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A History of the Use of ACIP Piles for Major Projects in Atlanta

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Abstract
In the Metropolitan Atlanta Area today, augered, cast-in-place (ACIP) piles will be considered on most projects where deep foundation support is required. ACIP piles were first used in Atlanta in the late 1960s, and application began to blossom in the mid-1980s. Current design practice for ACIP piles is addressed in another paper in this conference. This paper describes the evolution of the ACIP industry in Atlanta, and details the use of ACIP piles on major projects in the Atlanta area.

Early Projects
It is of interest to look at the use of ACIP in Atlanta in terms of how the industry in general evolved, since the contractors involved, and the equipment available has a significant impact on application. The ACIP pile process grew out of a modification of pressure grouting processes at Intrusion-Prepakt, Inc, in the late 1940s. The first piles were created by augering to the desired level, placing a grout pipe beside the auger to the tip, then grouting through the pipe as it and the auger were withdrawn. This process was modified as suitable hollow-stem auger was developed, and in 1956, a patent was granted to Raymond Patterson for construction of cast-in-place piles by pumping grout through a hollow-stem auger. Licenses were granted to Lee Turzillo Contracting Company and Berkel & Company Contractors, Inc. in the late 1950s.

Both Intrusion-Prepakt and Turzillo were initially active in the southeastern United States and both executed projects in Atlanta in the late 1960's. One of the early projects was the Georgia Plaza, near the state capitol complex. An interesting aspect of this project is that 10 compression load tests were performed even though the project was of fairly modest size. The piles were 14-inch diameter, and had a design capacity of 50 tons. The boring logs could not be located, but the shape of the load-displacement relationships indicates limited penetration into partially weathered rock.

During this period, augers were advanced by units that developed about 15,000 ft-lb of torque. Leads were mounted on mechanical cranes that made it difficult to retract the auger smoothly, and grout was placed with pneumatic pumps. Masonry sand was used in the grout (to allow the grout to be pumped with the pneumatic powered piston pumps), and grout was batched on site from bagged cement, fly ash and a grouting agent. The use of the fine masonry sand made the consistent production of grout with a compressive strength 3000 psi a challenge. The construction of 400 to 500 linear feet of piling in a single day was considered quite an accomplishment.

The level of ACIP activity increased steadily in the early 1970s, although they were still being used primarily where loads were fairly modest or where substantial uplift resistance was required. Water treatment facilities proved to be a good market niche for the system and Berkel & Company executed its first project in the Atlanta Area during this period at the R. M. Clayton Water Treatment Plant.

Transitional Period

The mid-1970s was an interesting period for Atlanta. In addition to MARTA, expansion of the airport, and construction of I-285, there was significant construction in downtown and suburban areas. The population surpassed 1,000,000 people, and Atlanta was being recognized as a major metropolitan power. Raymond Step-Taper piles had long been a staple of the deep foundation market in Atlanta. Additionally, inexpensive oil-field pipe that could be used as piling became available, and driven systems tended to dominate the market, with drilled shafts being used where loading and subsurface conditions were appropriate.

