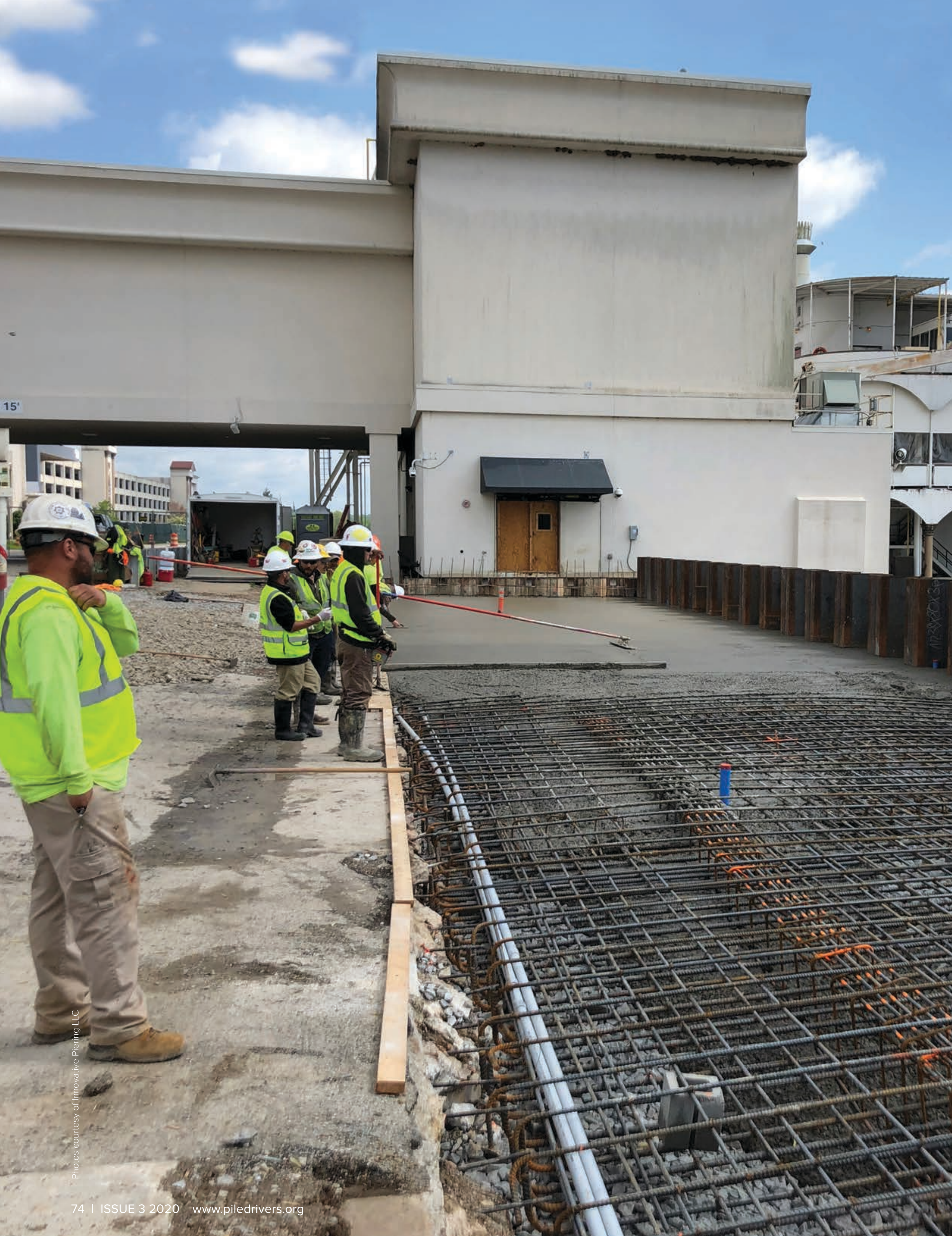
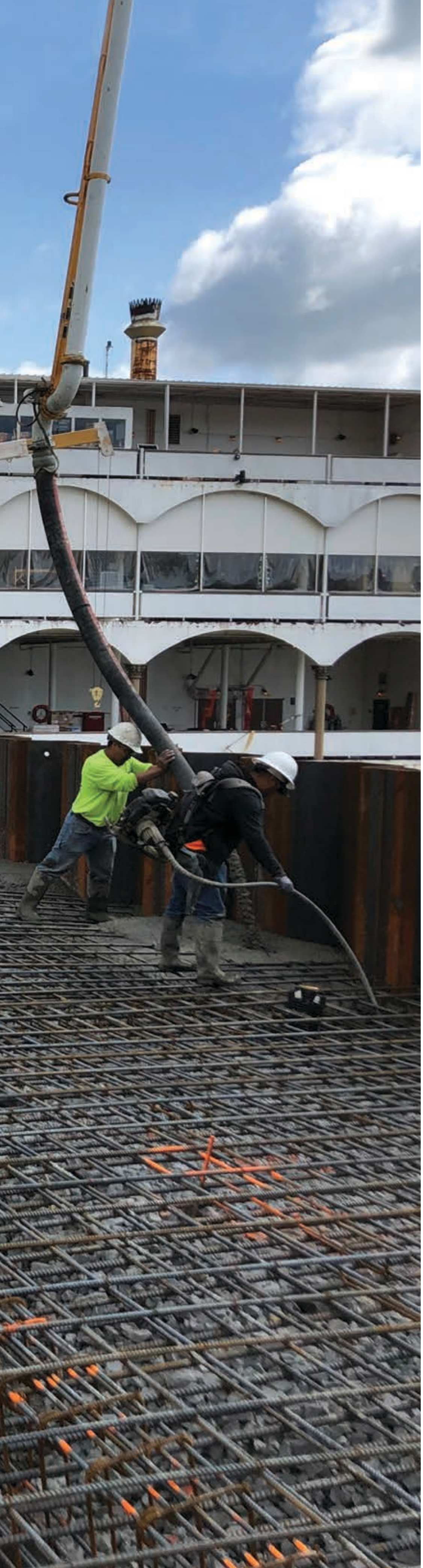


