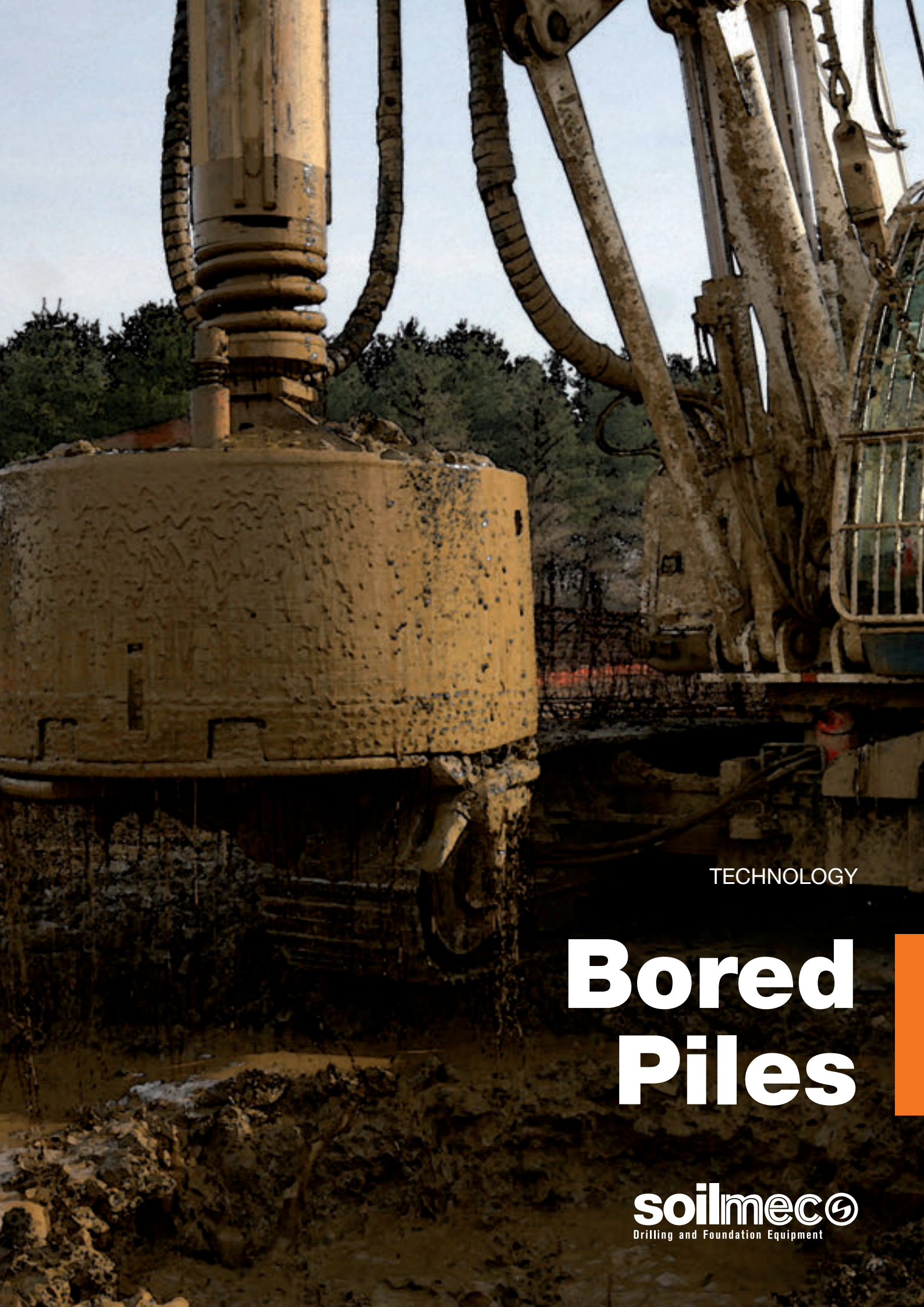


TECHNOLOGY

Bored Piles

soilmec
Drilling and Foundation Equipment

Bored pile technology dates back to the beginning of the last century

Nowadays, with increasingly powerful equipment available and borehole walls supported by bentonite or polymer slurry, **this technology can be used to construct foundation piles up to 4 m in diameter and 100 m deep**


Drilling diameters
up to 4,000 mm
Drilling depth
over 100 m
soilmec
SR-75
www.keltbray.com
Keltbray
020-7643 1000
soilmec
ESG

Technology

The large diameter bored piles are foundation structure characterized by a cylindrical shape with a diameter larger than 600 mm; manufactured by excavating ground through a rotary drilling equipment with a complete soil removal and cast in place by casting concrete into the borehole.

The bored piles construction entails two main steps, the drilling phase (*Demolition - Removal - Stabilisation*) and the construction phase (*Reinforcing cage - Casting - Curing*).

