

## **APPLICATION OF CAGNIARD THEORY TO REFLECTION AND REFRACTION OF EXPLOSION SHOCK WAVES IN SOIL AND WATER**

BRITT, J.R.

Exact, closed form integral solutions of L. Cagniard for the reflection and refraction of spherical waves in elastic solids were extended to model shock wave propagation in multi-layered materials such as soil-rock and the ocean-ocean bottom. In this paper the theoretical development is discussed briefly and calculated ground shock particle velocity waveforms and underwater explosion pressure waveforms are compared with measurements.

The model is able to reproduce both the airslap and groundroll contributions of ground shock from air burst explosions. The calculations are in excellent agreement with velocity waveforms obtained in the CENSE test program at blast pressures up to about 40 psi (0.3 Mpa) in weak soil and to hundreds of psi in rock.

At higher pressures the model still predicts the general character of the motion. Since the theory follows rays, the composite waveforms can be dissected to study the contributions of individual arrivals.

In underwater explosion applications the model reproduces detailed reflected pressure waveforms with a high degree of accuracy over a broad range of incident angles at pressures into the 0.1 - 0.2 kbar range. Comparisons are made in the ocean and in micro-scale laboratory tests. Finally, the model is used to study propagation in the real ocean environment where both the water and the ocean bottom are highly stratified.