ACOUSTICS2008/864
Static and dynamic nonlinear behaviors of unconsolidated granular media

Zhiqu Lu and James Sabatier
University of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, USA

Unconsolidated granular media such as sands, soils, and glass beads, exhibit astonishing static and dynamic nonlinear behaviors that are quite different from those of elastic materials such as liquids and crystalline solids. They can generally classified as mesoscopic hysteretic nonlinear materials since hysteresis is a universal phenomenon for these materials. In order to understand the mechanism and to quantify the nonlinearity of unconsolidated granular materials, a series of studies have been conducted on re-molded unconsolidated soils. The systematic research consists of three parts: (1) a triaxial cell test with pre-defined stress-paths and sound speed measurement, focusing on the exploration of the role of hysteresis in both linear and nonlinear acoustics; (2) the phase shift method, using non-classical nonlinear acoustic theory to measure the hysteretic nonlinearity parameter; (3) the study of fluid effects on the hysteretic nonlinearity parameter. The study reveals many static and dynamic nonlinear behaviors of soils, including: nonlinear stress/strain relationship, hysteresis loop, end-point memory, much greater dynamic elastic modulus than static elastic modulus, strain-amplitude dependence of elastic modulus, linear resonant frequency shift and phase shift relationships against strain, extremely high values of the hysteretic nonlinearity parameter, harmonics generation, and moisture effects.