THEORETICAL AND EXPERIMENTAL ATTENUATION OF ELASTIC SPHERICAL WAVES

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ABSTRACT

The solution to the elastic spherical wave equation has two terms: one with $1/r$ dependence and one with $1/r^2$ dependence, where r is the range. This solution is presented in terms of a reduced velocity potential (RVP) and the attenuation of peak velocity u_{max} is shown to depend on the finite rise time of the wave. Examples are presented to illustrate that when the rise time is very small, the attenuation of u_{max} approaches $1/r$, and when the rise time is very large, the attenuation approaches $1/r^2$. For both extremes, log-log plots of u_{max} vs. r are nearly linear because one term dominates. For intermediate values, both terms come in to play and the curves are not straight, i.e. there is no single power-law exponent that will fit them exactly. In fact, not only does a power-law give an imperfect fit, the best-fit power law depends on the range of data selected for the fit.

The theory is compared with particle velocity measurements from an experiment with a spherical explosive charge in a well-characterized homogenous block of rock in which radial velocity was measured at several radii. An elastic precursor was observed in the experiment and its attenuation is consistent with the theoretical attenuation for the observed rise time. The main wave velocity histories were converted to reduced velocity potentials (even in the inelastic region) to determine the elastic radius, the range at which the RVP becomes constant. Using the observed rise time of the velocity pulse in the elastic region, the elastic wave speed, and the elastic radius, the theoretical attenuation is in good agreement with the measured attenuation.