RESONANT OSCILLATIONS OF THE OVERBURDEN EXCITED BY SEISMIC WAVES

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The nature of the surface layer plays a dominant role in determining the local intensity of earthquake motion. It is known that this intensity is higher on loose material than on basement rock. Moreover, the motion of the ground may be characterized by large amplitude slowly-decaying waves of nearly constant period. This phenomenon has been interpreted as being due to the effect of resonant oscillations of the surface layer excited by seismic waves. When an infinite train of harmonic elastic waves is propagated from beneath into stratified ground, stationary waves are set up in the various strata. The amplitude of oscillation at the surface becomes a function of the period of the wave and there are certain dominant frequencies for which the spectral response is a maximum. The general theory for this case has been given by K. Kanai (1957). This study, however, is confined to the case of a single low velocity layer overlying high velocity bedrock.

Several three-component quarry blast records, obtained from an area where a thin layer of low velocity overburden lay over limestone bedrock, were made available to the author. The later sections of the longitudinal and transverse component traces on these records are marked by the presence of long trains of slowly-decaying waves of constant period. The latter are interpreted as resonant vibrations of the overburden as excited by transverse waves propagating from below and their period values agree with the values predicted from theory, provided the lowest frequency mode is considered.

Three-component seismograms obtained from experimental seismic shooting work in the same area exhibit similar characteristics and are interpreted on the basis of the same theory.

An attempt is made to study the phenomenon of resonant vibrations in the laboratory with the help of two-dimensional seismic models. The field conditions are approximately simulated by cementing nylon layers of varying thicknesses to an aluminum base plate. Two identical barium titanate piezoelectric crystals, sensitive primarily to motion transverse to their axes, are used to transmit and detect the sinusoidal steady-state signals provided by a low frequency oscillator. For different thicknesses of the nylon layer, the signal output is observed as a function of the oscillator frequency. Amplitude maxima are observed not only for the frequency values predicted from theory but also for those associated with reflection from the edges of the model. The model studies confirm the generation by transverse waves of resonances of forced oscillations of the fundamental as well as the higher order modes.