2012 Honorable Mention

Structural Repair of Galveston Island Historic Pleasure Pier Cycle of Life

By Hank Taylor

During the late 1950s to the mid-1950s, Galveston Island was a destination for those who came to Texas to have fun and conduct a little business. The Pleasure Pier, constructed in the early 1940s as a multi-purpose convention and entertainment venue, measures 1200 ft (370 m) long by 120 ft (37 m) wide and uniquely juts out over the Gulf of Mexico. A convention and exhibition hall was located on the main part of the pier. The middle section of the pier had an amphitheater for concerts and a large screen for movie projection. The end of the pier farthest from the beach was locally known as the "T" Head, the best fishing spot on the Gulf Coast.

Island locations along the Gulf Coast seem to attract hurricanes. Hurricane Carla in 1961 damaged many structures on the pier beyond repair; the pier eventually had to be scrapped completely clean. Local investors with the "build it and they will come" mentality designed and built a 10-story hotel on the pier known as The Flagship Hotel. It was built in 1965 with much fanfare and excitement as the first and only luxury hotel extending over a continental body of water. Unfortunately, the marine environment, including sea salt, winds, and high humidity, has led to a slow deterioration of all exposed materials (refer to Fig. 1). As a result, hotel occupancy gradually declined, funds for regular maintenance were reduced, and hotel guests on a tourist-dependent island were attracted to other venues. The hotel, under the ownership of the city of Galveston, was abandoned in 2005. Landry's Inc., a nationally recognized developer of entertainment, hospitality, and restaurant businesses, bought the pier from the city with expectations to redevelop the hotel and bring it into its holdings.

Fig. 1: Deteriorated columns between water line and deck

In 2008, Hurricane Ike, a Category 2 storm, caused serious damage to 17,500 island homes and businesses and severely ravaged the 10-story hotel, leaving it unsalvageable. The new owners envisioned the Galveston pier as an entertainment forerunner to existing piers in Santa Monica, CA, and Chicago, IL. Hurricane Ike changed their short-term needs but not their goal to restore the Galveston pier to the 1940 era when it was originally known as The Pleasure Pier. The new redesign was very ambitious and included a plan for 16 action-packed rides, a midway, and two restaurants on a deck pier now littered with storm damage, an abandoned hotel, and a concrete pier with added structural decay. The owner decided to demolish the hotel and structurally restore the concrete pier before installing any amusement rides, the entertainment midway, or restaurants. They hired the engineering firm of Stanley, Spurling & Hamilton from Houston, TX, to assess the pier and begin a preliminary design to structurally restore it. Considering the semi-tropical marine environment that included constant wave action, harsh UV exposure, airborne chlorides, and potential hurricanes, the accelerated deterioration and harsh conditions needed to be addressed with every engineering design and construction step.

Little or no maintenance over the 70-year life of the pier has resulted in exposed reinforcing steel with accelerated corrosion and concrete spalling at piles, beams, joists, and reflective overhead flat plates. The new design plan increased live- and dead-load factors on the pier, harmonic motion of ride equipment, anticipated high lateral wind load

Fig. 2: Surface preparation of deck support beams

Fig. 3: Surface preparation of pier columns

on buildings, and structural longevity that had to be assessed and designed into the restoration. During the design phase, Epoxy Design Systems, Inc. (EDS) worked closely with Stanley, Spurling & Hamilton Engineering to provide conceptual ideas for materials, as well as restoration means and methods to incorporate into the overall project. EDS provided expertise based on 35 years of structural concrete restoration and repair experience. Using experience from several successful past projects that used the shotcrete process and techniques to repair concrete structures, different repair methods and shotcrete materials were incorporated to meet design criteria, including technical test data for material choice, constructibility for different repair types and conditions, and coordination of materials with Quikrete. Specifications were developed for specific pier areas requiring different repair solutions (refer to Fig. 2 and 3). All corroded reinforcement with cross-sectional loss greater than 25% were replaced, anchored, and coated with anti-

