Semi-analytical hybrid approach for modelling wave phenomena in a layered elastic structure with multiple piezoelectric transducers and cracks

Mikhail V. Golub*, Alisa N. Shpak, Sergey I. Fomenko and Sofya A. Glinkova

Institute for Mathematics, Mechanics and Informatics, Kuban State University
Stavropolskaya 149, 350040 Krasnodar, Russian Federation
e-mail: m_golub@inbox.ru, web page: http://immi.kubsu.ru/

ABSTRACT

A considerable number of methods employed in non-destructive evaluation and structural health monitoring for damage identification are related to elastic waves. A number of built-in or on-board piezoelectric transducers and sensors are used to excite wave motion and record structural responses afterwards. This paper presents a semi-analytical hybrid approach for simulation dynamic behaviour of a multi-layered elastic waveguide with systems of delaminations and piezoelectric actuators/sensors mounted on the surface. The presented method extends the hybrid approach proposed in [1] for modelling dynamic interaction of perfectly bonded or partially debonded piezoelectric structures with a layered elastic waveguide. The hybrid approach combines the advantages of the frequency domain spectral element method [2] to discretize complex-shaped piezoelectric structures and the boundary integral equation method [3, 4] to simulate wave propagation in multi-layered waveguides with a set of horizontal delaminations. The coupling of the two methods is performed in the contact area between waveguide and transducers via the introduction of an unknown traction vector-function. The proposed method is applicable to the multi-parameter analysis of the phenomena related to elastic wave scattering and excitation. The advantages of the presented extended semi-analytical hybrid approach method along with the results of the parametric analysis of wave propagation in the considered structures are discussed.

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