Photos courtesy of Innovative Piering LLC



HORSESHOE CASINO RETAINING WALL PROJECT

By Micah McRae, Innovative Piering LLC

Innovative Piering was contracted as a design-build contractor to address a failure of an existing sheet pile wall. The sheet pile wall was originally constructed around 1997 and experienced a total failure in early 2018. The failed retaining wall supported site soils and a trucking/loading dock area. When the wall was first visited, it showed signs of significant lateral movement, in the direction of the river (south). This was documented by photos and showed movement in excess of 13 inches where the concrete met the sheet pile wall. Also noted was the ejection of the existing tension ties/micropile bars, some of which remained in suspension on the existing waler beam, and others were ejected into the river.

This lateral deflection created a hazardous condition forcing the total closure of the dock area. It also made for difficult demolition. Once the area was made safer, a geotechnical drill collected soil information to provide the basis for Innovative Piering's design solution.

Some of the design considerations for this project were:

- Not increase loads on the secondary retaining wall that carries the roadside load or depend on the roadside retaining wall for any additional load
- Could not damage or alter the existing roadside retaining wall, as its condition was immeasurable
- Permitting by USACE titled the project as a "maintenance/repair," so long as we didn't change the design style or move the wall north/south by greater than two feet
- The dock and retaining wall structure needed to be as close to the original condition as possible
- The wall needed a life expectancy of a minimum of 25 years
- The wall needed to be free draining, not to be designed to combat hydraulic loads
- The drainage plan needed to account for silt infiltration and maintenance of river sediment deposits

