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A study of fundamental solution in orthotropic thermodiffusive elastic media ☆

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ABSTRACT

The present investigation is to study the fundamental solution for two dimensional problem in orthotropic thermodiffusive elastic medium. After applying the dimensionless quantities, we have derived the most general expression for displacements, concentration, temperature, normal and tangential stress. The general solution for a point heat source on the surface of a semi infinite orthotropic thermodiffusive plane has been obtained. A special case of interest is also deduced from the general expression in the absence of diffusion effect. The amplitude of surface displacements, temperature change and concentration are computed and presented graphically to depict the effect of diffusion.

1. Introduction

Fundamental solutions play an important role in solving boundary value problems frequently encountered in science and engineering. They are the foundations of a lot of further works. For example, fundamental solutions can be used to construct many analytical solutions of practical problems when boundary conditions are imposed. Many studies have been directed towards obtaining full space Green's function for elastic solid in isotropic and anisotropic media such as studies from Lord Kelvin [1], Freedholm [2], Synge [3], Pan and Chou [4], and Wang [5].

A great deal of works for fundamental solutions can be found in the literature. Mindlin [6] studied the fundamental work for an isotropic half space. For transversely isotropic materials, Pan and Chou [7] derived the point force solution of an infinite body for two different cases considering the eigenvalues by using a complicated group of general solution. Later Wang and Chen [8] and Wang and Zheng [9] studied the solution for a point force applied on the boundary of a transversely isotropic piezoelectric half-space and derived the general solution of the equation of equilibrium. Ding et al. [10] systematically studied the general solutions of equations both of move and equilibrium of transversely isotropic piezoelectric materials and also obtained the solutions for point forces and point charge applied on the boundary of a half space.

Ding et al. [11] obtained the fundamental solutions for transversely isotropic media by using body potential theory and constructing a kind of harmonic function. Lee and Jiang [12] obtained the two dimensional fundamental solution by using the double Fourier transform, but only considered one case of the eigenvalues. Sosa and Castro [13] also gave the solutions for a point force applied vertically on the boundary of a half-plane as well as for a point charge applied on the boundary.

The generalized theory of thermoelasticity is one of the modified versions of classical uncoupled and coupled theory of thermoelasticity and has been developed in order to remove the paradox of physical impossible phenomena of infinite velocity of thermal signals in the classical coupled thermoelasticity.

Lord and Shulman [14] formulated a generalized theory of thermoelasticity with one thermal relaxation time, who obtained a wave-type equation by postulating a new law of heat conduction instead of classical Fourier's law. Green and Lindsay [15] developed a temperature rate-dependent thermoelasticity that includes two thermal relaxation times and does not violate the classical Fourier's law of heat conduction, when the body under consideration has a center of symmetry. One may refer to Hetnarski and Ignaczak [16] for a review and presentation of generalized theories of thermoelasticity.

Diffusion can be defined as the movement of particles from an area of high concentration to an area of lower concentration until equilibrium is reached. It occurs as a result of the second law of thermodynamic which states that the entropy or disorder of any system must always increase with time. Diffusion is important in many life processes. Nowadays, there is a great deal of interest in the study of this phenomenon, due to its many applications in geophysics and industrial applications. In integrated circuit fabrication, diffusion is used to introduce "dopants" in controlled amounts into semiconductor substrate. In particular, diffusion is used to form the base and emitter in bipolar transistors from, integrated resistors from the source/drain regions in Metal Oxide Semiconductor (MOS) transistors. In most of the application, the concentration is calculated using Fick's Law. This is a simple law which does not take into consideration the mutual interaction between the introduced substance and the medium into which it is introduced. Study of this phenomenon diffusion is used to improve the conditions of oil extractions. These days' oil companies are interested in the process of

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