



**SIP & T**

**Rotary  
Drilling  
Tools**

## WHO WE ARE

Since 1996 the purpose of SIP&T has always been to manufacture a wide range of rotary tools and Kelly bars with highest level of reliability and performance in the field of vertical foundations.

The search for high performance, combined with the search forever better reliability, has always been the real and recognizable philosophy of SIP&T in construction sites around the world.

Numerous efforts have been made, over the years, by SIP&T engineers and workers to offer to customers the best power tool and Kelly bar suitable to the excavation. This concept combined with the competent advice received from our customers and drill operators, together with the continuous activity and research of our technicians in all type of work on construction sites and in soils around the world, has recently led to the creation of our new range SHD, which for us means simply SUPER HEAVY DUTY.

However, we believe that drilling is a complex and difficult process where the theoretical knowledge must be reflected in the practice and execution. In order to obtain the best of the new hydraulic innovations installed on the machine and transfer properly to the ground, we have created a new and complete range of drilling tools and accessories.

The SHD Line tools has been introduced as product line with the goal of even better satisfying various requirements of customers. In details, the line is manufactured accordingly to the different rigs torque and soil-rock hardness. Such line of drilling tools has some basic principles, which are dealt with utmost priority, such as:

- Quality
- High performance
- Greatest reliability
- Highest safety levels
- Lowest maintenance
- Long lifetime
- Customized design

Short delivery time can be met even for special tools or components. Highly flexible production line, experienced technicians pleased to assist clients on site and extensive stocks are prerequisites for this.

Client satisfaction is key criteria for all tools and components we make.











# A thousand of these "Kellys"!



**Last August, the employees of the Company based in Campania and specialises in the design and manufacture of vertical drilling tools with large diameter celebrated an important milestone: the production at the Baronissi manufacturing plant of the 1,000<sup>th</sup> Kelly bar**



**A**mong the few companies in the world able to achieve a result of this kind, SIP&T decided to celebrate the production of the 1,000th Kelly bar in front of the largest of its two production units, at the presence of all its staff. At the end of the ceremony, the Kelly bar no. 1,000 was shipped to New Zealand, where SIP&T has recently signed an important partnership agreement with a major local business that will represent.

### A bit of history

When in 1996, Francesco Montuori decides to create SIP&T in Baronissi, he has already clearly in mind the outline of his business plan: to become the benchmark in the production of tools and Kelly bars used in the vertical drilling of underground engineering works.

To achieve this goal, he invests and strongly believes in people, or better, in a certain "type of people", with genius and passion, always ready for new challenges and willing to get involved in the continuing pursuit of excellence in the field of underground engineering.

In a few years, the Company begins to develop a precise structure, a strong aptitude for technological innovation, the enhancement of human capabilities, upgrading and internationalisation. The management aims to overcome the resistance of operators in the industry, historically tied to German manufacturers, to promote an innovative technology "Made in Italy" in a field with a strong mechanical culture.

The Company today is a very dynamic group, consolidated in the wide range of products and constantly looking for new solutions to the increasingly complex challenges faced by civil engineering worldwide. A team in whom the most advanced tools of research and technology coexist together with the willingness to invest capital and human resources in order to stay competitive and successful.

### Kelly no. 1,000

The 1,000th Kelly bar will be used on a rig having a nominal torque of 390 kNm at an



Kelly bar for piling rigs with torque between 200 and 390 kNm, 160 and 320 kNm and 140 and 460 kNm

operating pressure of 300 bar and 60 rpm. A drilling equipment item weighing 14.5 t, with a transport length of 18.5 m, formed by four sections, for a maximum depth of 60 m. A solution for large-diameter piles that also happens to be one of the top-range models manufactured by SIP&T, which the Company proudly claims is the "most complete in the world". Actually, in addition to the Kelly bars that are compatible with the major piling rig brands, SIP&T designs and manufactures buckets, core barrels, augers, special tools, tremie pipes, casings, CFA, FDP tools and Stop ends, as well as a customer service network that is even able to assist the most remote areas of the globe.

