1,133 Feet of Microtunneling

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Bradshaw Construction Corporation (Bradshaw) recently completed a single 1,133-foot-long microtunnel drive of 96-inch OD Permalok steel casing for the Metropolitan Sewer District (MSD) of Louisville & Jefferson County, Kentucky. This paper highlights certain challenges of slurry microtunneling long drives of steel casing in fine-grained soil conditions, as well as project specific difficulties related to the microtunneling and installing two carrier pipes to design grade through a single casing.

The River Road Interceptor project was designed to improve MSD's sewer network. It is located partially within the City of Prospect, Kentucky. The scope of the project included a 42-inch gravity sewer and 30-inch PVC force-main installed underneath Harrods Creek, U.S. Highway 42, and then Harrods Creek again. The project was designed with six separate trenchless crossings. The contract geotechnical report indicated the trenchless crossings would be installed through a full face of silt, well below the water table, with an approximate depth of 35 feet, to invert from the ground surface.

The bidding process allowed the contractor to propose an alternative trenchless design and installation method with their bid. Bradshaw proposed one long, larger-diameter trenchless installation in lieu of the six designed. This would allow both sewer lines to be installed within a single jacked steel casing. To accomplish this, the casing diameter was

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increased to 96 inches and the three relatively short trenchless crossings increased to 1,133 feet in length. Slurry microtunneling was chosen for the installation method because the casing was below the water table in silt and there was less than one diameter of cover at both crossings of Harrods Creek. The casing grade was set to that of the 42-inch gravity sewer and a custom cradle designed and built to ensure proper grade of both sewer lines.

Flynn Contracting (Flynn) bid the project using Bradshaw's alternative trenchless design and method. They were awarded the project and subcontracted the trenchless work to Bradshaw.

Geology & Environment

With the proposed single-drive alternative, one of Bradshaw's primary focuses was to understand the ground conditions to be encountered. The ground needs to be excavated, transported, and separated for the slurry-based microtunneling system to work. Although the contract geotechnical report detailed a full face of silt, Bradshaw obtained additional soils information to better understand the behavior of the soil. Key parameters to understanding ground behavior include geological makeup, particle size distribution and plasticity index. This information was used to determine the type and size of the slurry separation plant and then supplementing them as needed. Even with the additional pre-construction soil borings, the soils encountered contained a greater percentage of plastic clays than anticipated.

In addition to the geological conditions, weather and potential flooding was a significant factor when planning this project. The elevation of Harrods Creek is highly dependent on the Ohio River, which fluctuates greatly depending on regional and local rainfall events. The choice of a single longer drive increased the exposure time to potential flooding. Bradshaw therefore chose to do the construction in the dry-season. However, even with this precaution, the project experienced a few flooding events. Flynn and Bradshaw were prepared with contingency operations to keep the microtunneling equipment from being damaged from flooding.

Microtunnel Construction

Bradshaw analyzed and adjusted the tooling of the MTBM cutter wheel, optimized the slurry line transport lines, mobilized four centrifuges and a de-silter, and implemented a unique polymer injection system at the point of separation. In addition, Bradshaw made contingent resources available to minimize stoppages. This proved critical since the jacking forces experienced were high due to the long drive, soil conditions, and shallow cover under the creeks. Among other features, Bradshaw provided intermediate jacking stations in the Permalok casing and a high-volume bentonite lubrication pump.

Another challenge with long drives includes access to the MTBM for any routine maintenance or unexpected repairs, as well as surveying. Due to the jacking length, Bradshaw implemented three layers of alignment and grade checks. These included the standard tunnel laser, self-performed and outside subcontractor survey checks. Bradshaw recommends any subcontracted surveying be quality-control checked on a regular basis, as many surveyors do not understand the necessity for accurate results, or the potential for atmospheric laser deflection within a jacked casing environment.

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After completion of the microtunneling, Bradshaw restrained the casing against floatation beneath the Harrods Creek crossings by installing a concrete cradle to counterbalance the flotation pressure, as well as welding many of the Permalok joints.

Carrier Pipe Installation

The two sewer lines were installed on a custom-built steel cradle one pipe joint at a time, surveying the invert of each joint. Although this process took substantial time, it was the only way to ensure the gravity line was installed to the 0.037% design grade and the forcemain had the specified clearance with no peaks to trap air.

Bradshaw assisted Flynn with the testing of the sewer lines by building a 71-ton capacity thrust restraint in each shaft. After successful pipe testing, Bradshaw backfilled the annulus between the sewer lines and the casing with a foam entrained cement slurry mix. This "cellular" backfill mix required on-site engineering quality assurance to verify the specified air-entrainment and unit weight goals were reached.

Large-diameter and long-length microtunnel drives can be successfully completed with a great deal of planning and an experienced microtunneling contractor. This type of project also necessitates the use of an on-site engineer full-time for problem solving and quality assurance. Such microtunnel drives necessitate a thorough soils investigation program as well as understanding those results in terms of properly excavating, transporting, and separating the microtunneled soils. As illustrated by this project, allowing a prudent trenchless contractor to implement alternative means and methods of construction can lead to a more efficient design which provides the desired product at less cost to the owner.