

# GeoDrilling International



## Piling and foundations

Piling-industry experts discuss best practice, industry trends and the latest equipment releases

## Drilling consumables

A look at the different categories of rotary drill bits, their benefits and applications

## Bauma preview

A guide to new and innovative drilling products on show at Bauma 2016



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DRILLING HI-TECH



# The building blocks

*GeoDrilling International* goes back to the foundations, looking at best practice, industry trends, innovation and equipment releases within the piling sector

**D**rilled or driven deep into the ground, piles form part of the foundations that support buildings, towers and bridges, among other structures, transmitting high structural loads downward to lower layers of strata with better bearing

capacities. Piles can also be used to construct permanent or temporary retaining walls for an excavation pit or cut in the terrain, or to block off groundwater. The length, diameter, material, shape and layout of the piles will differ according to their intended use.

Piles are installed into the ground through a variety of methods, which are often divided into two main categories: drilled piles – kelly/classic bored pile, continuous flight auger (CFA), full displacement and double-rotary head drilling – and driven piles installed with a hydraulic vibratory hammer or hydraulic impact hammer.

“The kelly method is used to produce uncased (normally as slurry-supported boreholes), partially or fully cased bored piles. The soil is excavated by a drilling tool mounted at the tip of a telescopic kelly bar.

“When the fully cased pile technique is used, the insertion of the full-depth casing is simultaneous to the excavation, until the final depth is reached,” explains Manfred Schoepf, head of marketing at Bauer Maschinen.

Bored piles are often of a larger diameter than CFA piles and are used to support greater loads, overcome underground obstructions, penetrate ground too hard

to bore using a CFA or create piles with a cut-off level beneath the platform level. The method also has the advantage of allowing the cage to be the full depth of the pile.

Alternatively, when adopting CFA drilling, an auger as long as the depth of the pile to be constructed is utilised.

