A Study of Surface Wave Propagation

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Abstract

In Physics, a surface wave is a mechanical wave that propagates along the interface between differing media, usually two fluids with different densities. A surface wave can also be an electromagnetic wave guided by a refractive index gradient. For electromagnetic waves, propagation may occur in vacuum as well as in a material medium. In radio-transmission, a ground wave is a surface wave that propagates close to the surface of the earth. Surface waves, in this mechanical sense, are commonly known as either Love waves or Rayleigh waves which travel through a wave guide. Love waves have transverse motion (movement is perpendicular to the direction of travel like light waves) where Rayleigh waves have both longitudinal (movement parallel to the direction of travel like sound waves) and transverse motion.

Keywords: Surface Waves; Boundry Conditions

1. Introduction

In physics, elasticity is the physical property of a material when it deforms under stress (e.g.externalforce) but returns to its original shape when the stress is removed. Here, stress may be defined as measure of the average amount of force exerted per unit area. It is measure of the intensity of the total internal forces acting within a body across imaginary internal surfaces, as a reaction to external applied forces and body forces. It was introduced into the theory of elasticity by Cauchy around 1822. Stress is a concept thatis based on the concept of continuum. In general, stress is expressed as $\sigma=F/A$ where F is the force acting over the area A , σ is the average stress. S.I.unit for stress is Pascal (Pa) which is a shorthand name for one Newton (Force) per square area (unit of area is meter square). Strain is the geometrical measure of

deformation representing the relative displacement between particles in the material body. Deformation is the change in shape due toan applied force. This can be a result of pulling forces, pushing forces, shear, bending or twisting. External forces are the forces acting between the body and the environment. It can be distant forces (gravity) or contact forces. The relation between stresses and induced strain is expressed by constitutive equations e.g.Hooke's law of elasticity, which states that the extension of a spring is in direct propagation with the loadadded toit as long as this load does not exceed the elastic limit. For systems that obeys Hooke's law, the extension produced is directly proportional to the load-

F= -kx, where x is the distance that the spring has been stretched or compressed away from the equilibrium position, Fis the restoring force exerted by the material and k is the force constant.

2 Seismology and Surface Waves

Seismology is the theoretical study of earthquake. At the time of earthquake; sometimes from an explosion, seismic waves are encountered. Seismic waves are waves that travel through the earth. Seismic waves are studies by the seismologists and measured by a seismograph. There are two types of seismic waves namely „body waves and „surface waves. Other modes of wave propagation exist than those described here, but they are of comparatively minor importance. Body waves travel through the interior of the Earth. They follow ray paths bent by the varying density and modulus (stiffness) of the earth‟s interior. The density and modulus, in turn, vary according to temperature, composition and phase. This effect is similar to the refraction of light waves. Body waves transmit the first-arriving tremors of an earthquake, as well as many later arrivals. There are two kinds of body waves: Primary (P waves) and Secondary (S waves). P waves are longitudinal or compressional waves, which mean that the ground is alternately compressed and dilated in the direction of propagation. In solids these waves generally travel slightly less than twice as fast as S-waves and can travel through any type of material. In air, these pressure waves take the form of sound waves; hence they travel at the speed of sound. P waves are sometimes called "Primary waves". When generated by an earthquake they are less destructive than S waves and surface waves that follow-them, due to their lesser amplitudes. S waves are transverse or shear waves,

which mean that the ground is displaced perpendicularly to the direction of propagation. In the case of horizontally polarized S waves, the ground moves alternately to one side and then the other. S waves can travel only through solids, as fluids (liquids and gases) do not support shear stresses. S waves are sometimes called "secondary waves", and are several times larger in amplitude than P waves for earthquake sources. Surface waves are analogous to water slowly than body waves. Because of their low frequency, long duration and large amplitude, they can be the most destructive type of seismic wave.

3 Case Study and Methodology

In Physics, a surface wave is a mechanical wave that propagates along the interface between differing media, usually two fluids with different densities. A surface wave can also be an electromagnetic wave guided by a refractive index gradient. For electromagnetic waves, propagation may occur in vacuum as well as in a material medium. In radio-transmission, a ground wave is a surface wave that propagates close to the surface of the earth. Surface waves, in this mechanical sense, are commonly known as either Love waves or Rayleigh waves which travel through a wave guide. Love waves have transverse motion (movement is perpendicular to the direction of travel like light waves) where Rayleigh waves have both longitudinal (movement parallel to the direction of travel like sound waves) and transverse motion. Thus, with respect to the direction of the oscillation relative to the propagation direction, we can distinguish between longitudinal waves and transverse waves.

Since a large number of investigations on surface waves in homogeneous as well as in heterogeneous layered earth models have been carried out and employed usefully to determine the structure of earth. At the early stage most of the work was done for a homogeneous medium. Wave propagation in heterogeneous media is difficult to analyze. The presence of large transverse motion in the seismograms was one of the first established facts of seismology. The analysis of Rayleigh and Lamb did not, however, explain this fact.

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Thermodynamics has undergone marked development in connection with important problems arising during the design of steam and gas turbines, jet motors, rockets, high speed aircraft, nuclear reactors etc.

Thus, the need for materials which can serve useful function at these temperature levels presents one of the most pressing and difficult problems, facing our technology. The dynamical theory of thermoelasticity is the study of interaction between thermal and mechanical fields in solid bodies and is of considerable importance in various engineering fields.

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 z = 0 between two orthotropic elastic half spaces are satisfied by appropriate particular solutions to obtain the frequency equation of the surface wave in the medium. Frequency equations of surface waves are also obtained for some limiting cases in absence of transverse anisotropy. The appropriate boundary conditions at an interface z = 0 between two dissimilar half spaces are satisfied by appropriate particular solutions to obtain the frequency equation of the surface wave in the medium. Frequency equations of surface waves are also obtained for some limiting cases in absence of thermal parameters and transverse anisotropy

4. Conclusion

The heterogeneous earth model cannot resolve these discrepancies and difficulties. The discrepancy in the observed data and theoretical results obtained from a simplified earth model is a commonly observed fact. The interpretation regarding the observed phenomenon do pose certain difficulties for which the theory of simplified model does not provide any explanation.

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