Existing pipe curve. ***Inset:*** *Insertion of three-foot joints for curve*

Difficult Slipline Necessitated Innovative Solutions

by Michael Spero, P.E.

The $8.9 million Henrico County, VA, Fourmile Creek Trunk Sewer Rehabilitation Project Contract No. 1 involved sliplining 4,000 feet of 84-inch deteriorated concrete sanitary gravity sewer pipe with 72-inch fiberglass pipe.

The project is in a growing suburban area east of Richmond, VA. It involved six horizontal curve sections and three crossings of a major interstate highway. Although there was enough room to slipline with a 78-inch liner pipe, the design engineer and owner decided to specify a 72-inch liner pipe due to the uncertainties of the condition of the pipe and the curved sections. This major interceptor sewer is very active and flows about half full most of the time – significantly more during wet weather.

The straight sections of the existing sewer required a relatively standard slipline operation using 20-foot lengths of fiberglass low profile bell slipline pipe. However, the curves were of a very short radius, averaging 170 feet and the average length of curve was 100 feet. The curves in the existing host pipe consisted of chords which were created by using 16-foot sections of reinforced concrete pipe (RCP) with a 5 degree bevel on one end of the pipe. The original design concept at the curved sections, developed by Greeley & Hansen LLV and contained in the bid documents, required the construction contractor to: excavate to the existing pipe spring line, install permanent sheeting with an impermeable liner, place a concrete work mat between the pipe and sheeting, remove the top half of the existing RCP, install the fiberglass reinforced pipe (FRP) liner and fill the annular space and excavation to the elevation of the top of the host pipe with cement grout. The existing RCP had a wall thickness of 8 ¾ inches with two layers of reinforcing steel. This would take a considerable amount of labor, materials and equipment by the contractor.

Modifying the bid

Future Pipe Industries (FPI) was selected to supply the fiberglass low profile bell liner pipe. The original bid proposal by FPI for the curve sections was to supply 16-foot pipe lengths with a 5-degree single miter bend near one end that would be laid in the bottom of the existing RCP with the FRP miters in the same location as the existing RCP bevels. The contractor, Spiniello Companies, asked FPI to see if there was any way to slipline through the curves to eliminate the costly excavation, pipe cutting and removal and extensive grouting. Normally, in order to slipline through a curved section, short pipe lengths are required. Due to the short radius, this would require 1.5 foot-long pipes which proved impractical. Standard low profile bell joints use a coupling laminated to the pipe end to form the bell and a grooved spigot with an O-ring gasket. In order to negotiate these small radius curves, the joint design needed to allow significantly more deflection than the standard-use sections with a practical length and provide for ease of installation.

FPI recommended using three-foot long pipe sections with gasketed spigots at both ends and a double bell floating coupling. Also, a coupling stop ring was bonded to each pipe to prevent the coupling from moving during the slipline push operation. This configuration would allow three times the standard joint deflection. Although the FPI standard low profile slipline pipe has a single O-ring on the spigot, it was decided to put 2 grooves and O-rings on each spigot to ensure a tight joint and account for the numerous unknowns about the condition and alignment of the existing pipe to be lined.

Sam Silva, the Spiniello Companies project manager, agreed to try using these short joints for two of the pushes. The first push was 470 feet with 189 feet of three-foot pipe sections in the lead to go through the curve followed by 280 feet of 20 foot pipe sections. The insertion pit was in the median of I-295 and transverses three lanes of the interstate highway. The push was successful in that the three-foot pipe sections negotiated the curve. The existing RCP in the last part of the curve had been exposed and the top of the pipe partially removed to observe the effectiveness of the short liner pipe sections. The liner was inspected by a closed circuit television (CCTV). Due to the flow, only the upper half of the liner pipe was visible. Most of the joints were observed to be closed except that there appeared to be some liner pipe joints that were over-deflected. Since it was impossible to accurately measure the joint gap using the CCTV, the top of the RCP was removed at these locations and it was confirmed that the joints were indeed over-deflected.

Apparently, after the push was completed, the liner pipe settled in the bottom of the straight sections of the existing RCP and over-deflected near the location of the existing bevel joints. The high sewage flow probably contributed to the liner movement. At all these joints, at least one of the spigot O-ring gaskets was fully engaged within the coupling and this single gasket would have sealed against leakage. Since the pipe had double gaskets the engineer and owner were more comfortable with both gaskets fully engaged. It was decided to shift the pipe on either side of the joint towards the center of the curve to reduce the gap and then move the coupling so that both O-rings on each spigot in question were fully engaged. This was done quite easily by using small hydraulic jacks. The operation was successful and the previously sliplined section was then grouted and no leaks were observed.

Choices

At this point Spiniello had three choices:

- Continue using the three-foot pipes, excavate and expose each questionable joint and re-align (this was not favored by the engineer or owner);
- Go back to the original concept of removing the top half of pipe at all curves; or
- Redesign the joint to allow more deflection and devise a method to prove that the installed joint is acceptable.

Option three was the preferred alternative. Based on these findings, FPI modified the joints using a longer coupling and moving the gaskets closer to the end of the spigot to provide for increased allowable joint deflection by providing more joint offset with the gaskets still fully engaged within the coupling. Also, lines were painted on the interior of the coupling that would only be exposed if the joint was over-deflected. This provided a “go, no-go” means for the owner and engineer to confirm by CCTV that the integrity of the joint was not compromised.

In all the subsequent pushes of FRP liner pipe through curves, the sliplining operation went smoothly and all joints were accepted without any additional work required. The grouting operation also was successfully completed without any leaks.

This project is an example of how a material supplier can work with a contractor to develop and analyze alternatives – essentially a form of value engineering – and reduce costs. Also, when the initial alternative concept did not obtain the full desired results, the supplier was able to modify the approach and overcome the difficulties. The success of this project also involved the cooperation of an open-minded engineer and owner. Many years ago a former engineering mentor suggested that this type of cooperative problem solving constituted “an elegant solution.”

About the author: Michael Spero, P.E., is currently the manager of engineering for Future Pipe Industries. His work history also includes a long tenure with Kellogg Brown & Root as a sewer and water infrastructure engineering manager.

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