TECHNOLOGY

CAP / CSP

Cased auger piles

TREVI

Boring without bentonite support

Pile diameter
from 600 mm to 1,200 mm

Max. cased drilling depth
21 m

Maximum pile depth
about 30 m

Rock drilling
up to resistances of 25/30 MPa
(unconfined compressive strength - UCS)

*The **CAP (Cased Auger Piles)** technology consists in drilling separate piles by means of a continuous flight auger coaxial to an external casing.*
*The same technique can also be used to drill secant piles; in this case it is named **CSP (Cased Secant Piles)**. The auger and casing are operated by two independent rotary tables which mutually counter-rotate and travel along the mast of the drilling rig.*

*This technique allows to drill **piles of a nominal diameter of 600 to 1200 mm**.*

The max depth achievable by the casing is 21 m, whereas the max depth technically admitted by the auger is roughly 30 m (depending on drilling diameter and tool).

The rotary tables travel along the mast independently: as a result it is possible to penetrate the auger and casing to different dephts, depending on soil type. Generally speaking, in case of cohesive or fine non-cohesive soils, the auger bit and the casing shoe are maintained at the same level; however, in the event of coarse non-cohesive materials the auger penetrates more deeply than the shoe in order to lighten the soil and make it easier to move it within the casing. In case of rocky soil, the casing advances as a core barrel, whereas the auger bit fitted with teeth suitable for rocks breaks up the "core" created by the casing. Both the auger bit and casing shoe are fitted with teeth, depending on the type of material to drill.

Technology

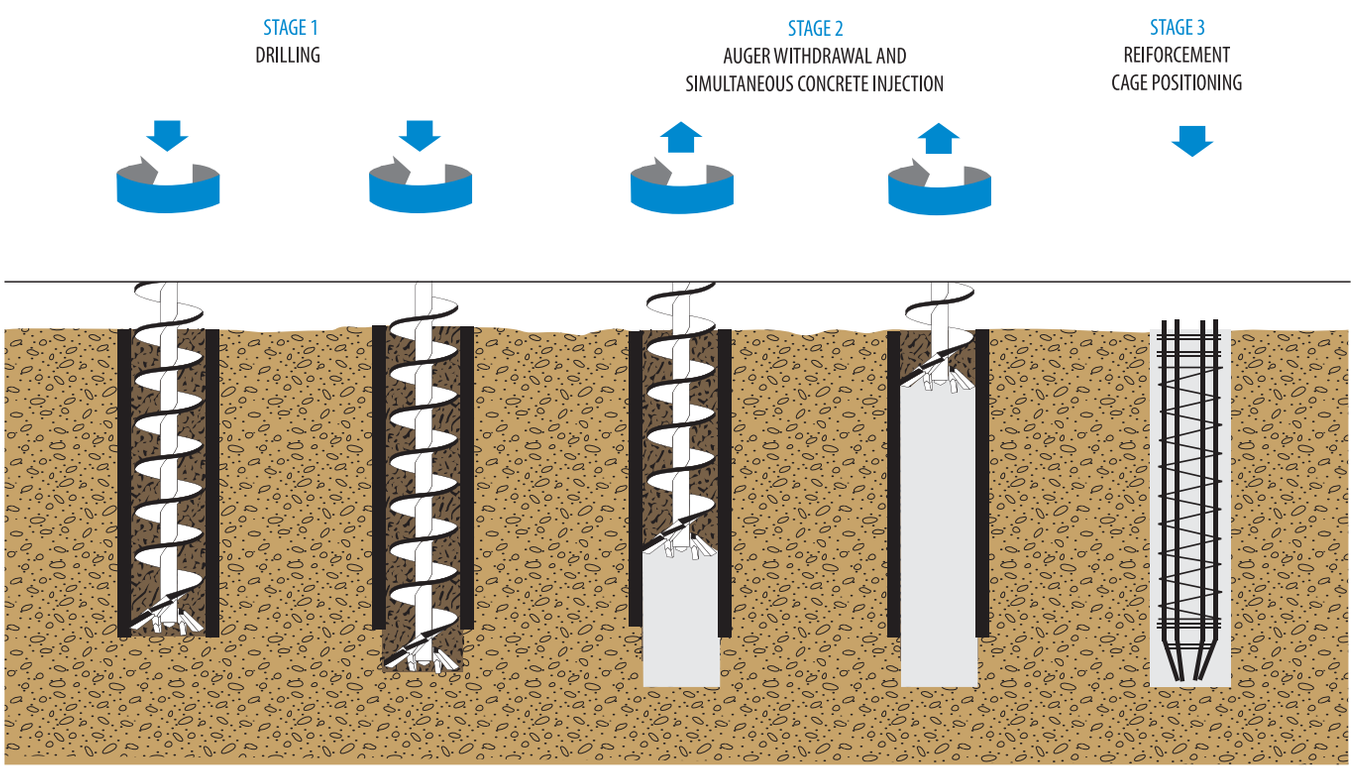
The operating sequence consists in driving the auger and casing simultaneously. Once the max casing penetration depth has been reached, it is possible to continue to drill to the design depth using the continuous flight auger only.

