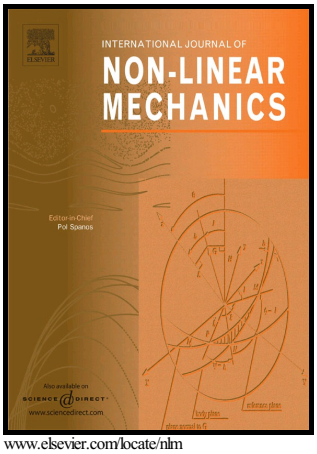
# Geometrically nonlinear, steady state vibration of viscoelastic beams

Przemyslaw Wielentejczyk, Roman Lewandowski




www.elsevier.com/locate/nlm

PII: S0020-7462(16)30418-8
DOI: http://dx.doi.org/10.1016/j.ijnonlinmec.2016.12.012
Reference: NLM2755

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

Received date: 22 July 2016
Revised date: 25 November 2016
Accepted date: 19 December 2016

Cite this article as: Przemyslaw Wielentejczyk and Roman Lewandowski Geometrically nonlinear, steady state vibration of viscoelastic beams *International Journal of Non-Linear Mechanics* http://dx.doi.org/10.1016/j.ijnonlinmec.2016.12.012

# Geometrically nonlinear, steady state vibration of viscoelastic beams

Przemyslaw Wielentejczyk, Roman Lewandowski*

*Poznan University of Technology, ul. Piotrowo 5, 60-965 Poznan, Poland*

przemyslaw.wielentejczyk@put.poznan.pl

roman.lewandowski@put.poznan.pl

*Corresponding Author: Tel.: +48616652472, Fax: +48616652059.

**Abstract**.

The problem of geometrically non-linear steady state vibrations of beams excited by harmonic forces is considered in this paper. The beams are made of a viscoelastic material defined by the classic Zener rheological model - the simplest model that takes into account all the basic properties of real viscoelastic materials. The constitutive stress-strain relationship for this type of material is given as a differential equation containing derivatives of both stress and strain. This significantly complicates the solution to the problem. The von Karman theory is applied to describe the effects of geometric nonlinearities of beam deformations. The equations of motions are derived using the finite element methodology. A polynomial approximation of bending moments is used. The order of basis functions is set so as to obtain a coherent approximation of moments and displacements. In the steady-state solution of equations of motion, only one harmonic is taken into account. The matrix equations of amplitudes are derived using the harmonic balance method and the continuation method is applied for solving them. The tangent matrix of equations of amplitudes is determined in an explicit form. The stability of steady-state solution is also examined. The resonance curves for beams supported in a different way are shown and the results of calculation are briefly discussed.

Keywords: Beam, Zener model, Nonlinear vibration, Steady-state analysis, Finite element method