TECHNOLOGY

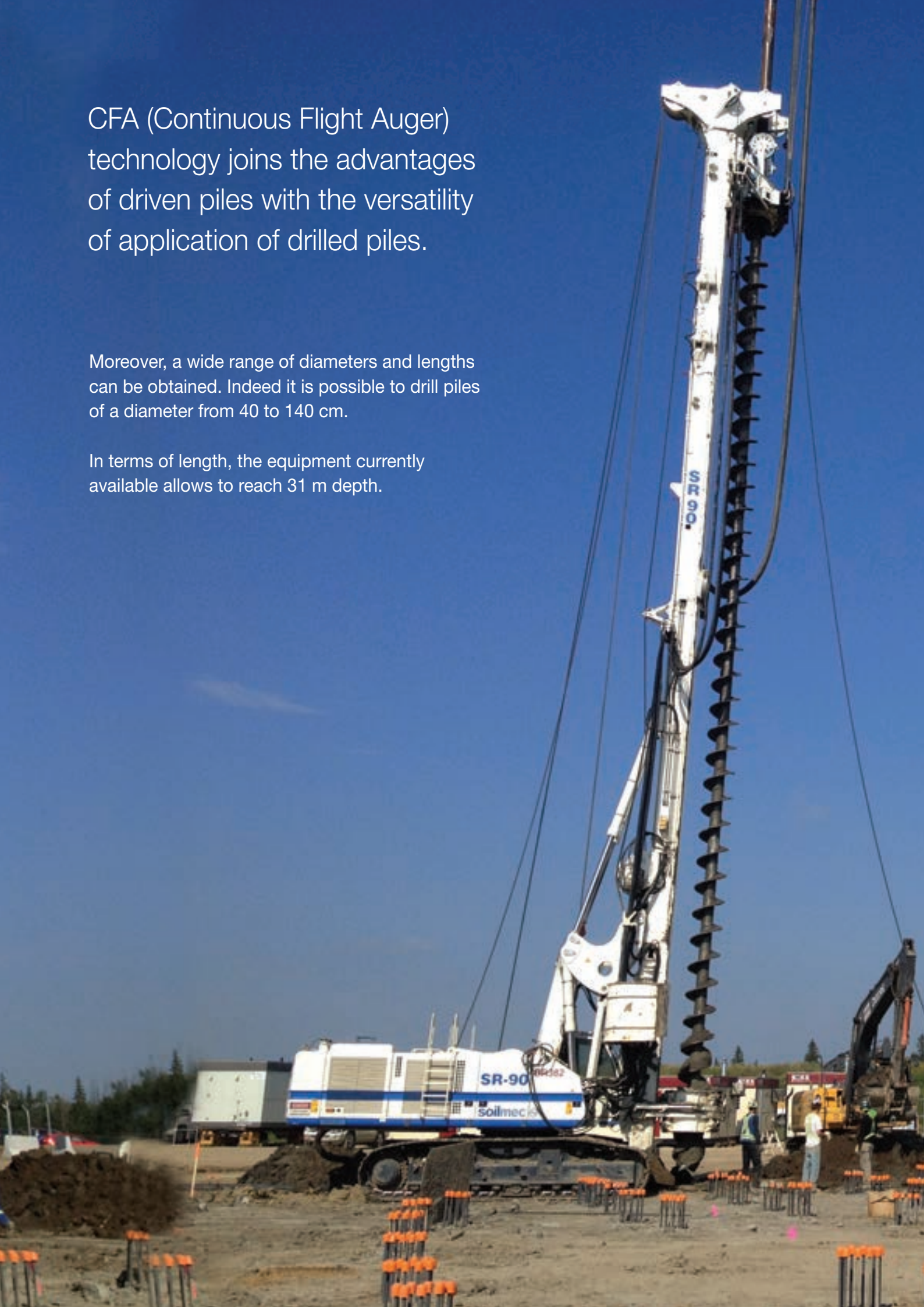
Continuous Flight Auger

soilmec
Drilling and Foundation Equipment

CFA (Continuous Flight Auger) technology joins the advantages of driven piles with the versatility of application of drilled piles.

