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REVIEW ARTICLE

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Surface Wave Propagation at the Interface between Two Orthotropic Elastic Half Spaces

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INTRODUCTION

Anisotropy is the property of being directionally dependent, as opposed to isotropy, which means homogeneity in all directions. Rayleigh (1885) studied the waves propagating along with plane surface of an elastic solid. Gold (1956) discussed the Rayleigh wave (surface wave) propagation on anisotropic (cubic) media. He has also studied the essential features of surface wave propagation for elastic waves on anisotropic media. Musgrave (1959) discussed the propagation of elastic waves in crystals and other anisotropic media. He briefly examined the conditions under which surface waves of Rayleigh and Love types may be propagated and problems of elastic wave propagation in anisotropic aggregates. Buchwald (1961) discussed the Rayleigh waves in transversely isotropic media. Anderson (1961) studied the elastic wave propagation in anisotropic layered media. He derived the periodic equations for Rayleigh, Stoneley and Love type waves.

Banerjee and Pao (1974) investigated the propagation of the plane harmonic waves in unbounded anisotropic solids. They found four characteristic wave speeds, three being analogous to those of isothermal or adiabatic elastic waves. The fourth wave, which is predominantly a temperature disturbance, corresponds to the heat pulses known also as the second sound. Lothe and Barnett (1976) studied the existence of surface waves solutions for anisotropic elastic half spaces with free surface. Crampin **(**1984) introduced the wave motion in an anisotropic solid which is fundamentally different from motion in an isotropic solid, although the effects are often subtle and difficult to recognize. He found that the behaviour of wave motion is difficult to understand without experimentation due to a wide range of three-dimensional variations which are possible in anisotropic media. Kausel **(**1986) discussed a problem on wave propagation in anisotropic layered media. He presented a method which provides an alternate solution to the problem in terms of a quadratic eigen value problem involving tri-diagonal matrices, for which the eigen values can be found with great speed and accuracy. The technique is then illustrated by means of an example involving a cross-anisotropic Gibson solid. Norris (1987) discussed a theory of pulse propagation in anisotropic elastic solids. Carcione et al. **(**1988) presented a new formulation for wave-propagation simulation in a transversely isotropic material. They used pseudospectral time-integration technique to solve the equations of motion.

Carcione **(**1990) discussed a plane wave analysis of the anisotropic-viscoelastic medium. He calculated the phase, group and energy velocities in function of the complex velocity. Lothe and Barnett (1990) gave the complete note on zero curvature transonic states and free surface waves in anisotropic elastic media. They deduced that present surface waves existence theory rests on the assumption that the slowness curve has non zero curvature at the point corresponding to the limiting wave. Alshits et al. (1992) discussed on the existence of surface waves in half- infinite anisotropic elastic media with piezoelectric and piezomagnetic properties. Wang et al. (1993) investigated the existence of one component surface waves in anisotropic elastic media. They deduced that search for one component surface waves has been connected with the space of simple reflection and the space of degeneracy. Carcione (1996) studied the wave propagation in an anisotropic saturated porous media. He showed that the three waves are propagative when the fluid is ideal (zero viscosity). He also confirmed that the slow wave becomes diffusive and appears as a static mode at the source location, when the fluid is viscous. Abd Alla (1999) studied the propagation of Rayleigh waves in an elastic half space of orthotropic material.

Adnan et al. (2000) studied the wave propagation in layered anisotropic media with applications to composites. Barnett (2000) discussed the bulk, surface and interfacial (stoneley) waves in anisotropic linear elastic solids. Gold et al. (2000) studied the propagation of elastic waves using a modified finite difference grid. Shuvalov (2000) developed a theoretical framework which describes the wave propagation in infinite homogeneous elastic plates of unrestricted anisotropy. A complete note on the theory of plane inhomogeneous waves in an anisotropic elastic media is given by Shuvalov (2001). In this theory of plane inhomogeneous elastic waves, the complex wave vector constituted by two real vectors in a given pane may be described with the aid of two complex scalar parameters. Sengupta and Nath (2001) studied the surface waves in fibre-reinforced anisotropic elastic media. Michel (2001) gave the explicit secular equation for surface acoustic waves in monoclinic elastic crystals. He derived the secular equation for surface acoustic waves propagating on a monoclinic elastic half space. Wang and Rokhlin (2002) investigated the stable recursive algorithm for elastic wave propagation in layered anisotropic media. Ting (2004) studied the polarization vector and secular equation for surface waves in an anisotropic elastic half space. He investigated the displacement at the free surface of an anisotropic elastic half space X2 > 0 generated by a surface wave propagating in the direction of the X1-axis traces an elliptic path. Ting (2006) showed that certain anisotropic elastic materials can have one or two sheets of spherical slowness surface. He found that the waves associated with a spherical slowness sheet can be longitudinal, transverse or neither. However, a longitudinal wave can propagate in any direction if and only if the slowness sheet is a sphere.

