively investigated by researchers. The recently proposed structural classification of vibro-impact systems (cf. [1-4]) can form the basis for understanding origins of their diversity, and, thus, the multiplicity of phenomena that accompany vibrations of such systems like chaotic motion, Feigenbaum scenario, mirror hysteresis, sudden changes in the chaotic attractor, intermittency, Devil's attractors and different types of grazing bifurcations [e.g., 5-13].

Nonlinearities caused by impacts complicate the mathematical model of the system

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