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## FHWA Releases GEC 8 – Design and Construction of CFA Piles

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The Federal Highway Administration (FHWA) has recently published Geotechnical Engineering Circular (GEC) #8 – “Design and Construction of Continuous Flight Auger Pile Foundations”. CFA piles have been a popular foundation alternative in the United States private sector and in international private and public sector work for years. Until recently, CFA piles were only approved by State DOTs on a project-specific basis considering technical feasibility, suitable project conditions, project performance requirements, construction quality control and assurance procedures, and cost. GEC 8 documents the current state-of-practice and presents FHWA’s recommended guidance for the design and construction of Continuous Flight Auger (CFA) piles, including Auger Cast-in-Place (ACIP) and Drilled Displacement piles.

GEC 8 addresses several issues on which there had been lack of industry consensus, recommends pile design and construction methodologies, and identifies technology gaps in current practice. In addition, GEC 8 provides a performance-based guideline specification that addresses different equipment and installation techniques which clearly have a significant effect on the performance and acceptance of CFA piles. Several important issues addressed in GEC 8 include:

- minimum requirements on rigs and equipment
- drilling penetration rates and controls related to soil mining, subsidence, damage to nearby structures, etc., including how to monitor and address these items
- rotation of the auger during grouting, and control of the operation during grouting and after grout return is observed
- use of CFA in dense soil and/or weathered rock
- specific requirements when a problem develops during installation
- test pile requirements, including proof load tests and non-destructive integrity testing
- QA/QC requirements to verify that production piles are consistent with test piles.

CFA piles have been infrequently specified in public works transportation projects due to the variable nature and the difficulties in quality control. Simple manual observation and control methods historically used in the USA for quality control of CFA pile installation have been deemed inadequate for transportation projects.

The most reliable means of achieving consistent quality control employs automated monitoring equipment during construction to provide a real time evaluation of each CFA pile installed. GEC 8 recommends the use of automated monitoring equipment as a mandatory contract requirement. As a minimum, the automated monitoring equipment should monitor and record the following:

- auger tip depth measured with a position sensor
- incremental grout or concrete volume measured with an in-line magnetic flow meter
- delivered grout pressure (from an in-line pressure sensor)
- auger rotation from a sensor mounted on the gearbox
- auger withdrawal rate.

Although it is possible to estimate volume by counting pump strokes and using an assumed volume per pump stroke, this volume determination is generally inaccurate due to inconsistencies of the pump and inaccurate “calibrations” of pump stroke volume. The Pile Installation Recorder (PIR-A) from Pile Dynamics, Inc. (see photo below) meets all the above requirements including incremental volume measurements via an in-line magnetic flow meter.

A pre-production testing plan is another GEC 8 recommended contract requirement. This plan includes pre-production static load tests, production static and/or dynamic load tests, and post installation integrity tests in sufficient quantities to demonstrate that the installed piles meet the intended performance requirements. The contractor must then install production piles in the same manner and to the same standards as the test piles to insure production piles will also perform as well as the test pile. An automated monitoring equipment (like the PIR-A) documents that each production pile is installed with the same care and volume as the test pile.



The Cross-Hole Analyzer (CHA) and the Pile Integrity Tester (PIT) manufactured by Pile Dynamics are used to perform integrity tests to verify that CFA piles are structurally acceptable. A dynamic load test system (e.g. APPLE available from GRL Engineers) can quickly perform dynamic load testing on CFA piles. Tests on production piling verify design parameters, reduce uncertainties, and increase reliability.

The GEC 8 design and construction guidance, coupled with performance based specifications, facilitates the implementation of CFA piles on highway projects. The use of automated monitoring equipment during CFA pile installation, along with integrity testing and dynamic load testing after installation, provides sufficient quality control to allow the use of CFA piles on highway projects.

A copy of GEC 8 can be downloaded from [www.fhwa.dot.gov/engineering/geotech/pubs/gec8](http://www.fhwa.dot.gov/engineering/geotech/pubs/gec8).