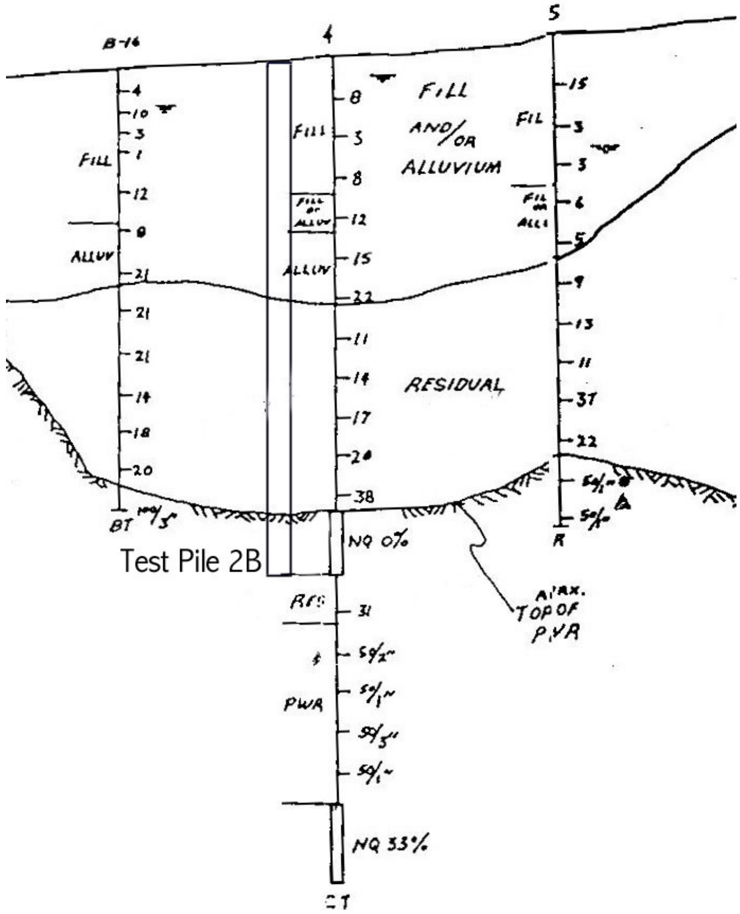
This time was also a transitional period for the ACIP industry. Equipment with increasingly higher torque was becoming available and the installation process was being refined. Grout was now routinely supplied by ready-mix companies, and mixes with concrete sand could be used thanks to more powerful and efficient pumping equipment. The original patent for ACIP piles expired in the mid-1970s, and the numbers of companies offering the system grew rapidly. This led to a transition in terms of the ACIP contractors who were active in the area, and by the early 1980s, neither Intrusion-Prepakt nor Turzillo had a major presence in Atlanta.

A notable ACIP project during this period was the initial work at the World Congress Center, which was executed in three phases by Hico, Berkel & Company, and Intrusion-Prepakt. The piles were 14 inches in diameter, and were designed for a working capacity of 80 tons.