Construction stages

Drilling stages

To stabilize the borehole, three methods can be used:

- Dry pile construction
Where the soil is stable, stabilisation operations can be avoided.

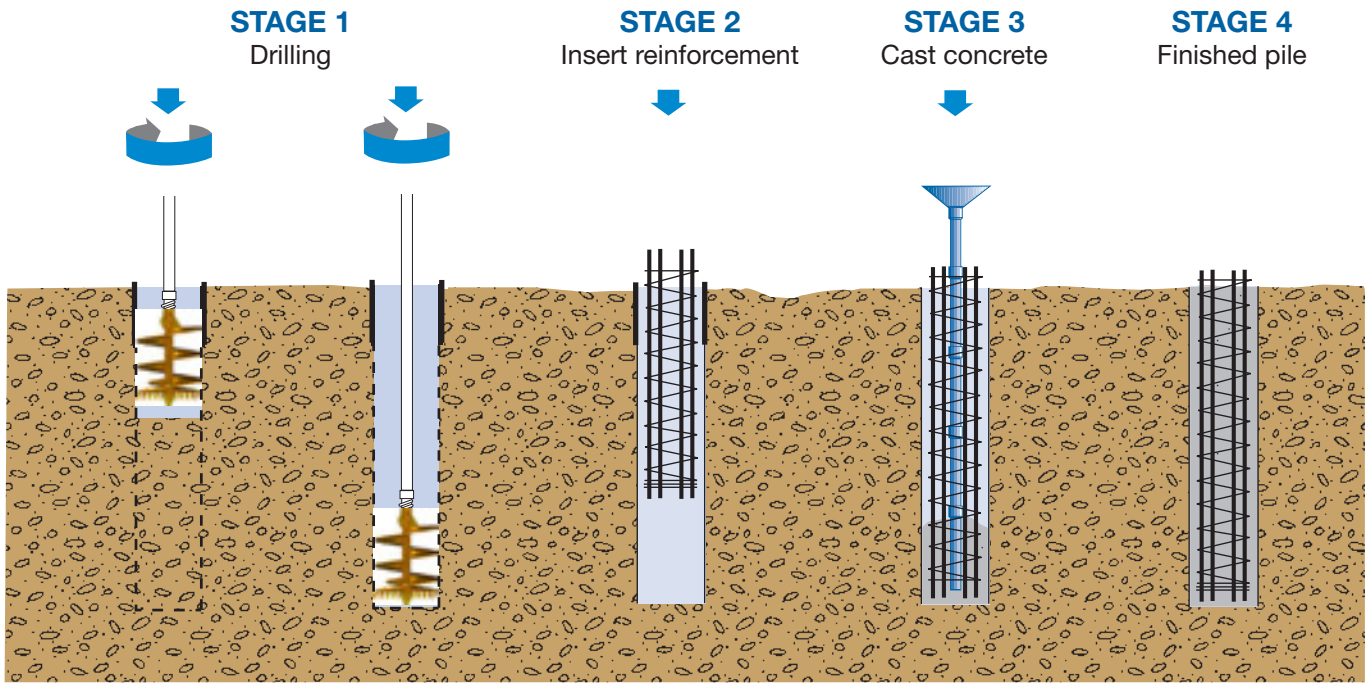
- Wet pile construction
Drilling mud (bentonite and polymer mud) is used to fill the borehole while drilling and prevents the borehole walls from collapsing.

- Cased pile construction
To drill the borehole, casings are used to maintain open the borehole.

The next step is the construction of the pile: firstly the reinforcing cage is lowered into the hole and then concrete is cast. Each of these methods have their own areas and applicability.

DRY EXCAVATION

The construction process consists of drilling the pile, removing loose material from the borehole, placing the reinforcement cage, and concreting the shaft.



Construction stages

Excavation WITH DRILLING FLUIDS

When drilling through loose soil or very soft clay below the water table, special bentonite or polymer slurries are used to stabilise the borehole walls.
Thanks to the greater specific weight of bentonite slurry compared to water and its capacity to create a waterproof layer over the borehole walls, these slurries, when applied for more than at least metre above the water table, help make the shaft watertight, preventing the walls from collapsing.

The drilling slurry, whether it is bentonite or polymer-based, is produced on site using specific high turbulence mixing plants.

