Geotechnical Engineering Seminar
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Mason 142A, 12:00-1:00pm

Liquefaction Mitigation via Colloidal Silica Gel: Small Strain Dynamic Properties

by Laura Spencer, MS

ABSTRACT:
Earthquakes pose a severe threat to the nation's seaports, which are critical assets in this era of global trade. Much of the damage to individual port components can be attributed to the hydraulically placed fills that are common at ports which are very susceptible to liquefaction. Liquefaction can result in large deformations and settlements, which can result in severe damage to critical structures and facilities, as well as floating of buried structures such as lifelines. During the 1995 Hyogoken-Nambu (Kobe) earthquake, the Port of Kobe sustained extensive damage that essentially halted operations at the port for months as a result of lateral spreading caused by liquefaction.

Passive soil improvement methods are an attractive alternative for situations requiring minimal disruption. Prior studies of candidate stabilizing materials (Gallagher and Mitchell, 2002; Gallagher et al., 2006; Persoff et al., 1999) have identified colloidal silica (Iler, 1979) as an ideal, environmentally benign grouting material with low initial viscosity, controllable gel times, and good long-term mechanical stability. Colloidal silica is an aqueous dispersion of silica nanoparticles that can be made to gel by adjusting the pH and ionic strength of the solution. Upon delivery to the target location, the stabilizer starts to gel or set rapidly at a predetermined time to bind the soil particles. In concentrations of 5 percent by weight, it significantly improves the deformation resistance of loose sands to cyclic loading (Gallagher, 2000; Gallagher and Mitchell, 2002; Whittle, 2007). Previous work on the applicability of colloidal silica gel as a passive liquefaction mitigation method has focused on the ability of the gel to resist deformations.

A comparative study of different concentrations of colloidal silica gel and sand mixtures is presented. The dynamic properties, shear modulus and damping ratio, of No. 120 Nevada sand permeated with colloidal silica gel were determined using resonant column tests. The behaviour of the gelled samples is compared to untreated sand samples. The effects of the concentration of colloidal silica gel by percent weight, cyclic shear strain and aging on the dynamic properties of the gel-sand mixtures were studied. Results show the shear modulus slightly increases as concentration of colloidal silica gel by percent weight increases and the gel-sand mixtures have a slightly higher shear modulus than untreated sand. A 5% by weight gel-sand sample subjected to a long-term, small-strain cyclic shear resonant column test for 680 hours after gelling shows an increase of 6 MPa (~12%) in the shear modulus.

BIO:
Laura Spencer is a PhD Candidate at the Georgia Institute of Technology, under the supervision of Dr. Glenn Rix. She obtained her BS with Honors in Civil and Environmental Engineering from Carnegie Mellon University and a MSCE from Georgia Tech in 2003 and 2005, respectively