"The construction of Kelly bar no. 1,000",

stated Francesco Montuori, SIP&T's CEO, during the ceremony, "not only represents an amazing result in the history of our industry, but bears witness to the great vitality of the SIP&T team, which continues to represent a benchmark in the field of rotary drilling tools for large diameter construction works. SIP&T has always invested with trust in people and research, with the awareness that the present and future leadership of the Company is founded on these two issues. Therefore, as we celebrate this milestone, our 1,000th Kelly bar, we are already geared to developing new technologies".

### Reaching for new goals

This achievement, which undoubtedly



is extraordinary, is the result of the commitment that all SIP&T employees have always shown in the Company, especially during the last few years. Thanks to this continuous support, SIP&T has become a worldwide benchmark for rig manufacturers and for end users working in the field of foundations. It is enough to say that, since 1996, SIP&T has produced and distributed its equipment, thanks to its global sales network, in every corner of the world, reaching over 90 countries across the five continents. From Kelly bar no. 800 to no. 1,000, only 2 years have passed, which have been intense and full of challenges, during whom SIP&T always committed to developing new products and services, by continuing its effort to consolidate the “team”.

Goals – even the most prestigious and important ones – are never an end, but a starting point from which to embark on new roads, paths and goals and from which to take on renewed challenges. “Our business”, says Francesco Montuori, “has experienced several changes. On an economic level, through steps of growth, consolidation and social changes, following the evolution of the relations in

the family and at work, evolving customs, and observing the changing lifestyles. Anticipating technological innovations that can improve the work of our customers. Organisationally, thanks to the perfect integration of ingenuity and Italian philosophy, geared towards continuous improvement and maximum efficiency. In the year of our 1,000th Kelly bar, which will remain dear to us just as the first one was, to start redefining international economic balances, radically transforming global lifestyles and grasping the opportunity of a global-scale sharing generated by social networks, we wanted to commemorate our Company’s sensational journey with an event that closed with a gala dinner in the charming scenery of the Amalfi coast. We wish to thank all those with whom we have built – and continue to build – this important story: our customers, our dealers and our suppliers, as well as all our people and our community. Constantly looking for new and improved solutions and assets, the manufacturing plant of Baronissi continues today to shape an important page of its history. A few months ago, the Company kicked off a new production cycle with a lay-out that includes all the

latest generation machinery that will be used to reduce delivery times and bidding prices. The global market conditions have long been difficult, but all tunnels have a way out along with an entrance. I have no doubt that the markets will recover stronger than ever. To be ready when they do, all we need to continue to work hard as we have always done in the past. The future will not disappoint us”.

During its years of growth, SIP&T has earned a very important position on the global market. Francesco Cantisani, International Sales Director of SIP&T, commented: “SIP&T’s organisation consists of a team of young, multicultural and multinational talents, whose long-term vision is aimed at sustainable growth based on the principles of innovation, efficiency and understanding customer needs. After 19 years of history, our signature ‘relentless’ spirit that has distinguished us in steadily pursuing improvement continues to be alive and kicking. We are an important business, where progress in terms of quality and efficiency are pursued consistently. Today, on the occasion of our 1,000th Kelly bar, I wish to express our gratitude



Welding robot for Kelly bar terminals



to all our customers and suppliers, the local community, and its founder and contributors, past and present. Together we have helped establish and support this important activity over the years. It is our belief that SIP&T will continue to play an important role, offering technical innovation, improving efficiency and helping to meet the needs of our customers. We look with optimism to the future and the new opportunities that we will be able to take”.

### A culture of quality

Luca Galdi, SIP&T Vice President and Production Manager at SIP&T, guided the press on a tour of the Company's renovated factory in Baronissi. Thanks to technological innovations, the culture of building within our manufacturing plant has evolved constantly, becoming, as pointed out by Galdi, “a benchmark of excellence that allows the hub in Baronissi to be counted among the most advanced production centres in the world in the manufacture of Kelly bars and rotary drilling tools”. Standing out for its high standards in terms of efficiency, productivity, safety, quality and working environment, the plant in Baronissi today features the innovative assembly line with variable pitch, which offers greater flexibility.