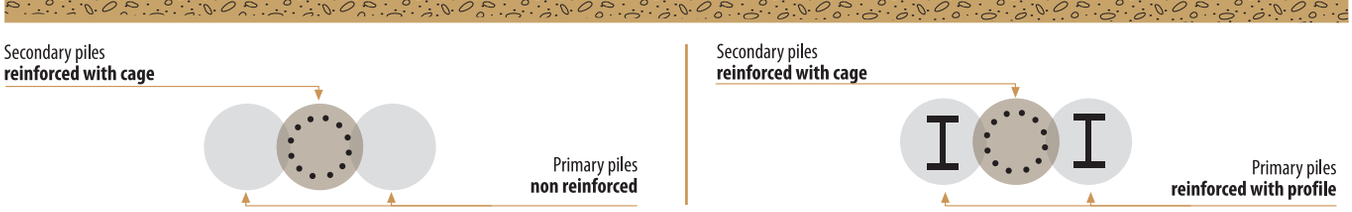
Then the auger filled with soil is extracted and at the same time concrete is pumped through the central hollow stem to fill the gap left by the drilled soil up to the work level. The casing is usually extracted once the auger has been lifted by a few metres inside it. Once auger and casing have been fully withdrawn, the reinforcement cage is positioned through the freshly pumped concrete.

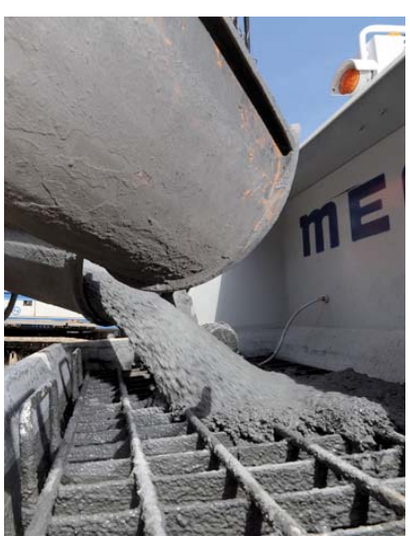
Pile concreting is carried out by means of a tracked concrete pump with an output ranging from 80 to 120 m^3/h.

To ensure the fast positioning of the cage into fresh concrete, the latter should have the following features: aggregates with a diameter of max 18 mm and S5 or SCC slump classes shall be used.

When using S5 concrete with slump higher than 220 mm, the max cage positioning depth is usually 12-15 m, whereas when using SCC it is possible to apply reinforcement cages to longer piles.







Before any jobsite is started, Trevi technicians can help to maximize the concrete mix design by collaborating with the client to ensure the technology is properly applied in compliance with the design requirements.

