



The Evolution of Augered Cast-in-Place Piles

In 2013, Augered Cast-in-Place (ACIP) piles are a mature foundation technology throughout the United States. General guidelines for the design and construction of ACIP piles are available along with numerous references for design in specific North American geologies. In fact, the current generation of contractors and geotechnical practitioners might view ACIP piles as just another deep foundation option to be considered, along with driven piles, drilled shafts and others. This acceptance has developed, however, over a 60-plus year period.

The term, Augered Pressure-Grouted (APG) pile is often used when referring to ACIP piles because the piles emerged out of construction processes at the Intrusion-Prepakt firm in the late 1940s. The company's specialty was pressure grouting and pre-placed aggregate concrete. The grouting was typically accomplished by driving a pipe to a target level and then injecting grout under pressure. In some soil conditions, it was necessary to use an auger to reach the desired grouting depth. In these circumstances, the grout pipe was driven beside the auger and grout was pumped as the auger was withdrawn. The grout pipe was then withdrawn as well. This was the genesis of the APG, or ACIP pile, and many piles were installed using this technique.

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Growing Knowledge Base

Another significant factor in the growth of ACIP piles during this time was a substantial increase in the knowledge base in the geotechnical engineering community and an increasing level of confidence in ACIP pile quality control processes. References for static capacity analysis and quality control began to appear more

frequently, and standard specifications became a part of the deep foundation literature. In 1990, the Deep Foundations Institute (DFI) published the *ACIP Pile Manual*. This was the first industry-based document that provided a detailed, comprehensive guide for installing ACIP piles (the manual was updated in 2003). DFI has also published a model specification and *Inspector's Guide to ACIP Piles*.

From the earliest installation of cast-in-place piles, the question of, "How do you know what you have here?" has asked been asked. The issues of whether or not the piles being formed were sound, continuous and of the proper diameter were of high concern, as installation was very operator-sensitive. Early basic inspection guides included monitoring the drill depths and the grout volume and reinforcing steel placement. The drill leads were marked to indicate drill depths and the grout pumps were calibrated for their output. From this, a pumping procedure in terms of the number of strokes-per-foot could be established for given diameters in varying soil conditions.

This same basic process is used today, but the methods of gathering information have changed radically. There are numerous monitoring systems on the market to electronically measure tool depth, torque, grout placement and a variety of other parameters during ACIP pile construction. The first modern automated monitoring system in North America was the Pile Installation Recorder (PIR), developed by Pile Dynamics, Inc. working with Berkel & Company on its development and implementation in 1995. Since that time numerous other automated monitoring systems have become available.

AUTHORS

Willie M. NeSmith, P.E. (retired), Alan Roach, President, and W. Morgan NeSmith, P.E., Chief Geotechnical Engineer, Berkel & Co. Contractors, Inc.

Early installation of ACIP piles



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Conclusion

Contractors working in the ACIP pile arena have recognized the need to develop higher-capacity equipment, refine installation and quality control procedures, and to develop materials and equipment to provide ever increasing capacities in a broader range of subsurface conditions. Material suppliers have developed grout additives that make it possible to cast piles with increasingly reliable high capacities and to insert reinforcing steel to greater depths. Just as important, many in the geotechnical community have responded with a willingness to evolve technically, and the result has been the application of ACIP piles over a broad range of construction types in an increasing variety of geologic settings.

Visit the DFI ACIP pile committee web page at www.dfi.org to learn more about this technology.