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When You're Done, Are You Really Done?

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1. ABSTRACT

As part of a Florida Department of Transportation (FDOT) Interstate I-75 Improvement project, an existing bridge on Fowler Av. over the Hillsborough River was to be replaced. The Hillsborough River is an Outstanding Florida Waterway and a very sensitive environmental area. The City of Temple Terrace had an existing 12 inch force main (FM) attached to the bridge that required replacement. Cardno TBE was retained to provide design, permitting and construction administration services for the City to relocate their utilities for the project. The utility relocation design included a subaqueous relocation of 1,000 feet of 12-inch sanitary sewer FM beneath the Hillsborough River by horizontal directional drilling (HDD).

The geotechnical investigation revealed that the soils encountered were sandy soils underlain by weathered limestone/calcareous clay and chert. The chert material had a relative Moh's hardness of 7. The boring logs also noted a loss of circulation.

The HDD operations presented its own unique challenges due to the chert and maintaining circulation. However, after the FM was constructed and in order to construct the new bridge over the Hillsborough River, FDOT allowed the contractor to construct temporary piles to enhance crane activities, adjacent to the FM. Due to the subsurface conditions and the close proximity to the FM special requirements were initiated to maintain the integrity of the FM.

2. BACKGROUND

As part of a Florida Department of Transportation (FDOT) I-75 Improvements, Cardno TBE was retained to provide design, permitting and construction administration services for the City to enter into a Utility Work by Highway Contractor Agreement (UWHCA) with the FDOT. The UWHCA allows the prime roadway contractor to coordinate and relocate utilities under the FDOT contract.

One of the utilities that required relocation was an existing 12-inch force main that was attached to the Fowler Avenue Bridge over the Hillsborough River (see Fig. 1). The force main was attached to the north bridge (west bound) that was scheduled to be replaced. Since this section of the force main could be routed to flow in either direction and it could also be placed out of service for an extended period of time, we originally requested that we be allowed to attach to the new bridge structure. However, the FDOT did not want utilities attached to the new structure so we had to find an alternative method of installation. Subsequently as part of our utility relocation design work we designed a subaqueous relocation of 1,000 feet of 12-inch sanitary sewer FM along SR 582 (Fowler Avenue) beneath the Hillsborough River. The Hillsborough River is and Outstanding Florida Waterway and a very sensitive environmental area. The material of choice for this project was Fusible polyvinylchloride pipe (FPVC) so that the bore hole could be keep to a minimum.

Figure 1 - Fowler Avenue crossing the Hillsborough River - Looking North

3. GEOTECHNICAL INVESTIGATIONS

The geotechnical investigation revealed that there was chert in the ground formation. The geotechnical report stated "It should be noted that chert was encountered within the SPT borings performed. This material can be very hard and difficult drilling conditions were encountered during performance of the borings. Based on a review of available data regarding this material, it should be anticipated that the Chert material has a relative Moh's hardness on the order of 7. The Contractor should be prepared for difficult drilling conditions into and through this material." In addition drilling fluids were lost during the geotechnical work indicating potential for sinkhole activity and loss of drilling fluid during the horizontal drilling operation.

4. DESIGN

The design of the proposed crossing had the deepest elevation of the HDD pipeline beneath the river at -25-feet. Ground surface elevations varied from app +30 to +40 feet in the vicinity west and east of the river. The river bottom is approximately 8-feet deep at the site and is at approximately elevation + 14-feet. The crown of the HDD bore was approximately 38-feet beneath the river bottom. The entry and exit angles were 12 degrees, and the vertical curve radii were 1,000-feet. The geometry of the bore profile provided a reasonable installation for the 12-inch diameter fusible PVC pipe material for the FM. Conductor casing extending into limestone was specified at the entry and exit locations to help maintain circulation and reduce hydrofracture risks**.**

During design coordination with the FDOT and other utilities, the only other existing utility on the north side of the bridge, where we planned to construct the new FM pipeline, was an existing 14-inch subaqueous high pressure gas main. We had plenty of room both vertically and horizontally to provide adequate separation between the two pipelines and allow for some variance due to the hard geological conditions.

5. CONSTRUCTION

Shortly after construction had started on the roadway project and prior to the HDD of the City's new FM, another gas company was onsite to install a 6-inch low pressure gas main approximately twenty feet horizontally south of our proposed alignment. We anticipated that we would have approximately 28-feet of vertical separation between the two utilities but because of the underground conditions we expected their bore path to vary from the anticipated alignment. The contractor for the gas main experienced difficult drilling conditions and had to restart drilling activities on several occasions. They estimated that the gas main was installed approximately 8-feet below the river bottom. Another matter that complicated our installation was that during the pilot bore for the 6-inch gas main they did not precisely track the actual vertical and horizontal location of the drill rods as they crossed the river. The only reliable as built information provided for the gas main was the entry and exit locations.