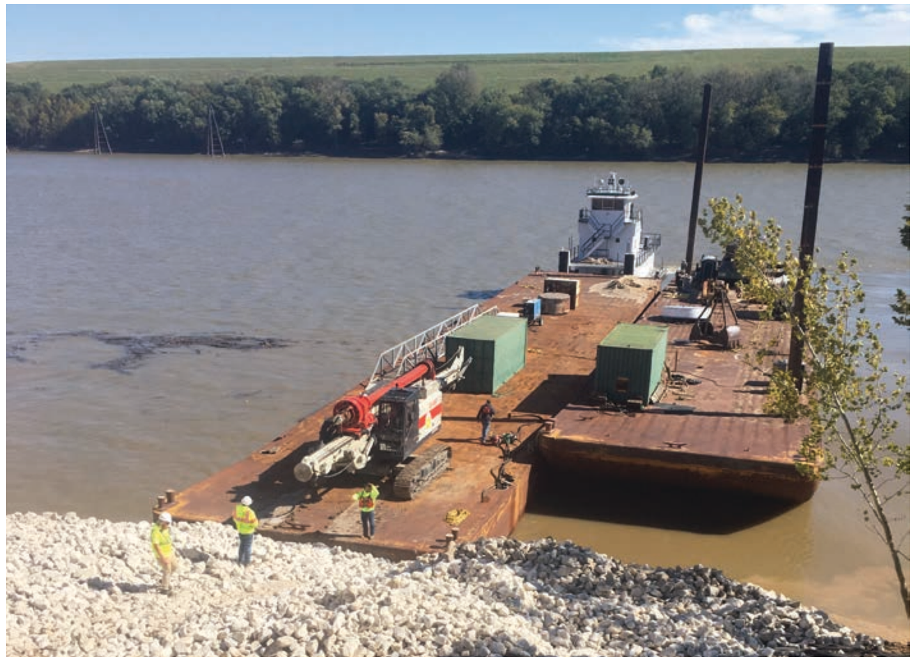
Phase 1: Demolition

This phase included selective demolition and disposal of the steel and site soils. The site soils were mostly used to balance the erosion that had scoured the area outside of the sheet pile wall. The steel had to be cut out and removed via crane. Once up to the roadway, the scrap steel was loaded into semi-trailers and hauled to a local scrap yard. As more steel was removed, more soils were able to be pushed into the voided 'beach' bringing the grade to its previous grade prior to the scour. Majority of the soils balanced was a sand and clay mix.

Another part of the project included importing barge loads of crushed stone to help prevent future scour of this beach. Therefore, once the soils filled in the eroded bank of the river, a fabric was laid over the soft soils, and capped with 12 to 18 inches of crushed limestone. Due to the next phases of this project, we imported this rock a little earlier than expected to provide a better loading ramp for barges to deliver a 50T drill rig. (But we'll talk more about that in the next phase.)

During the demolition phase, the interior of the dock area began its descent, about 24 feet. This elevation was the elevation needed for the subsequent phase. It did mean safety precautions, such as constructing safety fencing and establishing measures for preventing fall or fall on hazards.

During this phase, on 9/8/18, one flood event occurred, bringing water to elevation 424 feet and forcing us to abandon operations while the river crested and receded. When the river allowed, we re-mobilized and continued demolition.



Phase 2: Pile driving

This phase required the installation of fourteen 14-inch H-piles to a depth of about 79 feet. The goal was to ensure the H-piles were socketed or embedded into the weathered rock layer. We assumed drilling operations would be the most dependable method to ensure we could engage the weathered rock layer. Therefore, we tactfully managed to source a drill rig, tools and marine equipment to allow us to land a large drill rig on the drill deck, 24 feet below the roadway.

The drill rig was loaded at a nearby marina and floated down river, and was carefully moored against the newly constructed, crushed stone pier we had built. Once the drill rig was in place, we began drilling the 70-foot, 24-inch drilled shafts. As we drilled the shaft, we used segmented casing to prevent the soils from collapsing. Once the soils were removed and we had a hollow shaft with five to six feet of embedment in the weathered rock layer, we would install the H-pile from overhead with a 65T crane. Once the H-pile was in place, we would pump 8,000# grout into shaft, from the bottom up. At that point, the casing would be removed, leaving in the ground a 24-inch drilled shaft with an H-pile in the center.

This system was just coming online, with operations yielding one pile per day when the river forecast showed another flood in route. The Innovative Piering team kicked it into high gear, planning an exit strategy. It included establishing the last day that we had to be able to successfully abandon the drilling operation and make a speedy exit. This included multiple tugboats, barges and a marine crew supporting us from the river. It included crane support overhead, assisting us with removal of drill tooling. And it took an aggressive action on part of the team to grade the beach adequately to time the barge deck aligning with the grade to allow us to track the drill rig back on to the barge. Unfortunately, however, only three drilled H-piles were installed.