“Since 2008”, explains Galdi, “to better respond to the new market scenarios, we reorganised our production, abandoning the push system used previously (which provided for the planning of production based on pre-established logics, designed for scale efficiencies) to introduce the pull system (where the market demand determines production output in terms of numbers and types of products). In order to meet specific marketing pressure, we also have introduced the patterns, addressed to different segments of the market. The plant in Baronissi is now highly advanced in terms of stock, which was organised in order to combine the assembly stages and lower volumes on the assembly line, creating new spaces, implementing safety and achieving the highest degree of efficiency and flexibility”.



Automated process of submerged arc welding of Kelly bars

In Baronissi, quality is also crucial, a commitment that has evolved over the years and is no longer simply confined to the product's conformity upon delivery, but extends to ensuring the same compliance throughout its lifetime. Presently, our quality control in Baronissi works with a strict focus on excellence and on reducing product flaws as much as possible. “The approach of our Quality Assurance”, concludes Galdi, “is based on planning and design of the control system of the product in all its phases: from design to pre-production, from mass production to after-sales service. By virtue of this approach, and thanks to the peculiar

partnerships established with suppliers, with whom SIP&T shares its know-how, the Company was able to significantly decrease our customer's need for service, more than ever before”.

### INFO



SIP&T  
[www.sipdrill.it](http://www.sipdrill.it)











# Kelly Bars: technological evolution

Being always a prominent representative in the field of large diameter vertical drilling tool production, SIP&T continues to stand out as a leading company, able to manufacture innovative Kelly bars compatible with most of worldwide drilling rig brands





**W**hen competition on the market gets increasingly fierce, innovating and renovating are fundamental key words for manufacturer. To achieve these goals, however, is not easy and it presumes, availability to invest in research and development and, secondly, being able to count on consolidated skills and know-how, are equally indispensable requirements. Every new addition on the market is, therefore, the result of a wise mix of these ingredients, whose outcomes depend largely - especially in a sector as complex as foundations - on the ability to satisfy the needs of the final user, the best judge of a product's worth.

### As reliable as steel

Young and motivated management team, wide range of products, fast services and high reliability are well-established features in a company like SIP&T, which has been in business since the '80s. The decade we are living in brings with it a series of generational changes giving a new look to the group from Campania, renewing its goals, market strategies and operating organisational methods. This way, the company has been able to quickly react to the changes that are remodelling the country's industrial structure. Even in 2013, the company was able to reach records figures for volume and turnover, focusing on two fundamental concepts: internationalisation and selection.

Today, the company's international dimension generates interesting figures and optimal prospectives. "We are structuring our network," explains engineer Francesco Cantisani, the Group's Sales Director, "to increase our presence on the international market. Working with foreign businesses is very stimulating and demanding, with an effect on costs that cannot be ignored. Just as true, however, is that foreign customers features are extremely interesting and very similar to our way of being in terms of reliability and extensive range. We have identified and signed sales agreements with businesses that have clear ideas, winning strategies and prospectives of growth. Setting up long-term collaboration models together has been our strategy over the last years: to the point that our first 50 customers have grown - in terms of



Kelly's solid model made by CAD 3D parametric Assigned material with mechanical and physical properties

*share-of-wallet in the company - by nearly 50%. To reach this, SIP&T invests in training, organisation and systems, variables that are much harder to be imitated and replicated from competitors compared to a simple production plant. Thus, the barycentre has shifted from investing in production assets (as the facilities are already excellent) to investing in people and skills".*

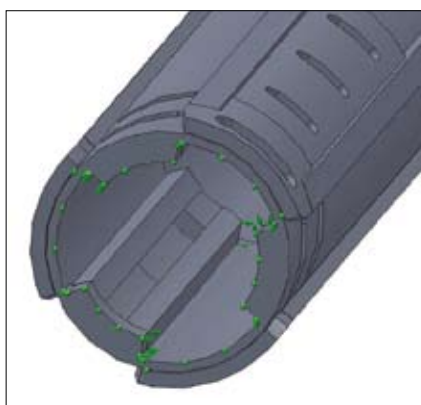
This renewed energy is also generational in nature: today, the group's entire management team is made up by people in their 40s. "We are a young group," continues Cantisani, "making this change enthusiastically, knowing that it's necessary to be able to grow. Obviously, the Campania company's new outlook cannot stray from guaranteeing products that are always at the top quality level. The wide range, which you can see on the company website [www.sipdrill.it](http://www.sipdrill.it), is certainly one of our winning features: the know-how developed in over 35 years of experience allows the company to create excellent quality products, thanks to our ability to get to the bottom of