Moreover, a wide range of diameters and lengths can be obtained. Indeed it is possible to drill piles of a diameter from 40 to 140 cm.

In terms of length, the equipment currently available allows to reach 31 m depth.



Wide range of application in any type of soil without the use of a drilling fluid

Minimum job site installation

Absence of vibrations and shocks during the pile construction

Higher production rate compared to other piling techniques

Technology

Continuous flight auger piles is a type of drilled foundation in which the pile is drilled to its final depth in one continuous process using a continuous flight auger. CFA piles are a replacement and cast in place piles type with a slight displacement of the soil, more noticeable using a large diameter hollow stem, that increases the final load bearing capacity.

The construction procedure consists of three steps, the drilling phase ***(demolition)***, the auger extraction ***(spoil removal and concreting)*** and the cage insertion ***(reinforcing).***

Construction stages

Continuous Flight Auger (CFA) piles are constructed with partial soil removal, which generates lateral soil compression. As a result the final lateral load bearing capacity is increased and becomes higher than in piles where ben-tonite slurry is used.

The level of lateral soil compression depends on the ratio between auger diameter and central stem diameter. The operating process consists in drilling soil with a continuousflight auger welded to a hollow central stem. The bit of the auger drills the soil that is partly pushed upward along the augerflights.
Once the design depth – corresponding to the length of theauger being used – is reached, the auger is withdrawn from the borehole while concrete is pumped through the hollow central stem to fill the hole. The reinforcement cage is lowered into the hole through the mass of fresh concrete. **This technique is usually employed to realise piles with diameters ranging from 400 to 1,400 mm**, down to a depth of 31 metres. A plug is located or realised directly at the bottom end of theauger and prevents soil from entering the hollow stem duringdrilling; the plug will then be ejected by the pressure of concrete filling the hollow stem when concrete pumping begins.

A cleaner is usually installed at the base of the mast that guides the auger. It cleans the flights of the auger as it is extracted andkeeps the auger centred during the early meters of drilling.

On top of the auger stands an extension that goes throughthe rotary head for the concrete to pass through. Concrete is pumped by a suitable concrete pump connected to theauger extension by either flexible hoses or pipes. The auger extension allows to increase the drilling depth.

