6th Annual Web Conferences 2020

Technical Committees

Live Streaming Daily – Technical Case Studies

December 6 – 10, 2021

The Geo-Institute Technical Committees will be live streaming the Soil Improvement Technical Committee on Thursday, December 9 at 2 PM EST. The topics include:

"Performance of the Wet Soil Mixing-Supported West Dowling Bridge during the 30 November 2018 Anchorage Earthquake", **Armin W. Stuedlein**, Ph.D., P.E., M.ASCE

The performance of improved ground during earthquakes continues to receive high interest in the geotechnical earthquake engineering profession given the need to establish best design and construction practices associated with ground improvement technology. The M7.1 30 November 2018 Anchorage earthquake produced significant shaking intensity at the West Dowling Street Bridge as recorded at a nearby ground motion station. This lecture describes the site and subsurface conditions at the bridge, the static and seismic design objectives, and the deep soil mixing ground improvement used to satisfy performance criteria. Then, an overview of the 30 November 2018 earthquake is described, followed by an exploration of the ground motion characteristics measured 0.6 km from the bridge. Observations on the bridge condition conducted following the earthquake by members of the Alaska Department of Transportation and GEER association are described within the context of the measured ground motions. The lecture concludes with Newmark-type seismic stability analyses conducted using the nearby ground motions to compare anticipated displacements with those observed following the earthquake. This case history provides a successful example of a shallow foundation-supported bridge abutment overlying deep soil mixing-improved ground and subjected to intense, directional ground motions.

"How burping bacteria can mitigate earthquake induced liquefaction: Distribution and durability of entrapped gas in the subsurface", **Leon van Paassen**, Ph.D., M.ASCE

Biological processes are being considered for their potential as ground improvement method. In one of these processes nitrate-reducing bacteria that are ubiquitous in the subsurface are stimulated to produce nitrogen gas bubbles, which get stuck between the soil grains. The entrapped gas dampens pore pressure build up during cycling loading of loosely packed sands and silts and therefore delays earthquake induced liquefaction triggering. The proof of concept of so-called Microbial Induced Desaturation (MID) or Induced Partial Saturation (IPS) as ground improvement technology has been demonstrated in various laboratory conditions and recently field trials have been performed in Portland. Proposed advantages of the MID technology include the ability to treat both sandy and silty soils. Since the substrates that are used to stimulate nitrate reduction are easily soluble in water, substrate solutions can be injected at low pressure and soils can be treated with limited disturbance at relatively long distance from an injection well, which facilitates treatment underneath existing structures. Current R&D aims to determine how the distribution and durability of the entrapped gas, the resulting resistance to liquefaction triggering and consequent deformations depend on the treatment protocol, soil stratigraphy and environmental conditions. Theoretical analysis demonstrated that entrapped gas can remain stable for several decades, the post-treatment monitoring at the Portland test site shows that the soils remain desaturated at least for more than two years.

"Lateral spreading and the stability of embankments supported on unreinforced rigid columns", **Aaron Gallant**, Ph.D., P.E., M.ASCE

Column-support is used to accelerate construction of embankments over soft ground to attenuate issues concerning deformations beneath the fill, adjacent facilities, and stability of the foundation soils. Today it is common practice to support embankments on grouted unreinforced high-modulus elements constructed with a hollow-stem drilled-displacement tool, continuous flight auger, vibro concrete method, or similar—which have limited bending resistance. Practitioners often apply area replacement ratios and/or geosynthetic reinforcement to avoid column fracturing or add steel reinforcement in perimeter columns subjected to higher bending loads when cracking is anticipated. As industry attempts to use lower area replacement ratios to improve cost and construction efficiencies, determining whether or not unreinforced high-modulus columns can tolerate some degree of cracking and safely support embankments is a salient consideration. It has been recommended by some that column fracturing should be avoided altogether due to the perception that column fracturing is either a major culprit, or indication of, lateral instability in the foundation materials. The role of column fracturing on lateral spreading and performance of column-supported systems is examined with field performance data aggregated from case histories that is complimented with 3D finite element analyses of embankments supported on unreinforced rigid columns.

"Evaluation of Resin Injection for Liquefaction Mitigation Using Blast-Induced Liquefaction Testing", **Kyle Rollins**, Ph.D., P.E., M.ASCE

A variety of ground improvement methods have been developed for mitigating liquefaction hazard in saturated sands. While these methods are capable of producing significant improvement in liquefaction resistance, most of them cannot be used where infrastructure is already in place. In contrast, polyurethane resin injection techniques have the potential for treating liquefiable soils around pipelines, highways, and below building foundations. To evaluate the potential increase in liquefaction resistance that resin injection can produce, field testing was performed at treated and untreated sites within the "red zone" in Christchurch, New Zealand. Improvement was evaluated both with in-situ testing and subsequently with blast-induced liquefaction testing. Resin injection was performed to a depth of 6 m with 50 injection points in a triangular pattern with a center-to-center spacing of about 1.2 m. The injection produced planar fins and dikes that radiated out from the injection point and compacted the surrounding sand as the resin expanded. In-situ tests included cone penetration testing (CPT), dilatometer testing (DMT) and shear wave velocity testing. After treatment, cone resistance increased by 68%, relative density increased by 32%, shear wave velocity increased by 25%, and dilatometer modulus increased by 135%. The lateral at-rest earth pressure increased from an average of 0.61 to an average of 0.84 or 38% overall within the treatment zone. Resin injection also reduced the degree of saturation within the treatment zone. In-situ testing conducted three years after treatment showed that these improvements were generally sustained. Blast liquefaction produced liquefaction in both the treated and untreated areas because of the high intensity; however, the build-up was much slower in the partially saturated layers. Liquefaction-induced settlement was reduced by 50% in the treated zone and the liquefaction-induced settlement was consistent with predictions following liquefaction using CPT-based methods. Differential settlement was significantly reduced relative to untreated areas which was consistent with other ground improvement strategies where the surface crust was thicker and stiffer. The results from the field testing indicate that resin injection has a high potential for mitigating liquefaction particularly where existing infrastructure is already in place.

"Polymerizing lignin to stabilize soils and its water resistance", **Jie Huang**, Ph.D., P.E., M.ASCE

This study explored the possibility of using alkali lignin, a waste biomass from paper or biofuel industry, as a soil stabilizer to improve the soil strength and then assessed the degree of improvement and durability of the improvement. Different from existing attempts that used lignin or its derivative directly, this study utilized chemical polymerization to expand and interlink the lignin molecular chains to make the stabilization better. The polymerization involved cross-linking phenoxy radicals of lignin precursors to form longer molecular chains at the presence of an enzyme as a catalyst. In this study, soil was treated with different lignin contents (8%, 10% and 12%) under different water/lignin ratios (0.4, 0.6, 0.8, and 1.0) and then cured in air or heat for various durations (4, 7, 14, and 21 days). The test results showed the polymerized lignin can improve the strength much more than direct use of lignin. In addition, the lignin dosage played an important role in the improvement: in general, higher dosage led to higher strength but the strength may be compromised if too much lignin was added. The study further indicated that the strength can be 40% higher than the ones cured in the air if appropriate cured in an elevated temperature environment. The water resistance test disclosed that even though soil treated by polymerized lignin was more stable than the soil treated by lignin, it may not survive prolonged soaked. Other chemical stabilizer, such as lime, can be used jointly with lignin to enhance water resistance.