Boundary condition: Loads

*the production process".*

The range is wide and includes Kelly bars, tools for different soil/rock morphologies, casings, tremie pipes, Continuous Flight Augers, full displacement tools, stop end elements for diaphragm walls and, of course, all the spare parts necessary to use them. In addition, service quality is another essential ingredient for the Group's success. "Speed in answering market requests is an essential element. Don't forget

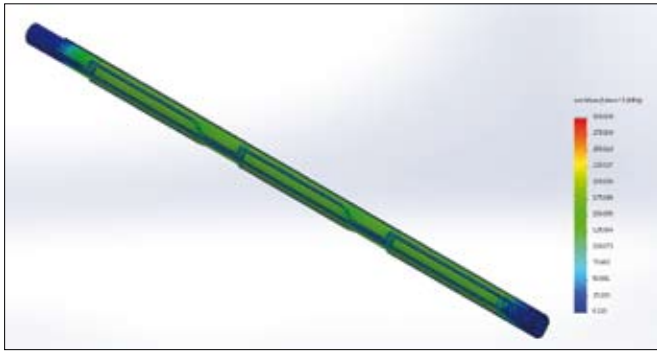


Boundary condition: Constraints

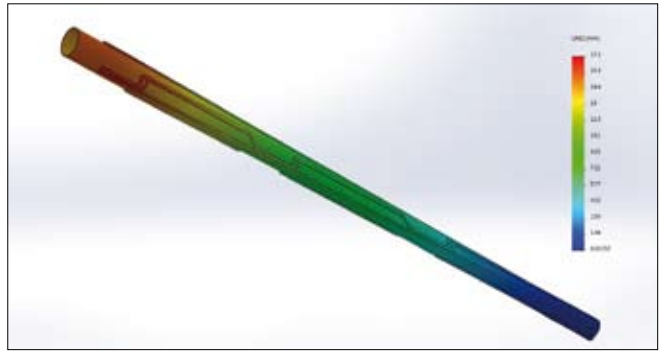


Discretized (Mesh) model

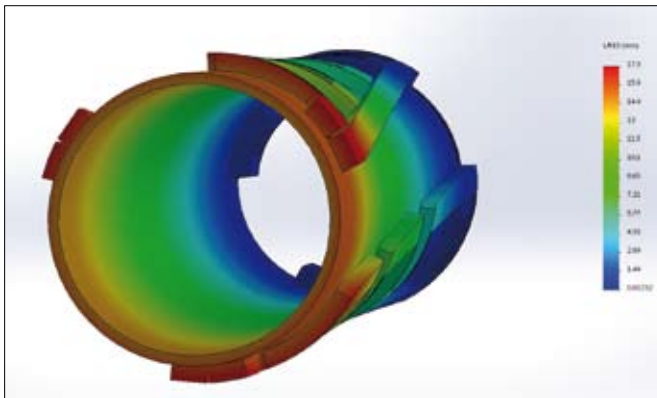




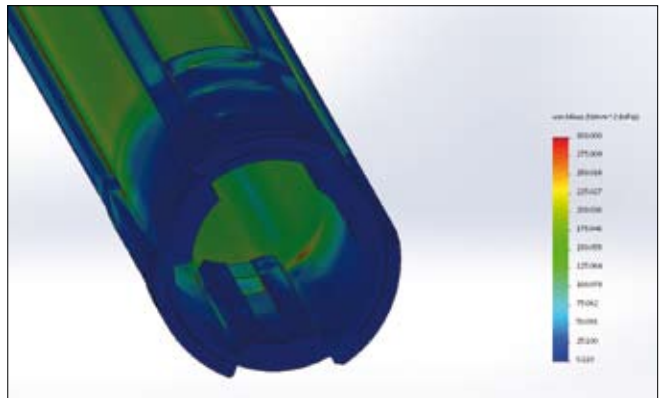
Von Mises Stress



Displacement along Kelly scope



Amplified Displacement along Kelly scope



Stress on terminal joint and along outer welded ribs

that the adjective 'urgent', conceptually speaking, characterises our job: that's why we're constantly investing whether in logistics and organisational efficiency. This is an aspect that allows us to get in touch with particularly structured companies that need fast response". The results are evident: in the last three years, the company has increased its annual turnover by 25%, in clear growth and bucking the trend compared to the general market.