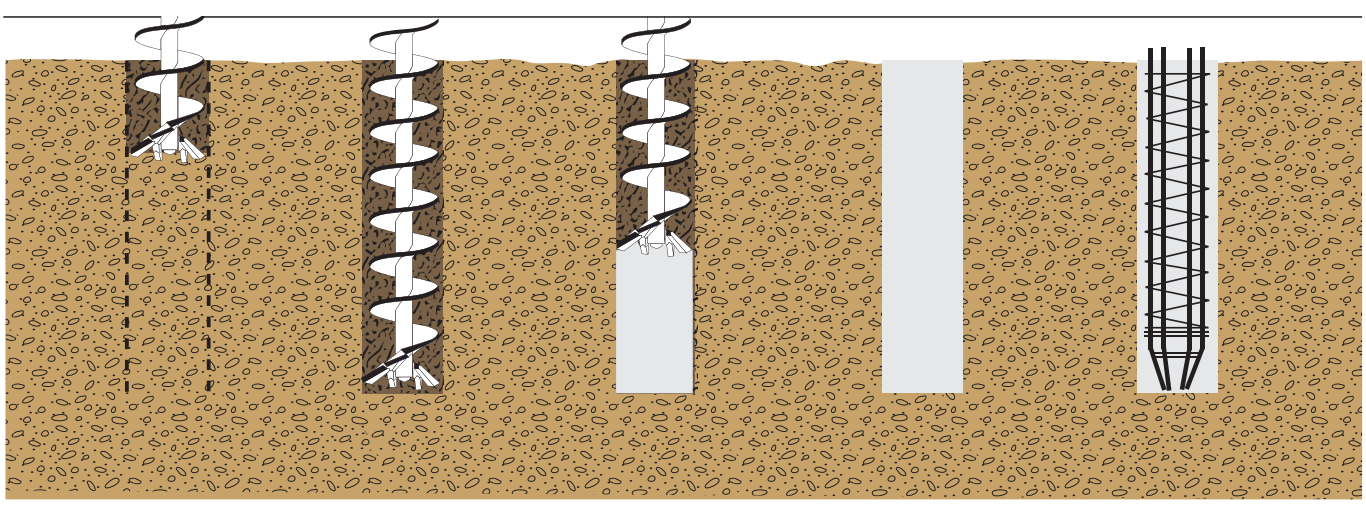
STAGE 1
Drilling

STAGE 2
The design depth is reached

STAGE 3
Auger with drawal and simultaneous concrete injection

STAGE 4
Concrete injection up to borehole mouth

STAGE 5
Reinforcement cage positioning



Construction stages

Concreting is one of the most delicate stages of the whole process as it is necessary to ensure that the void left by the auger being withdrawn is filled in a constant and homogeneous way.
The concrete pressure (or rather, the presence ofconcrete throughout the auger stem), the feeding flow rateand the auger withdrawal speed are the key parameters tobe constantly monitored and recorded during this construction stage.

Concrete specifications & properties

Since the reinforcement cage is installed after concreting,it is necessary to choose concrete specifications and designer defined strength parameters that ensure the easy penetration of the cage through the soil.

Aggregates' maximum diameter shall not exceed 18 mm. The amount of concrete to be pumped for an easy installation of steel reinforcement varies between 350 and 450 kg/m^3 of mix.
It is also necessary to employ suitable plasticizers and retarders to ensure a slump suitable for the penetration ofthe reinforcement cage.
Generally speaking, when using S5 concrete characterized by a slump value exceeding 220 mm, it is possible to insert reinforcement cages of a lengthup to 18 m. As an alternative, superfluid self-compacting concrete (SCC) can be used. This type of concrete does nothave a specific slump value, its main features being the diameter of the "patty" generated after the Abrams coneis removed (recommended value >650 mm) and T500, i.e.time needed for the patty to spread and rech 500 mm diameter (recommended value < 5 seconds).
If the concrete complies with said specifications it is possible for the reinforcement cages to be lowered 36 m deep.

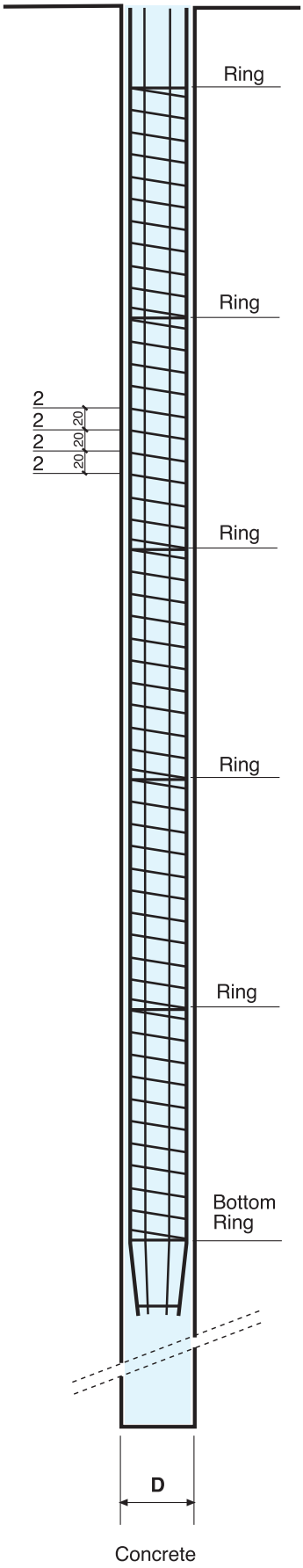
S5 Concrete_ Slump > 220 mm

S5 Concrete_ Pile diameter > 650 mm. Time to get 500 mm < sec

Concreting

Pile concreting shall be carried out using a concrete pumpproviding an output of 80 to 120 m^3/hour at a working pressure of about 50 bar, equipped with 4"- 5" flexible hosesand rigid pipes.Soilmec has developed special concrete pumps for piles. Theyare crawler-mounted concrete pumps equipped with watertank and air compressor to let the pump autonomously cleanthe concrete hopper and the concrete delivery line up to the CFA bit.

