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Dispersion of Torsional Surface Wave in a Pre-stress Anisotropic Porous Medium With Rigid and Traction Free Boundary Surface Over Sandy Half-Space

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Abstract

In this article, an endeavor has been made to infer the dispersion equation of the torsional surface wave in a pre-stressed an anisotropic porous medium over a dry sandy semi-limitless medium. The case insightful investigation of rigid boundary and traction free boundary surface of the upper layer has been examined in points of interest. The elastic equations of motion have been defined independently for different media utilizing Biot's hypothesis. The dispersion equations of motion for both cases have been acquired under the suitable limit condition in the term of Whittaker function and its derivatives.

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Keywords: *Torsional wave; inhomogeneity; porosity; sandy; phase velocity; dispersion equation.*

1. Introduction

A model of Earth's inside and surface geographical structures may be thought to be comprising of the fluid-filled porous layer at which density and elastic moduli change intermittently. The layers of the Earth are liquid-soaked poro-elastic and truly anisotropic in nature. Association between fluid motion deformation in the porous medium is depicted by poroelastic models. Inside the Earth structure liquid soaked porous rocks are accessible as limestone and others pervaded by groundwater or oil or gas. The greater part of these hydrocarbons are all that much like a hard wipe, full gaps yet not compressible. The gaps or pores can contain water or oil or gas and rock will be splashed with one of these three. The openings are significantly more minor than wipe holes yet they are still holes and they

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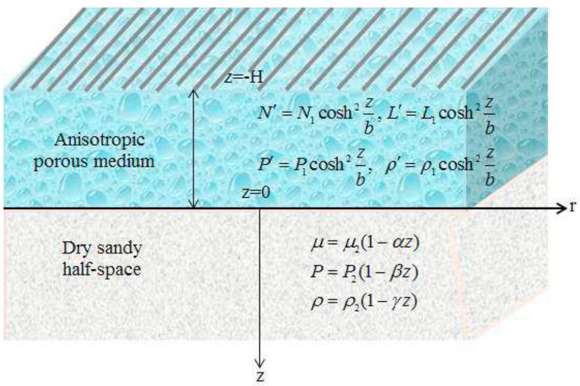
are called porosity and the layer is called porous layer.

The phenomena of wave propagation in liquid soaked porous media having the distinctive sort of material properties have been subjected of a few investigators because of its critical application in geophysics and seismology. There are various speculations portraying the mechanical properties of porous materials. The most no doubt understood one of them is the Biot's [1, 2] combining consolidation hypothesis of fluid saturated porous solids. The investigation of the porous medium in late time has procured prime premium. Great writing about the propagation of the seismic wave is contained in their surely understood book was given by Ewing et al. [3], Gubbins [4], Boer [5] and Achenbach [6]. Ke et al. [7], Day and Sarkar [8], Sona and Kang [9] and, Wang and Tian [10] examined the dispersion of surface wave in prous medium. Propagation of Love waves in the fiber-reinforced layer over a gravitating porous half-space has been pointed by Chattaraj and Samal [11]. Dispersion of the waves is influenced by the vicinity of introductory contact of dry sandy. A dry sandy mantle may be dealt with as a half-space comprise of sandy particles having no environment of moistness has been characterized by η, known as the sandy parameter. The propagation of Love wave in a dry sandy layer has been pointed by Pal [12].

This paper has been encompassed to analyze the dispersion of torsional surface wave in initially stressed anisotropic porous layer of finite thickness with rigid and footing free limit surface over sandy half-space. The inhomogeneity in the porous layer has been taken as $N' = N_1 \cosh^2\frac{z}{b}, L' = L_1 \cosh^2\frac{z}{b}$, $p' = p_1 \cosh^2\frac{z}{b}$, $\rho' = \rho_1 \cosh^2\frac{z}{b}$ whereas inhomogeneity in the sandy mantle has been taken as $\mu = \mu_2(1-\alpha z), p = p_2(1-\beta z)$, and $\rho = \rho_2(1-\gamma z)$ where b is constant whose dimension is equal to length and α, β and γ are also constant whose dimension is equal to the inverse of the length.

2. Formulation of problem

consider an anisotropic porous layer of thickness H under compressive initial stress p' along radial direction r over dry sandy mantle half space under compressive initial stress p with and without rigidity is depicted in the Fig. 1 and Fig. 2 respectively. To study torsional surface waves a cylindrical coordinate system $(z, r, \theta)$is introduced with z-axis directed to downwards positive. Where r and θ be the radial and circumferential co-ordinate respectively. The origin of cylindrical co-ordinate system has been taken at the surface of sandy half space.



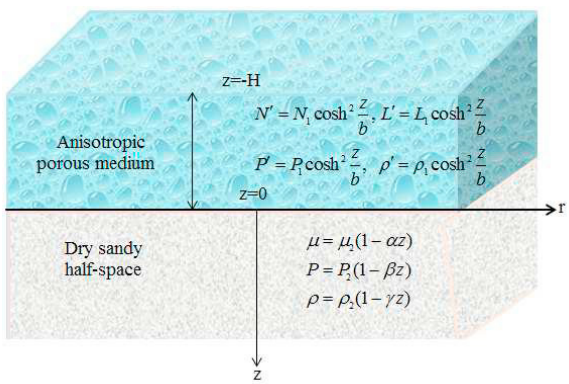


Fig. 1: Geometry of problem; with rigid boundary surface; Fig. 2: Geometry of problem; traction free boundary surface

3. Dynamic of the Layer

3.1. *Dynamic of inhomogeneous anisotropic layer*

The dynamic mathematical statement of motion for anisotropic porous medium under the impact of gravity and without body forces for the dispersion of torsional surface is given by Biot [2] as

$$\frac{\partial s'_{r\theta}}{\partial r} + \frac{2}{r}s'_{r\theta} + \frac{\partial s'_{\theta z}}{\partial z} - \rho'\frac{\partial \omega'_z}{\partial r} = \frac{\partial^2}{\partial t^2}\left(\rho'_{rr} v'_\theta + \rho'_{r\theta} V'_\theta\right) \quad (1)$$