WASTEWATER COLLECTION
CASE STUDY

CLIENT:
Municipal Wastewater Treatment System

FACILITY LOCATION:
Ontario, Canada

EQUIPMENT NAME:
North and South Force Mains

UTCOMP PRINCIPAL ENGINEER:
Geoff Clarkson

UTCOMP ENGINEERING ANALYST:
Mark Putt
George Ivanov

Figure 1 Corrosion of exposed steel

SUMMARY

Fiberglass-Reinforced Plastic (FRP) repair was successfully designed and installed to replace corroded steel piping in wastewater service without interruption of service. UltraAnalytix™ was utilized to ensure quality control and assurance during each phase of construction and ongoing monitoring through frequent inspections.

BACKGROUND

Wastewater from residential and businesses is collected into wet wells within pumping stations through gravity fed pipelines. When it reaches a certain level in the wet well, pumps automatically turn on. The pumps in these stations are used to increase the pressure of the wastewater in the force mains to be able to overcome the elevation changes while being sent to the wastewater treatment facility.

As part of a large collection system, the municipal client operates and maintains a number of wastewater pumping stations throughout a populated city in Canada.

The client contacted UTComp requesting an inspection and assess the integrity of the pumping station's two force mains. Due to the extensive corrosion both internally and externally, a rehabilitation was needed quickly and conveniently as the force mains were too vital to be shutdown for complete replacement.

The City began investigating options to repair the corroded steel force mains while leaving the force mains in service. After considering several repair options, they decided on using UTComp® FRP expert engineering services to design and oversee the FRP repair of the corroded force mains for quality assurance and compliance with the design. This also included ongoing inspections to assess the integrity of the repair.

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PROJECT DESCRIPTION

UTComp was requested to inspect and assess the integrity of a certain pumping station's force mains. The two existing steel force mains used to transfer wastewater from the pumps were inspected by ultrasonic thickness measurement and found to be corroded internally as well as externally. There was very low remaining thickness which posed a critical risk of loss of containment. They required immediate repair. These large force mains are vital in transferring wastewater to the treatment system and could not be place out of service long enough for a replacement. No shutdown could possibly be scheduled in the near future.

The City began investigating options to repair the corroded force mains while leaving the force mains in service. After considering several repair options and consultation, they decided to use UTComp® to design and oversee the FRP repair of the corroded force mains. The city's decision to utilize UTComp's expert knowledge and specialized skills on the standards and codes relating to FRP, as well as our experience in finding solutions for safe optimal operations was proven to be the right choice.

During the inspection, no liquid sewage leaks were noted but there was possible seepage through the corroded pipe. While there was a long-term plan to replace this system, this immediate repair needed to be leak tight and reliable for up to 25 years. FRP has been used effectively for piping systems where corrosion is a concern in a wide range of applications and industries. The repair was designed on the assumption that the steel will eventually corrode through its thickness, then leak. The FRP would be designed to provide full structural, leak-tight replacement for the corroded steel pipe from the concrete bulkhead/ collar to the inlet piping past the force main valve. This work consisted of designing and applying FRP reinforcement to contain the force main contents in case of corrosion failure and provide structural support to the knife gate valve.

Formation of FRP consists of wetting fabric made from glass fibers with liquid resin then placing it over a surface that will support the FRP while the resin hardens from a cross-linking chemical reaction. When the resin is hardened, it takes the shape of the surface – in effect, the surface acts as a mold. Layers of wetted glass are added and harden to develop the structural strength required. It is normal for FRP pipes to be formed over a mold that is not bonded to the FRP, so that it can be removed while keeping the full developed strength of the FRP. This repair was designed using this principle, where the existing corroded steel pipe was used as a mold to shape the repair, without need to be bonded to the FRP.

Execution of the repair was as follows:

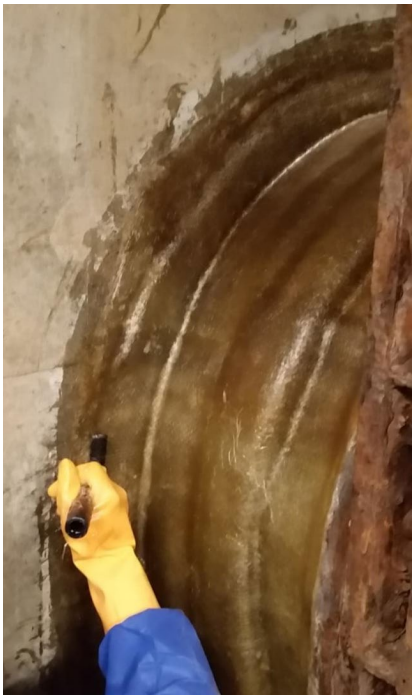

Figure 2 Applying FRP stages

- Chopped strand glass fabric saturated with resin was wrapped around the corroded pipe so that contaminants and scale from the corroded pipe are contained. Wrapping was done until the outer surface gelled and hardened.
- The surface of the concrete bulkhead, collar, wall, and the steel inlet pipe, flanges and valve body were grounded and prepared for application of FRP.
- Derakane™ 8084 primer was applied to the prepared concrete and steel surfaces. This primer has been proven to provide reliable bonding of FRP to both concrete and steel.
- FRP was then applied as designed to the wrapped pipe, concrete and steel surfaces to provide a leak tight and structurally sound repair. Putty was applied as required to provide smooth transitions for the FRP.