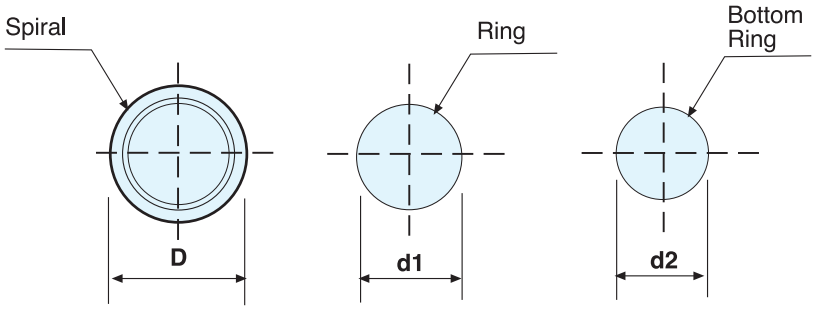
Construction stages



Reinforcement cages

Since the reinforcement cages are lowered down to thebottom of the pile through a mass of fresh concrete, theyshall be assembled with the utmost care and according towell defined specifications.

The spiral shall be rigidly fixed to the longitudinal bars, preferably welded. For increased stiffness, fewer vertical bars with larger diameter are to bepreferred to a high number of small diameter bars, considering the same steel bending resisting section. This allows to make the cage assembly stiffer and reduces the total lateral surface of friction against concrete.
The end section of the cage shall be slightly conical so as to facilitate insertion and centring into the borehole. Lastly, the cage outer diameter shall be smaller than the diameter of a cage tobe used for a pile having the same diameter but bored with bentonite slurry. Besides installing the auger extension, an alternative way to increase total drilling depth by 6 to 9 metres is to use aloader connected to the drill rig mast: the loader, through an automatic rotation system, makes it possible to add anauger section to the drill string in use. While pile concreting shall be always carried out up to the ground level so as to avoid soil collapsing superficially that may contaminate the concrete, during the subsequentstage of cage installation the cage can be “pushed” below that height by using a vibrator.



CFA steel reinforcement cage indicative quantities and dimensions

Pile Diameter (mm)	**Vertical bars** (number & diameter)	**Spiral** (diameter & pitch)	**Ring**	**Cage** (dimensions)	
(n / cm)	(n / cm)	(mm / cm)	(mm)	**d1** (mm)	**d2** (mm)
400	**6 ø 18**	**ø 8/20**	**ø 14**	**200**	**150**
450	**6 ø 18**	**ø 8/20**	**ø 14**	**250**	**200**
500	**6 ø 18**	**ø 8/20**	**ø 14**	**300**	**250**
600	**6 ø 18**	**ø 8/20**	**ø 16**	**400**	**350**
700	**6 ø 20**	**ø 8/20**	**ø 16**	**500**	**450**
800	**8 ø 20**	**ø 8/20**	**ø 16**	**600**	**550**
900	**8 ø 24**	**ø 10/20**	**ø 20**	**700**	**650**
1000	**10 ø 24**	**ø 10/20**	**ø 20**	**800**	**750**
1200	**12 ø 24**	**ø 10/20**	**ø 20**	**1000**	**950**
1400	**14 ø 24**	**ø 10/20**	**ø 20**	**1200**	**1150**

Auger cleaner

One of the problems of CFA drilling is that soil and cuttings remain inside the auger flights. When the auger is extracted from soil, it is always full of cuttings, and actually the filling level between the flights can vary depending on the depth and type of soil: higher filling levels are caused by compact cohesive soils. Soil and debris removal from the auger while this is withdrawn from the ground is therefore essential. Spoil must be removed at the lowest possible level, as the flights come out of the hole. For this purpose, auger cleaners have been designed, the most common and effective one is the roller-type auger cleaner. Auger cleaners can have one or two rollers, and are available in different sizes and types, one roller cleaner can be fitted with a blade that scrapes the auger surface.

