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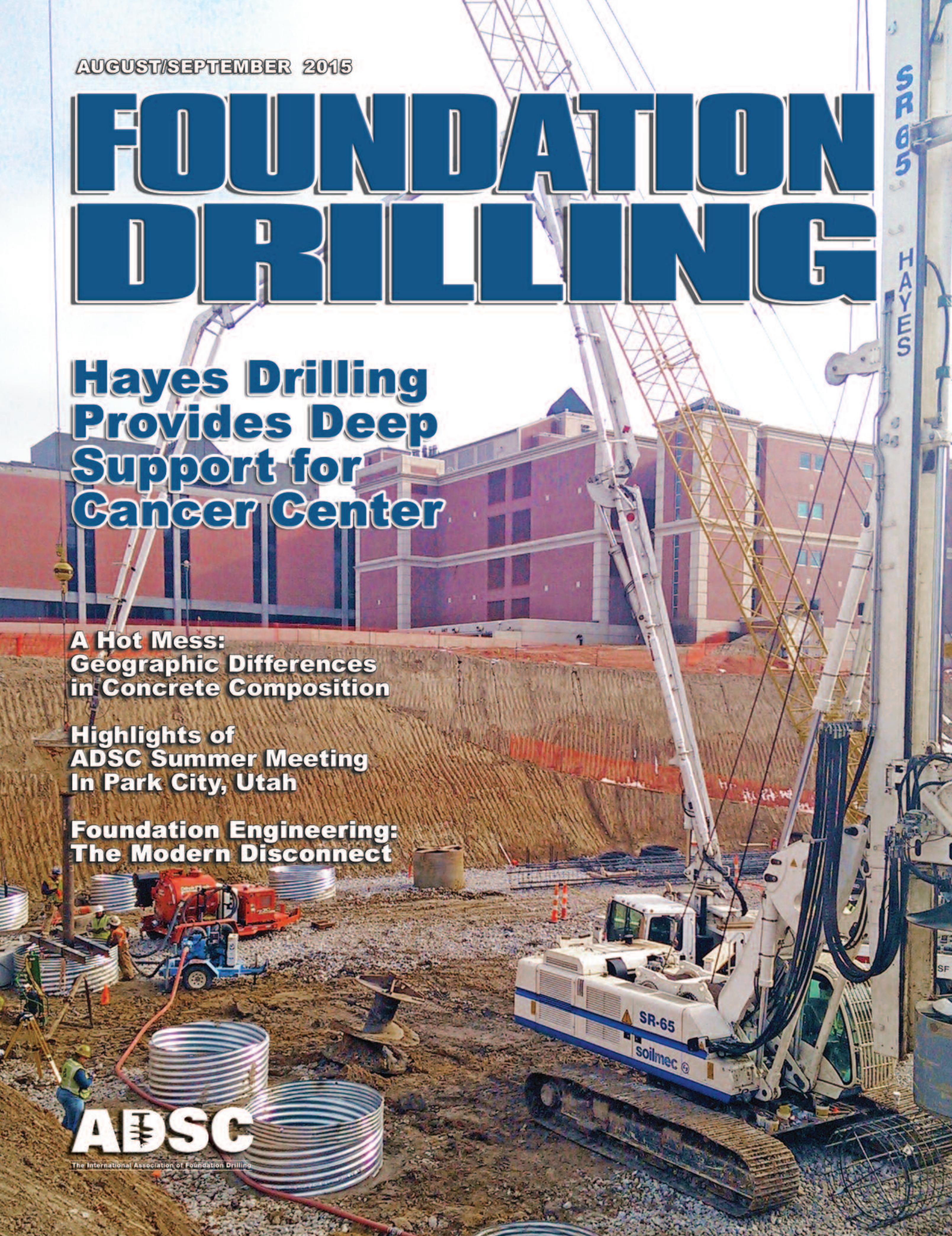
FOUNDATION DRILLING

Hayes Drilling Provides Deep Support for Cancer Center



A Hot Mess: Geographic Differences in Concrete Composition

Highlights of ADSC Summer Meeting In Park City, Utah

Foundation Engineering: The Modern Disconnect

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Hayes Drilling, Inc. installed 182 drilled shafts that ranged from 36 to 72 inches in diameter and from 50 to 110 feet in length.

