STEEL BRIDGE PILING REPAIRS

Using Underwater GFRP

STRUCTURAL STRENGTHENING

CASE STUDY
Maraba PA, Brazil

BACKGROUND

Opened in 1985, the Carajás Railroad ranks as Brazil's most efficient railway thanks to constant technology investments made by railway management. This 892-kilometer railway links the world's largest open-air iron ore mine in Carajás to the Port of Ponta da Madeira, in São Luís (MA), Brazil transports 120 million tons of cargo and 350 thousand passengers per year.

A section of the railway passes over the Tocantins River via Ponte Rio Tocantins Bridge in Maraba PA, Brazil. This 1.67-kilometer bridge with 147 underwater reinforced concrete steel-jacketed pilings is maintained by global mining company Vale. While the steel jackets were intended to be sacrificial and designed only to protect the concrete pilings, increased rail traffic due to mining production increases, coupled with extensive steel jacket corrosion, resulted in the necessity for the steel jackets to perform as structural elements. Therefore, to prevent further corrosion on the steel jackets, a coating system was needed to extend jacket design life. The pilings are 1.5-meters OD and approximately 4.5-meters long. Figure 1 shows an overhead view of the bridge with the white repaired pilings visible.

Figure 1: Overhead view of the bridge.

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DESIGN CONSIDERATION

Prior to selecting ClockSpring|NRI's Syntho-Shield product as a solution for corrosion protection of the steel jackets, two other solutions were considered by the client.

Underwater Epoxy Putties

Epoxy putties have been used for many years as a steel coating for underwater applications. These systems are adhesion critical, requiring hydro blasting to ensure a good bond. Achieving a good surface preparation underwater can be difficult, with flash rust slowing down the installation process or causing premature debonding on newly installed product.

In addition, epoxy putty installation requires a larger mobilization, including a boat, a generator, a hydro-blaster, and 10 divers, and was estimated to take one day for each piling for the Tocantins project. Adding further complication, epoxy putty installation uniformity varies greatly based upon diver experience. Installed thickness, hand-applied, varies from diver to diver. Figure 2 shows an example of uneven epoxy installation.

Figure 2: Epoxy putty installation process.

Rubber and FRP jackets

Pile jacketing is a common method to repair underwater piles. One of the solutions considered for this project involved rubber jackets with a petrolatum tape primer. FRP jackets are size specific and FRP jacketing repair was quickly excluded by Vale due to its high cost, long lead-times for jacket manufacture (up to six months), difficulty transporting the jackets to the remote bridge location, and the massive equipment mobilizations required to install the FRP jacketing.

The selected solution: GeoTree Solutaion's Syntho-Shield corrosion protection system

The Syntho-Shield system is comprised of three components; a Petrolatum primer/tape system undercoating for long term corrosion protection, Syntho-Glass XT for mechanical protection, and Syntho-Glass SPF as a final mechanical and UV protection barrier. The Syntho-Shield system provides the steel- jacketed piles both long term corrosion protection as well as mechanical and impact strength.

One of the great benefits of the Syntho-Shield system is that it can be applied to marginally prepared surfaces. The requirements for surface preparation are removal of all loose scale, rust, or other foreign matter in accordance with SSPC SP2 “Hand Tool Cleaning” or high-pressure water washing.

Vale elected to use Syntho-Shield due to the surface preparation requirements, ease of installation, high productivity during installation, very low material waste, non-toxicity to divers, and the quality control of the installation, with its uniform thickness application.

Project execution

The general contractor, Texeira Duarte, and its subcontracted diving contractor provided project supervision and labor. The length of the project was 135 days with three crews using four or five people per crew, each working five days per week. Above water applications achieved installation productivity of 40m2/day per pile utilizing a four-member crew (one supervisor and three divers). Submerged applications resulted in a 10m2/day per pile, utilizing three divers, one supervisor, one reserve diver.

Installation staging

Due to the large size of the pilings, and the twenty-minute Syntho-Glass XT and one-hour Syntho-Glass SPF respective working times, the application was completed in 1.5-meter sections. The application process included the following steps:

1. Application of the petrolatum primer and tape, as shown in Figure 4.
2. Installation of two layers of Syntho-Glass XT, spiraled around the perimeter of the piling with a 50% overlap, as shown in Figure 5.
3. Application of two layers of compression film, allowing the Syntho-Glass XT system to set for forty minutes, as shown in Figure 6.
4. Removal the compression film and installation of two layers of the Syntho-Glass SPF, as shown in Figure 7.
5. Application of two layers of compression film to allow the Syntho-Glass SPF system cure.

Steps 3 and 4 were necessary to avoid any bleeding of the petrolatum tap and XT resin into the UV coating system. This effect would have made the UV coating layers appear damaged and discolor overtime. In addition, at the termination of each 1.5-meter completed section, layers of the petrolatum tape and the composite layers were staggered with at least five cm to ten cm gap between. This would allow for the following sections to tie-in properly on the same piling. An example of the staggered layers of the different system can be seen in Figure 8 below. Finally, for piling areas that were not fully wrapped by an end of a workday, compression film was used to cover the exposed petrolatum tape sections.

Figure 4: Application of the petrolatum primer and tape.

Figure 5: Application of two Syntho-Glass XT layers.

Figure 6: Application of compression film on top of the Syntho-Glass XT layers.

Figure 7: Removal of the compression film and installation of the Syntho-Glass SPF.

Figure 8: Staggered system layers on a repaired section and beginning of the installation of the next repair section.

PROJECT SUMMARY

The Ponte Rio Tocantins project included wrapping 147 steel piles with Syntho-Shield system. This project included various challenges including high current conditions, difficult access to the pilings, and poor visibility underwater. Though the client had considered various solutions for corrosion protection of the steel piles, they ultimately decided to use Syntho-Shield. The project was executed successfully leaving the client and contractor very pleased with ease of application, installation productivity, repair uniformity, total lower effective cost, and small mobilization required. Based on this success, Vale has moved forward to using the same product to repair additional structures. Pictures of the finished wrapped piles are shown in Figure 9 below.

Figure 9: Pictures of the completed work.

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