Soilmec designed a revolving and openable auger cleaner with the special function to open itself in two part to allow the rotary to reach the lower position of the mast going beyond the cleaner itself.

This allows to reach the same depth achievable without the auger cleaner.

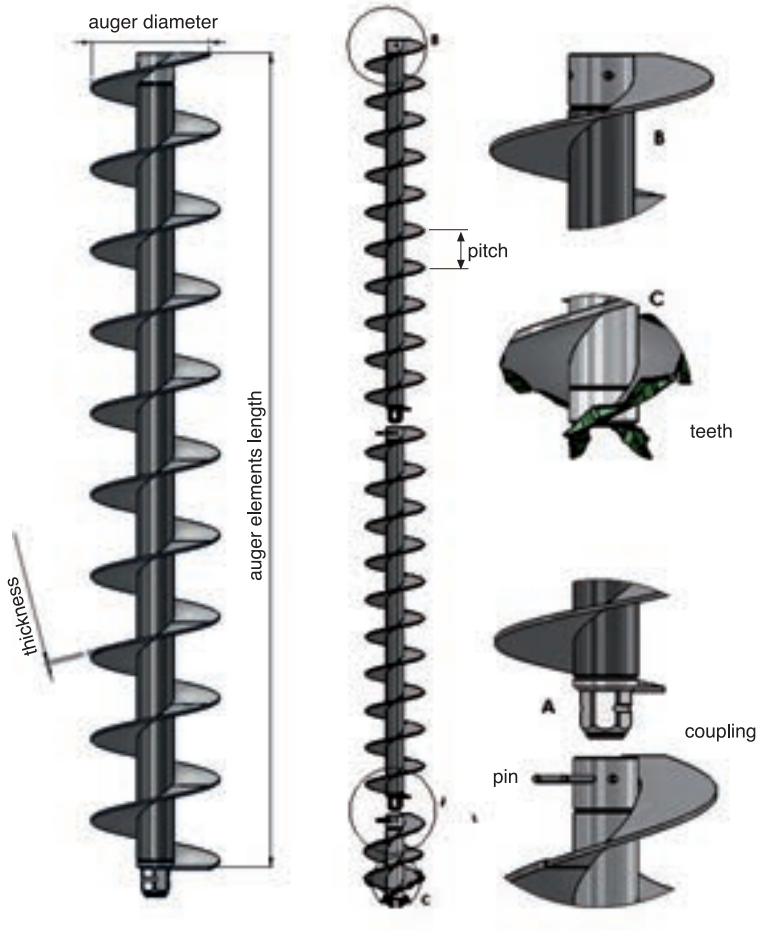
Over years, other auger cleaning methods have been designed:

The **brush-type cleaners**, that consist of two rotating cylinders with steel cables fixed to them in the radial direction, so as to create a cylindrical brush.

The **star-type auger cleaner**, two sets of rollers (or blades or even steel cables) are arranged in a star-like shape around an axis; the circumferential distance between the elements corresponds to the auger pitch.