After the 6-inch gas main was installed the sub-contractor for the City's HDD work mobilized. To accurately locate and guide the bore, specifications required the use of a wire-line steering system with TruTracker.

Basic components of a wire-line steering tool include a down hole probe placed inside a nonmagnetic drill collar near the drill bit, wire connecting the probe to an interface unit on the drill rig, readout box, and computer and printer at the driller's station.

The probe's accelerometer measures gravity and resolves the tool's vertical-horizontal inclination. A magnetometer measures the earth's magnetic field and dip angle to resolve the tool's relationship to magnetic north. Information is transmitted to the interface unit that connects to a laptop computer and printer. The readout box provides the driller with constant updates of drill head roll, pitch and direction. Wireline systems usually are used with a Tensor TruTracker surface grid system – special software and wire coil placed along the line of the drill path (Fig. 2). TruTracker provides a method of verifying that data from the wireline system are not being affected by magnetic forces or other interference and will provide an accurate alignment of the drill path.

Figure 2 – Wire Coil placement for TruTracker – Looking West

After the guidance system was installed the contractor started the pilot bore and was unsuccessful in maintaining the proposed bore path. After several attempts the contractor requested that they be allowed to vary the bore path depth due to the hard material that was encountered. After several unsuccessful attempts the original bore path was not stable and they could not get confining material to use as guidance. We agreed to allow the contractor to move the entry pit approximately 140 feet east which also shortened the length of the bore.

After remobilizing to the new entry point and several additional attempts the pilot bore was successfully installed across the river bottom. The exit point of the drill head was approximately 3-feet north of the designed exit point.

The contractor started back reaming and successfully completed both the 16 and 20-inch back reaming requirements prior to the product pipe pullback.

Due to limited layout space for fused pipe, three strings of ~320LF each were pre-fused and two intermediate fuses occurred during pull back. The specifications also required the pipe to be full of water during pullback. The hardness of the FPVC was beneficial in pulling through these significant rock conditions. The FPVC pipe that saw full bore path pull back was inspected and wasn't gouged to meaningful degree (FPVC can be gouged to 10% of wall thickness without impacting pressure rating).

The new FM pipe was subsequently pressure tested, connected and was ready to be placed into service. Our project at this time should have been complete except for a few punch list items. Not quite.

6. POST CONSTRUCTION ACTIVITIES

The owner of the high pressure 14-inch gas main advised everyone that they were going to have to relocate their gas main on the east side of the river due to conflicts with the west bound bridge approach. Fortunately the new 12-inch FPVC FM was deep enough in this area that there was no conflict.

Additionally we were notified that the high pressure gas main, on the west side of the river, was being relocated due to a conflict with modification of an existing box culvert. Fortunately, again, the new 12-inch FPVC FM was not going to be in conflict with the relocation of the high pressure gas main. Again our project should have been complete. Not quite.

Lastly we were advised that the roadway contractor was going to have to construct a special "temporary trestle" which would be installed on the north side of the existing bridge. The purpose for the temporary trestle was to support a crane during construction since the existing bridge could not withstand the weight of the proposed crane that was required to install the support piles for the new bridge.

The approved temporary trestle plan indicated that the first pile was going to be installed approximately 25-feet south of the newly installed 12-inch FPVC FM. However, the northern line of temporary support piles would be located approximately 15-feet south of the new 12-inch FPVC FM. See Fig. 3.

