

# Special Bulletin Feature: STABILIZING GROUND WITH CEMENT

## The Use of Augered Cast-in-Place Piles

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### Introduction

In recent years many modifications to construction methodology in urban areas have been necessitated by environmental considerations. It is often unacceptable to install driven piles in the urban environment due to restrictions on noise, vibrations, soil displacements or space.

A piling method developed in the mid to late 1950s has become more commonly used to meet the demands of urban restrictions. This methodology uses a continuous flight hollow-stem auger, drilled to a predetermined depth through which a fluid grout is pumped as the auger is withdrawn to form a concrete pile. Known by many proprietary or trademark names, these piles have been named augered cast-in-place (ACIP) piles by the Committee on Augered Cast-

in-place Piles of the Deep Foundations Institute. A typical ACIP piling rig is shown in Figure 1.

### Installation

Figure 2 shows the sequence of ACIP pile installation. ACIP piles are installed by drilling to the design depth with a continuous flight hollow-stem auger with a removable plug at the toe or side of the auger. The plug is necessary to prevent drilled soil from running up inside the hollow-stem auger as it is advanced.

After the auger reaches design depth it is withdrawn approximately 6 inches and a fluid grout is pumped under a pressure of 200 to 300 psi (measured at the pump) into the hole through the hollow stem auger. Pumping continues until a head of 5 to 10 feet is built up by grout moving up the flights of the auger.

The auger is then slowly withdrawn while grout is continuously pumped at a rate equal to about 1.15 times the volume of the drilled hole. The excess grout is pumped to assure that a positive head of grout is maintained at all times

and that the hole is completely filled with grout. It is generally recommended that a slow positive rotation of the auger be maintained throughout the withdrawal process.

ACIP piles can be reinforced with a central bar installed full length through the hollow-stem before grout placement, or by installation of a reinforcing cage or steel section in the fluid grout after the auger has been withdrawn.

Typically, reinforcing cages, rolled sections or pipes cannot be manually installed much deeper than about 15 to 25 feet into the fluid grout. The use of mechanical equipment to push the reinforcing is not recommended. A corrugated shell placed at the top of the hole protects piles from being damaged due to collapsing material and helps to prevent laborers from falling in the hole. Piles typically range in diameter from about 14 to 22 inches with capacities up to 150 tons.

### Grout Characteristics

The grout used in ACIP piles typically consists of Portland cement, sand, water and a mineral admixture and/or approved fluidifier. Some pumps are capable of placing grout with pea gravel sized aggregate. Typical design strength of the grout is 4,000 psi although some recent projects have seen the use of higher strength grouts.

Grout fluidity is checked using a flow cone with flow rates normally specified in the range of 10 to 25 seconds for a flow cone with a 3/4 inch opening. The most important aspect of the flow

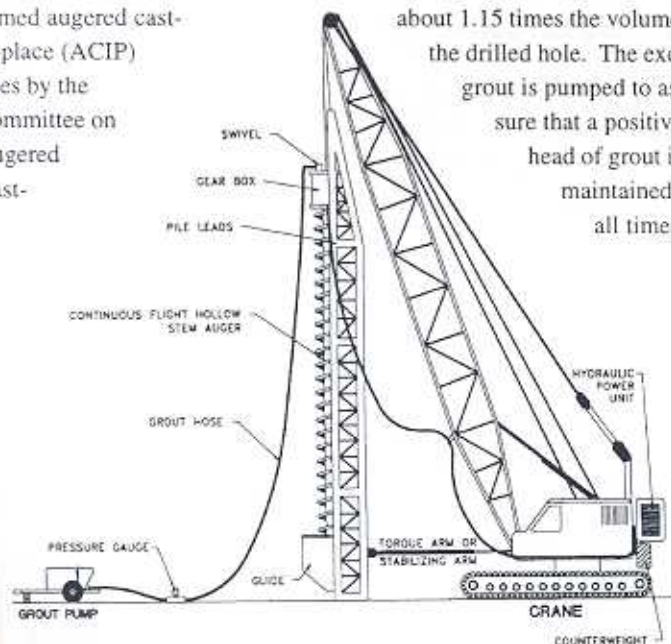
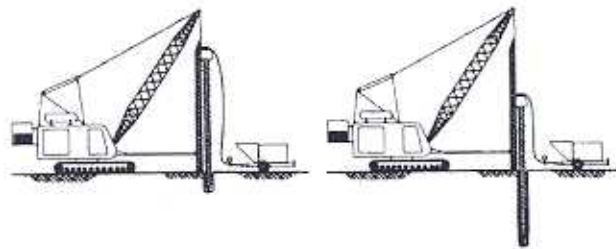
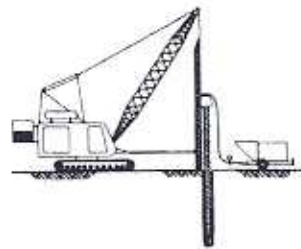