Drilling Tools

intermediate elements auger

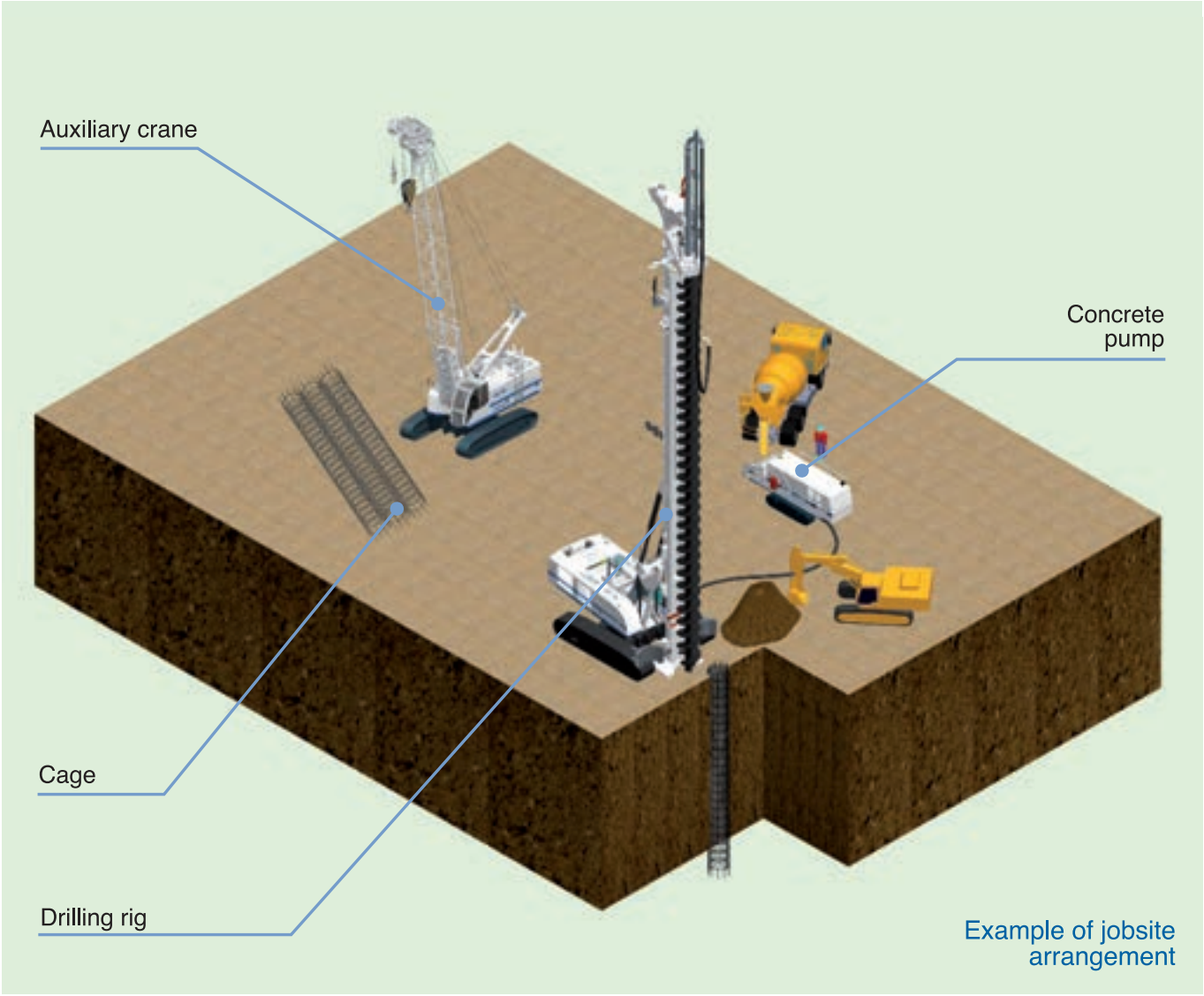


SOILMEC drilling rigs can be equipped with four different models of continuous flight auger:
HD-4, HD-5, XHD-5 and **25HD-5**, according to the torque on the rotary.

The connections between auger elements are made of quick coupling exagonal joints. They are built with special steel and they have 2 safety pins to prevent disconnections. The auger tip element is provided with a disposable plug to prevent entering of the soil through the hollow shaft. The plug is blasted when the auger is extracted and concrete, is pumped. According to the different soil conditions the leading element can use flat teeth for medium-soft ground or rock teeth; all of them can be easily changed.

Job site logistics

For the construction of CFA piles, the jobsite has to include a drilling rig, a small-sized tracked hydraulic pump, a backhoe excavator for debris handling and an auxiliary crane for cage positioning, whether needed.



Example of jobsite arrangement

Technologies advantages

The main advantages of the CFA technology are listed below:

• No drilling slurry is used: the debris has the same environmental features of soil in-situ before drilling.

• No vibrations or impulses typical of percussion systems.