Cover Feature

Hayes Drilling, Inc. Provides Deep Support for Cancer Center

By Antonio Marinucci, Ph.D., MBA, P.E., American Equipment and Fabricating Corp., and Jeremy Bennett, Hayes Drilling, Inc.

Established by the University of Nebraska, the Fred and Pamela Buffett Cancer Center (formerly the Eppley Cancer Center) is expected to revolutionize cancer research and patient care, and to coordinate all cancer research activities across the entire university. The Center "will bring together elements that aren't commonly associated with cancer care, including music and fine art, meditation and yoga," wrote Director Kenneth H. Cowan, MD, Ph.D.

Named for Fred and Pamela Buffett in recognition of a gift from the Rebecca Susan Buffett Foundation, the proposed $370 million Cancer Center will be home to state-of-the-art cancer and ambulatory care centers located at 45th and Dewey Streets in Omaha, Nebraska. Within the nearly 600,000 square foot Cancer Center, three dedicated areas will be established: a inpatient hospital with up to 108 beds, a tower with 98 research laboratories, and a multidisciplinary ambulatory (non-cancer) outpatient center.

Given the site's relative proximity to the New Madrid seismic zone, a seismic analysis was performed to determine the design response spectrum for the site and the structural response to the design event.

The research tower will span about 252,000 square feet over ten floors, and will be dedicated to researching various types of cancer (e.g., pediatric, breast, prostate, and lymphoma), to cancer vaccines, and drug development. The inpatient/outpatient treatment facility will be spread across seven floors covering an area of about 325,000 square feet, and will house dedicated areas for clinics, infusion, and radiation; therapy, surgery, radiology, and collaborative treatment/diagnostics; and an inpatient hospital.

Site Conditions

Terracon Consultants* performed the field investigation and laboratory testing to determine the ground conditions, subsurface profile, and design parameters for the proposed site. As reported in the "Geotechnical Engineering Report - Comprehensive Cancer Center & Ambulatory Center" (Terracon, 2013), the general subsurface profile is composed of a layer of fill and lean clay to a depth of about 18 feet, underlain by a layer of stiff to very stiff lean clay to a depth of about 43 feet, which is then underlain by glacial till (Nebraska Till). The groundwater table, as determined from two piezometer wells, was located at a depth of about 26 feet, which is approximately 29 feet below finished floor level of the basement.

Foundation Design Considerations

The proposed buildings will be constructed using a cast-in-place, reinforced concrete frame structure. Given the site's relative proximity to the New Madrid seismic zone, a seismic analysis was performed to determine the design response spectrum for the site and the structural response to the design event. Accordingly, per the contract documents, the anticipated maximum loading imparted to the foundation(s) include column loading of 2,500 kip/each, wall loading of 5 kip/LF, and an area load of 100 psf acting on the grade beams.

The shear strength parameters for the distinct layers within the soil profile were estimated based on N-values from the soil borings, cone tip and sleeve friction from the cone soundings, unconfined compressive strength, Pres-

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Drilled shafts were in close proximity to existing structure.

Completed basement core was on the critical path.

suremeter test results, and Osterberg O-Cell test results. Based on the field and lab test results, Terracon established that the allowable compressive skin friction for the Glacial Till above

Drilled shafts were chosen as the preferred foundation system because of economic advantages offered where a single shaft can be used to support large column loads without the need for a pile cap.

and below a depth of about 20 feet was 1,200 psf and 1,600 psf, respectively; the allowable compressive skin friction for the Outwash and Nebraska Till was 2,000 psf; and the allowable end bearing in the Outwash and Nebraska Till was 20,000 psf.

The research tower and inpatient/outpatient treatment facility will be supported on straight-sided drilled shafts bearing in the Nebraska Till. Drilled shafts were chosen as the preferred foundation system because of the economic advantages offered where a single shaft can be used to support large column loads without the need for a pile cap.

