PDCA 2005 Project of the Year: Over $1 Million

Charleroi Locks & Dam River Chamber Stabilization

The Locks and Dam #4, located on the Monongahela River near Charleroi, Pennsylvania, is in the initial stages of a multi-phase construction project under the direction of the U.S. Army Corps of Engineers. The dam structure was renovated in the 1960's and remains in excellent condition. The lock structures, however, are in poor condition and are in need of replacement. The existing locks were constructed in the 1930's and are supported on driven timber piles. The locks are comprised of a 56'x 720' main landside chamber, and a 56' x 360' auxiliary river chamber. As one of the initial contracts to be awarded as part this multi-phase project, the purpose of the River Chamber Demolition Contract was to perform the preliminary work necessary for the future construction of the new middle wall. Notice to Proceed was issued in October 2003 to Choi Enterprises, Inc. who, in turn, sub-contracted Joseph B. Fay Company to perform the work. The concrete floor struts and pavers of the existing river chamber needed to be removed for the future construction of the foundation of the new middle wall whose center line will pass directly through the existing chamber.

Before the chamber could be dewatered for this work, 36-inch steel struts needed to be installed within the chamber to support the middle and river walls. The lower portion of the river wall that would be subjected to a water head differential when in the dewatered state had to undergo additional stabilization measures because the existing timber piles would not be able to take the additional loading conditions. This was accomplished with the H-Pile Stabilization Program that was conducted from August 25, 2005 until it's completion on October 26, 2005.

Driven Pile Considerations

The Charleroi Locks & Dam #4 River Wall Stabilization was chosen as the PDCA Project of the Year (over $1 million) for the extensive use of driven piles on a lock construction project to stabilize a portion of the lower river wall of the lock and to protect and prepare the river chamber for dewatering. The project pile work consisted of 814 tons of PS27 sheet pile and 180 tons of plated HP 14 x 117 piles. The main features of construction were to install a 30' diameter protection cell, a 47' diameter guard cell, two 47' diameter closure cells with 15' diameter arc wings, a 90' long sheet pile cut-off wall, a jet grout cut off wall, 40 plated HP 14 x 117 support piles, and the demolition of concrete struts within the dewatered chamber.

One of the most crucial features of work was the installation of the 40 support H-piles. These piles were installed to support the massive concrete monoliths of the lower guard wall while the river chamber was in the dewatered state. The design called for the piles to be driven to bearing capacities up to 600 tons. Approximately half

of the piles were to be driven on a batter of 9 to 29 to match the slope of the river face on the monolith wall. The remaining piles were driven plumb to match the chamber face of the monolith wall. All piles were to be connected to the monolith walls by welding them to 5'x 8'x 2" thick steel connection plates that were bolted to the monolith wall face. Precise control during driving was critical to keep the piles on the proper batter and to keep them within the limited weld zone of the connection plates. Access was difficult as the top of the monolith wall was only 5-feet wide and 22-feet above the waterline.

The Joseph B. Fay Company first drilled a series of 24, 1-3/8" holes into the monolith wall to grout in the anchor bolts that would hold the pile connection plate. After the connection plate was mounted, special knockout template frames were fabricated that attached to the connection plate anchor bolts to align the pile at the water line. The templates were fabricated with removable shim plates to account for the cover-plated portion of the HP14x117. The top 22 feet of each HP14x117 pile was plated with 1" thick by 16" wide steel plates on both flanges. This caused a need for a 14" guide template during early driving and a 16" guide template near the end of driving. A combination access platform and variable width template was anchored to the top of the monolith wall to provide access for the crew and receive the pile leads. The Joseph B. Fay Company consulted PDCA member Sunbelt Pile Driving for their hammer needs and a Berminghammer B5505 (rated energy of 106.2 kip-ft) equipped with a hydraulic starter and 32" box leads was chosen to drive the piles. A barge mounted 4000 Manitowoc crane handled both the piles and the hammer. The piles were set through the top access template and into the drive frame guides. Once the piles were set, the leads were pinned to the access template, and after the pile and leads were properly aligned, driving began under the direction of Michael Morgano of PDCA member GRL Engineers, Inc. who performed dynamic testing on each pile.

The scope of the dynamic testing first involved the testing of two piles, which were monitored using the Pile Driving Analyzer® during initial driving and during restrike, approximately one week after initial driving. Testing was also to be performed on each of the 40 production piles during initial driving to compute pile capacity and evaluate pile integrity. The piles were to be driven through about 20 feet of alluvium to the top of rock at elevation 690 feet. It

