Large Diameter Rehabilitation in Houston

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The existing tunnel was approximately 132-inches in diameter and the 120-inch CCFRPM pipe has an outside diameter of 126-inches. This allowed a clearance of only three inches which due to the high strength thin walled Hobas pipe, maximized the I.D. post rehab.

The Northside Sewer Relief Tunnel reached depths of 50 to 60 feet below grade. Installation method.jpg – A custom made pipe carrier and pusher was designed to install the 120-inch CCFRPM pipe.

THE CITY OF HOUSTON operates and maintains approximately 6,000 miles of gravity sewers with diameters ranging from 6-inch to 144-inch in diameter. The average daily wastewater flow through the system is estimated at 277 million gallons per day (MGD). With some depths reaching 80 feet, the City's extensive urban population makes access to these sewers for inspection and repair difficult.

Constructed in the mid 1980's, the Northside Sewer Relief Tunnel (NSRT) was the largest of Houston's deep sewer tunnels. In 1988, the NSRT was completed and put into service. It was lined with a mechanically attached liner of high density polyethylene (HDPE) and in the early 90's sections of the liner began to fail leading to overflows and the removal of the liner. In 1994, an inspection found that more than half of the tunnel showed signs of corrosion.

In early 2000, multiple engineering firms began designing the rehabilitation of roughly eight miles of the reinforced concrete pipe (RCP) tunnel. This was known as the Northside Sewer Rehabilitation Program. Due to funding constraints these projects were put on hold until around 2007-08 and beginning with the largest diameter sections first, NSRT was bid in phases.

Innovative Installation Techniques

NSRT- Area 5, Phase One was put out to bid in September 2011. It was decided in the design process to slipline the RCP with Fiberglass Reinforced Thermosetting Plastic (FRP) pipe. Boyer, Inc. of Houston was awarded this phase. They installed 2,200 feet of 120-inch centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM) pipe. The flush reline CCFRPM pipe was manufactured by Hobas Pipe USA of Houston. The existing tunnel was approximately 132-inches in diameter and the 120-inch CCFRPM pipe has an outside diameter (O.D.) of 126-inches. "This size pipe had never been installed before inside a 132-inch tunnel and Boyer was ready to take on the challenge. In fact, Hobas had never manufactured this size pipe before," stated Datta Shirodkar, P.E., project manager, Boyer, Inc.

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NSRT- Area 5, Phase One was designed by the Engineer as a sliplining project to install the pipe in live flow. "We knew from the beginning that it was not possible to install such a large pipe in minimum live flow and decided to carry the pipe in place one joint at a time. Mr. Bill Ofiel, one of our senior project managers, designed a custom pipe carrier to transport the 120-inch pipe inside the 132-inch tunnel and a custom pipe pusher to push one joint of pipe into another (Bell & Spigot connection). Boyer, Inc. also developed a very innovative way of making miters on site by cutting two pieces of pipe at an angle and then joining the pieces together using a FWC coupling. This method of making miters using FWC couplings was used on smaller size pipe but never on a pipe with 126-inch O.D. The size and weight of the pipe along with the constraint of installing it inside a 132-inch I.D. tunnel forced us to think outside the box and come up with new and innovative methods. There were lot of stressful moments and passionate discussions within our team during the course of this project and the successful installation of the pipe without any re-work made it all worth the effort," explained Shirodkar.

The pipe sections were carried into place and assembled inside the tunnel, much like a two-pass operation with the host pipe serving as the primary tunnel. The condition of the existing sewer made this the best installation method

Restoring Structural Integrity

NSRT-Area 4 bid in April 2012 and consisted of about 4,900 feet of the same 120-inch flush reline pipe. Oscar Renda Contracting of Roanoke, Texas was the low bidder on NSRT-Area 4. NSRT-Area 5, Phase Two was awarded to Oscar Renda in March 2014 and they installed 3,000 feet of 120-inch pipe in early 2016. Before Oscar Renda could begin the installation they had to prepare the existing tunnel. "Most of the joints had deteriorated and were leaking ground water. The former corrosion protection system was in disrepair and had to be removed. Finally, many areas of the tunnel contained up to three feet of debris that had settled into the existing system. The cleaning process required us to remove the debris as well as sheets, battens and anchors from the protection system," explained Bart Adams, houston area project manager, Oscar Renda Contracting.

