Figure 1. Nomenclature used for Auger Piles in Europe and the USA (Prezzi and Basu 2005).
# DEEP FOUNDATIONS: CAST-IN-PLACE (CIP) PILES

Table 8-1. FHWA NHI-05-042 (from NAVFAC DM7.02).

<table>
<thead>
<tr>
<th>PILE TYPE</th>
<th>AUGER PLACED, PRESSURE INJECTED CONCRETE PILES (CFA PILES)</th>
<th>TYPICAL ILLUSTRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPICAL LENGTHS</td>
<td>5 m - 25 m (15 – 80 ft)</td>
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<tr>
<td>MAXIMUM STRESSES</td>
<td>33% of 28-day strength of concrete.</td>
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<td>TYPICAL AXIAL DESIGN LOADS</td>
<td>260 kN - 875 kN (60 – 200 kips)</td>
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<tr>
<td>DISADVANTAGES</td>
<td>• Greater dependence on quality workmanship.</td>
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<td></td>
<td>• Not suitable through peat or similar highly compressible material.</td>
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<td></td>
<td>• Requires more extensive subsurface exploration.</td>
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<td></td>
<td>• No driving observation (blow count) to aid in assessing capacity.</td>
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<tr>
<td>ADVANTAGES</td>
<td>• Economy.</td>
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<td></td>
<td>• Zero displacement.</td>
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<td></td>
<td>• Minimal vibration to endanger adjacent structures.</td>
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<td></td>
<td>• High shaft resistance.</td>
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<td></td>
<td>• Good contact on rock for end bearing.</td>
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<td></td>
<td>• Visual inspection of augured material.</td>
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<tr>
<td>REMARKS</td>
<td>• Best suited as a friction pile in granular material.</td>
<td></td>
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</tbody>
</table>

ACIP – Auger Cast In Place
DD – Drilled Displacement
CFA – Continuous Flight Auger
APG - Auger Pressure Grouted
APGD - Auger Pressure Grouted Displacement
CFA Piles: Construction Process

Figure courtesy of Trevispa.eu

Figure 2.2. Schematic of CFA Pile Construction (FHWA GEC-8 from Bauer).
CFA Piles: Construction Process

Balanced auger rotation and penetration rates (No “Lateral Feed”).

Excessively slow penetration rate and an insufficient base feed to keep the auger flights full (Lateral “Feed”).

Figure 2.5. Effect of Over-Excavation using CFA Piles (FHWA GEC-8 after Fleming 1995).
**Drilled Displacement* Piles: Drilling Tools**

* Screw piles

**Figure 2.1.** Drilling tools for installation of different drilled displacement piles (Basu and Prezzi 2009).
**DRILLED DISPLACEMENT PILES:**
**AUGER PRESSURE GROUTED DISPLACEMENT (APGD)**

- Patented by Berkel & Company Contractors.
- Loose to Med. Dense Sands (N<25)
- 0.30-0.45m OD
- Up to 24m Long

**Figure 2.1.** Installation stages for APGD piles (Basu and Prezzi 2009).
DRILLED DISPLACEMENT PILES:
DUAL-DISPLACEMENT, CIP CONCRETE PILE (ATLAS)

- See De Cock and Imbo (1994)
- 0.31-0.56m OD
- 0.45-0.81m (Enlarged Flange)
- Up to 25m Long

Figure 2.3. Installation stages for Atlas piles (Basu and Prezzi 2009).
**DRILLED DISPLACEMENT PILES:**

**DeWAAL PILES**

- Morris-Shea has exclusive US rights.
- Consists of a sacrificial tip, a partial-flight auger and a displacement body.
- 1-2ft OD
- Up to 120ft Long

**Figure 2.4.** Installation stages for DeWaal Piles (Basu and Prezzi 2009).
DRILLED DISPLACEMENT PILES: FUNDEX PILES

- American Pile Driving Inc. in US.
- A casing/tube with a conical auger tip attached to its end is rotated clockwise and pushed down into the soil
- 0.38-0.52m OD
- Up to 25m Long

Figure 2.5. Installation stages for Fundex Piles (Basu and Prezzi 2009).
**Drilled Displacement Piles:**

**Omega Piles**

- Malcom Drilling & L.G. Barcus & Sons.
- Grout is injected under pressure into the casing even before the desired depth is reached.

**Figure 2.7.** Installation stages for Omega Piles (Basu and Prezzi 2009).
CFA Piles: Geotechnical Conditions

FAVORABLE

• Medium to Stiff Clay Soils.
• Cemented Sands or Weak Limestone.
• Residual Soils.
• Medium dense to dense silty sands and well-graded sands.
• Rock overlain by stiff or cemented deposits.

After FHWA GEC-8

Figure courtesy of DFI
CFA Piles: Geotechnical Conditions

Unfavorable

- Very soft soils.
- Loose sands or very clean uniformly graded sands under groundwater.
- Residual Soils.
- Geologic formations containing voids, pockets of water, lenses of very soft soils, and/or flowing water.
- Hard soil or rock overlain by soft soil or loose, granular soil.
- Sand-bearing stratum underlying stiff clay.

After FHWA GEC-8
CFA Piles: Geotechnical Conditions

Unfavorable

- Highly variable ground conditions.
- Conditions requiring penetration of very hard strata.
- Ground conditions requiring uncommonly long piles (>100ft).
- Ground conditions with deep scour or liquefiable sand layers.

Figure courtesy of Rockal.com

After FHWA GEC-8
CFA PILES: PROJECT CONDITIONS

CFA VIABLE WHEN:

- Projects where speed of installation is important.
- Batter Piles Required.
- Projects where large numbers of piles are required.
- Low headroom conditions.
- Rock overlain by stiff or cemented deposits.

After FHWA GEC-8

Figure courtesy of SoilMec
DRILLED DISPLACEMENT PILES

ADVANTAGES

• Better performance in loose sandy soils.
• Little or no spoil removed from site.

DISADVANTAGES

• Difficult to penetrate dense or hard soils and more limited depth range.
• Effect of displacement.

After FHWA GEC-8

Figure courtesy of Morris Shea Bridge Co. Inc.
PILE CAPACITY PREDICTION METHODS: CPT BASED (PARTIAL LIST)

- Schmertmann Method (1978)
- De Ruiter and Beringen Method (1979)
- Penpile Method (1980)
- Prince and Wardle Method (1982)
- Tumay and Fakhroo Method (1982)
- Aoki and De Alencar Method (1975)
- Philipponnat Method (1980)
- LCPC (Bustamante and Gianeselli) Method (1982)
- Eslami and Fellenius Method (1997)
- Powell et al. Method (2001)
- UWA-05 Method (2005)