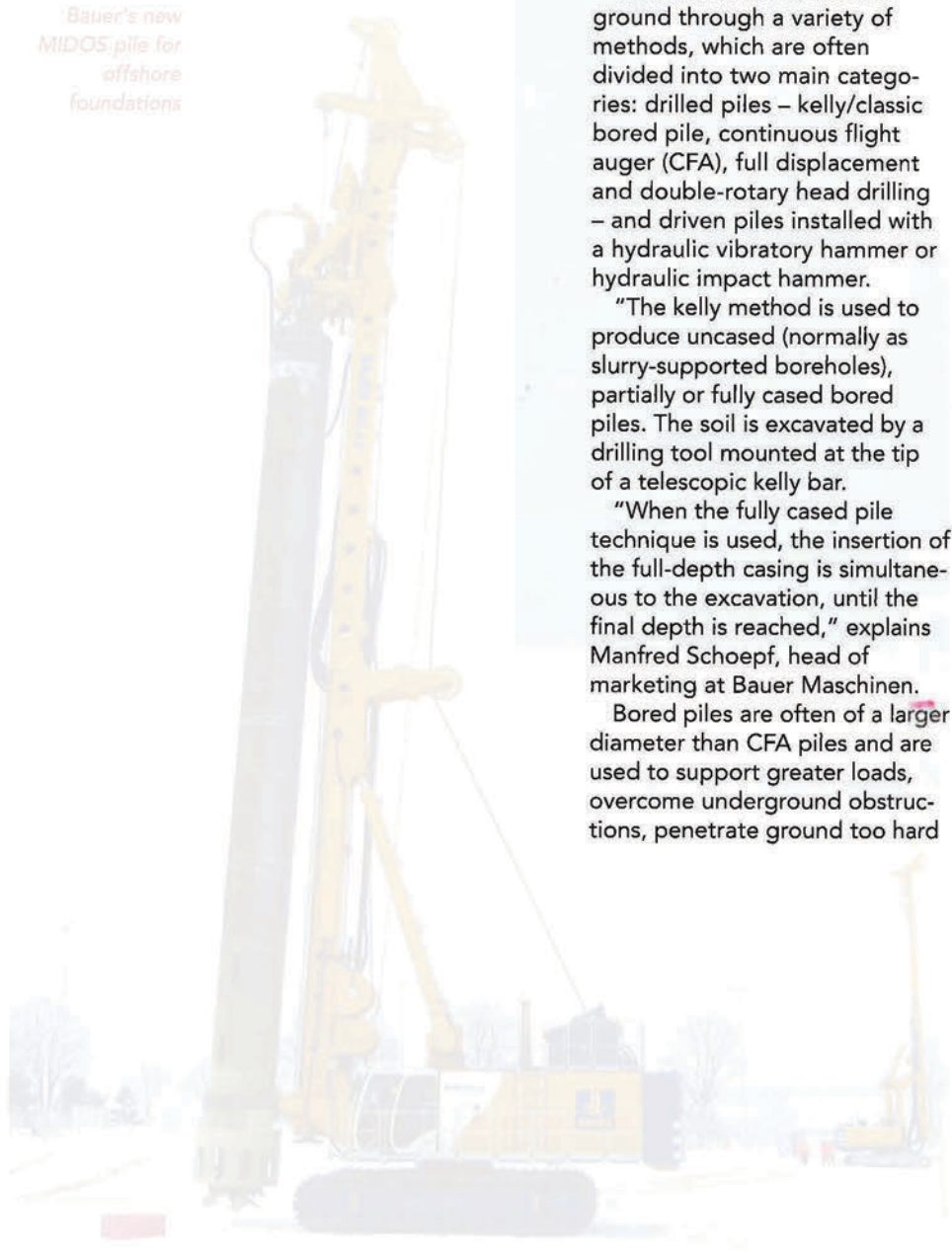
“The auger is rotated and screwed into the ground to the design depth and then withdrawn while pumping concrete through the hollow stem. Once the auger has been withdrawn and the borehole is full of concrete, a reinforcement cage can be placed,” describes Federico Pagliacci, Soilmec’s vice-president of development.

“The cased auger pile (CAP) technique is an evolution of CFA. The drilling system consists of the same auger used in CFA placed inside a steel casing. Auger and casing are activated by two independent rotary drives. During drilling, the auger and casing penetrate the soil simultaneously; however, depending on the type of soil or rocks, the auger tip can be maintained ahead of the casing shoe or vice versa.”

Van Elle’s Ashley Burley adds: “The CFA system of drilling is one of the quietest piling solutions available and is virtually vibration-free, making it ideal for working in close proximity to existing buildings or in environmentally sensitive areas. This method enables piles to be formed in water-bearing strata, without the need for casing, bentonite or polymers. It is suitable for constructing piles in almost any type of strata: sands, gravels, silts, clays and soft rocks, or even a combination of these.”

The key advantage of the full-displacement piling system, in turn, lies in the avoidance of drilling spoil; it is suitable in displaceable soils. The drill string consists of a starter auger, followed by the displacement body and an extension rod. During drilling and extraction, the surrounding soil is displaced. ▶

Bauer’s new MIDOS pile for offshore foundations



- Concreting and reinforcement is executed as in the case of the CFA pile.

"Driven piling provides a slender section pile with high structural capacity for compressive loading and is suitable for wet or dry ground of strengths ranging from very soft to hard. The piles can be installed in a logical sequence, which opens up the site quickly for follow-on trades, and there is no spoil to remove from site. Driven piles can cater for compression, tension, shear and bending moment loads in various combinations," explains Chris Primett, managing director of Aarsleff Ground Engineering.

"Driven piling suits the transference of load through soft material onto bedrock as the pile is pre-formed and the soft material does not pose a risk to mis-formed piles or flighting of material while boring a rock socket. Driven piles gain shaft friction through both cohesive and granular material and can rely on a high end-bearing capacity."

