



## **SERVICE LIFE EXTENSION: OYSTER CREEK BRIDGE REHAB CASE STUDY**

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**Abstract:** Aging highway infrastructures have been posing challenges to Departments of Transportation across Canada. Not limited to Canada, most of the highway structures ecosystem has been built after the second world war. Hence in any given jurisdiction, there is a number of bridges that would require either replacement or extensive rehabilitation. In the times of limited budgetary resources, the DOT maintenance departments are called upon to devise strategies aiming at doing more with limited resources. It is even more challenging when these structures are subjected to harsh marine environment such as the one prevalent in Maritime Provinces. This case study focuses on how PEI-DOT has been tackling over more than the last decade the challenges of managing its aging highway bridges. The current case study shows how combining the usage of modern materials could result in service life extension of an extensively damaged bridge. Hence, the selected case provides rehab details of a structure built in early 1950's that were implemented by the PEI-DOT maintenance department. It was one of the first PEI structures on which FRP composites were used to repair/strengthen the selected bridge. Not only its service life was extended - bridge still in service today- but the repair costs were a small fraction of what would have been if the replacement had been in works. Emboldened by such a success, the Department has extended such solution to several other structures that were in need of repairs.

### **1 INTRODUCTION**

Built in early 1950's, the bridge is a short span timber structure supported on timber piles. In 2008, a routine inspection revealed that the timber piles of the west bent were severely damaged due to excessive loading from the backfill lateral pressure and/or overloading. Located in the river channel, the piles of the mid span bent were also subjected to significant deterioration due to ice lift and abrasion in the splash and tidal zones (Fig. 1).

Due to the structure advanced condition, it was slated either for replacement or major rehabilitation. Meanwhile, the bridge was posted to limit the allowed traffic weight/load (Fig. 2 (a)). After in-depth consideration and discussions, the PEI-DOT maintenance department decided to investigate the use of FRP composites in order to strengthen the substructure elements made of timber piles. Although it showed sign of aging, the deck was still in a better shape as opposed to the piles.

## **2 OVERVIEW**

As a first step, an excavation was conducted to expose the on-shore timber piles. It was then evident that these piles c/w tie-backs had practically failed (Fig. 2 (b)). Hence, several options were investigated and it was decided to strengthen these piles with PR jackets. These jackets were prefabricated of GFRP sheets and pre-molded with 2 to 4" gap to fit 12"-dia timber piles. The gap size depended on the pile condition.

The selected repair method presented several advantages including low cost, QA guarantee, and speed of execution. Hence, PR jackets made of glass fibers were fabricated off-site in a controlled environment and subsequently brought to site in suitable lengths. The selection of the jacket material was mainly due to its low cost without compromising the system overall performance. In addition to strength, G-FRP elements would offer improved ductility when compared to other types of composites such those made of Carbon or Aramid fibers.

To ensure that the repairs were sound, the 15-ft PR-Jackets were extended by 3-ft below the failure location of each pile. Once secured in-place, the space between the pile and the inside diameter of the jackets was filled with high strength tremie grout. A total of seven timber piles were strengthened by using this method as shown in Figs 3 (a) & (b). It should be noted that prior to jackets placement, clamps were installed at damaged locations in order to secure these piles during the repair process while allowing the posted traffic over the bridge to be uninterrupted.

Subsequently, the piles at mid-span that extend into the water were also wrapped with two layers of GFRP in order to protect their respective tidal and splash zones against adverse effects of the tides as well as the ice abrasion (Fig. 4 (a)) The application of FRP layers was as per the wet lay-up method (Karbhari 2007, Hollaway and Teng 2008).

The whole operation was completed over five (5) working days by certified applicators. By using GFRP PR jackets, the cost of the whole operation was reduced. Hence, the overall repair cost was around CA\$ 50,000.00; this constitutes a tiny fraction of what would have been if the structure had to be partially (i.e. driving new piles) or totally replaced. As aforementioned, while these repairs were being implemented, the structure remained open to traffic. Hence, there were practically no traffic disruption over the bridge during the rehabilitation phase. Subsequent to aforementioned repairs, the bridge posting was removed. As repaired, the structure is still in service today; a Fall 2017 site inspection/visit indicated that the structure was still performing well (Fig. 4 (b)).

## **3 LESSONS LEARNED**

The success of this project is mainly attributable to the forward looking attitude and the outstanding managing ability of the PEI-DOT team coupled to the selection of experienced applicators.

After examining several options, the selected FRP repair system came to be the most cost effective for the Owner and less disruptive for the users. In addition, the removal of the weight restriction and the service life extension were additional benefits.

Low cost and very limited traffic disruption were the hallmark of this project. Although at that time, there have already been few field tests/applications relative to using FRP systems for strengthening existing structures by PEI-DOT, the success of this project led to the extension of this solution to other problematic structures. Hence today, PEI-DOT has become a pioneer and been on the avant-garde in embracing the use of FRP composites as a viable option in the management of aging structures given the harsh environment of the region.

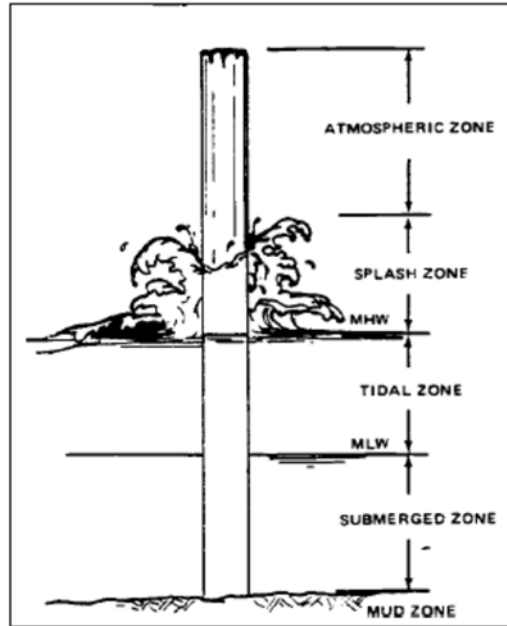


Fig. 1 Submerged Pile: Typical Degradation Zones (UFC 4-150-07, 2012)



a) Weight Restriction



b) Excavation Below Mud Line of the On-Shore Timber Piles

Fig. 2 Oyster Creek Bridge (PEI) 2008:



a) PR Jackets after Grouting (Looking North)



b) PR Jackets after Grouting (Looking South)

Fig. 3 Oyster Creek Bridge (PEI) 2008



a) Wrapping of Mid-Span Timber Piles



b) Fall 2017 Site Inspection/Observation

Fig. 4 Oyster Creek Bridge (PEI) 2008

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