BY CHRIS OURAND

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Foundation Problems Evaporate for Maryland Plant

In early 2008 the Frederick County (Md.) Division of Utilities and Solid Waste Management awarded a $72.9 million contract to expand its New Design Road Water Treatment Plant (NDRWTP). The project nearly tripled the size of the treatment plant's capacity from 8.8 to 25 mgd and included expansion of a presedimentation basin, rapid mixers, three flocculation basins, three sedimentation basins, six filters, four filter effluent pumps, an ultraviolet disinfection system, and a high-service pump station. In addition, modifications and upgrades were made to the system's existing sedimentation basins, rapid mix area, and filters. Finally, the project added a new backup power system.

At the outset of the project, the general contractor was fine with estimates of what would be required to get the job done. The project owner was, too, because the cost estimate had come in at less than had been expected. Instinct, however, told Jon Bennett, chief engineer with Purcellville, Va.–based Geostructures, that foundation support for the water treatment plant would be more difficult to achieve than the initial projections indicated. The karst terrain around Frederick County—signified by surface depressions, underground cavities, and even sinkholes—had a track record for creating construction chal-

Micropiles are engineered to withstand from 20 to 200 tons each in soil at depths of up to 100 feet. The small 7-inch-diameter micropiles are lower in cost than conventional piles or caissons that can be up to 40 inches in diameter.

lenges and made for a certain level of skepticism.

"It's always a challenge to find suitable rock in these conditions, so we have to apply our design–build approach to make sure the right solution gets deployed and there are no settlement problems for the life of the structure," Bennett said. He's in a good position to know. As an active contributor to industry organizations that have developed specifications for foundation support systems, Bennett understands the detailed practices for planning, design, and construction of various foundation structures. He can also attest to the potential danger of building on weak soils where differential settlement can crack walls and floors, leading to costly downtime and repairs. To cover all bases and satisfy the owner and general contractor, Bennett and his design–build team ran several scenarios for subsurface stabilization at the NDRWTP.

A traditional, deep foundation solution such as driven piles or caissons would work well if the terrain were more predictable. However, the "pinnacled" limestone and complex site geology meant that piles would not penetrate easily or uniformly to a bedrock layer. Another option, Rammed Aggregate Piers®, has worked on other sites but was not considered here because of the thickness of the weak soil layers (50 ft or more) and the variability of depth to rock because of the karst conditions. These conditions are formed by underground water flows and lead to characteristic cavities that are costly to fill and difficult to reinforce.

In consultation with the geotechnical engineers at Rummel, Klepper and Kahl, the GeoStructures team recommended and proceeded with the installation of micropiles. Designed with casing that incorporates a sacrificial steel allowance for dealing with a potentially corrosive environment, micropiles provide both tension and compression resistance when they are drilled through overlying weak layers of soil and then "socketed" into bedrock. This transfers the structural loads from a footing to the rock.

"We drilled the first two test piles down 100 feet to get a rock socket in suitable material," said Bennett. "We make judgments along the way based on drill penetration rates and rock composition so we can have a solid comfort level when there is satisfactory material for load transfer. When necessary, we use specialized low-headroom equipment to fit under any overhead obstructions when the rigs or other conditions inhibit conventional deep foundation installations."

Micropiles are engineered to withstand anywhere from 20 to 200 tons each in soil at depths of 100 ft. Their load capacity is verifiable through tension or compression testing. The strength of the 361 micropiles installed at the NDRWTP comes from their high-strength steel casing and internal grout. The small, 7-in.-diameter micropiles result in a lower material cost when compared with conventional piles or caissons that can be up to 40 in. in diameter, and they can be more efficiently designed to deal with a wider variety of loading conditions and subsurface chal-

The unpredictable karst terrain of Frederick County, Maryland, made micropiles a more dependable choice for building the foundation for the expansion of the New Design Road Water Treatment Plant.

lenges. With the projected tripling of plant capacity to 25 mgd multiplied by 8.3 lb/gal, the plant's new filter building would exert significant pressure on the pervious ground.

"There's an irony somewhere in us having to fix the underground, water-caused problems before we can provide the aboveground water treatment service," said Brad Smith with the project's general contractor, Fru-Con Construction. "But that's what can happen, and it's a significant-enough issue that it can alter scheduling. We've shifted our priorities by starting other structures earlier than planned to keep crews going."

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To the industry, proper foundation support is a consideration that may become more of an issue than operators realize. According to a recent survey in *Water and Wastes Digest*, one third of respondents are planning construction of new facilities in the next 24 months, and 44% are planning upgrades in the same time period.

WIDER USE CREATES NEED FOR UNIFORM STANDARDS

Micropiles have been used for decades, but GeoStructures' Bennett notes that they are gaining popularity among geotechnical engineers and builders because of their design versatility, cost advantages, and strength. The Federal Highway Administration led the way in micropile technology in the late 1980s and early 1990s by developing standard design guidelines. Over time, other standards and code documents have been published with varying design guidelines in terms of allowable stresses for the structural and geotechnical design of micropiles. The standards contained within these various guidelines do not always agree. When builders are designing a project that uses micropile technology, caution should be taken. These different perspectives can be confusing when specifying and producing preliminary designs.

In 2006 the International Building Code adopted its provisions for micropiles, leading to an even wider application throughout the United States. NDRWTP was designed to this standard, notes Bennett, and greater awareness of the differences in standards is leading toward greater safety and project efficiency.

"Micropiles are being used increasingly in a variety of applications, from foundation support or retrofitting to slope stabilization and earth retention. Increased industry research and development efforts and design standardization mean valuable time will be spent designing for the right load capacity instead of simply focusing on which standard to use," he affirms.

The $73 million NDRWTP expansion was chosen over a new plant because of a lack of available land in the county in proximity to the source—the Potomac River. The plant will become operational in 2010 and will serve nearly 80,000 households.

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