Burley describes two further rotary methods, including the Odex drilling system that utilises an off-centre reaming bit to drill a hole larger than the external diameter of the casing tube. The casing then closely follows the drill and produces a straight, accurate and permanently cased pile/rock socket.

This method is normally used when drilling through tough ground conditions and/or bearing loads are particularly large; leaving the casing in means that it is a strong but expensive pile.

The Duplex drilling system, in turn, uses an inner drill string and temporary outer casing to control

## Piling benefits

Van Elle lists the advantages of rotary bored, CFA and driven piles.

### ROTARY BORED

- They can carry significant loads;
- The size and depth range is greater than CFA;
- A number of piles can be drilled before concreting;
- Minimal ground disturbance – with limited risk of damage to adjacent structures;
- Suitable for all soil types;
- Simple and efficient installation process; and
- Ability to drill through most obstructions and socket into rock.

### CFA

- Able to carry high load/shear/moment capacity;
- Low noise and vibration;
- Quick installation; and
- Suitable in almost any strata.

### DRIVEN

- No spoil removal from site;
- No wet product deliveries;
- Cost and time effective in most ground conditions;
- Easy to cut to level; and
- Small, versatile rigs can be used for short segmental sections.

flushing and avoid cavities. The casing itself has cutting teeth and spins with the down-the-hole (DTH) drill in the centre, removing the trapping effect.

### THE RIGHT TECHNIQUE

The most suitable technique for a given project depends on the technical specifications set by the designer, the type of soil or rock to be drilled and project logistics.

"There are many different factors that need taking into account when choosing the right piling technique. That's why Van Elle encourages clients to use a reputable ground-engineering contractor to produce high-quality investigations that not only confirm the ground conditions but extend to depths greater than the anticipated pile length.

"This enables the pile design engineer to optimise the number, type and length of piles, ensuring that the most cost-effective foundation solution is offered to the client. Investing in high-quality ground investigation, with early input from the specialist geotechnical contractor, will ensure that the scope of work is appropriate to the proposed development, which will result in a saving of both cost and time," says Burley.

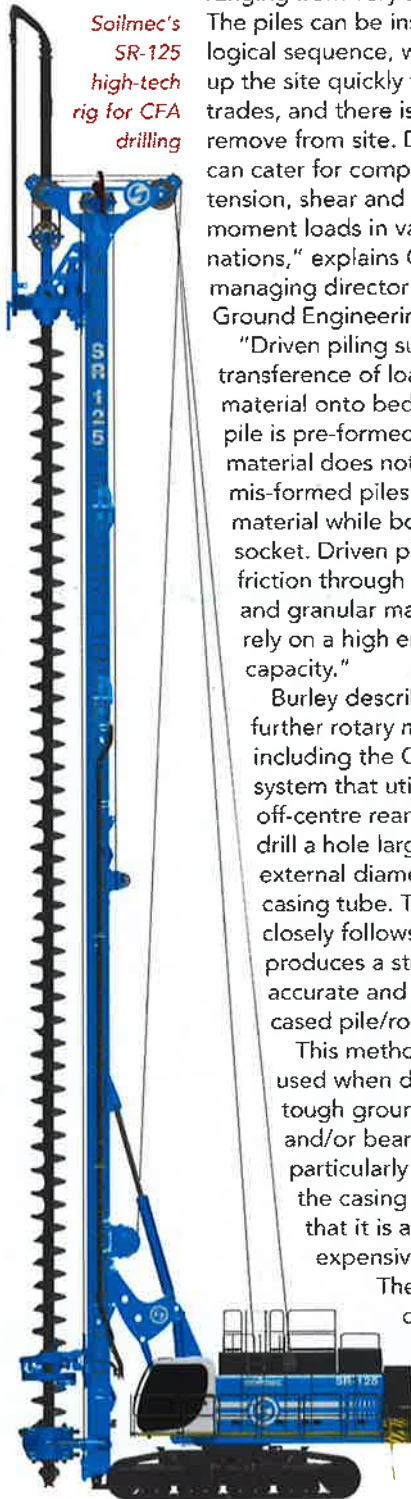
Pagliacci comments: "The designer can ask for a specific

technology to be adopted or can set some limits to the use of drilling fluids, for instance, thus dictating a specific drilling technique. They can also set specific features of the reinforcement cage or concrete to be used, making it necessary to discard some pile-construction techniques.