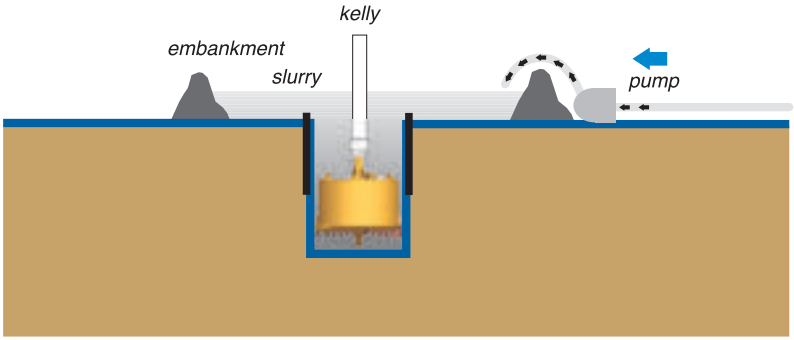
The following quantities of bentonite or polymer are used to prepare the slurry:

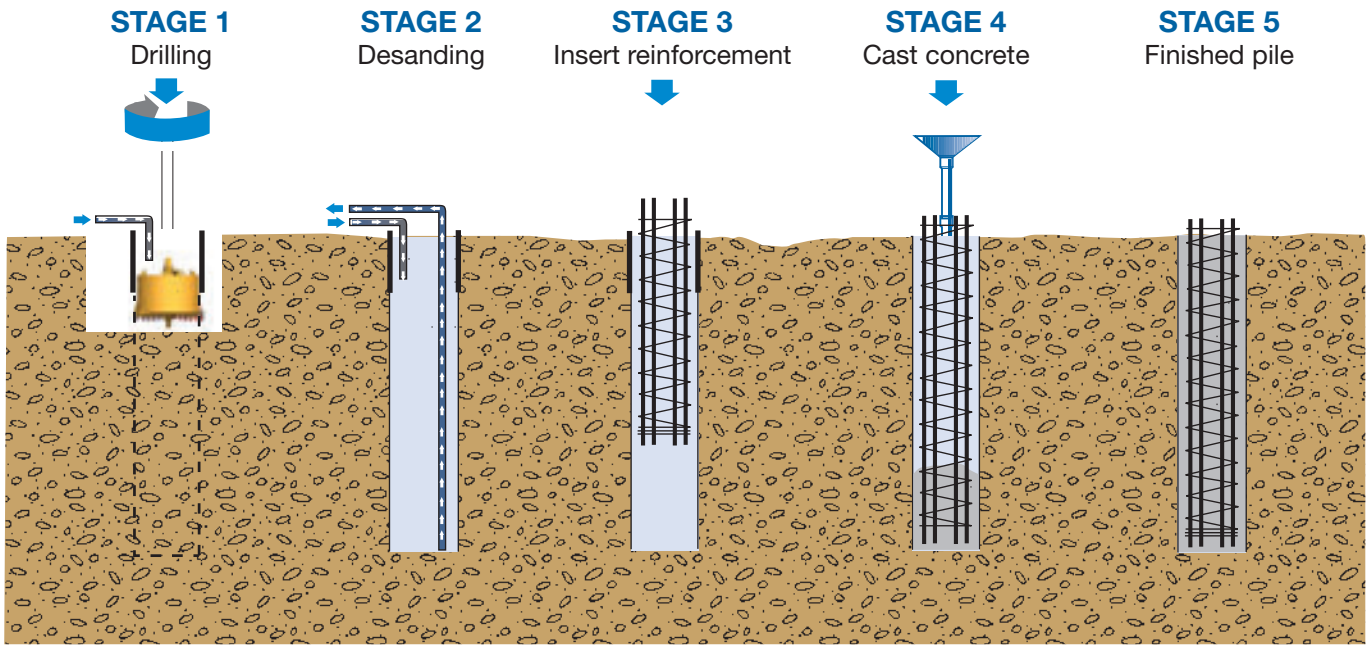
- **bentonite:** **30-70 kg per 1,000 litres water**
- **polymer:** **0.5-3 kg per 1,000 litres water**

It is important to have a constant supply of slurry on site in case its level suddenly drops, should workers encounter cohesionless, particularly loose soil or underground cavities.
The slurry must have certain rheological characteristics, such as density, viscosity and sand content, in order to effectively stabilise the borehole and these parameters must be checked periodically during work.
Once drilling operations are complete, the bottom of the borehole is cleaned using a special “cleaning” tool and the slurry in the borehole is desanded.
This is carried out by lowering a centrifugal pump to the bottom of the hole and pumping the slurry to a special piece of equipment called “desander”.
At the desander, the slurry is fed through a series of vibrating screens and hydrocyclones which separate it from soil residues before conveying it back to the borehole. This process operates in a continuous cycle so the slurry in the borehole remains at the same level.

Excavation WITHOUT DRILLING FLUIDS

If drilling fluids cannot be used, boreholes can be supported by temporary casings. As for the foreshaft, the temporary casing can be driven into the ground using the rotary head of the drilling rig (up to 15-20 m) or a hydraulic vibratory hammer connected to a service crane.
As a general rule, the techniques described above are not effective at depths greater than 20 m and the temporary casing can only be driven using a special piece of hydraulic equipment called “casing oscillator”.