ASME RTP-1 provided guidance for fabrication and materials but not accreditation, as that was not required.

The rehabilitation work was completed in two phases over a 2-year period. Each phase was planned around the dew point being reliably below the raw sewage temperature. This meant that the temperature was to be below 14°C (57°F) during the daytime.

The FRP applied to the force main sections was designed to contain the full surge pressure expected in the system. The required structural strength was developed primarily by the number of woven roving layers applied. The design of the FRP required a minimum of 13 layers of woven roving for pressure containment. During installation, all layers of woven roving applied were monitored.

Figure 3 First stage has been applied. When cured, this stage provides a sound surface over pipe and concrete to support lamination

SOLUTION

A UTComp® Engineer visited the site to perform an initial site assessment and gather information on the layout and dimensions of the corroded force mains. The FRP repair was designed on the assumption that the corroded steel pipe would ultimately fail, and fluid containment and structural strength would be supplied solely by the FRP repair with no contribution from the underlying steel.

The repair was designed with no surface preparation of the corroded steel to avoid accelerating the reduction of the thickness causing a potential breach. The corroded pipe was treated as a laminating mold rather than as a bonding substrate. The surfaces of the adjacent concrete at the wall penetration and the gate valve and intact piping upstream was prepared for bonding to the new FRP laminate. An FRP lip around the nozzles at the top of the mains were also added for small spill containment.

UTComp® prepared design calculations and drawings, supervised the successful installation of the repair, and inspected the repair in several stages. UltraAnalytix™ was utilized to ensure quality control and assurance during each phase. All repairs were completed while the force mains were in operation and fully charged. No interruption in service occurred during both phases.

The completed reinforcement has been in continuous service since completion in 2018. The repair is expected to continue in service for up to 25yrs, even when the steel is completely corroded. Regular evaluations of the FRP over-wrap are completed using the UltraAnalytix™ inspection system.

Figure 4 Installation of laminate on the North and South force main pipes and gate valves

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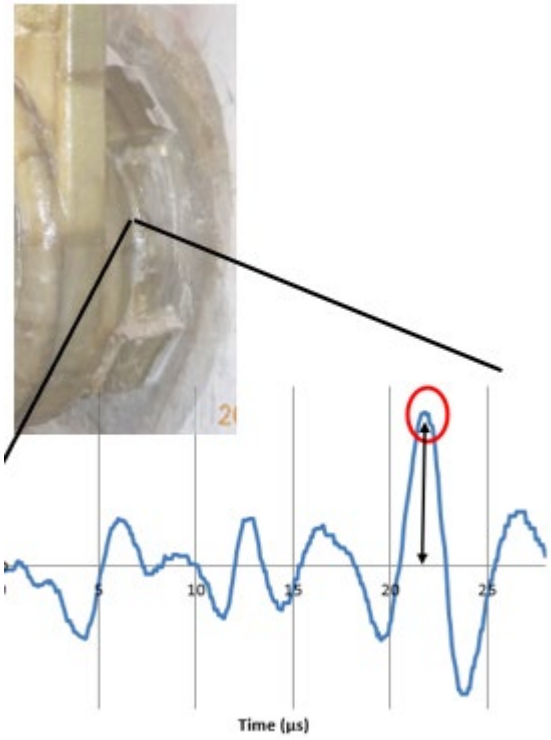

ULTRAANALYTIX™ EVALUATIONS

UltraAnalytix™ ultrasonic inspections are completed on a regular basis to determine both the condition of the FRP overwrap and whether the substrate steel pipe has corroded through. Closely-spaced ultrasonic readings are taken from the FRP where it is bonded directly to the substrate steel pipe to identify where the pipe has been corroded through and the FRP has been exposed to both the mechanical loads from loss of pipe and the pipe contents. A typical reading where damage has not occurred is to the left. UltraAnalytix™ system evaluation was also recommended after all significant process excursions and environmental events took place.

UltraAnalytix™ analysis software is able to identify where damage has occurred to the substrate bond and to the FRP as a result of the new conditions. This data allows ongoing assessment of the condition and the reliability of the FRP repair.

