Wednesday, 3/15/2017

8–9:30 a.m.

Seismic Parameters 3

Chairs: Adrian Rodriguez-Marek, Virginia Tech; Ashly Cabas-Mijares, Virginia Tech

Free-field Cyclic Response of Dense Sands in Dynamic Centrifuge Tests with 1D and 2D Shaking

Alfonso Cerna Diaz, Scott M. Olson, Ozgun A. Numanoglu, Youssef M.A. Hashash, Lopamudra Bhaumik, and Cassandra J. Rutherford, University of Illinois at Urbana–Champaign; Thomas Weaver, U.S. Nuclear Regulatory Commission

The seismic performance of many nuclear power plant (NPP) structures depends on the cyclic shear stress-shear strain-volumetric strain behavior of dense, compacted coarse-grained soils used to support their foundations. However, when these deposits are thick, even relatively small volumetric strains can result in nontrivial settlements that can impact NPP structures. Here, we describe the results from dynamic centrifuge tests performed on thick layers (prototype thicknesses of 10.25 and 20.5 m) of saturated dense (relative density, Dr~95%), Ottawa sand. Models were excited using unidirectional (1D) and bidirectional (2D) broadband motions (Arias intensities ranged from 0.1 to 5 m/s). Centrifuge test results indicate minor differences between 1D and 2D response spectra. In contrast, 2D shaking in dense sands caused increases in porewater pressure (PWP) generation and volumetric strains (ev) of approximately 200% compared to 1D shaking. These increases in PWP and ev were considerably larger than observed by others for loose sands.

A Framework for Evaluating the Effects of Drained Cyclic Preshearing on the Liquefaction Resistance of Ottawa Sand

Erin L.D. Sibley and Scott M. Olson, University of Illinois at Urbana–Champaign; Carmine Polito, Valparaiso University

A series of cyclic simple shear tests were conducted on reconstituted specimens of clean, fine-grained Ottawa C109 sand at three relative densities. Small-amplitude drained cyclic preshearing strains of 0.02-0.3% were applied to the specimens for 30-1000 cycles. After drained cyclic preshearing, the specimens were subjected to higher amplitude cyclic shear strains under constant-volume conditions until liquefaction occurred. The test results are compared with constant-volume cyclic shear tests without preshearing to evaluate the influence that strain amplitude and the number of cycles of drained cyclic preshearing have on the liquefaction resistance of Ottawa C109 sand. Based on this comparison, a framework for understanding drained preshearing is proposed.

Site Classification of Strong Motion Stations of Uttarakhand, India, Based on Model Horizontal to Vertical Spectral Ratio

Harinarayan NH and Abhishek Kumar, Indian Institute of Technology, Guwahati

In order to monitor the ongoing seismicity in different parts of the active regions of India, 300 state of the art digital strong motion accelerographs are installed. The accelerograms from the recording stations are available in PESMOS website. The recording stations are classified based on the physical description of local geology and not based on in-situ field tests. Thus, there exist an ambiguity in the assessment of local site conditions for these recording stations. Unless the site class (SC) is known, recorded ground motions cannot be used with confidence. Several research efforts have been directed towards the use of horizontal to vertical spectral ratio (HVSR) technique as a tool to access the local site

condition. There is consensus among the scientific community regarding the peak frequency (fpeak) obtained from the HVSR method to identify the soil fundamental frequency. In this study, theoretical HVSR curves for 12 recording stations located in the Tarai region of Uttarakhand are generated using a Matlab tool called Model HVSR to obtain the fpeak and peak amplification (Apeak). Further, these values of fpeak and Apeak for all the 12 recording stations are estimated using the HVSR based on strong ground motion records. Results obtained from both the above methods show 1:1 correspondence. The values of fpeak obtained for 12 stations range from 1 Hz to 5 Hz based on model HVSR and from 1.1 Hz to 3.3 Hz using the HVSR based on strong ground motion records. These findings are also matching with the existing field studies. Present analyses show a clear difference in the SCs suggested by PESMOS and the one obtained from the present study. Once correct information on SC is known, recorded ground motion at each station can be used with confidence.

Volumetric Strain in Non-plastic Silty Sand Subject to Multi-directional Cyclic Loading

Lopamudra Bhaumik, Cassandra J. Rutherford, Alfonso A. C. Diaz, Scott M. Olson, Ozgun A. Numanoglu, and Youssef M. A. Hashash, University of Illinois at Urbana–Champaign; Thomas Weaver, U.S. Nuclear Regulatory Commission

Structures founded on dense, compacted sands are currently designed based on the shear stress – shear strain (γcs) – volumetric strain (εv) response of clean sands primarily obtained from unidirectional element tests. This may lead to underestimation of εv under multidirectional seismic loads and incorrect settlement estimation for sands with fines. This paper presents results from first of a kind strain-controlled unidirectional (sinusoidal) and bidirectional (circular, figure-8) cyclic simple shear tests. Clean Ottawa sand and a non-plastic Mississippi River silty sand were tested at modified Proctor relative compactions (RC) of 92 to 99%. At the same RC, presence of non-plastic fines decreased εv. Volumetric strain under bidirectional loading normalized by εv under equivalent unidirectional loading (comparable γcs, RC, overburden pressure) was found to be a function of the number of loading cycles, load path and γcs. A figure-8 loading path yielded higher settlement than an equivalent circular loading path.

Linear and Nonlinear Shear Moduli of Materials Associated with Heap Leach-Pad Mining

Andrew K. Keene, Hamza Jaffal, Kenneth H. Stokoe, and Chadi S. El Mohtar, University of Texas at Austin; Andres Reyes, Anddes Asociados SAC; Renzo Ayala and Denys Parra, Anddes Associates

Heap leach pads consist of layers of blasted and/or crushed ore placed over a liner containment system from which metallic substances are harvested via solution circulated into the heap. Also associated with this mining approach are waste dumps where the low-grade ore materials are deposited. When these pads and dumps are constructed in seismically active areas (such as the Andes Mountains in Peru), determination of the linear and nonlinear shear moduli of the materials used to construct the leach pads and waste dumps become essential in evaluating seismic slope stability of these systems. In this paper, the linear and nonlinear shear moduli of the two types of blasted mine materials determined from laboratory and in-situ testing are presented. Resonant column (RC) and cyclic triaxial (CTX) tests were conducted on reconstituted specimens at several mean effective stresses at shear strains ranging from the linear to highly nonlinear range. The two materials exhibit dynamic behavior generally consistent with that of gravels. Finally, in-situ shear wave velocity measurements from the final placement were conducted and the results are in good agreement with the shear wave velocities determined from RC testing.