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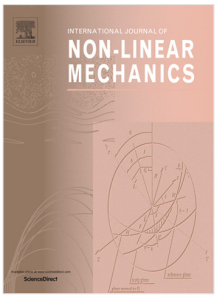

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Rocking of Rigid Block on Nonlinear Flexible Foundation

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Abstract

The two prime models used currently to describe rocking of rigid bodies, the Housner's model and the Winkler foundation model, can capture some of the salient features of the physics of this important problem. These two models involve either null or linear interaction between the block and the foundation.

Hopefully, some additional aspects of the problem can be captured by an enhanced nonlinear model for the base-foundation interaction. In this regard, what it is adopted in this paper is the Hunt and Crossley's nonlinear impact force model in which the impact/contact force is represented by springs in parallel with nonlinear dampers. In this regard, a proper mathematical formulation is developed accounting for the possibility of uplifting in the case of strong excitation. Further, an averaging procedure has been developed to expeditiously derive the steady state response amplitude in case of harmonic base excitation. The analytical study is supplemented by experimental tests developed in the Laboratory of Experimental Dynamics at the University of Palermo, Italy. In this context, because of the obvious relevance for historical monuments, free-rocking tests are presented for several marble-block geometries on both rigid and flexible foundations. Numerical vis-à-vis experimental data are examined, showing that the proposed nonlinear model is sufficiently versatile to capture additional aspects of the physics of the problem even for quite soft foundation materials.

1 Introduction

The behavior of block-like structures allowed to rock due to base excitation has been a longstanding problem of technical interest, and still attracts the attention of a significant number of researchers. This persistent interest relates to the practical relevance of the highly nonlinear phenomenon of