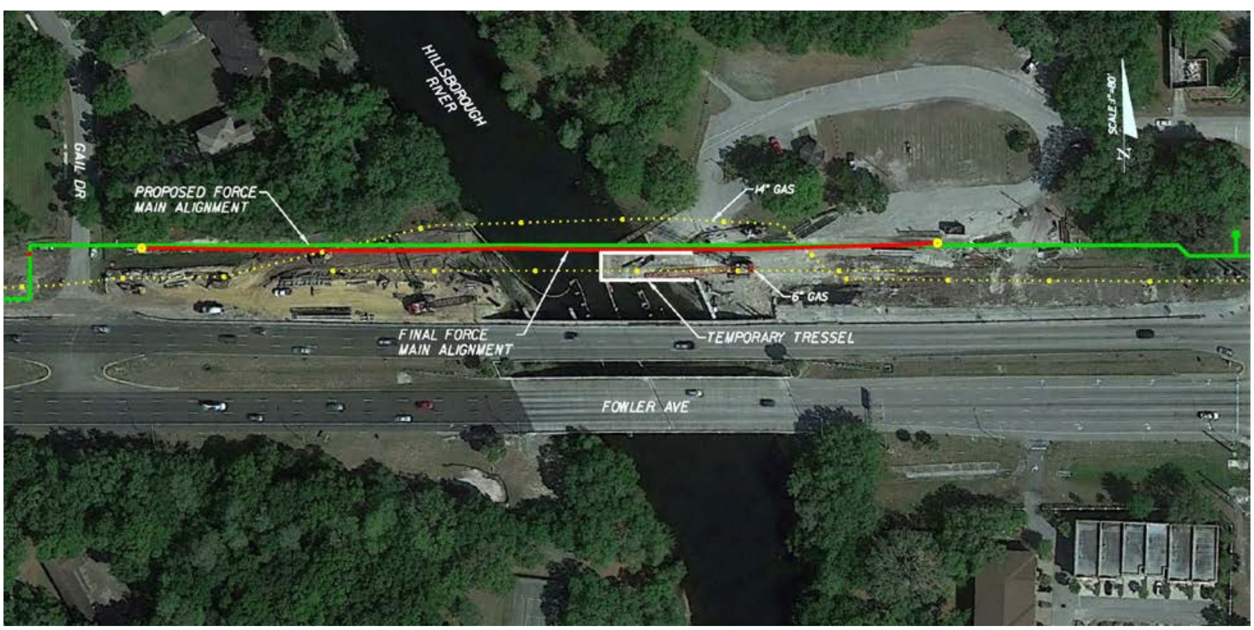

Figure 3 – Temporary Trestle

The plan also indicated that the bottom elevation of the proposed piles may be at an elevation of -15.00. The as built plans for the 12-inch FPVC indicated that the 12-inch FPVC had an elevation of -16.00 slowly rising to an elevation of -9.00. There were concerns that damage may occur to the 12-inch FPVC FM pipe during the temporary trestle and bridge piling installation operations. This concern was due to the hammering and vibration of the temporary and permanent piles, the strength of the chert material, the loss of drilling fluids that were encountered during the geotechnical investigating and concern that horizontal movement of soils and material below ground may impact the new FM.

During this time it was noticed that construction activity was taking place on the ditch line west of the river. Due to restricted right of way the new force main had been installed near the top of the bank of the ditch on the west side of the river. It was noted that the ditch banks had been excavated and the ditch realigned. This placed our new air release valve and vault in the center line of the ditch. In addition the construction activity had reduced the ground cover over the 12-inch FM to less than 15 inches for approximately 50 feet.

At that time we requested a meeting with the owner, FDOT and contractor to discuss our concern that there could have been a possibility of damage to the existing 12-inch FPVC FM during the initial construction and realignment of the Special Ditch. We also discussed the potential for damage to the FM during the pile driving activity for the support of the temporary trestle and bridge pilings.

We worked with the FDOT and requested that some minor modifications be made to the special ditch sections so the new ARV vault was not in the centerline of the new special ditch section. We also requested that concrete paving be installed in the ditch flow line for additional protection to the new FM.

Additionally we requested that the 12-inch FPVC FM be pressurized to 100 PSI and a pressure gauge installed in the west ARV/Valve Vault prior to the final re-construction of the special ditch modifications and for the duration of the temporary trestle and bridge construction. The 100 PSI line pressure would provide an opportunity to see if any damage occurred to the 12-inch FM during the ditch modifications and would also allow us the opportunity to monitor the FM during the final ditch construction and the pile installation for the temporary trestle and the bridge. We were fortunate that this section of the force main could be routed to flow in either direction allowing the section of force main crossing the river to be taken out of service for a period of time. This would have occurred and the new force main not installed until all of these post construction discoveries had been completed had they been known in advance.

7. FINAL COMPLETION

Subsequently in April 2013 the special ditch modifications were completed. In mid-July of 2013 the temporary trestle was completely removed and the piles for the new bridge had been installed. Our FM was successfully drilled, tested and ready to be placed into service in late June 2012. Due to the temporary trestle construction, bridge pile construction and special ditch construction, our FPVC FM was placed into service approximately one year after it had been constructed and tested.

8. CONCLUSION

The 100 PSI line pressure provided an opportunity to see if any damage occurred to the 12-inch FM during the ditch modifications and allowed us the opportunity to monitor the FM during the final ditch construction and the pile installation for the temporary trestle and the bridge. The FPVC pipe was chosen for this critical, subaqueous HDD as it provided the required flow area with the smallest possible OD. Due to the significant rock formations along the required HDD alignment, minimizing the borehole diameter had significant economic advantage.

Finally done! Or are we?