Ting (2007) has shown that the one-component surface waves cannot propagate in a semi-infinite thin layer. He presented Love waves in an anisotropic elastic half-space bonded to a thin anisotropic elastic layer. The dispersion equation so obtained is valid for long wavelength. He also presented the effective boundary conditions for two thin layers bonded to two surfaces of a plate and a thin layer bonded between two anisotropic elastic half-spaces. Stuart (2007) studied the review of the effects of anisotropic layering on the propagation of seismic waves. He deduced that the propagation of both body and surface waves in anisotropic media is fundamentally different from their propagation in isotropic media.

Ting (2008) studied the steady waves propagating in a plate that consists of one or more layers of general anisotropic elastic material. The surface of the plate can be a traction-free (F), rigid (R) or slippery surface (S). The interface between any two layers in the plate can be perfectly bonded (b) or in sliding contact (s). The thickness of the layers need not be the same. Zhang et al. (2008) studied the dispersion splitting of Rayleigh waves in layered azimuthally anisotropic media. They found that Rayleigh wave dispersion can be induced in an anisotropic medium or a layered isotropic medium. For a layered azimuthally anisotropic structure, they modified the traditional wave equation of layered structure to describe the dispersion behavior of Rayleigh waves. Ting (2009) discussed the explicit conditions for the existence of exceptional body waves and subsonic surface waves in anisotropic elastic solids. He found that the only two wave speeds are possible for an exceptional body wave. Gupta et al. (2009) investigated the possibility of propagation of torsional surface waves in an anisotropic porous gravitating medium with rigid boundary. They observed that torsional surface wave propagates in anisotropic porous medium with rigid boundary in presence or absence of gravity field.

Ting (2010) discussed the existence of anti-plane shear surface waves in anisotropic elastic half-space with depth-dependent material properties. He found that an anti-plane shear surface wave does not exist in an anisotropic elastic half-space when the material is homogeneous. Ting (2010) studied the existence of exceptional body waves and subsonic surface waves in monoclinic and orthotropic materials. He gave the explicit conditions for the existence of an exceptional body wave in monoclinic materials with the symmetry plane at x 1 = 0, x 2 = 0 or x3 = 0 and in orthotropic materials with the symmetry planes coinciding with the coordinate planes. He found that non-existence of an exceptional body wave ensures the existence of a subsonic surface wave. Pham et al. (2010) studied the rotational motions in homogeneous anisotropic elastic media under the assumption of plane wave propagation. By using the Kelvin–Christoffel equation, they obtained the expressions of the rotational motions of body waves as a function of the propagation direction and the coefficients of the elastic modulus matrix.

Ting (2011) studied the surface waves in an exponentially graded, general anisotropic elastic material under the influence of gravity. He generalized the problem to exponentially graded general anisotropic elastic materials. Gupta and Gupta (2011) discussed the propagation of torsional surface waves in an anisotropic porous half space in the presence of a gravity field. Cristini and Komatitsch (2011) presented a review of wave propagation at the surface of anisotropic media (crystal symmetries). Baron (2011) studied the propagation of elastic waves in an anisotropic functionally graded hollow cylinder in vacuum. He investigated the influence of the tubular geometry of a waveguide on the propagation of elastic waves. Ogden and Singh (2011) studied the propagation of waves in an incompressible transversely isotropic elastic solid with initial stress. They derived the general constitutive equation for a transversely isotropic hyperelastic solid in the presence of initial stress, based on the theory of invariants. In the general finite deformation case for a compressible material this requires 18 invariants (17 for an incompressible material).

The surface wave propagation at the interface between two orthotropic elastic solid is studied. The governing equations are solved to obtain the general solution in y-z place. The appropriate boundary conditions at an interface between two orthotropic elastic half spaces are satisfied by appropriate particular solutions to obtain the frequency equation of the surface wave in the medium. Some special cases are also discussed.

REFERENCES

Nayfeh, A.H. and Anderson, M.J. (2000). "Wave propagation in layered anisotropic media with applications to composites," *Journal of Acoustical Society of America*, 108. pp. 471-472.

Norris, A.N. (1987). "A theory of Pulse propagation in anisotropic elastic solids," *Wave Motion*, 9. pp. 509-532.

Nowacki, W. (1966a). "Couple stresses in the theory of thermoelasticity I," Bulletin of the Polish Academy of Sciences: Technical Sciences, 14 (2) pp. 129-138.

Nowacki, W. (1966b). "Couple stresses in the theory of thermoelasticity II," Bulletin of the Polish Academy of Sciences: Technical Sciences, 14 (3), pp. 263-272.

Nowacki, W. (1966c). "Couple stresses in the theory of thermoelasticity III," Bulletin of the Polish Academy of Sciences: Technical Sciences, 14 (8) pp. 801-809.

Nowacki, W. (1962). "Thermoelasticity," *Pergamon, Oxford*.

Ogden, R.W. and Singh, B. (2011). "Propagation of waves in an incompressible transversely isotropic elastic solid with initial stress: Biot revisited," *Journal of Mechanics of Materials and Structures*, 6, pp. 1-4.

Othman, M.I.A. and Abbas, I.A. (2010). "Effect of rotation on plane waves at the free surface of a fibre- reinforced thermoplastic half-space using the finite element method," *Meccanica*, 46, pp. 413-421.

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