SURFACE WAVE ATTENUATION IN NORTH AMERICA EAST OF THE ROCKY MOUNTAINS

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The fact that earthquakes which occur in the central United States have larger felt areas as well as larger areas of damage than earthquakes of comparable magnitude in the western United States has been known for some time. These phenomena can be explained by a lesser absorption of short-period surface-wave energy in the central United States. The value of the absorption coefficient (γ), as well as the focal mechanism and depth, determine the intensity versus distance and magnitude formulas which are required by structural engineers and city planners for the design of earthquake-resistant structures in this region.

Some of this needed information can be obtained by studying the absorption of surface waves generated by central United States earthquakes. In this dissertation frequency-domain studies of absorption of Love and Rayleigh waves in the period range 1 to 50 seconds were made for the portion of North America east of the Rocky Mountains, using the data of five earthquakes in the central United States. In addition, the data of two nuclear explosions from the Nevada Test Site were also analyzed for paths to the east of the Rocky Mountains.

Three methods were employed to obtain the absorption coefficients. All of the methods use ground amplitude spectra of the surface waves recorded by long-period seismographs. The first method (curve-matching) is favored because of consistency of results. In this method, log-log plots of amplitude versus distance curves at each period are compared with those of theoretical curves (calculated from $A \sim \exp(-\gamma\Delta)/\sqrt{\sin\Delta}$, γ as parameter). The theoretical curve is superimposed over the observational data, to yield the intercept and γ values. The second method (station-pair) uses the spectra at two stations on the same great-circle path. This method minimizes the azimuthal and source effects. However, when working with earthquake data it is difficult to find two stations with exactly the same azimuth. A small difference in azimuth can be important if the stations happen to be near a nodal line. The third method was applied by Tryggvason (1965) to explosion-generated Rayleigh waves. It is assumed that the energy is radiated equally in all directions about the source and that γ is distance and azimuth independent. For a given period a plot of log (Amplitude $\sqrt{\sin\Delta}$) versus Δ should yield a straight-line relationship of slope γ, which is determined by a least-squares procedure.

Due to low absorption asymmetry of the source and lateral heterogeneities in the crust, the latter two methods did not appear to yield very reliable results. However, the curve-matching method yielded reasonable results that can explain the large felt areas in the central United States due to moderate-size earthquakes. It also provided an estimate of the spectrum at $\Delta = 1^{\circ}$ (near-field spectrum) that can be employed to estimate focal depths, seismic moments and to predict the ground motion at a given distance. For eastern North America the average value of γ for Rayleigh waves was found to be: 0.05 deg^{-1} in the period range 1 to 10 seconds, 0.03 deg^{-1} in the range 11 to 20 seconds and 0.02 deg^{-1} in the period range 21 to 50 seconds. The corresponding values of γ for Love waves are: 0.10 deg^{-1} in the period range 1 to 4 seconds, 0.05 deg^{-1} in the range 5 to 10 seconds, and 0.03 deg^{-1} in the range 11 to 30 seconds.