Propagation of elastic waves in a fluid-loaded anisotropic functionally graded waveguide: Application to ultrasound characterization

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Abstract: Non-destructive evaluation of heterogeneous materials is of major interest not only in industrial but also in biomedical fields. In this work, the studied structure is a three-layered one: a laterally heterogeneous anisotropic solid layer is sandwiched between two acoustic fluids. Many studies have demonstrated the interest of studying the propagation of Lamb waves to evaluate plane waveguides. Numerous works have reported on the relationship between the zeroes and poles of the reflection coefficient of a fluid-loaded plate and on the dispersion curves of "Leaky Lamb Waves" as a key element in ultrasonic evaluation. In this presentation, an original method is proposed to solve the wave equation in the frequency domain in such a structure without using a multilayered model for the plate. This method is based on an analytical solution, the matricant, explicitly expressed under the Peano series expansion form. This approach is validated for the study of a fluid-loaded anisotropic and homogeneous plane waveguide with two different fluids on each side. Then some preliminary results on the propagation of elastic waves in an asymmetrically fluid-loaded waveguide with laterally varying properties are given. The influence of a linear gradient on the frequency spectrum of the reflection coefficient is investigated. At the interface between the incident fluid and the waveguide, the reflected wave is sensitive to a linear gradient of the mechanical properties in the plate. These results are promising especially in the context of ultrasound characterization of cortical bone *in-vivo* using axial transmission technique whose set-up corresponds to the presented configuration.

Key words: Axial transmission, bone, laterally graded plate, fluid/solid medium, matricant, Stroh formalism, waveguide.