• No trenches or open-cut excavation resulting in soil decompression. This technology is especially suitable for the construction of diaphragm walls next to existing buildings and structures.

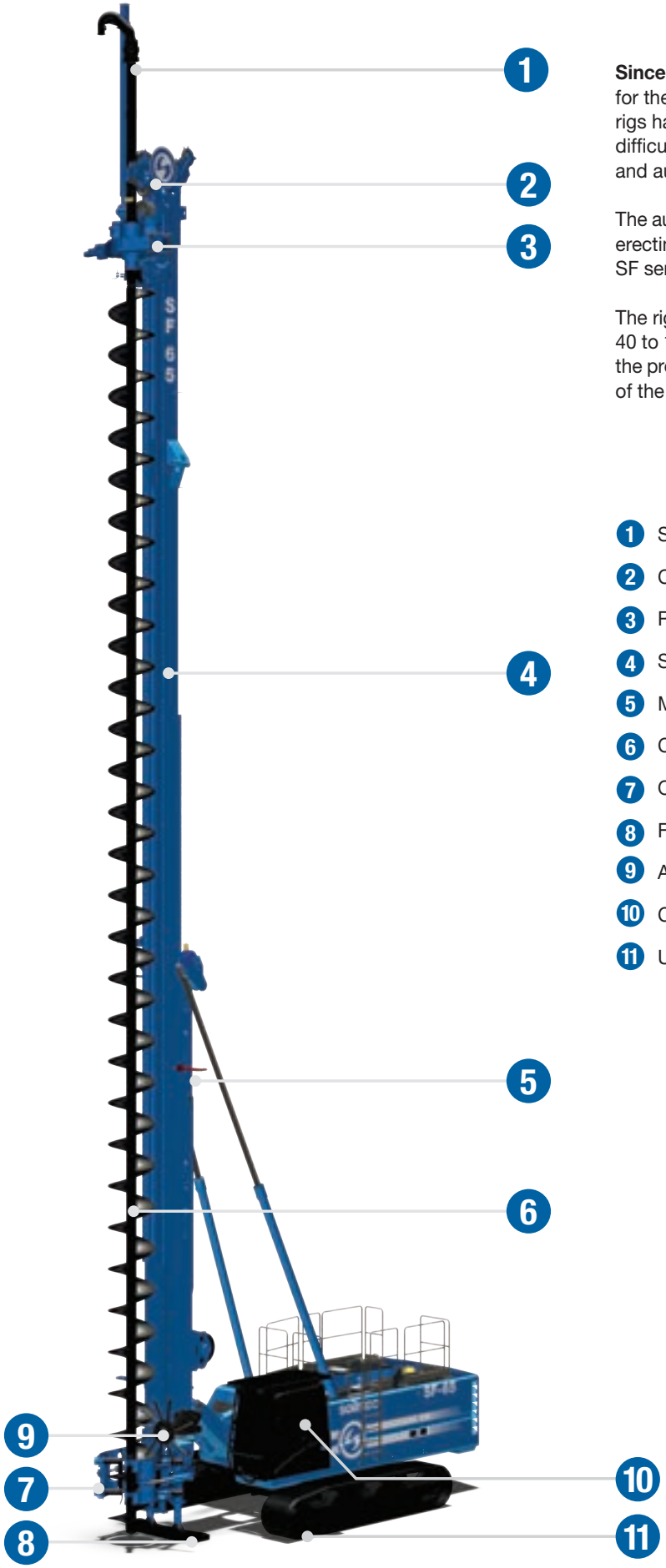
• No cumbersome mixing and desanding plants that are on the contrary needed for the construction of standard diaphragm walls or when working with a hydromill.

• Doubled operating speed, under the same geological conditions, with respect to standard Kelly method.

The absence of soil decompression during pile construction makes it possible to work in the proximity of existing structures. Moreover, as no drilling slurries are used (bentonite or polymer), the size of the jobsite installation is reduced and the problems of cuttings disposal are minimized, as they are not contaminated by slurry.
As the technology does not involve soil decompression, the bearing capacity of a CFA pile is higher than any equivalent drilled pile.