The UltraAnalytix certified inspector who collected the data has verified that the data was obtained and provided in accordance with the UltraAnalytix ™ procedures, training, and licensing. Data analysis and reporting has been completed by UTComp in accordance with UltraAnlaytix™ procedures and training.

ABOUT

UTCOMP®, INC

UTCOMP®, Inc is an industry leader in engineering and evaluating fiberglass-reinforced polymer (FRP) equipment. Industries around the globe are switching to FRP to take advantage of its high strength to weight ratio and superior corrosion resistance to steels. UTCOMP® is built on a solid foundation of research, engineering knowledge and experience. The company is involved from the engineering of innovative solutions, material selection, design, oversight of fabrication and supervision of the installation. UTCOMP®'s unique

ultrasonic testing is able to provide ongoing inspection and analysis of assets, assessing their condition to provide valuable life cycle information.

UTCOMP – ENGINEERING

UTCOMP®'s team of engineers successfully pushes the boundaries of normal industry guidelines while working with the complex material: Fiber Reinforced Plastic and other composites. The expert advice comes from years of experience. Our mastery of the specialized standards and codes relating to FRP, as well as our experience in finding solutions for safe optimal operations maintains our reputation of excellence. UTCOMP® is constantly building capacity in the FRP industry to ensure we are on the forefront of the changing landscape. UTCOMP® is committed to ensure that our customers have "Composite Asset Intelligence" to operate their equipment and facilities with maximum safety and longevity.

The CTO and Principal Engineer, Geoff Clarkson, has over 30 years of engineering experience. This company provides FRP reliability solutions and tools for end users using the UTCOMP® System, visual inspection as well as other techniques. Geoff is the developer of the UTCOMP® System, an innovative approach to NDE of FRP which gives end users reliable and valid information about their FRP assets.

His career has enabled the development of a high level of expertise in all aspects of the engineering, design, inspection and evaluation of FRP. Since 2006, Geoff has focused his attention on the development of non-destructive tools for evaluating FRP and providing useful reliability information to end users. UTCOMP® has worked with customers to develop best practices, manuals and other organizational support documents for regulatory and company compliance.

UTCOMP® has a number of engineers who have worked closely with Geoff to develop the same level of skill and knowledge of FRP. This company is committed to ensuring that companies are not left without resources and is committed to the success of your project.

ULTRAANALYTIX™

UltraAnalytix™ is a patented non-destructive and non-intrusive method for in-service and quality assurance inspection of industrial equipment made of fiber-reinforced plastic (FRP) and other composite materials.

The UltraAnalytix™ system combines ultrasonic data collected in the field, external visual inspection and analysis using a proprietary algorithm, a system that is based on more than 60 years of scientific research, including work originally conducted by NASA.

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It is more than conventional ultrasonic thickness testing: innovative post-processing of the raw ultrasonic data using a proprietary algorithm provides repeatable and reproducible results. These results have been validated by UTComp internal research and by independent research at the University of Alabama and York University in Toronto, Ontario. Learn more about UltraAnalytix™ research & validation.

The UltraAnalytix™ system and method for analysis of fiber reinforced composites has been issued U.S. Patent No. 9,989,502 and U.S. Patent No. 10,527,591 B2 and is in use worldwide in many different industries.
The UTComp UltraAnalytix™ system is a non-destructive means of inspecting new FRP or composite material assets to provide owners with assurance that the equipment or components comply with specifications, are free of manufacturing defects and will meet their intended serviceability.

Data is collected from an external surface, often while tanks or piping are in operation, thereby limiting the need for confined space entry. There is never a need to cut test samples out of the asset, allowing the structural integrity to remain intact and reducing the need for confined space entry. Plant shutdowns and confined space entry are usually not required to obtain information about:

- FRP strength
- FRP thickness
- Corrosion Barrier Condition
- Abrasion and corrosion damage
- Structural changes occurring within the FRP structure not available by visual inspection
- Damage cause by mechanical loads such as impact, poor supports, earthquake, hurricane, etc.

Other UltraAnalytix™ advantages include:

- FRP of all ages can be evaluated WITHOUT previous information.
- The initial testing can be completed in the manufacturer's facility, and while the plant is in full production.
- The owner does not have to wait for a shutdown or, worse yet, create a shutdown for the inspection.
- A baseline from manufacturer or installation can be set for ongoing inspections.
- The regular scheduled inspections create a monitoring curve.
- Data can be collected by UTComp-trained personnel: UTComp employee, an end-user employee, manufacturer or a licensee.
- Provides production information for manufacturers to minimize wastage or over production.
- Provides measurement for acceptance criteria.
- Verify the quality and successful achievement of customer requirements.

- Proactive inspection can help avoid failures therefore avoiding costly repairs, clean up and negative public relations.

For more information on UltraAnalytix™ or UTComp, please visit us at www.utcomp.com.

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