**Always cutting edge**

The company's core business is, without any doubt, Kelly bar production (both interlocking and friction). Kelly bars transfer maximum torque and crowd force from rig to the drilling tool. Understanding customer requests, analysing reports from the different construction sites where SIP&T Kelly bars have been used, studying their performance in geologically challenging soil strata and checking their output, we decided to enrich and development company know-how by introducing the Finite Element Method (FEM) for each Kelly bar.

FEM is a numerical method that can be used to solve complex problems and today, has become the main method for structural

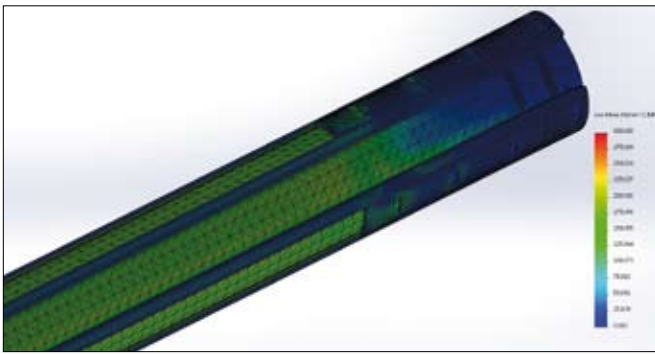
analysis. As its name suggests, it breaks a complex problem down into a finite number of simple problems. A continuous structure has actually an infinite number of simple problems but analysing the finite elements predicts the behaviour of a continuous structure via meshing into "finite elements", analysing a finite number of simple problems. Every element in a finite element analysis is one of these simple problems. Every element in a finite element model contains a finite number of nodes that define the boundaries of the element to whom loadings and bonds can be applied. The finer the mesh, the greater the number of nodes and elements and the more faithfully the structural geometry, load application, as well as stress and strain gradients can be represented. There is one compromise to live with: the greater the number of model nodes and elements, the greater the calculation power needed to solve the complex problem. Designing Kelly bars is essentially a repetitive process: a concept is developed, feasibility analysis is run, drawings are produced, prototypes are built and tested, the test results are evaluated and the process repeats itself until a version that can be made is found. FEM analysis is funda-

mental in facing and solving the challenges that come up during the various product development stages.

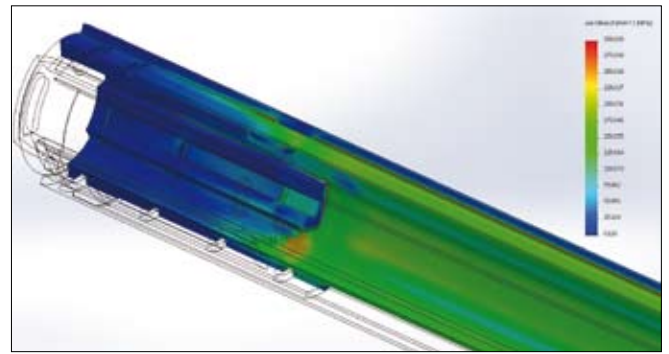
SIP&T has gained enormous benefits from implementing this analysis into its production process; in detail, the variety of materials used to build Kelly bars has been increased, optimised weight, thickness and shape, reduced testing time and, with it, time-to-market. The greatest advantage, however, is in the Kelly bar production stage, during whom we have noted a considerable reduction in the weight of the materials used, reduced material waste, reduced production times and, at the same time, increased production capacity and energy efficiency.