Construction stages

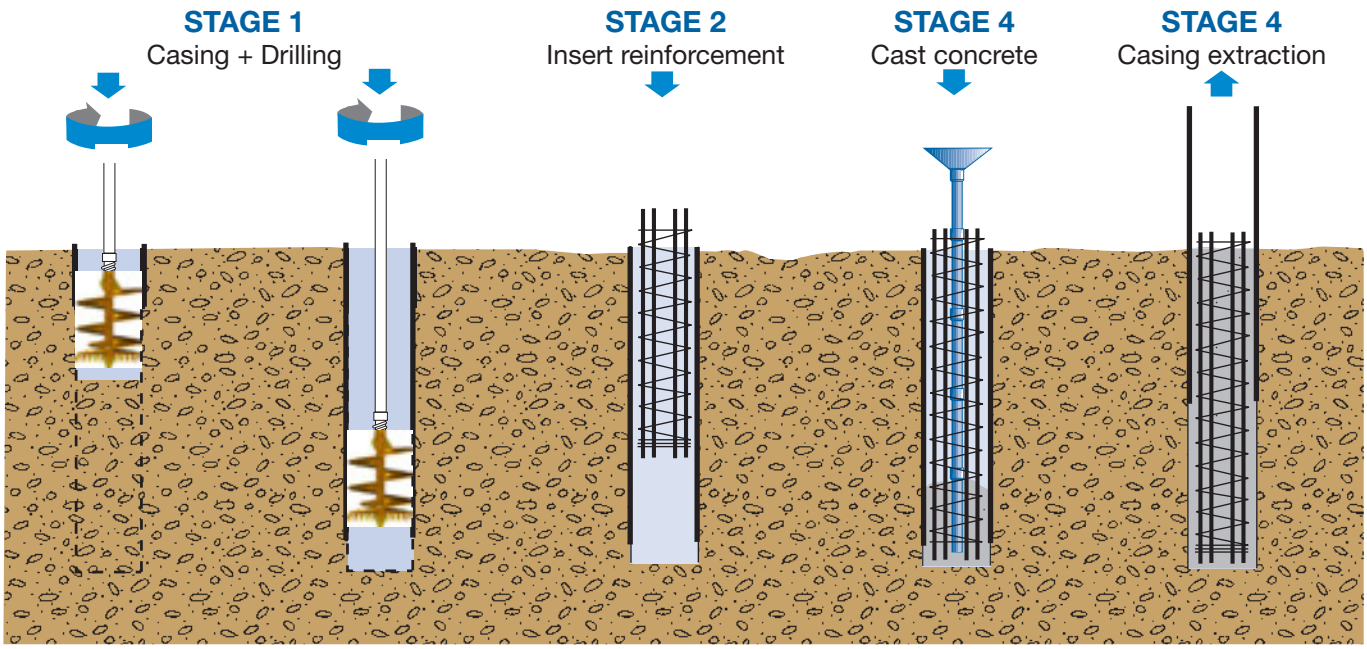
Excavation
WITH CASING SUPPORT

Segmental casing is used as a temporary or permanent support for a bored piling system with deeper unstable soil conditions. It is utilised during the driling stage and can be installed and extracted by using a drilling rig or an oscillator attached to a rig, service crane or power pack. A large casing driving plate is fitted under the rotary to couple the first 1.5 m-casing section. The soil therein is removed by means of boring tools such as an auger or drilling buckets. The sections are joined using mechanical joints until the desired length is achieved.

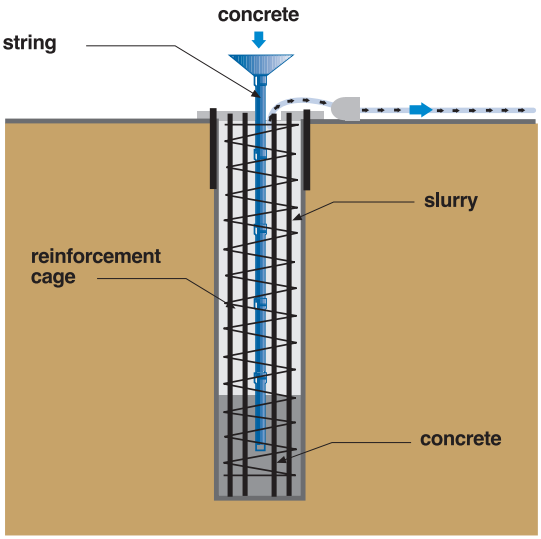
During the concreting stage casings are withdrawn in segments, extracted by the piling rig and or oscillator. Segmental casing method can be applied to foundation piles, secant pile and contiguous retaining walls. Casing drilling is recommended in soils with rocks or boulders which tend to displace the kelly bar from the drilling axis, and thus cause serious damage to them. There are two type of casings:

Temporary Casing: Temporary casing is used to retain the sides of the borehole only long enough for the fluid concrete to be placed. The temporary casing remains in place until the concrete has been poured to a level sufficient to withstand ground and groundwater pressures. The casing is removed after the concrete is placed.