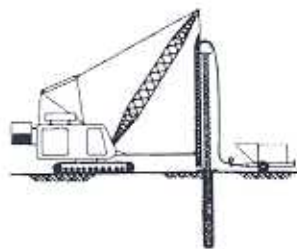
Figure 1 Typical ACIP Pile installation rig. Courtesy Deep Foundations Institute



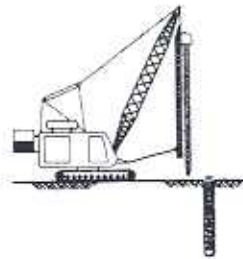
1. ADVANCE HOLLOW STEM AUGER TO REQUIRED DEPTH.



2. LIFT AUGER 6", PUMP GROUT UNTIL A HEAD OF GROUT IS ESTABLISHED ON THE AUGER FLIGHTS.



3. WITHDRAW AUGER WHILE CONTINUOUSLY PUMPING GROUT.



4. INSTALL REINFORCING CAGE.

Figure 2 ACIP Pile installation procedure Courtesy Deep Foundations Institute

rate is to verify that the consistency of the grout remains the same throughout the project.

Grout is most often tested against the design mix by using 2 inch cubes, however, many design professionals use standard 6 inch by 12 inch cylinders. Specifications may contain limitations on the temperature and aging of the grout in trucks. It may also be beneficial to obtain a small sample of the grout from the truck to be set aside and monitored for an initial set. Once the initial set occurs, it is generally no longer capable of being pumped.

**Inspection**

The critical phases of installation for inspection are the rate of advance during drilling versus volume of material removed and the volume of grout placed versus rate of auger withdrawal. In non-plastic silts below the ground water table, or running sands, over-rotation of the auger can cause loss of ground resulting in settlement of adjacent structures.

**New York City Building Code**

The New York City Building Code severely restricts the use of uncased, cast-in-place piles.

Nevertheless, the New York City Department of Environmental Protection has recognized the credibility of ACIP piles and the Buildings Department has accepted their use. It should be recognized however, that there are many pitfalls to their use and it is important to have an experienced contractor perform the installation, and the piles designed and inspected by an experienced professional. For further reading, the writer recommends the Augered Cast-in-Place Piles manual and the Inspector's Guide to Augered Cast-in-Place Piles, both published by the Deep Foundations Institute. ■

**About the Author: Joel**

*Moskowitz is a partner in Mueser Rutledge Consulting Engineers. He is past president of the Deep Foundations Institute and served as chairman of the Committee on Augered Cast-in-Place Piles.*

**A Mix Design Minute**

*Although the design strength is sometimes referred to as "minimum strength," this does not mean that an occasional test result below the minimum indicates "bad" concrete. Because of variations in sampling, variations in handling and curing, and within-test variations, as well as variations in all the constituents in concrete, completely uniform test results are impossible. Indeed, it is a statistical reality that as more tests are made, a below "minimum" result will inevitably occur.*