SF-50
soilmec

Soilmec Equipment



Since 1982, with the first CM-42, Soilmec experience for the construction of continuous flight augered pile rigs has enabled the operation of the system even in difficult grounds, thanks to the use of different teeth and augers.

The auger system is operated by multifunctional self-erecting fully hydraulic rigs of the SR series and the SF series, especially designed for the CFA pile.

The rigs can cover a wide range of diameter, from 40 to 140 cm and depth down to 31 m, to overcome the problems connected to the project and execution of the piles.

1. SLEEVE EXTENSION
2. CATHEAD
3. ROTARY HEAD
4. SLIDING MAST
5. MAST
6. CONTINUOUS FLIGHT AUGER
7. OPENABLE AUGER GUIDE
8. FOOT ELEMENT
9. AUGER CLEANER
10. CAB
11. UNDERCARRIAGE

Soilmec Equipment

Evolution range

Dedicated kelly method drill rig optimally designed to give you the best drilling performance.

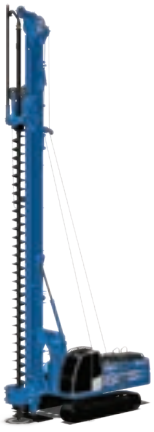
EVO

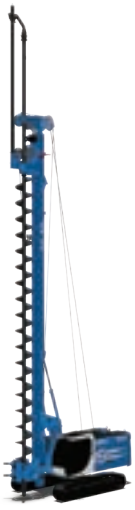
EVO line - Model	SR-40	SR-60	SR-80
Max pile diameter	1000 mm	1000 mm	1200 mm
Max pile depth	20 m	22 m	23,7 m
Extraction force	520 kN	560 kN	800 kN
Operative weight	49 t	62 t	79 t

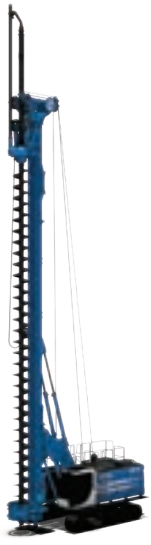
Advanced range

A flexible machine, optimized to give you the best drilling solution.

ADV







ADV line - Model	SR-30	SR-45	SR-75
Max pile diameter	900 mm	1000 mm	1200 mm
Max pile depth	23 m	21,5 (24) m	25,5/27 (29) m
Extraction force	380 kN	480 kN	984 kW
Operative weight	38 t	41 t	71 t

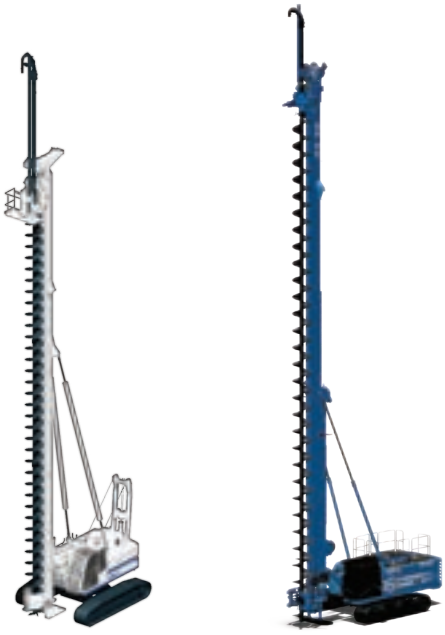
High technology range

A multipurpose machine, optimized to give you the best technological solution

HIT line - Model	SR-95	SR-125	SR-145
Max pile diameter	1200 mm	1200 mm	1200 mm
Max pile depth	30/32 m	32/36 m	32/36 m
Extraction force	1100 kN	1036 kN	1362 kN
Operative weight	94 t	127 t	140 t

SF range

Compact hydraulic drilling rig specially designed for CFA



SF series	SF-50	SF-65
Max pile diameter	900 mm	1000 mm
Max pile depth	25 m	30 m
Extraction force	510 kN	527 kN
Operative weight	35 t	51,5 t

All technical data are purely indicative and subject to change without notice

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