Permanent Casing: The use of permanent casing is implied by its name; the casing remains and becomes a permanent part of the foundation. An example of the use of permanent casing is when a drilled shaft is to be installed through water and the protruding portion of the casing is used as a form.



Construction stages



INSERTING THE REINFORCEMENT CAGE

The steel reinforcement cage is inserted in the shaft using a service crane of a suitable capacity. As it is being lowered, concrete or plastic spacers are applied to the outside of the cage to ensure the designed concrete cover.
In order to guarantee sufficient concrete cover at the bottom of the pile, the cage is supported and suspended 15-20 cm from the bottom of the hole.
Upon request, the cage can be fitted with 2" iron pipes on the inside to carry out non-destructive sonic tests.

CASTING THE CONCRETE

Once the cage has been inserted, the borehole is filled with concrete.

To do this, a string of steel pipes with an internal diameter of no less than 250 mm is lowered down the centre of the shaft. As a general rule, the string is made up of 2 or 3 metre long sections which are connected to each other until they reach the bottom of the hole. A funnel is placed at the top of the string and the concrete is poured into it.

The concrete flows down the pipes and , when it reaches the bottom, it begins to fill the hole, rising back up. Thanks to the considerable difference in density between the two fluids, the slurry does not mix with the concrete but is forced up towards the surface where it is collected in special slurry pits, ready to be used again. As the concrete rises inside the borehole, the string is shortened to ensure that no more than 3-4 m of piping is immerged in the wet concrete at any one time.

Once the concrete has reached the pre-established level, the pouring stops and the string are removed completely.

CURING

Once the curing time of concrete has elapsed, an excavation is made around the foundation pile group. Pile heads are trimmed to leave the reinforcement bars only.

Job site logistics

A typical jobsite constructing bored piles through slurries will use the following equipment:

A - a hydraulic drilling rig;

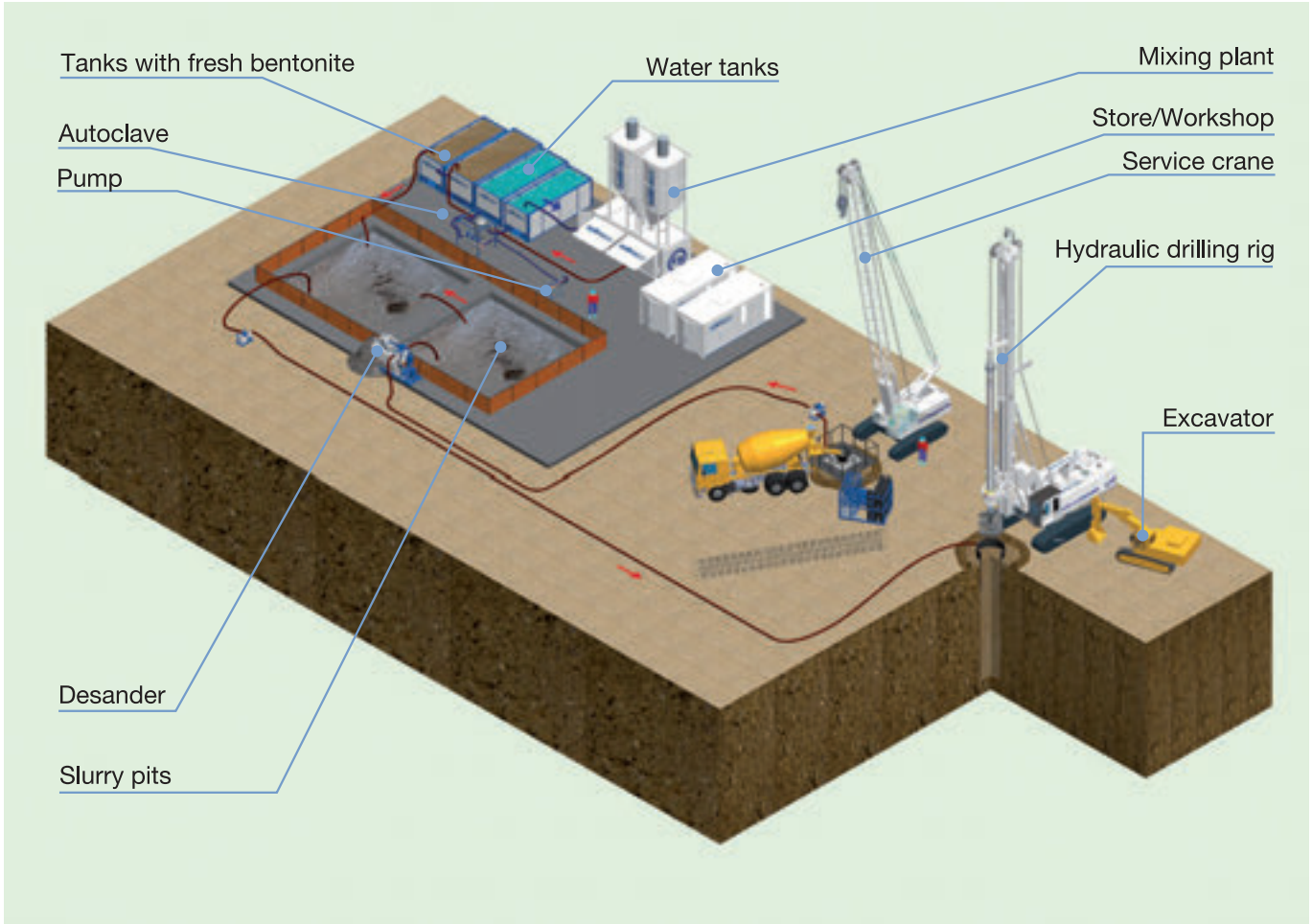
B - a shovel or a backhoe excavator to carry the excavated soil away from the work area;

