Mitigation of Traffic-Induced Ground Vibration by Inclined Wave Barriers

a Three-Dimensional Numerical Analysis

Andersen, Lars; Augustesen, Anders Hust

Published in:
Program and Book of Abstracts

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

of recording the sound generated by a steel pellet when falling down on a laminated floor of height known. The first part of this numerical model, which uses FEM, reproduces the mechanical part of the experiment when the pellet impact, allowing us to obtain the transient velocity of each cell for the considered mesh. The second part, i.e. the acoustic problem, consists of obtaining the sound pressure level at the microphone position by means a FDTD algorithm. This numerical model allows us to identify laminated floors if the mechanical characteristics of the material components are known, as well as to characterize them from the perceptive point of view.

Session S04
Wave Propagation in Solids and Structures

1044 Trapped Modes on Micro and Macro Level

Indeitsev Dmitry*, Mochalova Yulia

Main principles of localization of waves in continuous media at the presence of inclusions possessing own dynamics are stated. Feature of the note is selection of a special class of problems from area of deformable body mechanics and thin film mechanics for which it is possible to allocate the basic conditions of formation of trapped modes of oscillations.

302 Predicting Phase Shift of Elastic Waves in Pipes Due to Fluid Flow and Imperfections

Jon Juel Thomsen*, Jonas Dahl, Niels Fuglede, Stephanie Enz

Flexural vibrations of a fluid-conveying pipe is investigated, with special consideration to the spatial shift in phase caused by fluid flow and various imperfections, e.g., non-ideal supports, non-uniform stiffness or mass, non-proportional damping, weak nonlinearity, and flow pulsation. This is relevant for understanding wave propagation in elastic media in general, and for the design and trouble-shooting of phase-shift measuring devices such as Coriolis mass flowmeters in particular. A multiple time scaling perturbation analysis is employed for a simple model of a fluid-conveying pipe with imperfections. This leads to simple analytical expressions for the approximate prediction of phase shift, providing direct insight into which imperfections affect phase shift, and how. The analytical predictions are tested against results obtained by pure numerical analysis (Galerkin expansion), showing very good agreement.

572 Green's Matrix and Boundary Integral Equations for Analysis of Wave Propagation in Elastic Helical Springs

Sergey Sorokin*

This paper is concerned with formulation of Green's matrix and boundary integral equations for helical springs. Green's matrix describes wave motion in an infinitely long elastic spring excited by a unit force (axial or shear force) or a unit moment (torque or bending moment). The energy transmission in each of these cases involves longitudinal, torsion and flexural waves propagating in the coil. However, their participation in the energy transmission is strongly dependent on the excitation frequency and on the type of excitation. This issue is explored in the first instance. Then boundary integral equations are derived from the Somigliana's identities for a spring of the finite length. The analysis of eigenfrequencies is performed with the special reference to their sensitivity to variations in boundary conditions.

512 Mitigation of Traffic-Induced Ground Vibration by Inclined Wave Barriers - a Three-Dimensional Numerical Analysis

Lars Andersen*, Anders Hust Augustesen

Double sheet pile walls can be used as wave barriers in order to mitigate ground vibrations from railways. The present analysis concerns the efficiency of such barriers, especially with regard to the influence of the barrier inclination and the backfill between the walls. Thus, the screening capabilities of an open trench, lined by sheet pile walls, are compared to those of a barrier with the original soil between the walls or a trench closed by a lid at the top. To this purpose, a three-dimensional boundary-element/finite-element model has been developed, based on a formulation in a moving frame of reference following the load. This allows a computation of the steady state response to a harmonically varying point source moving at different speeds typical for a train.

240 Singular Features of Traveling Wave Propagation in Rotating Elastic Bodies of Revolution in Frictional Contact

Oleg Kirillov*

A brake can be modeled as an axi-symmetric rotor perturbed by dissipative, conservative and non-conservative positional forces originated at the frictional contact with the anisotropic stator. It is well-known that bending waves can propagate along the circumferential direction of an elastic body of revolution rotating about its axis of symmetry. The frequencies of the waves plotted against the rotational speed are referred to as the Campbell diagram. Since the spectrum of a perfect rotationally symmetric rotor at standstill contains infinite series of double semi-simple eigenvalues (the doublet modes), the Campbell diagram contains the eigenvalue branches of forward and backward traveling waves originated after the splitting of the doublet modes caused by the gyroscopic forces. The eigenvalue branches correspond to simple eigenvalues and intersect each other forming a spectral mesh in the frequency-speed plane with the double eigenvalues at the nodes. Computing sensitivities of the doublets we find that at every particular node the untwisting of the mesh into the branches of complex eigenvalues is determined by only four 2x2 subblocks of the matrix of a perturbation. Selection of the unstable modes, leading to self-excited vibrations in the subcritical speed range, is governed by the exceptional points at the corners of the singular eigenvalue surface known as the double coffee-filter, which is common in the problems of electromagnetic and acoustic wave propagation in stationary anisotropic media. Orientations of the eigenvalue surfaces as well as the geometry of the domains of unstable waves in the parameter space are substantially determined by the Krein signature of the eigenvalues at the nodes of the spectral mesh. Explicit expressions approximating the eigenvalue surfaces and the instability domains are derived. With their use bifurcation of the instability domains with the variation of the structure of the matrices of perturbation is studied in detail.

556 Vibration Analysis of a MEMS Ring-Based Rate Sensor by the Ray Tracing Method

Benjamin Chouvion*, Stewart McWilliam, Colin Fox, Atanas Popov

In this paper a wave approach, known as the ray tracing method, is used to analyse the vibration performance of a Micro-Electro-Mechanical Systems (MEMS) ring-based rate