"The choice of the piling rig having adequate torque delivered by the rotary table and crowd force, and of the drilling tools, mostly depends on the presence of loose or cohesive soils, boulders, blocks or rock levels, rather than on the technique to be adopted."

Nowadays, the market offers piling rigs of extreme weight and high installed power that allow successful work in any soil conditions, and to construct piles of large diameter at impressive depths. "Indeed, it is quite common to build piles of a diameter larger than 3m to depths of more than 80m," adds Pagliacci.

For city projects in confined areas, the CFA or CAP techniques are often preferred, as they involve a limited range of equipment, there is no need for drilling-fluid preparation and treatment plants and drill cuttings are not contaminated by drilling fluids.



Soilmec's SR-125 high-tech rig for CFA drilling

**LATEST DEVELOPMENTS**

Some of the most recent trends within the piling sector include a move towards larger and higher-capacity piling rigs, as well as a focus on health and safety, environmental issues and efficiency.

“We see a clear trend towards larger machines. At the same time, the reduction of fuel consumption and noise emissions becomes increasingly important. Further aspects are accuracy and data-reporting systems to control and optimise the drilling and piling works,” says Liebherr’s marketing manager, Tobias Froehlich.

Michael Finch, managing director of Casagrande UK, continues: “We also see a trend towards increasingly deeper and larger-diameter CFA piles in the UK driven by the fact that in most UK ground conditions, CFA offers a more cost-effective and environmentally sensitive piling

technique than other methods. To this end, Casagrande has been introducing upgraded versions of most of its models with extended CFA drilling depths to meet this demand.”

One important safety aspect is the fitment of working platforms and handrails on rigs that comply with both legal requirements and internal standards. Many of the recent developments are also related to or a direct result of customer requests and requirements.

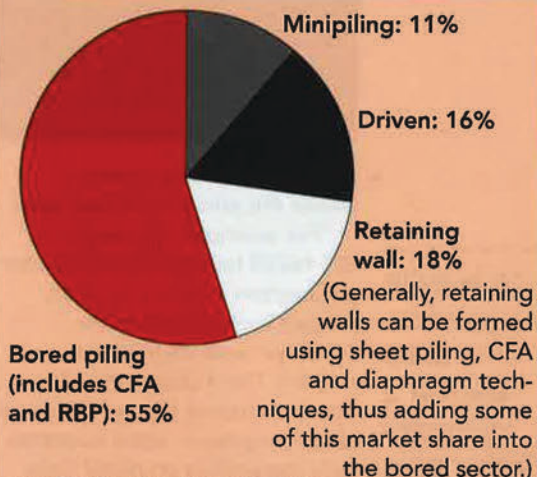
“Many of our larger customers are adopting their own standards for the safe working of their personnel on and around piling rigs, and manufacturers have to be ready and willing to work with customers to satisfy their requirements on this.

“Casagrande has recently supplied B360XP rigs to both Select Plant and Balfour Beatty Ground Engineering, and both customers had different require-

ments for the working platform and handrail design on the rigs, which Casagrande had to accommodate,” says Finch.