Fig. 4: Scaffolding setup for open access to underside of deck

corrosion material in advance of any shotcrete material. Access to the pier underside and safe support of all workers was a major problem for the duration of the project over salt water with wave action around pilings, tidal fluctuation, afternoon storms, and constant prevailing winds. Once the 10-story hotel was demolished one floor at a time by a specialty demolition contractor, working platforms 120 x 200 ft (37 x 61 m) were suspended and anchored 7 ft (2.1 m) below the pier deck and at existing concrete columns. Betco Scaffold of Houston designed, engineered, erected, and sequentially moved multiple sections to designated work zones, beginning at the farthest point over water allowing safe access for EDS to structurally restore each pier element (refer to Fig. 4). Environmental restrictions were in place throughout the project by the city of Galveston, the U.S. Coast Guard, and the Environmental Protection Agency (EPA) for concrete demolition dust control, debris removal, and cementitious overspray during shotcrete placement. Large tarps, screens, netting, tethers, and tie-offs were present each day as workers restored each platform section in a predetermined repair sequence to completion (refer to Fig 5).

The on-site engineer inspected for sufficient removal of deteriorated/micro-fractured concrete; surface profile of mechanically prepared sound concrete; minimum 1 in. (25 mm) concrete removal behind existing in-place reinforcing; complete corrosion removal at reinforcing; new steel placement; anchoring and lap spicing; anti-corrosion coating; and constant measuring of shotcrete thickness, cover at reinforcement, density, compression, and consolidation. Presoaking the properly prepared concrete substrate to surface saturated dry (SSD) ensured a monolithic integrated bond line between enhanced micro-silica shotcrete pneumatically applied freeform using three C-10 dry-mix shotcrete machines purchased from Gunite Supply and Equipment in Houston, TX. Once each underside structural member received the required shotcrete thickness of material, the surface was struck and finished to match dimensions of the existing pier concrete. The on-site inspector monitored the shooting of test panels on a daily basis in accordance with material specifications accepted by the engineer and owner.

So life moves in a circular pattern, from Pleasure Pier to hotel to Pleasure Pier…truly historic.

About Epoxy Design Systems, Inc.

The company, established in 1977, is a specialty trade contractor that repairs, protects, and strengthens existing concrete structures in domes-

Fig. 5: Shotcreting deck beam overhead with very limited access height

tic and international commercial, industrial, and marine environments. EDS is a charter member of ASA. While most projects are within 500 miles (225 km) of Houston, TX, domestic projects have ranged from the Brooklyn Battery Tunnel, New York City, NY; the Southeast Financial Tower, Miami, FL; Arizona Power, Page, AZ, and a private owner in the remote high desert of Nevada, AZ. The locations of international projects include Aruba, St. Croix, Panama, Honduras, Chile, Thailand, and the U.S. Naval Facility on the island of Diego Garcia in the Indian Ocean.

***Hank Taylor**, Founder of Epoxy Design Systems, has been involved with infrastructure concrete repair since 1974. He is past ICRI Board member, has attended all but three World of Concrete conventions and several manufacturers training seminars, and was one of six people in the inaugural Sika Applicator Program. He is an ASA Founding Charter Member. Based in Houston, TX, he is President of the firm and joins 20 other fellow employees whose mission is to repair and restore America's infrastructure back to its original glorious state.*

By the Numbers

- 4,700,000 lb (2,100,00 kg) of Quikrete Shotcrete MS placed
- 17,000 lb (7700 kg) of supplemental steel reinforcement
- 70 employees
- 14 months

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Project Name
Galveston Island Historic Pleasure Pier—Structural Concrete Repair

Project Location
Galveston, TX

Shotcrete Contractor
Epoxy Design Systems*

General Contractor
Ardent Construction

Architect/Engineer
Stanley Spurling & Hamilton Inc.

Material Supplier/Manufacturer
The Quikrete Companies*/
Gunite Supply & Equipment*

Project Owner
Landry's Inc.

*Corporate Member of the American Shotcrete Association