Pin Piles[SM]: Foundations for SCR Retrofits

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Summary

Nicholson Construction Company has established itself as the U.S. authority for the design and construction of Pin Piles, high capacity drilled and grouted steel pipe piles also referred to as micropiles or minipiles. As the leading installer of Pin Piles in the U.S., we have completed over $155 million worth of Pin Pile foundations on over 150 projects nationwide. Nicholson has installed Pin Piles for multiple Selective Catalytic Reduction (SCR) upgrade projects for coal-fired power plants. We have gained much insight through our experience and interaction with consulting engineers, general contractors, specialty structural erectors, and power plant personnel.

Pin Piles are the foundation system of choice for many SCR upgrades because of the following characteristics:

1. Vibration and impact to adjacent structures are minimal
2. Pin Piles can be installed in limited-access areas such as building interiors, and below overhead structures
3. Pin Piles can be installed adjacent to or through existing foundations to accommodate retrofitting and use/upgrading of existing foundations
4. Installation costs are relatively low.

Headquartered in Pittsburgh, PA, Nicholson is a leading specialty geotechnical contractor that has been providing innovative and cost-effective services in ground treatment, ground improvement, and structural support for over 46 years. Our design and construction teams are among the most knowledgeable and experienced in the world. We are also proud to be the North American affiliate of the world's oldest specialty geotechnical contractor, Rodio Group based in Milan, Italy. Together Nicholson and Rodio share technology, ideas and resources for geotechnical projects worldwide.

Due to recent United States Environmental Protection Agency (USEPA) mandates, many existing coal-fired power plants must reduce nitrous oxide (NO_x) emissions at their facilities by the year 2003. SCR technology is one option to effectively reduce these emissions. Retrofitting SCR technology presents distinct challenges not only to system engineers because of potential interferences, but also to structural engineers because of the extensive foundations that the new equipment requires. SCR units are typically erected adjacent to or above existing structures and often require deep foundations to resist the large compression, uplift, and lateral loads that are induced at the base of the structure. In many cases it is not practical to install a traditional deep foundation element such as driven steel or timber piles, or concrete-filled drilled shafts. In these cases Pin Piles have proved to be the most appropriate solution.

Pin Piles are drilled-in elements typically ranging from 5 to 12 inches in diameter, which usually consist of steel pipe (casing), steel reinforcement, and cement grout. They derive capacity in the ground from side friction and perform very well in both compression and tension. Working load capacities typically range

from 50 to 200 tons. Pin Piles are installed using rotary drilling techniques similar to those used in the oil and gas industry. Nicholson utilizes three drilling techniques:

1. Positive circulation or external flush drilling
2. Duplex drilling
3. Rotary eccentric percussive duplex drilling.

The appropriate drilling method is selected based on the subsurface conditions and site accessibility. The piles derive their geotechnical capacity through grout to ground adhesion in the bond zone. In soils this bond is typically developed using pressure grouting and in rock, tremie grouting. The pile's structural capacity is provided by grout (typically 4 ksi), steel casing (typically 80 ksi), and reinforcing bar (typically 75 ksi).

Pin Piles are installed in a wide range of access and ground conditions, which makes them ideally suited to working in and around existing power generation plant structures. The following case history demonstrates a typical Pin Pile application for SCR upgrades.

The foundation construction for this coal-fired power plant located in Kentucky along the Ohio River involved the design and installation of Pin Piles in the Unit 2 boiler house, adjacent to the existing stack, and in the area between the stack and the boiler house. The retrofit required construction of foundations in and around existing and operating equipment without interruption to plant activities. Drilling for the piles occurred in areas of tight access and limited headroom adjacent to blowers, fans, ductwork, and cable trays. In many areas, the overhead clearance was as low as 12 feet. Borings in the area indicated that the upper 15 to 25 feet of soil was comprised of silty sand and sandy silt with clay. Underlying these strata was a layer of sand with some silt and gravel that became coarser with depth. The sand below a depth of approximately 60 feet became very dense and contained cobbles and boulders near the top of rock. The upper bedrock surface, which consisted of hard limestone, occurred at a depth of approximately 130 feet.

The design loads were 200 tons in compression and 100 tons in tension. A total of 119 piles were installed in 12 pile caps. The Pin Piles consisted of 9-5/8 in. outer-diameter steel casing with 0.45-inch wall thickness. The piles were drilled to the top of competent rock, and a Grade 80, 95-feet-long all-thread bar was installed, using couplers, for reinforcement. The grout consisted of neat Portland cement grout (water-cement ratio of 0.45), with a minimum 28-day compressive strength of 4000 psi.

Piles located in areas of unrestricted access were installed with a large, hydraulic track-mounted drill rig and the limited access piles were installed using an electric-powered mini rig. To verify the actual load carrying capacities of the piles, a non-production pile was installed and tested in accordance with the Standard Test Method (Quick Load Option) for Piles Under Static Axial Compressive Load (ASTM D1143-81). The maximum test loads applied were 400 tons in compression and 200 tons in tension. The load testing was completed in December 2000, and the production piles were installed between January and mid-February 2001.