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RECENT ADVANCEMENTS TO ENHANCE PERFORMANCE & REDUCE RISKS IN DEEP FOUNDATIONS AND GROUND IMPROVEMENT

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ABSTRACT

The geo-structural deep foundation construction industry is a high-risk environment that is becoming more perilous and costly. Various techniques and approaches are used to mitigate risk beginning in the planning phases of a project then during construction and through maintenance and operation. However, available resources (e.g., financial, personnel, and time) are finite, where more is being asked to be delivered with even less. In recent years, due to imposed demands from owners, the industry has been tasked with delivering constructed facilities in shorter time, with more efficient use of resources, and to serve for even greater life cycles. As ideal project sites are becoming limited or scarce, the risk of satisfactory performance increases as the project demands increase. This paper will present recent advancements used to enhance performance and reduce risk in deep foundations and ground improvement that have been implemented with increasing use during the past two decades, and some within the past five to ten years. The paper will include a discussion of the technique, device, and/or approach along with practical applications, installation details, and select test results and observations.

- A Smart Cell is a closed-type tip post-grouting device that is attached to the bottom of the steel reinforcement cage of a bored pile (i.e., drilled shaft) and is used to enhance performance and to reduce uncertainty thereof. Unlike the tube-a-manchette system, control of the grout is maintained within the device during injection and a uniform stress is imparted across entire base area simultaneously, inducing a pre-mobilization load into the shaft as well as the soil. The greater amount of load that can be induced from the injection process, the greater amount of pre-mobilization and improvement in performance can be achieved.
- Although originally developed in the 1980s, the Expander Body (EBI) was enhanced due to implemented innovations to the system and was redeployed in the late 1990s/early 2000s. The EBI consists of three integrated components: a folded steel tube/shell with a circular cross section, a central reinforcement section, and primary and secondary grout delivery mechanisms. Primary grouting is performed to expand the shell while the secondary is to perform post-grouting below the pile toe. As grout is injected under pressure, the folded steel section contains the grout and expands outward into the surrounding soil, resulting in compaction or densification of the in-situ soils. The EBI has been added to the lower portion of various smaller diameter bored piles (e.g., CFA piles, micropiles, drilled displacement (DD) piles) and ground anchors to increase the axial resistance of the pile or ground anchor via enhancement of the side and end resistance.
- A Super Cell is a specially designed bi-directional static load testing device that utilizes built-in hermetically sealed pressure cells to apply large axial loads more economically, in less time, and in a much safer manner than conventional top-down static load testing methods. For these embedded cells, concrete flow around and through the device is enhanced due to (1) the open nature of the device, (2) the device being secured to the reinforcement cage without the use of large bearing plates, and (3) the use of cone-shaped flow guides that facilitate concrete flow and reduce buildup of laitance below and above the cells.

- Soil improvement methods have been used to minimize the consequences of liquefaction by changing the characteristics and/or response of a liquefiable soil deposit. Expediting drainage using in-situ vertical drains (earthquake drains or EQ-Drains) represents one approach to soil improvement. By decreasing the drainage distance from the depth of interest vertically to the ground surface to radially between the drains, vertical drains expedite the dissipation of excess pore water pressure and ensure that the generation of excess pore pressures in the soil remain below a prescribed value. EQ-Drains comprise two elements: a slotted corrugated plastic pipe, with a typical nominal inside diameter of about 100 mm (4 in), and a geotextile sock, which encases the EQ-Drain to minimize the flow of soil into the EQ-Drain while allowing the fluid to pass.