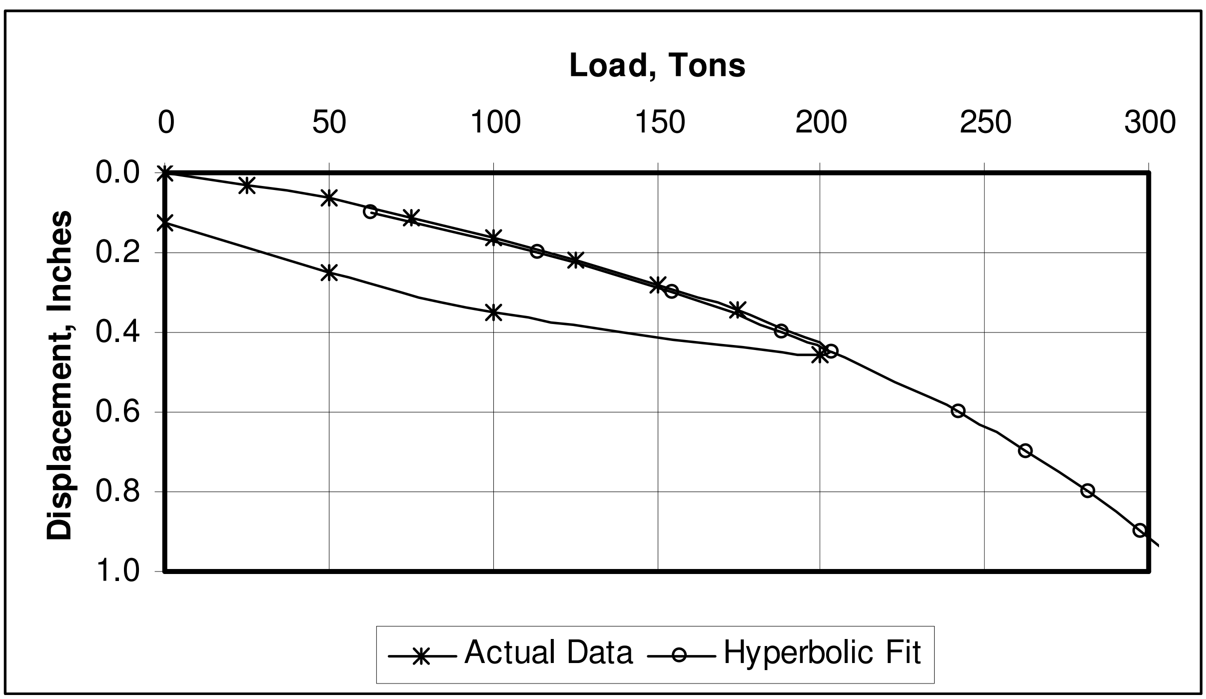
The Current Era

The mid-1980s was a pivotal time for the deep foundation industry in Atlanta. Raymond Pile Driving was in decline, and the oil field pipe that had been so plentiful (and cheap) was beginning to dry up. In the ACIP industry, equipment capable of producing 30,000 to 40,000 ft-lb of torque was now available, along with more powerful, more reliable and higher volume grout pumps. Additionally, there was now a substantial knowledge and experience base in the local Geotechnical Engineering Community, and an increasing level of confidence in ACIP quality control processes.

Berkel & Company Contractors opened an office in Atlanta in 1985, and one of the first projects for the new office was the Corporex Center at 400 Interstate Parkway North. On this project, all piles were drilled to refusal, (which ranged from 25 feet to 115 feet) and the design load was 100 tons, for 16-inch diameter piles. The general subsurface setting and the results of a load test at the Coporex site are shown on the following page.



Profile at Corporex Load Test 2B



Load Test 2B, Corporex

The industry continued to expand the limits of ACIP piles in Atlanta, and in 1990, the Georgia Dome was supported on approximately 30 miles of 18-inch diameter ACIP piles with a design capacity of 150 tons. . The toe levels were established by drilling to refusal or to a maximum of 80 feet, which established the practice of using “friction” ACIP piles in Atlanta. This was a watershed project in terms of the drilling criteria capacity, and depth, and clearly demonstrated the versatility of ACIP piles.

Preparation for the 1996 Olympic Games brought a flurry of construction to Atlanta, much of it supported by ACIP piles. The most visible symbol of the Olympics, the Olympic Stadium (later to be transformed into Turner Field, home of the Atlanta Braves), saw the installation of over 123,000 linear feet of piling that ranged from 35 feet to 85 feet in depth. Like the Georgia Dome, the design capacity was 150 ton. However, here the pile diameter was 16 inches, which necessitated the use of grout with a compressive strength of 6000 psi.

The Omni Arena, which was constructed in the 1970s, was demolished in 1996 and replaced with Phillips Arena, the current home of the Atlanta Hawks. The Omni was supported by 80-ton capacity Raymond Step-Taper piles. Some of the old piles were integrated into the new foundation scheme, which consisted primarily of new 16-inch ACIP piles with a design capacity of 150 tons, to depths of up to 90 feet. At least one of the ACIP piles was loaded to 400 tons.

Clearly, the major thrust in the use of ACIP piles in Atlanta has been in development of equipment and processes to go “bigger and deeper”, and the increase in design capacities over the past 30+ years reflects that emphasis. Certainly, increases in capacity of conventional ACIP piles will occur with development of more powerful equipment, however, new processes seem to be the likely source of significant changes in the cast-in-place industry.

Augered, cast-in-place displacement (ACIPD) piles have been used on several projects in Atlanta. The approach with ACIPD piles is to improve the materials adjacent to the pile shaft and thus increase shaft resistance. The Berkel Displacement Pile tool is shown in Figure 1, and the installation platform is shown in Figure 2. Currently, tools ranging from 12 inches to 18 inches in diameter are available. The auger section is typically about 3 feet in length, but may be longer, depending upon application. The typical installation platform includes a vertical mast with an attached turntable capable of producing 180,000 ft-lbs of torque. Within the mast assembly, there is a winch and system of cabling that allows a downward force (crowd) of 80,000 lbs to be placed on the tools.