Customers are also asking for different equipment and features, ▶

**UK market shares**



Source: UK Federation of Piling Specialists' quarterly stats – Q1: 2014 to Q4: 2015



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### Now trending

According to Bauer Maschinen, some of the main trends and innovations in the piling equipment sector are:

- Increase of productivity by optimising the efficiency of hydraulic systems and engine output;
- Focus on H&S and the environment by incorporating structural design changes to

reduce noise emissions and introducing obligatory safety elements on the piling rigs to increase the safety level for the whole workforce; and

- Introduction of electronic systems for assisting the operator during operation, for collecting, transferring and analysing machine and process-related data.

**"It is quite common to build piles of a diameter larger than 3m to depths of more than 80m"**

- ▶ depending on the country where the piling rig will be used.

"For example, the recent EN 16228 has introduced stricter parameters in terms of safety-related components in the European and US markets, and the Tier 4 diesel emission standard makes it possible to use diesel engines in some countries only depending on diesel type; as a result, the customers from countries where the said regulations have not been enforced yet cannot appreciate these models," says Pagliacci.

"Similarly, the electronics of piling rigs are increasingly complex, which makes their use quite difficult for those using them for the first time, or those working in low-tech countries where operators and mechanics have poor knowledge of technology.

"Moreover, new recording

systems have been introduced to record the operating parameters of the machine and the technology being used, which ensure remote data transmission. Such technologies are very much appreciated by customers who have to run and monitor a set of machines or have to provide all construction-site data to their own customers. Nonetheless, for those who do not need it, it makes things more complicated."

Accordingly, some customers are asking for simpler piling rigs, which are easy to use and service, while others require machines that offer more in terms of installed power, torque delivered by the rotary table, diameters and depths to be reached. Customers also ask for the rigs to be multifunctional, so they can be used for both foundation engineering and soil consolidation.

## New technology

### BAUER

In 2011, Bauer Maschinen introduced two lines of drilling rigs: the ValueLine and PremiumLine. While the PremiumLine rigs are multifunctional machines for different uses in foundation engineering, the ValueLine is optimised for kelly drilling. In the last years, performance-increasing improvements have been made to all machines. For example, all PremiumLine drilling rigs are equipped with the Bauer energy-efficiency package (EEP).

At Bauma 2016, Bauer Maschinen will present a new generation of the ValueLine drilling rigs – a medium-sized platform range designed for bored piles with a diameter of up to 2.5m and a drilling depth of up to 70m. This medium-sized platform range includes the Bauer BG 26 and the BG 30. The core element of these rigs is the joint BT base carrier, which was entirely designed and constructed by Bauer. An integrated service platform allows for easy, convenient and secure access for all types of maintenance work on the upper carriage.

Bauer also offers some new extension developments, for example an extremely long rack for cutter-soil-mixing. The guide

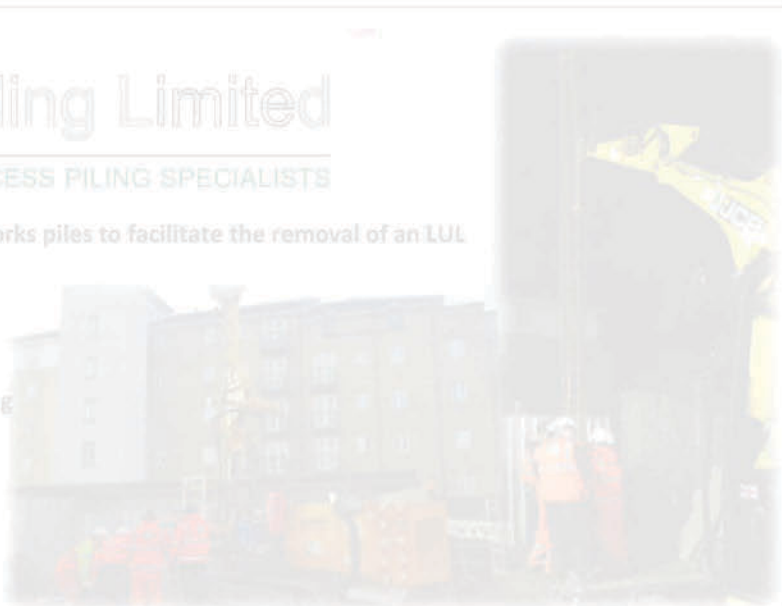
## GSS GSS Piling Limited

RESTRICTED ACCESS PILING SPECIALISTS

GSS Piling successfully completed temporary works piles to facilitate the removal of an LUL railway bridge.