C - a plant to produce the slurry;

D - a plant to desand the slurry;

E - a service crane to position the steel reinforcement cage in the borehole and to handle the string of pipes to cast the concrete.

Note:
Jobsite DRY / CASED ***(A+B+E)***
Jobsite SLURRY ***(A+B+C+D+E)***



Drilling tools

The type and configuration of drilling tools are chosen according to the nature and geomechanical characteristics of the soil to be excavated.

An auger or a bucket can be used to bore cohesionless soil or average compacted clay.

An auger consists of a central shaft with a spiral-shaped flange welded around it. The cutting edges of the helical flange have wedge-shaped teeth. Augers are suitable for digging clayey or cohesionless, dry soil. In fact, if there is ground water, the excavated soil can often fall back into the hole as the tool is being lifted out.

A bucket is made up of a hollow, cylindrical section fitted with a hatch on the bottom with a slit that is attached by a hinge to one end of the cylinder. Cutting teeth are welded onto the edge of the slit to help load the soil into the cylindrical bucket and also prevent it from falling out when the tool is withdrawn. Once the drilling tool has been brought to the surface, the hatch is unhooked from the bucket body and the soil is discharged. As it is a closed drilling tool, the bucket is ideal for digging loose, cohesionless soil or soft clay below the water table.

A rock auger or a core barrel can be used when boring highly compacted clay or rocky soil.

A rock auger uses different cutting teeth compared to a traditional auger. The teeth on a rock auger are not wedge-shaped but conical (they are also called “bullet” teeth, as they look like the streamlined tip of a bullet) with a heavy-duty metal element inserted at the top. The teeth are also housed in supports to allow them to rotate around the axle, hence wear of the cutting tip is uniform. Thanks to this configuration, rock augers are ideal for drilling highly compacted clay and soft or very weathered rocks.

When digging very hard rock formations, the most suitable drilling tool is the core barrel. A core barrel is basically a bucket without the hatch on the bottom, fitted with cutting teeth along the whole lower edge. Thanks to the special arrangement and configuration of the teeth (which can vary according to the hardness of the soil), once the rock core has entered the inner cylindrical assembly, it will not fall out as the barrel is being extracted.

Whatever the drilling tool used, it is connected to the kelly bar by a male-female coupling.

