

Two Grain Silos That Had Settled Were Restored With ECP Steel Piers™ Guernsey, Iowa

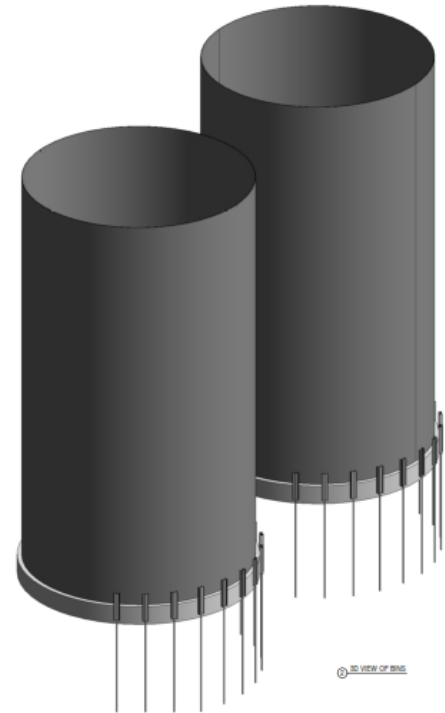
Two 84 foot tall grain elevators with a diameter measuring 48 feet were tilting. The distress suggested failure of the 17 inch thick reinforced concrete foundation. The plan was to install ECP Steel Piers™ spaced six feet on center around the elevators. The estimated dead load on each of the 25 piers per silo was 23,760 pounds. The live load estimate for a full elevator of 135,000 bu. of corn is 7,560,000 pounds.

Poor drainage and standing water was observed near the elevators. This drainage problem eventually permitted erosion and loss bearing capacity of

the soil. The soil no longer was supporting the structural dead load and the live loads including the grain stored in the elevators. The result was a failure of foundation support for a portion of each structure, which allowed the two elevators to tilt.

The engineer recommended installing ECP Steel Piers™ for supplemental foundation support. The ECP Steel Piers™ would terminate at a stable load bearing stratum deep below the failing soil. The plan was: 1.) correct the poor drainage, 2.) recover the lost foundation elevation, and 3.) inject polyurethane grout into the void under the slab that was created when the steel piers recovered the lost elevations.

ECP Steel Piers™ were selected because of stable support, rapid installation and ease to restore the foundation. During the installation and restoration process, the steel resistance underpinning did not cause any disturbance to nearby structures or to the weak soil adjacent to the elevator foundations. The PPB-350



Project Summary			
Project: Brooklyn Elevator Company - Grain Silo Restoration			
Installing Contractor:	Iowa Wall Sawing Independence, Iowa	Engineer:	Mark Schuchard, P.E. VJ Engineering, Coralville, Iowa
Product Installed: ECP Model PPB-350 Steel Pier™ with 4" Sleeving			
Total Number of Placements:	50	Average Pier Depth:	50 feet
Ultimate Capacity:	86,000 lb.	Reinforcing Sleeve Depth:	17.5 feet
Average Proof Test:	73,000 lb.	Average Lifting Force:	42,300 lb.
Factor of Safety:	1.7 : 1 Test Load to Lifting Force		2.0 : 1 Ultimate to Lifting Force

ECP Steel Pier™ System uses 3-1/2 inch diameter pier pipe. Additional pier stability through the depth of weak and saturated soil was accomplished by installing, 17-1/2 lineal feet of 4 inch diameter sleeving over the pier pipe and then filling each pier pipe with concrete grout. This increased the moment of inertia (stiffness) of the steel pier system.

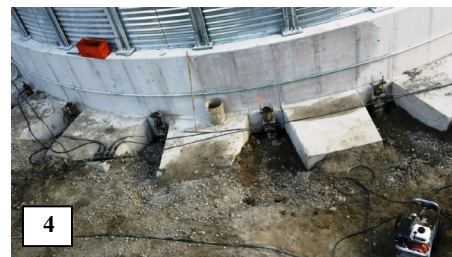
The Model PPB-350 ECP Steel Piers™ were installed on this project using vibration free hydraulics to achieve pier depths between 43 and 56 feet below grade where suitable end bearing was found. Once end bearing resistance was encountered, a proof test load was applied to each pier. All testing was performed prior to placing the ECP Steel Piers™ into service. Proof load test forces ranged from 62,000 to 74,500 pounds depending upon the location of each pier on the structures.

Installation and Restoration Photographs

1. Poor drainage and standing water was blamed for the deterioration and loss of soil support under the elevators.
2. The 17 inch thick foundation was cut to allow the ECP Steel Pier™ brackets to be installed under the vertical wall of the elevators. Standing water was encounter in the process confirming the drainage problem on the site.
3. The PPB-350 under footing brackets were installed and bolted in place with the bearing plates in contact with the underside of the foundation. A technician is shown advancing the 3-1/2 inch diameter pier pipe into the soil until suitable firm bearing was encountered. Once the bedrock was reached, ranging in depth from 42 to 56 feet, the technician installed 17-1/2 feet of 4 inch diameter sleeve over the pier pipe to stiffen the pier shaft and strengthen the coupled joints. Following the pipe and sleeve installation, the pier pipe was grouted with cement grout. Each pier was then proof tested to an average force of 72,000 pounds to verify the competency of the load bearing stratum deep below the surface.
4. Once all of the piers were installed and proof load tested, restoration was accomplished by attaching a lifting assembly to each pier bracket and then placing a 25 ton hydraulic ram between the pier cap on top of the pier pipe and the lift assembly. The hydraulic rams applied an average 42,300 pounds of force simultaneously at each pier placement to recover lost elevation. The lifting force at each placement was monitored with a pressure gauge. Elevation recovery of 1-1/4 inches was achieved at one elevator, and the other elevator foundation was lifted 1 inch.
5. Once the lost elevation was recovered, bolts on the pier caps were tightened, then the 25 ton hydraulic rams and lifting assemblies were removed. Prior to filling the elevators with grain, the void beneath each slab was injected with polyurethane foam to provide soil contact and support.

The concrete that was cut and removed for pier bracket access was replaced with new concrete. The disturbed soil in the area of work was replaced and graded for positive drainage. Other drainage improvements insured that the cause of the failure was corrected and the underlying soil was no longer saturated.

This project was successfully completed within budget and to the engineer's specifications by Iowa Wall Sawing.



ECP Steel Piers™
*“Designed and
 Engineered to Perform”*