The works required the installation of 508/450mm diameter piles through 5m depth masonry abutments. This was undertaken during night and day possessions where casings were cast in as sacrificial liners during night and the piles bored and completed during the day.

[www.gss-piling.uk](http://www.gss-piling.uk) ☎ 01707 260022



### ► SOILMEC

Soilmec has recently released the Blue Line, which has been developed to meet requests from the global market. It has been divided into three main lines:

**Evolution:** This line is driven by the core business and includes the SR-40, SR-60 and SR-80 models, mounted on a Caterpillar carrier. They are suitable for bored piles and CFA only and are equipped with Tier 3 engines.

**Advanced:** The key feature of this line is flexibility. It includes the SR-30, SR-45, SR-65, SR-75

and SR-85. The drilling rigs can be equipped with Tier 3 or Tier 4 engines, and manufactured to comply with EN 16228 requirements. They are specially designed for bored piles, CFA and displacement pile (DP) technologies. Moreover, all these models can implement CAP, Turbojet and low headroom (LHR) application technologies.

**High-Tech:** The key idea of this line is multipurpose. It includes the SR-115, SR-125, SR-135, SR-145 and SR-165. They can be equipped with Tier 3 or Tier 4

engines, and manufactured to comply with EN 16228 requirements. They are designed for bored piles, CFA and DP. They are also equipped with the hydraulic and electrical connections to convert them for CAP, Turbojet and LHR, by simply changing some structural elements.

Soilmec has also developed a new technology named traction compacting technology (TCT), which decreases the down-crowd force needed for DPs. TCT requires small drilling rigs (or it may enlarge the field of application of DP rigs) because the displacement process takes place during tool extraction.

All rigs in CFA or DP configuration have higher extraction force than down-crowd force. The TCT features three sections: a lower tip with teeth, mounted on a short drilling string, with or without flight auger; an upper section fitted with flights, rigidly connected to the upper drilling string and to the lower tip; and a partially free-to-rotate middle section fitted with flights and bore stabiliser.

As in CFA, drilling is performed by clockwise rotation. The drilling string is rotated counter-clockwise. The central section of the tool cannot rotate because of the friction against the borehole walls. Upper and lower sections turn together; this rotation causes the lower tip to move against the tool flight creating a sort of cover above the concrete gate.

This mechanical gate separates the tip through which concrete flows out, from the central portion. By extracting the tool with a counter-clockwise rotation, soil is forced downward and displaced laterally by the central portion of the tool.

### VAN ELLE

The Elemex drilling system is a rotary innovation developed by Atlas Copco (working with Van Elle), which combats tough ground conditions and flushes the spoil back up through the

### Aarsleff: Driven-piling project

A typical driven-piling project starts following mobilisation with a trial piling exercise: this is where a series of piles is driven at working pile locations across the site to allow the contractor to gauge the on-site driving characteristics compared with the site-investigation report. This allows the contractor to monitor the rate of penetration and length requirements to tailor the pile supply to suit the required length and hence reduce wastage to a minimum.

Driven piles displace the soil sideways during driving, which densifies the ground creating a shaft friction and prohibits pathway creation. This makes a driven pile suitable for contaminated sites as no spoil is generated, thus saving costs to the client in its removal, no contamination is dragged down, and pathways are not created for contamination transfer.

Further to the benefits of a driven pile in contaminated ground mentioned above, the concrete grade can be higher due to the pile being cast in factory conditions and not having on-site casting problems to deal with. This allows a DC-4 to BRE SD 1 mix to be used, which provides the highest protection against sulphates and aggressive ground conditions. The site in mind had contamination within the made ground and hence a driven pile suited.

