

FTC-004



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Inspection Report

Long-Term Performance of Tyfo[®] Fibrwrap[®] System

Nine-Year Inspection of Tyfo[®]
Fibrwrap[®] System Applied in a
Marine Environment

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Nine-Year Inspection of the Tyfo® Fibrwrap® System Applied in a Marine Environment

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In May 1999, the Tyfo® Fibrwrap® System was applied to repair and retrofit corroded beams, slabs and columns on an upscale restaurant, which was in poor condition structurally and aesthetically due to exposure to marine conditions. After nine-year of service, the repaired structure was visually inspected. No significant failures were found, indicating the reliable long-term performance of the Tyfo® Fibrwrap® System in harsh environments.

1. Background

The upscale restaurant located in Redondo Beach, CA, USA, was in poor condition structurally and aesthetically mostly due to exposure to marine weather conditions, such as sea water immersion, ocean surf, high humidity and high winds etc. The actual situation of the restaurant can be seen in the pictures presented in Figure 1 and Figure 2, which were taken in 1998 before retrofit and strengthening. It was found that the slab, beams and pilings were severely deteriorated (Figure 2). Due to such poor conditions, the city required a permanent repair of corrosion damage to pilings, beams and slab or the restaurant would have to be demolished.

The deterioration of pilings, beams and slab required a phased retrofit, which would include the strengthening of specific areas and sealing the entire underside of the restaurant. To reach those requirements, the Tyfo® Fibrwrap® System was selected as the long-term solution. A process of discovery was initiated to remove unsound concrete. After treatment with a corrosive inhibitor system (Tyfo® CIS), the exposed steel and surrounding concrete was sandblasted. Polymer-modified concrete was then applied to reform members to their original shape. The Tyfo® SEH glass and SCH carbon systems

were applied to strengthen the structures. A final application of Tyfo® WEB and Tyfo® U finish were used as a water sealant and protection from the harsh environment.

The project was finished in May 1999. The photograph in Figure 3 shows the restaurant just repaired with the Tyfo® Fibrwrap® System.



Figure 1: Un-repaired restaurant with poor conditions.



a



b



c

Figure 2: Corroded slab (a), beam (b) and pilings (c).



Figure 3: Photograph of the just repaired restaurant in 1999.

2. May 2008 Inspection

Nine years after the installation was completed, the Tyfo® Fibrwrap® System was visually inspected. No significant failures, such as delamination of the strengthening layers, cracks and/or embrittlement of the materials were observed.



Figure 4: The restaurant on May 28, 2008

The photograph of the current restaurant is shown in Figure 4, which was taken in a similar direction as compared to the photograph in Figure 3 (just after installation). As shown, after nine years service, the repaired elements are sound and in good condition. It should be noted the black mark on the first piling is due to containment of petroleum rather than cracking. The containment is assumed to be coming from sea water surge, and is also found on the slab and beams of this building.

2.1 Pilings: All pilings exhibit perfect conditions. No delamination, blister or significant defects were found. As shown in Figure 5, no defects on the surfaces, facing the ocean or on the opposite surfaces, were found.

However, there are two pilings, which show a short, narrow and shallow crack in the FRP (fiber reinforced polymer) along the joint line between the beam and the piling. One is

the first piling from the right in Figure 4 and the other is immediately next to this one on its right side, which is not shown in the photo. It is worth noting that both pilings are facing the west direction. The crack may come from the high temperature rise in the daytime, due to the strong sun exposure in the afternoon. Those slight cracks are not expected to cause deterioration of the reinforcement of the Tyfo® Fibrwrap® System.



a



b

Figure 5: Photograph of piling. a) the side facing the ocean and b) the back side.

2.2 Beams: No signs of significant failures, such as delamination of FRPs from the concrete, cracks etc. were found on any beams (Figure 6). However, on some regions, coating was peeling off from the FRP (Figure 7). Since most surfaces (facing the ocean or on the opposite side) do not have such problem, the peeling off of the coating may be due to the installation process. For example, the coating may have been applied on the wet FRP surface, leading to a poor adhesion. In such a high humidity environment, it is not surprising to have such problems. As shown in Figure 8, the surface of the beam is covered with a layer of sea water with droplets, which is taken at 10 a.m. on a sunny day.



Figure 6: No signs of defect on the beam.



Figure 7: Some paint peeling from FRP on the beam.



Figure 8: Water droplets formed on the beam. Picture was taken at 10 am., May 28, 2008.

2.3 Slab: Similar to the beams, no significant defects were found on the slab (Figure 9). Most parts of the slab look perfect. However, there are some areas which also show peeling off of the coatings. As believed, the mechanisms are the same as the case for the beam.



Figure 9: Repaired slab without defects after 9-year of services

2.4 Materials: After nine years of exposure to the harsh environment, exposed FRPs (which are directly exposed to the environment due to the peeling off of the coating) did not show any color change. At the same time, all the materials appear very tough and strong, which is indicated by the extreme difficulty to cut off a small piece of sample with a sharp knife. Both phenomena indicate that no significant degradation has occurred in the materials.

3. Conclusions

The nine-year inspection of the Tyfo® Fibrwrap® System, which has been exposed to the harsh marine conditions, proved positive overall. No significant failures, such as delamination, cracks, blister and severe degradation of the materials, were observed. All those observations indicates the Tyfo® Fibrwrap® System possesses proven long-term performance in a marine environment.