Application and Use of Continuous Flight Auger Piles in Western Canada

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CFA Piles – A Brief History

• Used in Europe and USA for over 25 years
• Aka – Auger Cast Pile
• First project in Western Canada in 2005
• 14,000 piles used on over 45 projects in Western Canada
• Over 25 full scale load tests completed and counting
Why Use CFA Piles?

• Why not?
• **Sleeves and/or temporary casings are not required**
• No impact shocks, vibrations, low noise, allowing piling work in sensitive urban and re-development areas.
• Can be utilized in a wide range of cohesive and cohesion-less soils, with or without the presence of a water-bearing strata.
• Production rates can easily outperform comparative cased holes or expanded base piles depending on soil conditions and concrete supply.
• Semi- Displacement, resulting in lateral soil compression that increase final load bearing capacity.
CFA Piles - Installation

**PHASE 1**
DRILLING

**PHASE 2**
WITHDRAWAL AND CONCRETING

**PHASE 3**
STEEL CAGE INSTALLATION
Drilling Phase

- The auger is screwed into the soil with little tailings elevation.
- Positive crowd pressure is maintained on the auger.
- A plug or hinged cap is located at the bottom of the auger that prevents soil from entering the hollow drill stem; the plug will then be ejected or open when concrete pumping begins.
- A positive penetration rate is maintained to prevent deconsolidation of the shaft in cohesion-less soils.
Extraction Phase

- Once design depth is reached, concrete pumping begins
- The stem plug is ejected under concrete pressure
- The auger is pulled with a slight forward or no rotation to avoid de-consolidation
- An auger cleaner at the base of the mast strips tailings from the flights as the auger is extracted
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CFA Piles - Applications:
- Buildings
- Process Units
- Transportation Structures
- Earth Retention Walls
- Ground Improvement

CFA Pile Load Capacity:
- 50 to 2,000 kN Axial
- Uplift Loads
- Lateral/Moment Loads
Advantages of CFA piles are:
• No vibration,
• Low noise levels,
• No temporary casing required,
• Speed of installation, and
• Lower unit cost.

Disadvantages of CFA piles are:
• Temperature limits on installation, and
• Difficultly penetrating very hard bearing layers.
CFA Pile Design

- CFA Pile capacity typically falls between a drilled and driven pile
- Load/Settlement behavior of CFA piles are similar to drilled and driven piles
- Total axial capacity $Q_T = Q_s + Q_B$
- Side resistance mobilized with small displacements
- Allowable side shear greater than that of a drilled pile
- Only design for end bearing is suitable soil conditions
CFA Pile Materials - Concrete

Typical Mix Design Proportions:

- 25 to 35 Mpa Compressive Strength @28 days
- Slump 200 mm +/- 25
- W/C = 0.45 Typical
- Up to 35% Flyash
- Air Entrainment
- Course Aggregate (14mm)
- 2 to 4 hour workability
- Hydration Stabilizer
- Mid/High range water reducer
CFA Pile Materials - Reinforcement

- The method of construction of the CFA pile requires the cage to be inserted after the concrete is placed.
- Cages have to be properly manufactured and well assembled (preferably tack welded).
- Minimum concrete cover is maintained by use of cage centralizers.
- The butt diameter of the cage is reduced to aid installation.
- Subject to concrete quality and consistency, it is today possible to install full length cages in one piece.
- Vibratory methods can be used to assist setting the cage.
CFA Pile - Quality Control

- Good site investigation that goes as deep as piles will be drilled (12 to 28 m).
- Experienced Geotechnical Inspector.
- Pile Installation Recorder (PIR)
- Post Installation Non-destructive Testing (NDT).
CFA Pile - Quality Control

During boring phase PIR records:
- auger rotation speed
- Penetration rate
- rotary torque

During concrete phase PIR records:
- Concrete pressure
- Lifting Rate
- and volume of concrete placed vs. extraction speed

The system displays in real time for operator control.
CFA Pile - Load Testing

Economics of Load Testing:

• The semi-displacement and construction process contributes to high capacities

• Resistance Factor 0.4 vs 0.6 – Huge Cost Savings!
CFA Pile - Load Testing

Load Testing Methods:

- Dynamic Pile Testing (PDA)
- Top Load Static Load Tests (conventional Load Frame)
- Rapid Load Testing – Statnamic Testing
- Osterberg Cell Testing (O-cell Testing)
CFA Pile - Load Testing

Top Load Static Testing:

- Compressive Loads Up to 6.5 MN
- Tension Loads up to 5.0 MN
- ASTM D-1184 Standard or Quick Load Test method
- Hydraulic Jack c/w Load Cell – Jack Runs Test, Load cell Confirms jack
- Strain Gauges for Load Transfer Down Pile Shaft
CFA Pile - Load Testing

O-Cell testing:
- No reaction piles
- Higher test loads (up to 150 MN)
- Direct measurement
- Special concrete mix
CFA Pile - Load Testing
CFA Pile - Load Testing
CFA Pile – Design Load vs. Displacement

Applied Load (kN) vs. Displacement (mm)
CFA Pile – Displacement at Maximum Load

Chart Title

Displacement (mm)

Applied Load (kN)
CFA Pile - Information

FWHA Geotechnical Circular No. 8

CFA Pile - Conclusions

- CFA pile is economical for projects with good to marginal soils
- Load testing is economical
- Load testing can be done quickly
- Project savings of 20 to 30%
- Test to failure when possible
CFA Moving Forward

- Cased Auger Piling (CAP)
- Cased Secant Piling (CSP)