After the trial piling had been completed, the 'set' was confirmed as acceptable to provide the required resistance and the pile would be adequate to carry the required load. A 'set' is a measure of the amount of penetration of the pile against a known energy



input and number of blows with the hammer and hence a driven pile is a testing pile, with each pile having its set monitored.

As the project progresses, piles are identified for load testing. For driven piles the most economical solution is to use dynamic testing methods of CASE and CAPWAP, where the pile has the testing gauges attached to the shaft and it is re struck.

The energy imparted on the pile, the distance moved and the acceleration of the pile are measured and then analysed to provide a measure of the load-carrying capacity and settlement at working load and 1.5 x working load. This information is what is achieved from a static maintained load test; however, for the cost of one maintained load test, numerous dynamic tests could be carried out to give a wider site picture as opposed to one location with a static.

Driven piles can be installed in a logical sequence as no on-site curing period is required, hence the various areas of the site were released to the contractor earlier than a cast in-situ project.

Far right: the Grundodrig 11XP HDD rig

productivity and operating flexibility. The new rigs have Tier 4 diesel engines and more powerful, lightweight rotaries with torque increased by more than 20% and pull-up of more than 30%.

Being exhibited for the first time at Bauma are the SR-125 in continuous flight auger configuration and the SR-145 in segmental casing configuration.

The micropile sector will be represented by the most recent models in the SM range, including the SM-4 designed to perform sectional flight auger technology. Finally, Soilmecc's water-well section will exhibit a truck-mounted rig. Stand: FN.522

#### TEI ROCK DRILLS

TEI Rock Drills will be introducing a new version of the TE160, the company's smallest drifter, weighing only 48kg and 448mm in length. The new TE160HEX version will be even lighter (44kg) and shorter (414mm); this version adapts the TE160 to use traditional  $\frac{1}{2}$ in (22mm) or 1in (25mm) hex steel.

However, the TE160HEX keeps the hydraulic rotation motor, giving this little drifter a full 140Nm of torque. The percussion unit remains the same with a blow energy of 102Nm and a frequency of 6,500 blows per minute. The

idea of the TE160HEX is to provide a solution for jobs that still require hex drill steel but can no longer safely use the old jackleg-style drills. The TE160HEX can be mounted to a lightweight feed system and then mounted to mini-excavators, Brokk remote carriers or other mounting. Stand: FN.815/2

#### TRACTO-TECHNIK

Installation and rehabilitation of mains and distribution pipes using trenchless technology has long been accepted. At Bauma, Tracto-Technik says it will show further developments for installing property service connections. The complete range of sectors can be installed and renewed without trenches using the Grundomat P displacement hammer, or the new Grundomat N; the latter can be equipped with a crowned head or a stepped head.

The cost factor was the main-spring for developing another TT innovation: the Grundopit K, which can be used for installing, repairing and renewing property service connections from a



keyhole access with a diameter of only 650mm. Another novelty with the mini-bore rigs for property service connection is the Grundopit 6V. This follow-up version surpasses the performance of the Grundopit 40/60 with regard to efficiency, speed and ease.

The fast-paced development of the steerable drilling technique allows for trenchless installation projects that would have been unthinkable a few years ago. According to Tracto-Technik, the Grundodrig rigs drive this development due to their versatility and profitability. Parallel installations up to 500m long are possible, with crossings beneath rivers and water bodies being completed frequently.