As the tool is advanced, the material penetrated is displaced horizontally, either at its horizontal position (in loose to medium soils), or after being transported upward by the auger to the displacing element (in medium to dense soils). In either case, material in the auger flighting is compressed by being forced to the ramp area and displacing element. Because the auger flighting is packed with material, there is an outward force in the vicinity of the auger section. Some densification can occur around the auger section and there is, at worst, neutral displacement around the auger.

The depth of the tip is displayed in the operator's compartment, and when the desired tip level is reached, downward travel of the tool is stopped and pumping of grout is begun. Grout pressure is monitored at the top of the tools and displayed in the operator's compartment, and when the target pressure has been reached, withdrawal of the tool is initiated. The withdrawal rate is varied to maintain grout pressure appropriate for the materials in which the pile is being cast. A target "lift off" pressure and a pressure range for shaft construction are set during probe pile and test pile installation, and a relationship between installation pressure and grout volume is established. Grout volume is checked to insure that the volume delivered is greater than the neat volume of the hole, but the pile is cast based on pressure.

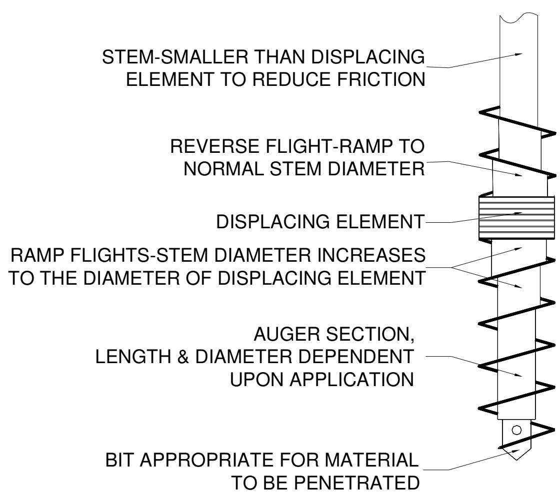


FIG. 1 Berkel Displacement Tool

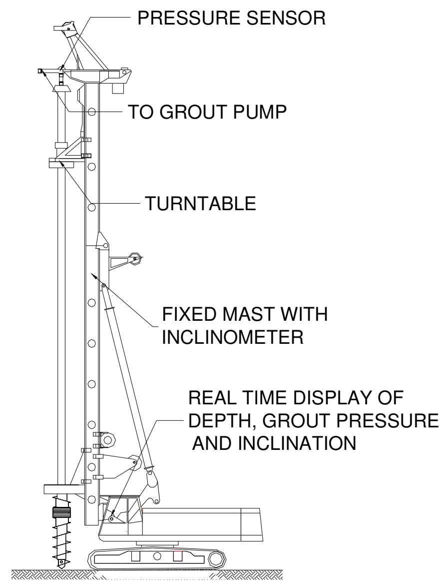


FIG. 2 Installation Platform

An issue with application of systems of this type in Atlanta is the nature of the residual soils. In materials that behave like granular soils, displacement leads to densification, and a significant increase in shaft resistance compared to conventional ACIP piles. Densification also increases the modulus of the soil between the piles, and thus applications where piles are used as settlement reducing elements, rather than load transfer elements appear promising. With increasing fines, the efficacy of displacement diminishes, and in materials with fines in excess of 50 percent by weight, shaft resistance for displacement piles begins to approach that of conventional ACIP piles. Site characterization, which is important with ACIP piles, becomes a critical issue for the technical application and constructability of ACIPD piles.

Conclusion

Over the past 30 years, the ACIP pile industry, and the application of the system in Atlanta have changed dramatically. Contractors working in the area have recognized the need to develop higher capacity equipment, and to refine installation and quality control procedures, The Geotechnical community has responded with a willingness to push the envelope technically, and the result has been application of ACIP piles over a wide range of construction types in a variety of subsurface settings, with working capacities three times those used in early applications.