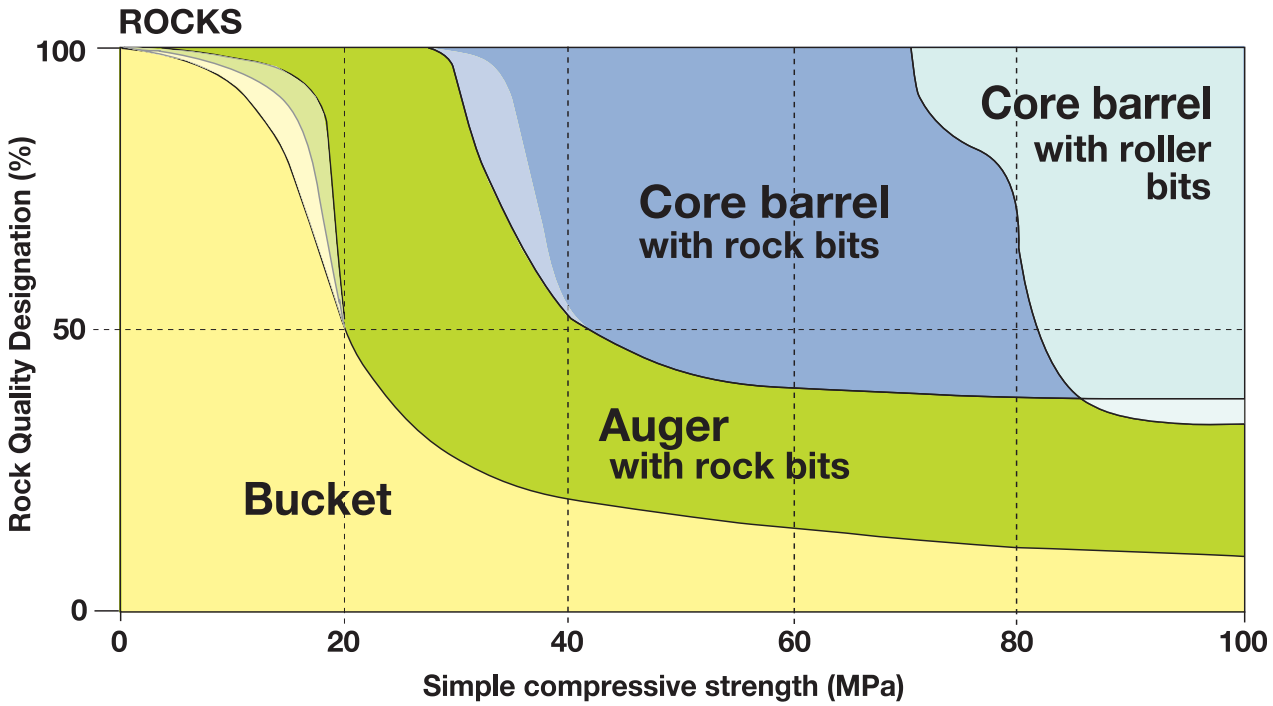
The kelly consists of a telescopic drill string (3- 5 sections depending on the depth to reach) with the most external section connected to the rotary head of the hydraulic drilling rig. This system delivers the necessary rotation and thrust to the tool.

COHESIONLESS SOIL

USCS (ASTM D-2487) Soil description						Drilling tools	
						BUCKET	AUGER
Coarse grain soil	Gravel > 50% of coarse fraction caught in screen no. 4	Clean gravel	GW	33°-45° 0 KPa	Well-graduated gravel and sandy gravel, little or no fine material	☑	☐
			GP	33°-45° 0 KPa	Well-graduated gravel and sandy gravel, little or no fine material	☑	☐
		Gravel with fine material	GM	30°-40° 0 KPa	Sandy and silty gravel, fine material >12%	☑	☐
			GC	30°-40° 0 KPa	Clayey gravel, fine material >12%	☑	☐
	Sand >=50% of coarse fraction passing through screen no. 4	Clean sand	SW	30°-40° 0 KPa	Well-graduated sand, from fine to coarse	☑	☐
			SP	30°-40° 0 KPa	Poorly graduated sand	☑	☐
		Sand with fine material	SM	28°-35° 0 KPa	Silty sand	☑	☑
			SC	28°-35° 0 KPa	Clayey sand	☑	☑
Fine-grained soils	Silt and clay Liquid limit (LL)<50		ML	0-200 KPa	Inorganic silt, very fine sand, fine silty or clayey sand	☑	☑
			CL	0-300 KPa	Inorganic clay with medium-low plasticity, silty and sandy clay	☑	☑
			OL	0-200 KPa	Organic silt and low-plasticity organic silty clay	☑	☑
	Silt and clay Liquid limit (LL)<50		MH	0-20 KPa	High-plasticity silt	☑	☑
			CH	0-200 KPa	High-plasticity clay	☑	☑
			OH	0-10 KPa	Organic clay, organic silt	☑	☑
	Highly organic soil		Pt	0-10 KPa	Muskeg and other highly organic soils	☑	☑

Prefix: **G** = Gravel **S** = Sand **M** = Silt **C** = Clay **O** = Organic **H** = Clay, LL > 50%

Suffix: **W** = Well-graduated **P** = Poorly graduated **M** = Silty **L** = Clayey, LL < 50 %



