

Earthquake Proofing by Blast Densification

by Ulrich LaFosse, P.E.

At first blush, one might think that the words *blast* and *densify* are almost opposites, since blasting is usually used to break up or loosen materials and densification refers to making things more compact. However, blasting was exactly what GeoDesign, Inc. used to successfully prepare a site prone to liquefaction for the new Marine Corps Training Center at the Westover Air Force Base in Chicopee, Massachusetts.

Liquefaction is a process by which saturated, loose sand loses shear strength during seismic shaking and behaves like a liquid, rather than a solid. The result could be excessive ground settlement and probable damage to the proposed building.

Conventional methods to mitigate this problem consist of either bypassing the liquefiable zone completely by using deep foundations or improving the ground using methods such as dropping large weights from a crane, inserting vibrating probes, grout injection, or deep soil mixing. However, these methods are typically two to four times more costly than blast densification, take weeks to take accomplish, and, sometimes, are not effective for certain soil conditions.

Blasting, an uncommon, but effective, ground improvement method consists of detonating buried explosive charges of sufficient energy to collapse the loose soil matrix into a denser and more stable arrangement.

For this project small diameter PVC pipes were jetted to a depth of forty feet on a grid pattern, and instruments to measure ground surface settlement were installed between the pipes. Explosive charges were set in the pipes and detonated in two overlapping coverages with a one-week waiting period in between.

Within a few seconds after detonation, significant eruptions of water occurred at each pipe. This was immediately followed by sand boils caused by a quick-sand like condition at and near blast locations. Following this dramatic display of man-made liquefaction, the excess surface water drained within an hour following the blasting, and site groundwater levels returned to their pre-blasting level within one week. Recorded settlement of the

ground surface ranged from 3" to 12", with an average of 7". This corresponds to an average volume change of about 4 percent based on the estimated thickness of the treated zone.

Ground settlement and densification were completed within about three days following the blasting. This project demonstrated that deep blasting is an attractive approach to resolving the vexing problem of cost-effectively treating liquefiable soils that preclude the use of shallow foundations without improvement. While the application of the technique is emerging for use in non-urban areas, it is sufficiently well-understood to provide a flexible and cost effective alternative to the more commonly used ground improvement methods. ■



Sand boils erupting 10 seconds following blasting at the Marine Corps Training Center at the Westover Air Force Base in Chicopee, Massachusetts.



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von Rosenvinge Elected to The Moles

On May, 2, 2007, Theodore von Rosenvinge, IV, P.E., CEO, GeoDesign, Inc. Geotechnical and Environmental Consultants in Middlebury, CT, was inducted into The Moles at the New York Hilton Hotel. The Moles membership is limited to 538 active members. The Moles, a fraternal organization of the heavy construction industry, is the most prestigious organization of its kind in the world. The Moles members are leaders in their profession who are dedicated to promoting the industry and supporting their colleagues through outreach programs and networking opportunities.



Often working underground, they change the face of the earth, building tunnels, dams, highways and bridges. In 1950, former president Herbert Hoover received one of two annual outstanding achievement awards and was labeled the "Grand Old Mole" for his engineering expertise. von Rosenvinge is a Registered Professional Engineer and a Fellow of the American Society of Civil Engineers. He was named the 2005 Connecticut Engineer of the Year by the American Council of Engineering Companies (ACEC), is past president of ACEC/CT and a director of ACEC national. ■



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