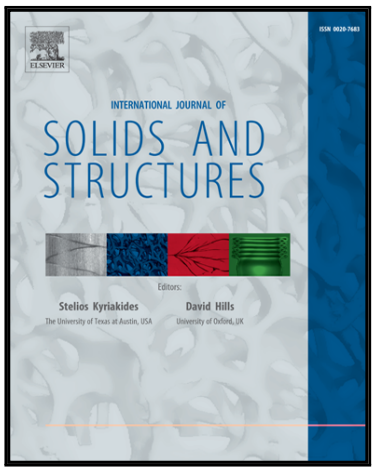
Accepted Manuscript



Mathematical model of a three-layer micro- and nano-beams based on the hypotheses of the Grigolyuk-Chulkov and the modified couple stress theory

A.V. Krysko , J. Awrejcewicz , S.P. Pavlov , M.V. Zhigalov , V.A. Krysko

PII: S0020-7683(17)30162-2
DOI: 10.1016/j.ijsolstr.2017.04.011
Reference: SAS 9534

To appear in: *International Journal of Solids and Structures*

Received date: 16 September 2016
Revised date: 30 March 2017
Accepted date: 10 April 2017

Please cite this article as: A.V. Krysko , J. Awrejcewicz , S.P. Pavlov , M.V. Zhigalov , V.A. Krysko , Mathematical model of a three-layer micro- and nano-beams based on the hypotheses of the Grigolyuk-Chulkov and the modified couple stress theory, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.04.011

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Mathematical model of a three-layer micro- and nano-beams based on the hypotheses of the Grigolyuk-Chulkov and the modified couple stress theory

A.V. Krysko[1,2], J. Awrejcewicz[3] , S.P. Pavlov[4], M.V. Zhigalov[5], V.A. Krysko[6]

[1]*Cybernetic Institute, National Research Tomsk Polytechnic University, 634050 Tomsk, Lenin Avenue, 30, Russian Federation* anton.krysko@gmail.com

[2]*Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, 410054 Saratov, Politehnicheskaya 77, Russian Federation ,* anton.krysko@gmail.com

[3]*Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski St., 90-924 Lodz and Department of Vehicles, Warsaw University of Technology, 84 Narbutta Str., 02-524 Warsaw, POLAND;* awrejcew@p.lodz.pl

[4,5,6]*Department of Mathematics and Modeling, Saratov State Technical University, Politehniekhskaya 77, 410054, Saratov, Russian Federation,* pspsar@yandex.ru[4], max.zhigalov@gmail.com[5], tak@san.ru[6]

The mathematical model of three-layered beams developed based on the hypothesis of the Grigolyuk-Chulkov and the modified couple stress theory and the size depended equations governing the layers motions on the micro- and nano-scales is constructed. The Hamilton's principle yields the novel equations of motion as well as the boundary/initial conditions regarding beams displacement. The latter ones clearly exhibit the size dependent dynamics of the studied micro- and nano-beams, and the introduced theory overlaps with the classical beam equations for large enough layer thickness. In particular, a three-layer beam with the micro-layer thickness has been investigated with respect to the classical theory of Grigolyuk-Chulkov. The derived boundary problem is of sixth order and can be solved analytically in the case of statics. The carried out numerical experiments allowed to detect and explain size dependent effects exhibited by the micro-beams. The beam deflections and stress yielded by the employed couple stress model are less than those predicted by the classical Grigolyuk-Chulkov theory, while the estimated eigenfrequencies are higher, respectively. It has been shown that the proposed model can be reduced to the classical three-layer Grigolyuk-Chulkov beam through increase of the layers thickness, which validates our approach.

Keywords*:* three-layer beam, modified couple stress theory, static/dynamic behavior, analytical solution

Download English Version:

https://daneshyari.com/en/article/4922531

Download Persian Version:

https://daneshyari.com/article/4922531

Daneshyari.com