While it was unfortunate and disappointing to have to shut down operations for the second time, we did learn a couple valuable lessons. The most important lesson was once we discovered how soft drilling the weathered rock layer was, the greater our confidence became to attempt to drive the H-piles, instead of drilling them. We also had greater confidence in the roadside retaining wall, as we had worked

Continued on page 78

INNOVATIVE PIERING™

Innovative Solutions for Deep Foundation Challenges

INNOVATIVE PIERING™
MARINE CONSTRUCTION

www.InnovativePiering.com

1.812.725.4446

diligently, monitoring the wall for movement with all the activity. These lessons caused us to rethink our strategy.

We asked our engineering team to study the projections and performance of using driven H-piles, socketed five feet into the rock, vs. drilled H-piles socketed five feet. The answer was within what was considered acceptable. Upon further investigation, we discussed our change in means and methods with the owners and got approval.

This did mean bringing in crane mats, a larger crane, vibrators and hammers and installing the driven H-piles from the roadway. We were very conscious throughout this project to monitor the existing roadside wall. Tiltmeters had been installed from the first day of operations, setting a baseline and allowing us to remotely monitor any lateral movement in the roadside wall.

Continued river flooding made the H-piles driving challenging. Work was performed by smaller barges placed in the proposed loading dock area. The H-piles were fitted with rock biting tips, to prevent them from deflecting or walking. The 5' embedment criteria turned out to be successful and the remaining 11 piles were driven to final elevation.

Phase 3: Sheet piles

This next phase included sourcing heavy gauge, 79-foot steel sheet piles. Transportation and logistics were challenging, as was the spatial constraints on site in the lay down area. But falsework/template material was installed, and sheet piles were fitted with the rock bearing teeth, to prevent deflection or walking. Next up, the sheet piles were vibrated down to end bear on the weathered rock layer. Once the sheets were installed and end bearing, extensions were welded to bring the tops of the sheets to the final "top-of-sheet" elevation. Again, all of this work had to be done from barge/platforms, as it was flooded for the majority of this phase.

Phase 4: Waler beams, tension ties, drainage and fill

This phase was ensuring the new sheet pile retaining wall engaged the 14 H-piles that were previously installed. The design basically consisted of two rows (top and bottom) of waler and tension ties. Basically, as designed by the geo-structural engineers, a waler beam was installed on the back side of the H-piles, and the other waler beam was installed on the outside of the new sheet pile wall. Alignment was critical, as the waler beams were pre-manufactured offsite. This means that final elevations and the east/west layout had to be about perfect in order for the tension ties to line up and the tension ties to be squarely loaded.

Once the waler beams were installed, and the tension ties connected the two waler beams, a steel reinforced concrete encapsulation occurred. Hundreds of cubic yards of 4,500 psi concrete was pumped and vibrated to fully encompass the steel tension ties, the waler beams and the steel reinforcement.

Our next priority was dealing with the drainage and the soil loading. We created a sloped bottom by pumping hundreds of cubic yards of a 150 psi flowable fill with 12 inches of fall toward the river. This gave us a strong bottom grade to evenly distribute the loads above and ensure water drained towards the river.

Once the flowable fill cured, we immediately set up a conveyor system to import the free draining, crushed stone. The stone would bed the pipe in place to ensure it was draining through the weep-holes in the sheet piles. For maintenance design, piping was installed vertical about every 18 feet to provide access for flushing of river sediment build up.

As the rock was placed, it would be graded in 12-inch lifts, and compacted with vibratory plate compactors around the edges, and sheeps-foot trench rollers/compactors and tracked equipment.

During fill operations, the roadside retaining wall was monitored, compaction and drainage practices were closely managed.

Phase 5: Structural slab on grade and finishes

The last phase of this challenging project was wrapping up the top side. It included a 12-inch structural slab on grade, thickened edges, a grade beam and 35,000 pounds of steel reinforcement incapsulated. It also included a cast in place loading dock, boat mooring, stairs and a ramp. Handrails and fencing were replaced, and pavement was placed to ensure safe access.

The operations phases of this project began 9/1/2018 and was completed on 5/8/2019. There were zero accidents or injuries on this project. ▼