Geophysical Research Abstracts,
Vol. 11, EGU2009-2544, 2009
EGU General Assembly 2009

Frequency- and stress-dependent changes in shear-wave velocity dispersion in water-saturated, unconsolidated sand

R. Ghose
(r.ghose@tudelft.nl)

Anelastic processes in the earth causes dissipation of seismic energy. Because of the fundamental laws of causality, the dissipation effects demand a frequency-dependent change of elastic moduli, and therefore, dispersion in elastic wave velocities. Assessing the dispersion of seismic shear waves in the unconsolidated subsoil is important for at least 3 reasons: 1) shear-wave velocity (Vs) is a key parameter in all dynamic loading problems; the frequency of the observed shear waves in field, downhole and laboratory measurements varies widely (20 Hz - 10 kHz), and consequently an uncertainty resulting from an unknown or poorly known estimate of dispersion may translate into erroneous evaluation and potential risks, 2) generally Vs-dispersion is considered negligible for the frequency range of practical interest; it is important to check this assumption and modify the site evaluation results, if necessary, and 3) the underlying soil-physics of any observed dispersion can be useful in estimating an unknown soil physical parameter.

In the present research, we have concentrated on Vs dispersion in saturated sand in laboratory, under varying vertical and horizontal stress levels that are realistic in the context of shallow subsoil investigations. We explored theoretical models to obtain insight from our experimental findings. Laboratory experiments involving array seismic measurements and accurate stress control present clear evidence of dispersive shear-wave velocity in saturated sand in the frequency range 2-16 kHz. The change of Vs as a function of frequency is clearly nonlinear. For low frequencies, as observed in the field data, our result indicates significant dispersion and, therefore, nonlinear variation of attenuation. This has important implication on site evaluation using Vs. Significantly, the data allows us to distinguish a frequency-dependence of the velocity dispersion. The relative importance of fluid motion relative to the skeleton frame (Biot theory) and the grain-to-grain interaction (grain-shearing theory) were looked into. Our result implies different mechanisms responsible for varying frequency- and stress-dependence of Vs in water-saturated, unconsolidated sand.