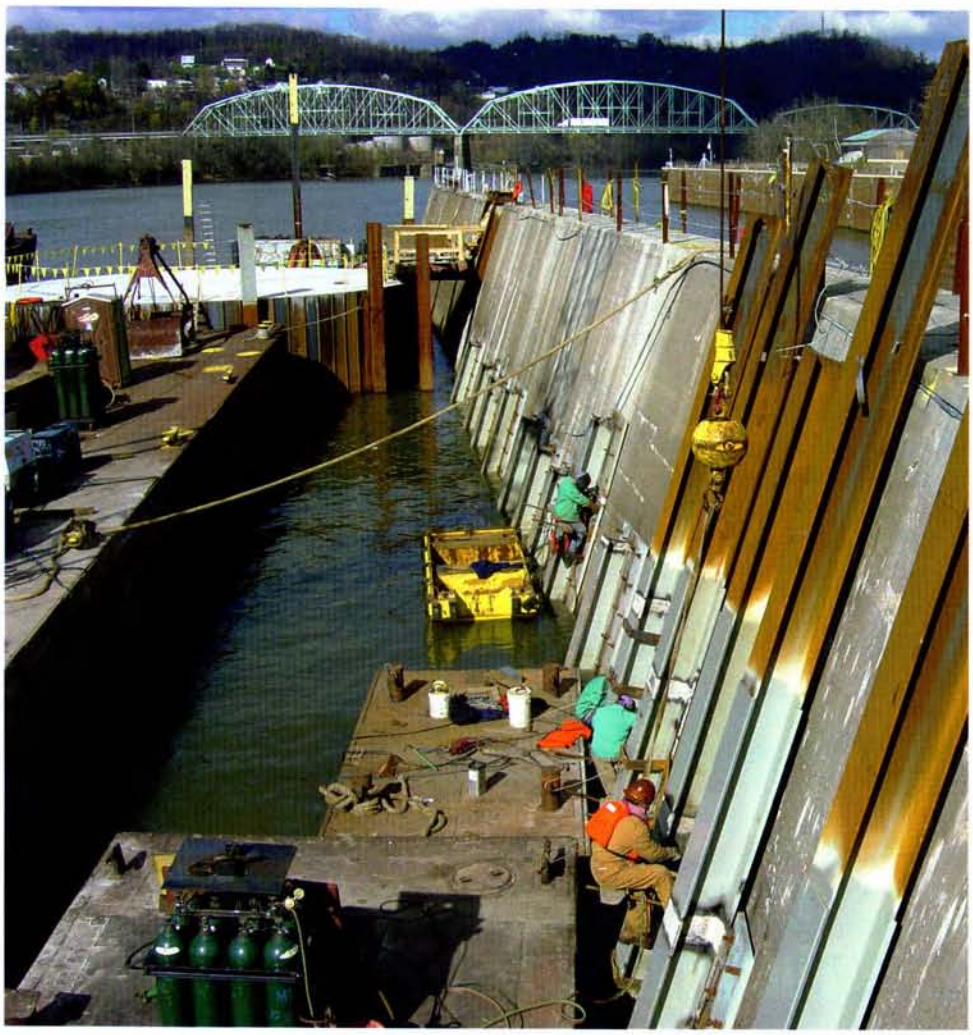
was assumed that the piles would drive through the upper Clay Shale formation until they reached the Ames Limestone formation at the approximate elevation of 680 feet.

Dynamic testing of the two initial test piles on this project indicated a potentially dangerous loss in pile capacity over time due to relaxation at the pile toe in the Clay Shale. The CAPWAP® computer program was used to analyze the collected data and indicated the loss in end bearing was approximate-

ly 22 and 38 percent for the two test piles. Based on these observations and on past experience with relaxation, criteria were established to estimate the capacity loss for piles within a given design load range as follows:

Adjustments to the required service life capacities of the piles were made to account for the losses. Using the above established criteria, the target end of drive capacities were calculated to account for the specified safety factor of 2, the assumed end bearing loss due to relaxation, and a small increase in friction capacity due to soil set-up. Because all piles on the project were tested, each pile was driven continuously until dynamic measurements indicated the target end of drive capacity had been mobilized, as opposed to the typical practice of determining blow count driving criteria to achieve the required service life capacity. Testing throughout the driving of production piles verified the required capacity and integrity of each pile and provided reliable foundation quality control.

Design Capacity Range	Assumed end bearing loss
400+ kips (1780+ kN)	22%
301 to 400 kips (1339 to 1780 kN)	38%
200 to 300 kips (890 to 1335 kN)	50%
less than 200 kips (890 kN)	60%



Design/Award Considerations

This project was considered for this award because the tolerance of driving piles was critical. The piles had to be driven under water with care to avoid existing underwater concrete structures. Likewise, the placement was critical for the next phase where battered anchors were to be installed between the piles to support the monolith wall sections for further excavation under the wall foundation. The piles were secured to the sides of the monolith wall sections by bolted 5' x 8' steel plates.

Project Benefit

This stable wall for future expansion of Charleroi Locks will allow larger barges to pass through locks, making transportation on the river more efficient and cost-effective. ▼

Owner: U.S. Army Corps of Engineers, Pittsburgh, PA

General Contractor: Choi Enterprises, Inc, Pittsburgh, PA

Sub-Contractor: Joseph B. Fay Company, Tarentum, PA

Pile Testing Consultant: GRL Engineers, Cleveland, OH

Suppliers: Sunbelt Pile Driving Equipment, Charlotte, NC; Skyline Steel, LLC, Parsippany, NJ; Dura-Bond, PA