MODEL STUDY OF EXPLOSION-GENERATED
RAYLEIGH WAVES IN A HALF SPACE

by

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The value of two dimensional model studies for elucidating a variety of seismological phenomena is well established. This study differs from the conventional modeling techniques in that small amounts of a chemical explosive are used to generate the seismic signal, thereby inducing stresses in the source region similar to those operating in full-scale seismic events. The investigation is confined to the study of explosion-generated Rayleigh waves on or within a half space under varying conditions. Three different modeling materials, aluminum, Plexiglas, and Styrofoam are selected on the basis of their widely different elastic and other physical properties. The charges are detonated either in contact with the upper free surface of the model, or in holes at varying depths below this surface. Using simple capacitance probes, the horizontal and vertical components of the extensional vibrations produced in the model sheet are measured at points very near the free surface.

The two dimensional theory of Lamb and Lapwood for a compressional source is approximately valid here, provided we replace the infinite solid compressional wave velocity by the plate velocity. For shots on the surface, Lamb's theory for the two dimensional case can be directly applied, assuming the explosion to generate a normal input stress of the form used by him. For shots within the material, one can make use of Lapwood's theory, provided the epicentral distance is large compared to the source depth. The Rayleigh waveforms expected for an impulse-type input are easily obtained from those given by Lapwood for a step-type input.

The surface shots from aluminum and Plexiglas produce Rayleigh waveforms consistent with Lamb's theory except that the observed motion is somewhat more oscillatory. For shot points in the interior of the three model materials, the observed waveforms do not agree entirely with those expected for either a step-type or an impulse-type input source. However, the waveforms in aluminum approximately agree with those expected for a step-type input while the waveforms for Plexiglas and Styrofoam are closer to those for an impulse. The variation of the Rayleigh wave period as a function of the depth of the shot point and as a function of the observed cavity radius in Styrofoam is also investigated.

An attempt is made to determine the depth at which the effect of the explosion changes from a vertically applied impulse to a buried source of compression. In both Plexiglas and aluminum, the transition takes place at a depth equal to the radius of the zone of inelastic failure around the shot. It seems, therefore, likely that this critical depth is equal to the radius of the equivalent cavity associated with the explosion in the medium. This phenomenon is a true indication of a change in the mechanism of Rayleigh wave generation, and is not related to the change from retrograde motion at the free surface to prograde motion in the interior associated with the change in sign of the radial component at depth.