In addition, Oscar Renda prepped the tunnel by essentially pressure washing the tunnel to remove any loose debris and inject the joints to stop the groundwater infiltration.

The flush reline pipe was manufactured with a flush bell-spigot. The flush bell-spigot joint consists of an integral straight bell fixed to one pipe end that seals to the spigot end of another pipe by compressing an elastomeric gasket contained in a groove on the spigot. An important characteristic of this joint in relation to this project is that the joint has approximately the same outside diameter as the pipe, so when assembled, the joint is essentially flush with the pipe outside surface. "This allowed a clearance of only three inches around the pipe and a very tight fit. The existing tunnel was 50 to 60 feet below grade and only a limited number of access shafts were installed," explained Adams.

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Short segments of CCFRPM pipe were manufactured by Hobas Pipe USA to facilitate assembly into the existing curved host.

Year of construction
2011 - 2016
Total length of pipe
10,000 feet
Diameter
120-inch
Stiffness class
72 psi
Installation method
Rehabilitation
Application
Sanitary sewer
Client
City of Houston
Installer
Boyer, Inc. and Oscar Renda Contracting
Advantages
Deep installation, various lengths, corrosion resistance

Overcoming Challenges

A project of this scope has its challenges. During the bid phase there was no confirmed method of by-passing the flows in the Northside Sewer system. The exact flows going through the NSRT 4 portion of the system were not known at the time of the bid. The bid documents explained that the contractor was responsible for by-passing, blocking, and/or diverting 33 million gallons per day of average daily flows. After the system was installed, adjustments had to be made due to the average daily flows being much higher than anticipated.

"The biggest issue for the NSRT 4 project, was how to by-pass the flows in the system. The City of Houston Wastewater Operations was a big help in working with us to figure out the best route to divert the flows within the system to maintain operations and be able to install the pipe," stated Adams. "Over several months, many coordination meetings were conducted, and several iterations of the by-pass system were developed before Oscar Renda and the City of Houston was able to agree on a path forward. An additional complexity to the NSRT 4 project was that both projects were dependent on the same by-pass system. An additional by-pass system was setup on the NSRT 5 project to by-pass additional lines coming into that system. All flows were being diverted to the 69th Street Wastewater Treatment Plant."

The traditional segmental slipline installation method of a liner pipe being pushed or pulled into an existing pipe usually during episodes of live flow was not utilized on this project. The existing RCP tunnel was made of mitered sections that would not allow the traditional sliplining method. Instead a combined method of sliplining and tunneling was used to install the new 120-inch pipe. The pipe sections were carried into place and assembled inside the tunnel, much like a two-pass operation with the host pipe serving as the primary tunnel. There are a number of curves throughout both phases; this along with the condition of the existing RCP made traditional segmental sliplining difficult.

"Sliplining could not be used because the relining pipe could not be pushed through the mitered sections of the existing tunnel using a true sliplining method. Pipe carriers had to be used in order to take individual pipe pieces through the tunnel to the point of installation. Extensive surveying and modeling was used to map the miters in the existing tunnel. This information was used to develop the layout for the reline pipe segments. During the installation, once the straight run of pipe reached a mitered section, dimensions were confirmed, and a system was developed in the field to miter each section of pipe as required. This method allowed us to make adjustments in the field in order to minimize delays to the installations," stated Adams. Hobas manufactured the pipe in varying lengths to assist with this process.

"The Hobas FWC gasket-sealed, push-on coupling seals directly to the unmodified exterior pipe surface. Since the O.D. is constant along the entire pipe section, field length changes may be accomplished by simply cutting the pipe at the desired location, chamfering the cut end and joining with the FWC coupling. This is true for pressure applications as well as non-pressure service," explained Randy Whiddon, field serve manager, Hobas Pipe USA.

Successful Installation

To summarize, approximately 10,000 feet of 120-inch CCFRPM pipe was installed deep beneath Houston. Creative installation techniques allowed for a successful project. The remaining phases of the NSRT are currently under design.