

Accepted Manuscript

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PII: S0020-7683(18)30125-2
DOI: [10.1016/j.ijsolstr.2018.03.017](https://doi.org/10.1016/j.ijsolstr.2018.03.017)
Reference: SAS 9942



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

Received date: 9 October 2017
Revised date: 14 March 2018
Accepted date: 16 March 2018

Please cite this article as: M. Bednarik, M. Cervenka, J.P. Groby, P. Lotton, One-dimensional propagation of longitudinal elastic waves through functionally graded materials, *International Journal of Solids and Structures* (2018), doi: [10.1016/j.ijsolstr.2018.03.017](https://doi.org/10.1016/j.ijsolstr.2018.03.017)

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One-dimensional propagation of longitudinal elastic waves through functionally graded materials

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Abstract

The one-dimensional propagation of longitudinal elastic waves along the thickness of a plate made of functionally graded materials excited by a harmonic force is reported in this article. The material properties of the plate are assumed to be graded along the thickness direction according to a trigonometric law distribution. This distribution smoothly connects the material properties of the upper and lower homogeneous materials that bounds the plate. The corresponding propagation equation is Ince-type equation that can be transformed to Heun's equation a local exact solution of which is expressed in terms of local Heun functions. The general nature of these functions is demonstrated based on four degenerate cases of Heun's equation. The transfer matrix method is used to study the elastic waves propagating in the inhomogeneous domain. The calculation of the transfer matrices requires the evaluation of the general solution in the interval containing two regular singular points. For this purpose, the modified Heun function is introduced. Based on the transfer matrices, the influence of both the asymmetry of the unit cell and various constituent materials on the transmission coefficient spectrum is studied. The transmission coefficient is also calculated for the locally periodic structures with the help of the Chebyshev polynomials.

Keywords: Heun's equation, Heun function, functionally graded materials

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