As it is the case for Trelicon CFA piles, the reinforcement cages for CAP/CSP must be assembled respecting a number of principles: the bottom part must be conic-shaped to facilitate driving and hole centring, whereas the cage body must be strengthened with bars of suitable diameter. The concrete cover must be at least 7.5 cm.

The auger/casing system guarantees high stiffness and deviations from the theoretical axis of the pile that are considerably lower than the ones obtained with the Kelly system or free continuous flight auger.
The deviation measured with CAP-CSP does not usually exceed 1% and it is even possible to reach 0.5% by taking special measures.

The Trevi equipment is fitted with a computer-aided control system called DMS, for drilling and concreting parameters. **Trevi has adopted Soilmec DMS in the CAP version, which allows to display all working parameters in the cabin and save them on a memory support, if requested by the customer.**

Thanks to its high accuracy, this technology is especially suitable for soldier piles walls.

The CSP system

Based on CAP technology, the Trevi Group has developed a system for the construction of secant pile diaphragms, named **CSP (Cased Secant Piles)**, which represents an alternative to standard diaphragm walls.

Cased Secant Piles are ideal when grab or hydromill-based technologies cannot be used due to soil stratigraphy, induced vibrations or, in general, jobsite logistics.

The CSP construction sequence entails the drilling of primary and secondary piles; when drilling the latter, the adjacent primary piles are partially destroyed.

By modifying the pile diameter and the distance between them it is possible to obtain the best compromise between the real final thickness of the wall *(pile cross-section)* and the concrete to cut when constructing secondary piles.

To ensure the correct planimetric positioning of the piles, it is necessary to construct a guide wall identifying the position of all piles unambiguously, and which can serve as a vertical guide during the initial steps of drilling.

The piles forming the secant pile diaphragms can be reinforced with different techniques and methods: the primary pile is not usually reinforced; however, if needed, reinforcement can be made by means of a reinforcement with a shape that allow the partial demolition of the primary elements when the secondary pile is excavated.

The primary and secondary piles can be constructed using different concrete types. For instance, it is possible to use a plastic mixture for primary piles: in this case they have a hydraulic retaining function only, whereas reinforced secondary piles assure the structural function of the diaphragm wall.

Adopted equipment and technology advantages

For the construction of CAP/CSP, the jobsite has to include a drilling rig, a compact tracked concrete pump, a backhoe excavator for debris handling and an auxiliary crane for cage positioning, whether needed.

For this technology, Trevi has adopted high power self-elevating crawler-mounted hydraulic drilling rigs.

The main advantages of CAP and CSP technology are the following:

- **Suitable for any soil type and soft rocks** with max unconfined compressive strength (UCS) of 25-30 MPa.
- **No drilling slurry is used:** the debris has the same features of on-site soil.
- **Possibility to overpass pre-existing structures** - both masonry and concrete structures.
- **No vibrations or impulses** typical of percussion systems.
- **No trenches or open-cut excavation** resulting in soil decompression. The technology is especially suitable for the construction of diaphragm walls next to existing buildings and structures.
- **No cumbersome mixing and desanding plants** needed on-site for the construction of standard diaphragm walls or by means of hydromill.
- **Doubled production rate**, under the same geological conditions, with respect to standard cased Kelly method.
- **Reduced jobsite costs** compared to standard pile construction.

World leader in ground engineering, Trevi has been working for more than 50 years throughout the world, strengthening its ability to provide solutions to any ground engineering issues.
Trevi works in the field of special foundation, soil consolidation, dam remedial works, tunnel construction and consolidation, marine works, rehabilitation and cleanup of contaminated sites and construction of underground automatic multi-storey car parks.
Trevi is committed to continuous innovation and search for solutions to complex problems of civil engineering worldwide.
Experimenting cutting-edge technologies, entrepreneurship and investing in research and human resources are the strengths of a company based in more than 30 countries.

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