One of the highlights in the HDD machine family is the Grundodrig 18ACS, which works efficiently in alternating soils as well as in hard rock. With the challenge of developing the urban underground network, the new Grundodrig 11XP was designed. Stand: FN.521/1



Above: Soilmecc's SR-145 in segmental casing configuration

Centre column: TEI Rock Drills' new TE160HEX drifter

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Super Jaws is available in two versions. One version utilises a drive shoe welded to the front of the casing. As the bit advances, the casing is advanced at the same rate due to the drive shoulder on the guide body contacting the drive shoe welded to the casing. The Super Jaws ND version allows the use of thick wall casing or thick wall threaded casing. The guide body has no drive shoulder and the casing is advanced via a casing hammer, duplex diverter or dual rotary. **Stand: C4.603/K**

#### ROCKMORE INTERNATIONAL

Rockmore International will launch its new Vector rod system. The company says it is designed to be a breakthrough in improving the performance and service life of extension drill tools in surface and underground percussive drilling applications, and that the new line of drill tools promises advantages in productivity and reliability.

After several years of research and development followed up with monitored field tests, Rockmore engineers developed a new thread design, XT, for the Vector rod system. The design incorporates new guided cylindrical contact zones between the male and female thread joints. These guided surface features are located in the nose and rear of the thread connections and serve various benefits and improvements over traditional threads.

The XT thread profile is based on the traditional trapezoidal 'T' thread design and is therefore compatible with industry standard thread types such as T38, T45, and T51. Thus, one can interchange and connect standard 'T' style threaded components with the new XT thread, although the guiding advantages aforementioned would be neglected.

To achieve the full benefits of the XT thread, however, one must consider the drill string as a system of connections between the shank adapter, rods and the bit in extension-drilling applications. Thus, the XT thread design

employed in the Vector rod system enables many performance and reliability benefits leading to major overall cost savings in the drilling cycle.

**Stand: C2.327**

#### SOILMEC

Soilmec will be present at Bauma with its new Blue Line range, which includes three product lines: Evolution, Advanced and High-

Tech. The range has been redesigned with the help of Porsche Consulting, a consulting company of the famous car manufacturer, which has given favourable indications in both design and production.

The new SR rigs have been designed to improve their ►

*Right: Rockmore introduces its new Vector rod system*





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# New year, new rigs

Two new rigs joined UK-based contractor Foundation Piling's fleet of rotary and continuous flight auger (CFA) machines at the start of 2016



Foundation Piling's new PVE 45 DR (above) and STM-20 (above right)

The Soilmec STM-20 is the first rig of this model to be supplied to the UK, having been manufactured in Italy and mounted onto a Volvo 6x4 truck at Soilmec's facility near Peterborough. The 20t-class truck-mounted rig is designed for large-diameter rotary drilling, complete with 4x7m locking kelly bar.

The Volvo chassis is an FM High Ride unit, suitable for off-road use. The Soilmec unit is also compatible with the rest of Foundation Piling's rigs, enabling tooling to be interchangeable. Experienced piling-rig operators have recently taken on the challenge of training and passing their LGV test so that they can move the unit without the assistance of a lorry driver.

With motorway and dual-carriageway work gaining more exposure, this rig provides the capability of moving between locations quickly and easily without needing a low-loader. The speed of rigging and de-rigging enables restricted working hours to be met more easily. Being lorry-mounted, on rubber tyres, prevents damage to surfaces that would otherwise need protection from metal tracks. This has proved advantageous on a recent project in Bedford, where areas surrounding a leisure complex are to retain the existing tarmac surface.

An emphasis on manoeuvrability was one of the factors that swayed Foundation Piling in the purchase of a PVE 45 DR. The Dutch-built



machine, supplied through AGD Equipment, is configured in CFA format. The complete rig can be turned within its own footprint by dropping jack legs down. With a torque of 15t/m and a pull-down winch capacity of 6t, this rig can drill 25m in a single pass.

The first contract for the rig was in the centre of Bristol, building 230 linear metres of contiguous piled wall. These were 750mm-diameter piles, bored into sandstone, creating a wall with a retained height of up to 11m.

The two rigs will give Foundation Piling greater flexibility of techniques and operations. ▼



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