Nonlinear guided bulk waves in heterogeneous elastic structural elements

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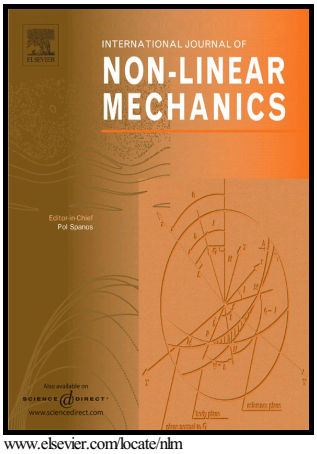

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PII: S0020-7462(17)30042-2
DOI: http://dx.doi.org/10.1016/j.ijnonlinmec.2017.01.012
Reference: NLM2772

To appear in: *International Journal of Non-Linear Mechanics*

Received date: 21 July 2016
Revised date: 17 December 2016
Accepted date: 17 January 2017

Cite this article as: Alexander M. Samsonov, Irina V. Semenova and Fedor E. Garbuzov, Nonlinear guided bulk waves in heterogeneous elastic structural elements, *International Journal of Non-Linear Mechanics* http://dx.doi.org/10.1016/j.ijnonlinmec.2017.01.012

Nonlinear guided bulk waves in heterogeneous elastic structural elements

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Abstract

Guided nonlinear bulk strain waves are considered in heterogeneous composite materials, containing macro- or micro(nano)inclusions as the main sources of nonuniformity. Theory is based on the combination of the finite deformation and the 5-constant (Murnaghan) nonlinear elasticity, that leads under several assumptions to the only nonlinear doubly dispersive equation with variable coefficients (DDE) for a component of longitudinal strain in rod and in shell. Numerical simulations performed and experimental data are discussed, and lead to conclusions concerning dramatic influence of heterogeneity in dynamic behaviour of strain solitons in solids. We have shown how different smooth variations in elasticity may lead to either amplification or decay of strain solitons in both polymer rod and shell. These date can be useful in the NDT problems, and in problems of the solids integrity under intense elastic pulse loading.

Key words: Strain waves, Nonlinear elasticity, Waveguides, Solitons

1. Introduction

Rapidly growing applications of composite materials in industry stimulate an analysis of various aspects of mechanical behavior of these materials. One of the areas in high demand is their elastic properties demonstrated under dynamic loading. Modern composite materials are, in general, heterogeneous with inhomogeneities varying from nano- to macroscale. Micro- and nano-structured composites, containing a matrix and a filler both with known physical parameters, have the characteristics, which differ considerably and often unexpectedly from those of the matrix, e.g., [1, 2, 3]. Much efforts are