

## **Outstanding Repair & Rehabilitation Project Award Recipient— Manchester Terminals, LLC Dock Rehabilitation**

In the summer 2006, our company was presented the challenge of restoring Houston's largest independently owned shipping terminal to its original state. Built in 1926, Manchester Terminals had seen its share of spot repairs. However, this hurricane-rated concrete facility never had a full-scale rehabilitation. At first sight, this project seemed to be an impossible task. The 1500 ft (457 m) international shipping facility showed significant damage and deterioration to over 90% of its existing concrete supports. In spots, entire columns were missing. In short, the entire concrete dock system was in danger of crumbling. During the site inspection of this project, company officials noted that it was by far the most expansive and challenging rehabilitation project our experts had ever seen.

Early discussions of the project with engineering staff laid out obstacles of accomplishing the repairs while keeping the facility in full service. Initially it was believed that this project could only be accomplished by hand patching and form-and-pour operations. However, the engineer was willing to explore the idea of shotcrete as an alternative method if a cost savings could be realized and it could be accepted by the owner. Discussions then began focusing on the ability of shotcrete to be placed on most any surface and at any angle with little to no formwork needed. The engineers were also sold on the compressive strengths and past performance of shotcrete. Test reports from previous projects allowed our company to show data-backed examples of shotcrete testing at much higher strengths than required. Of additional importance was the ability of our company to maintain such a small work area in order to accommodate ongoing shipping operations at the facility. After discussions with both the owner and engineer, shotcrete was the overwhelming choice.

Contracts were then issued and the project was underway.

Using the dry-mix process, our staff set lofty goals beginning at Station 0000 with plans to work continuously to Station 1500 and complete the over 20,000 ft<sup>2</sup> (1858 m<sup>2</sup>) project in less than 180 days. Work began on the meticulous removal of deteriorated concrete to sound concrete with special care given to ensuring that the demolished waste was not introduced back into the Houston Ship Channel. The owner quickly came to appreciate the small footprint that our operations consumed and pointed out that, contrary to initial beliefs, no disruptions in service were seen as a result of our project.

Shortly after beginning the shotcrete operations, our company was faced with an additional challenge. A loaded ship had struck the dock causing significant damage, which potentially could have shut down that portion of the dock and significantly limit the owner's ability to meet the demands of signed contracts for ships enroute to the facility.

Because of the flexibility that shotcrete operations innately have, we were able to move from the portion of the dock we were currently completing and immediately mobilize our operations to the newly damaged site. Within a matter of weeks, we were able to repair and reopen the damaged area. In contrast, it was estimated that form-and-pour repairs would have taken significantly longer and forced both the previous work area and the emergency repair area to stay closed to ship traffic throughout the process. This again proved the importance and versatility of our process.

We believe that it was at this point that the owner truly came to appreciate the value of shotcrete and decided to embark on a full-scale rehabilitation of the entire dock system, adding an estimated 21,000 ft<sup>2</sup> (1951 m<sup>2</sup>) of rehabilitation.

This total dock rehabilitation included the repair of all columns and beams supporting the dock system as well as a large array of varying spall repairs to the underside of the of the deck floor. Additionally, the owner opted to install a state-of-the-art fender system to help prevent future damage.

Repairs were made by pneumatically chipping away all loose and unsound concrete and removing and replacing steel reinforcement. Surface preparation was accomplished by water-blasting the steel and sound concrete and

applying a corrosion inhibitor prior to the application of shotcrete. A minimum 2 in. (50 mm) clearance was used throughout the process to ensure proper encasement of the steel.

As one can imagine with the booming chemical, gas, and oil refining operations in the Houston area, care needed to be given to providing a consistently solid material that could resist the natural effects of salt water and chemical attack common in this region. In response to this challenge, our company chose to use prepackaged dry-mix shotcrete material. In doing so, we were able to ensure that no contaminants were introduced during the batching process and as a result of other environmental unknowns. The material used was a fiber-reinforced, silica-fume-enhanced, structural dry-mix shotcrete. This material was of great interest to this project due to our past experience with the product and its high bond strength, low permeability, and excellent resistance to freezing-and-thawing cycling and salt scaling. This project also called for a high compressive strength due to the large ships, which have a tendency to “bump” the docks. In response, our material choice proved to have an average 28-day compressive strength of over 7000 psi (48 MPa), which far surpassed that over other application methods and materials explored. Once application was completed, the area was trimmed to true lines, relieved of any excess material, and given a natural gun finish to beams and deck underside and a steel trowel finish to the columns and dock facing.

Shortly after the completion of the dock-face repairs and installation of the new fender system, another large, fully loaded ship “bumped” the dock. To the owners amazement, the only visible damage was to the bolts anchoring the fenders. In fact, the bolts, which were steel, bent to the point that the ends were touching the shotcrete face of the dock, yet no damage was present on or around the area that had been repaired using shotcrete.

To prove the importance of shotcrete to this project and the owner’s new-found trust in this method of repair, it should be noted that this project initially was slated for only one phase, which included the dock face and associated columns and beams. By completion, however, the project had seen the addition of three phases. This is a testament to what we in the industry already know—that shotcrete, when installed properly, is a far superior product to other types of similar materials.

In summary, our company took on a project that many in the industry deemed the “impossible, company-breaking” project. Yet through the innovations seen in recent years within the industry, we were able to take a project never designed for shotcrete and not only make the repairs cost effective, but also underbid all other methods explored. It should also be noted that we did not “break” the company and in fact were able to complete the project on time and within budget. Since the completion of this project, we have been fortunate enough to have the opportunity to make other engineers and construction managers aware of the shotcrete method, its ease of installation as compared to other forms or repair, its cost effectiveness, and its various methods of application.

The importance of shotcrete to the Manchester project cannot be overstated. This project was initially engineered to be a hand patch, form and pour project.

Not only would this have proven to be an unwise choice, but it would likely have caused the owner to endure countless additional repairs and a substantially larger amount of money over the course of several years and several lengthy repair cycles. The notion that Shotcrete could be a viable repair option for such an extensive project was initially hard to swallow. In reality, the project was an easy sell. Shotcrete’s past performance record truly worked to our advantage. Shotcrete’s versatility in application and history of success was without a doubt the single most important selling point for this project.

As the project progressed, our method again proved shotcrete’s importance as seen by a ship striking the dock causing no structural damage. This reiterates that the proper application of shotcrete produces a substantially stronger product than like-material installed using other methods. The project owner’s appreciation for the shotcrete method was again shown in the full rehabilitation of the ports dock system more than doubling the initial contract and amount of shotcrete applied at this facility.

Our company also saw first-hand the importance of the shotcrete method by the addition of several other projects that were signed merely by other engineers and contractors viewing the Manchester Project and witnessing the advantages of the shotcrete method. As the saying goes, we in the Shotcrete business have a single disadvantage over other types of repair in that we tend to work ourselves out of business. In a word, our process is so reliable that one repair is all it takes to outlast our lifetime!