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EVALUATING CFA/ACIP PILES

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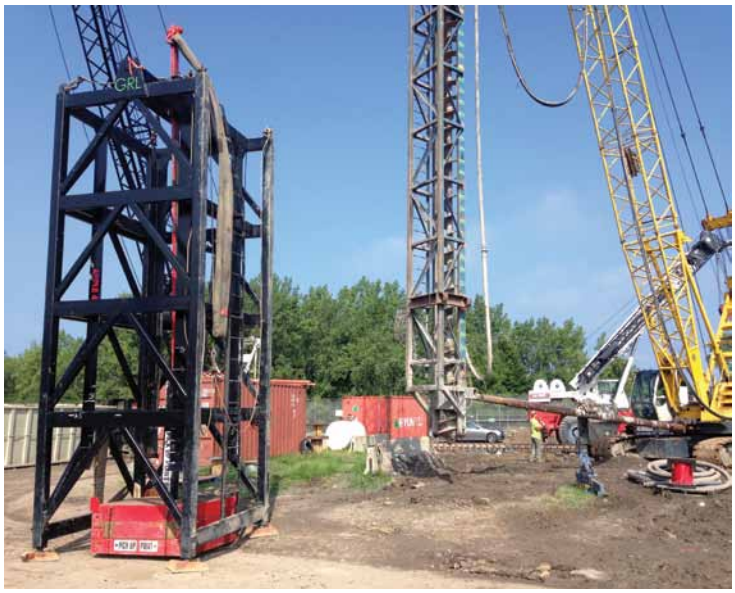
Any deep foundation must be structurally sound and have adequate geotechnical capacity. The methods to establish that the foundation will indeed perform satisfactorily, however, vary with their type.

Driven piles are "tested piles" because the blow count (or permanent set per blow) is often correlated with static or dynamic testing, giving an indication of their structural integrity and capacity. Drilled shafts (bored piles) are designed conservatively and can be inspected prior to concrete placing, with integrity confirmed by nondestructive tests. Their capacity can be evaluated by static tests (load applied conventionally at top, or using embedded bi-directional load cells), or by dynamic testing using a large drop weight. Evaluation of Continuous Flight Auger (CFA) or Augered-Cast-In-Place (ACIP) piles is generally more complicated since during installation you cannot directly inspect structural integrity; the inability to inspect the hole prior to grouting causes some engineers to avoid this alternative. Fortunately there are methods available to monitor CFA/ACIP piles during installation and to evaluate them after construction.



ACIP piles were selected for the Easterly Waste Water Treatment Plant expansion in Cleveland, Ohio. Installation cranes were fitted with Pile Installation Recorders. Seen on the foreground is the APPLE 4 system utilizing a 12 ton drop weight being used to load test 16 test piles across the site. Pile Integrity Testing is specified for 10% of the piles.

Low Strain Integrity Testing (ASTM D5882) has been successfully used for decades to inspect CFA/ACIP piles for structural deficiencies. An accelerometer is attached (typically with wax) to the pile top and an input is generated by a hand-held hammer. The Pile Integrity Tester (PIT) evaluates the resulting signal for early tension reflections which indicate a structural weakness. The method should be used to look for major defects and evaluated with consideration of the soil profile. There are limitations to the tested pile length (although critical major defects occurring near the pile top are still easily found), while evaluation below the first major non-uniformity is generally inconclusive.

For larger diameter CFA/ACIP piles, Crosshole Sonic Logging (CSL; ASTM D6760) may be performed but requires multiple access tubes attached to the reinforcing cage (it is not an option if there is no cage, and for partial length cages it can only inspect the section of pile that has a cage). A transmitter probe in one tube sends a signal to a receiver probe in another tube. The probes are pulled simultaneously from bottom to top to evaluate the signal arrival time and strength along the entire pile length; the test is repeated for each pair of tube combinations. Significant arrival time delay or weak signal strength indicate an anomaly or potential problem.

Thermal Integrity Profiling (TIP) is a new option that uses the heat of cement hydration to evaluate pile integrity. A Thermal Wire® cable with temperature sensors closely spaced along its length is attached to the center bar (or multiple cables attached to the reinforcing cage). If there is a lack of heat-producing cement at any location (defect) there will be a sharp reduction in temperature at that location. This method has advantages over PIT in that large bulges do not diminish the ability to evaluate the shaft below the bulge and there are no pile length limitations. Further, testing is generally done in the first day after casting rather than after the concrete has cured as PIT and CSL require, speeding construction approvals. If the center bar or reinforcing cage is not full length, TIP can only inspect the section of pile that has a center bar or reinforcing cage.

Evaluating the capacity of CFA/ACIP piles requires large forces. Traditional static load testing is always an option, but requires either a large dead weight (greater than the desired maximum test load) or anchor piles, and either can be relatively costly and time consuming. Alternately, CFA/ACIP piles can be evaluated dynamically using a drop weight of approximately 2% of the desired maximum test load. This much smaller weight requirement, and the speed inherent to dynamic testing, typically allows a larger number of piles to be tested at a greatly reduced cost. GRL Engineers often tests these piles with one of its APPLE systems (systems weigh from 5 to 80 tons to accommodate a whole range of ultimate capacity requirements). Testing is according to ASTM D4945 and results are evaluated by the signal matching software CAPWAP®.

By using the PIR to monitor the installation of all CFA/ACIP piles along with one or more options now available to evaluate their integrity and capacity, the designing engineer can confidently specify CFA/ACIP piles.