Drilled Shaft Construction

Working under contract to Kiewit Construction*, Hayes Drilling, Inc.* began construction of the drilled shafts for the research tower and clinical treatment facility in December 2013 and completed its work in September 2014. Utilizing a Soilmec SR-

Hayes scope included alignment of all reinforcing steel cages.

625* drill rig for almost all of the drilling on the project, Hayes Drilling, Inc. installed 182 drilled shafts that ranged from 36 to 72 inches in diameter and from 50 to 110 feet in length. In total, Hayes Drilling constructed approximately 10,000 linear feet of drilled shafts resulting in about 13,000 cubic yards of concrete poured (averaged around 1.5 completed shafts/day).

Low headroom nightwork was required at the front entrance.

For the foundations supporting the new building structure, the site was sloped down approximately 15 to 30 feet in order to perform the site preparation work, the construction of the basement level, and utility installation. Excavating the soil down to the required elevations significantly reduced the amount of drilling, casing, and time needed to construct the drilled shafts. At the subfloor elevation, corrugated metal casing was installed for multiple reasons: (a) to provide radial support at the ground surface to prevent borehole instability, (b) to provide formwork for the top of the drilled shaft, (c) to be used as a reference marker for concrete placement to ensure the required grade beam elevation, and (d) to provide a good working surface for a potential construction joint at top of drilled shaft.

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Due to the possibility of water-bearing sands, perched groundwater, and instances of relatively soft soils, Hayes Drilling used the wet method technique in which polymer slurry was used in conjunction with steel casing to successfully construct the drilled shafts. The embedment depths into the Nebraska Till in which the drilled shafts were tipped ranged from 5 to 25 feet depending upon location within the structures' footprint. To minimize the amount of time the hole remained open, the reinforcement cage, with tubes, where required, for the Crosshole Sonic Logging (CSL) testing, and concrete were placed soon after the borehole was drilled.

Displacing the slurry during placement, concrete, with a slump between 6 and 8-inches, was pumped through a tremie pipe. The project specifications required a concrete mixed design with a minimum 28-day compressive strength of 4,000 psi. To achieve both

To assure a quality product, approximately 10% of the drilled shafts (20 each) were tested using the Crosshole Sonic Logging test method, where no defects or integrity issues were found.

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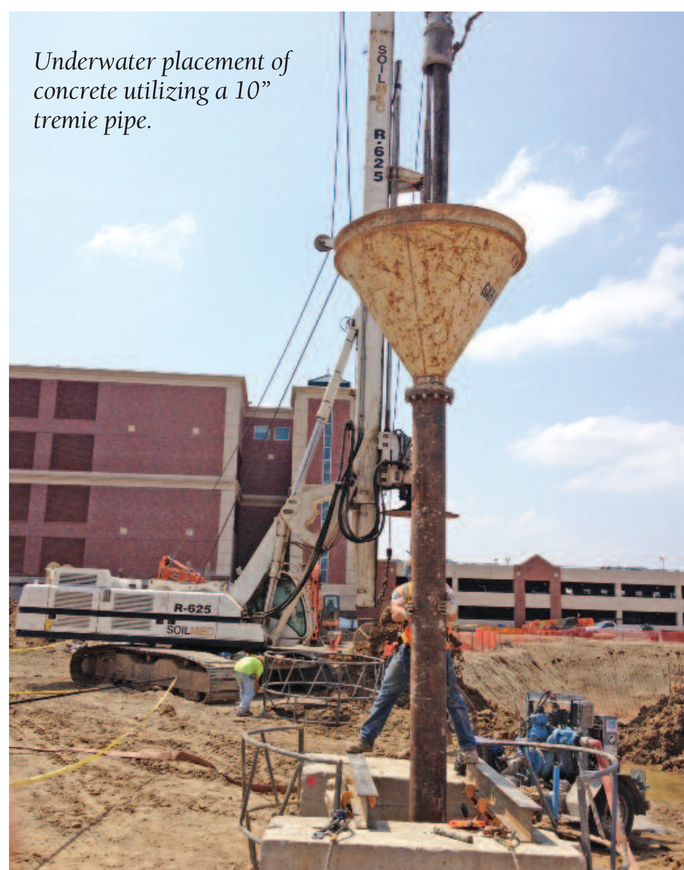

Underwater placement of concrete utilizing a 10" tremie pipe.