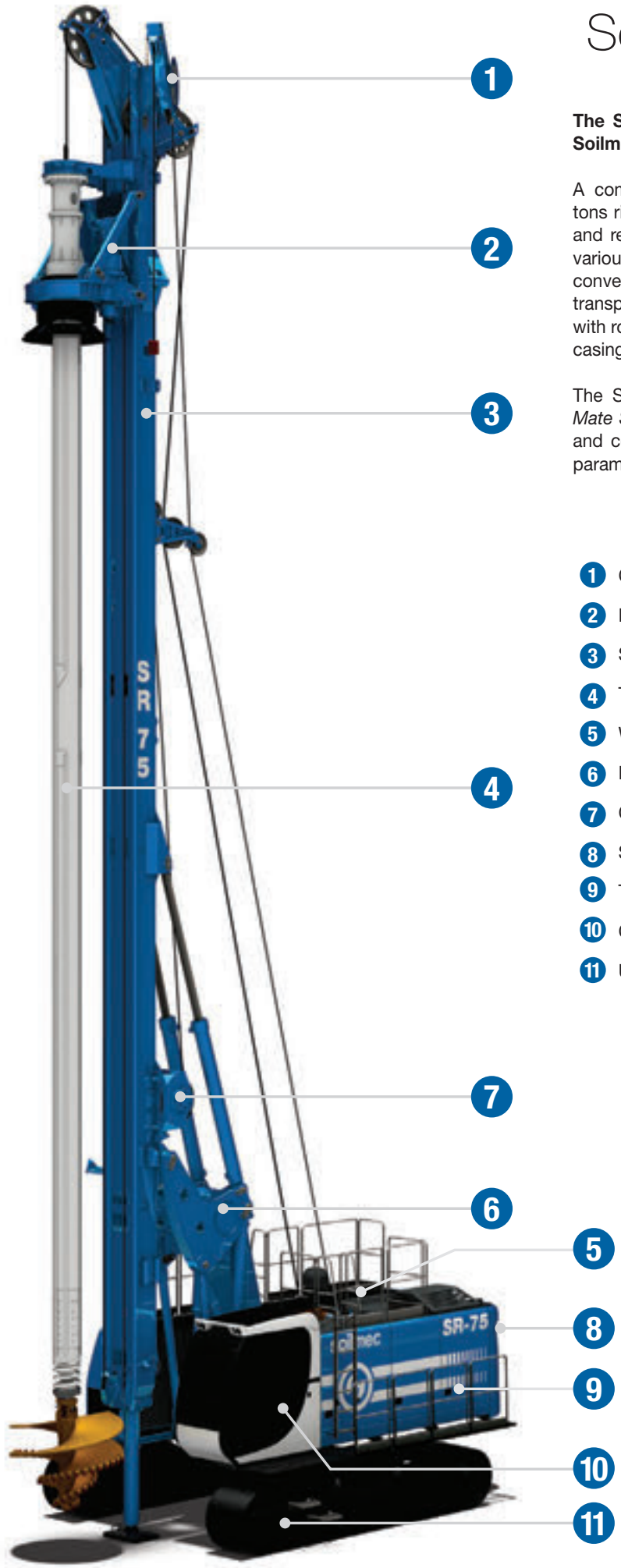

SR-75
soilmec
soilmec
CAT

Soilmec Equipment

The SR line reflects more than 45 years old of Soilmec experience in foundation technology.

A complete and assorted range, from 20 to 140 tons rigs, designed to meet the need of bored piles and really multifunctional machine, able to perform various technologies application thanks to a rapid conversion kit. The SR rigs are self-mounting, easily transportable equipment, capable to driving casing with rotary and pistons/winch or in combination with casing oscillator.

The SR rigs are equipped with the DMS (*Drilling Mate System*) on touch screen panel for monitoring and control of the rig performances and operating parameters.



1. CATHEAD
2. ROTARY HEAD
3. SELF ERECTING MAST
4. TELESCOPIC KELLY BAR
5. WINCHES
6. PARALLELOGRAM SYSTEM
7. CROWD SYSTEM
8. SELF ERECTING COUNTERWEIGHT
9. TURRET
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	1500 mm	1800 mm	2000 mm
Max pile depth	61 m	71 m	77 m
Max torque	161 kNm	201 kNm	271 kNm
Rated engine power	180 kW	261 kW	328 kW
Operative weight	51 t	66 t	85 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	1500 mm	1500 (3000) mm	2000 (2500) mm
Max pile depth	48 m	65 m	76 m
Max torque	130 kNm	185 kNm	290 kNm
Rated engine power	164 kW	201 kW	328 kW
Operative weight	36 t	41 t	74 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	2100 (3000) mm	3000 (3500) mm	3000 (3500) mm
Max pile depth	106.5 m	121 m	121 m
Max torque	351 kNm	435 kNm	435 kNm
Rated engine power	403 kW	470 kW	470 kW
Operative weight	96 t	135 t	149 t

Crane attachment rotaries range

Mechanical and hydraulic rigs to equip your crane for large diameter bored piles

SA & SR series	RT3-ST	SA-40
Max pile diameter	3000 mm	4000 mm
Max pile depth	78 (120) m	94 (106) m
Max torque	210 kNm	413 kNm
Min. crane capacity	40 t	90 t

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

Bored Piles_002 02/2016

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