Drilling of main level shafts.

strength and workability, the mix design incorporated the use of fly ash, a water reducing/retarding admixture, and a high range water reducer (a superplasticizer to provide workability during concrete placement). To assure a quality product, approximately 10% of the drilled shafts (20 each) were tested using the Crosshole Sonic Logging test method, where no defects or integrity issues were found.

Construction Challenges

In the area adjacent to the main entrance of the hospital, two drilled shafts approximately 40 feet in length were constructed using a limited access drill rig. Since this is an active hospital and a frequently used entrance, the drilling in this area had to be performed at night. Given the subsurface conditions and contractual restrictions, permanent steel casing was utilized to support the borehole and form the drilled shafts. By using permanent casing, potential disruptions and the time required to perform the construction work in this critical and highly trafficked area could be minimized.

Another challenge to constructing the drilled shafts at this site was weather conditions, especially since most of the drilled shaft construction was performed during winter. From December 2013 through February 2014, the temperature in Omaha, Nebraska ranged from a high of 65°F to a low of -11°F, with average high and low temperatures of 32°F and 11°F, respectively.

Although there were minimal weather-related delays to the overall schedule, the bitter cold temperatures during the winter

Drilling adjacent to backfilled basement walls

Rendering of completed Buffett Cancer Center Project.

months added another layer of complexity to this project. For the majority of the work, the drilling and installation operations went relatively well. Preventing the slurry from freezing, however, wasn't as easy. During the winter, the slurry tanks were wrapped and insulated with concrete blankets, and straw bales were stacked on the north facing walls of the tanks. As an added measure, Hayes Drilling also used tank heaters and wrapped the valves with heat tape.

Besides the cold weather, there were ground related complications due to unstable, caving soils and loss of drilling fluid, both of which required a change to the planned drilling operation. In some of the boreholes, fluid loss occurred at depths between 48 and 60 feet, coinciding with the glacial sand strata, which contained varying amounts of gravel. Towards the end of the work with about 20% of the drilled shafts left to be constructed, there was a substantial loss of drilling fluid realized during drilling. Stressing the importance of containing the slurry for more than just borehole stability, drilling fluid was noticed in the storm sewer/water collection basin in the nearby parking structure. Various additives were tried and mixed with the polymer slurry to mitigate the fluid loss but each proved to be unsuccessful; consequently, maintaining borehole stability with polymer slurry alone was not sufficient. Per the contract specifications, the use of bentonite slurry on this project was not allowed.

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For a few locations where the glacial sand layer and, therefore, fluid loss was minimal, the integrity of the boreholes were maintained by supplying more slurry (to offset the fluid loss) during drilling and concreting. In other locations were the fluid loss during drilling was substantial, the boreholes were backfilled with a mix of excavated soil and lean mix, and were then re-drilled at a larger diameter using permanent casing. As a result, the owner issued a change to use permanent casing, which added cost to the project but was successful in maintaining borehole stability for the affected drilled shafts.

The installation of the drilled shafts was completed on time and on budget (excluding the change for the purchase of permanent casing). Work on the superstructure is ongoing, and the Cancer Center is expected to be completed and operational in the fall of 2016.

**Indicates ADSC Member.*

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Project Team

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General Contractor:	Kiewit Building Group, Inc.*
	Phil Spencer, Project Manager
	Brent Clausen, Project Engineer
	Jason Bauer, Job Superintendent
Specialty Foundation Contractor:	Hayes Drilling, Inc.*
	Jeremy Bennett, Project Manager
	Bob Gade, Superintendent
	Chad Keillor, Superintendent
	Adam Nash, Foreman

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