"From a commercial point of view," says Cantisani, "we have recorded a remarkable increase in demand and price-quality ratio by differentiating the product. The outstanding feedback from construction sites have confirmed improvements in Kelly bar behaviour and have, therefore, strengthened customer loyalty. We have increased the number and types of Kelly bars on the market, almost completely eliminating the cost and number of Kelly bar returns due to breakage or design flaws". All of this allows us to quickly (two-

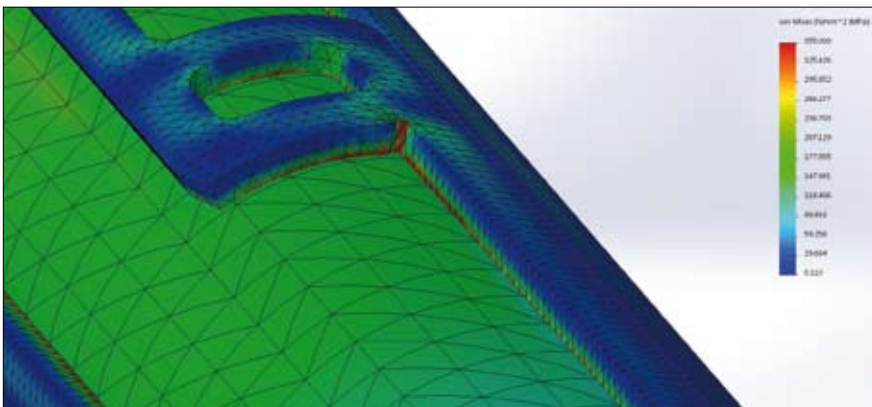




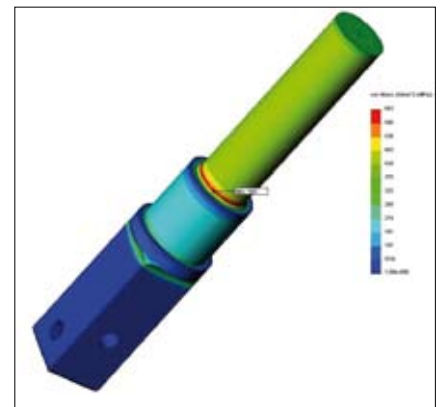
Stress on terminal joint and its welded pipe



Stress on inner welded ribs



Stress on Lock Device



Stress on Drive Stub

three weeks) supply the final user with the finished equipment, built in accordance with the drill torque and the project features of the pile to drill. To date, SIP&T designs and produces the right Kelly bar compatible with the related rotary head for all major drill brands and models. The torque range to keep in mind is vast and goes from a minimum of 40 kNm to a maximum of 480 kNm; the maximum reachable depth is up to 100 m. To this end, remember that the maximum length of a telescopic Kelly bar (consequently, its drilling depth) and its ability to drill the soil depend on three factors: the type of drilling rig, the winch pulling capacity and the type of tool used.

SIP&T can customise the length of the Kelly bar, the number of its elements, the rotary drive passage, the drive stub, the kelly guide flange, the swivel joint with the wire steel cable, the upper and lower shock absorber systems, the profile and pitch of the lock and unlock systems on the different elements, as well as the drive shell on specific customer requests. Perfect Kelly bar sizing requires studying of soil geological report, precise knowledge of the maximum torque that can be applied to the Kelly bar, the suitable tool

to advance quickly and safely. Upstream of all of this is proper FEM analysis that considers all the previously mentioned parameters plus the mechanical features of the materials used. This way, the parts of the Kelly bar that are more highly subjected to stress are identified and, therefore, the product design starts from pipe quality, diameter and thickness, as well as from the width and thickness of the ribs to weld onto the pipes to stiffen them, ending up with the right tolerance between the various elements making up the Kelly bar itself. Special attention is given to sizing the drive shell, which transfer rotary drive and crowd force between an element and the next one. This is a delicate aspect and, more often than not, defines a successful Kelly bar. In general, dimensional checks are done during the production process, using go/no-go gauges and non-destructive testing with liquid penetrant and ultrasonic flaw detectors to check welding efficiency. The materials used are high quality and certified according to international standards; they are chosen following engineering criteria including, for example, high resistance to wear. Modern CAD/CAM tool machines allow complex mechanical process-

ing. Innovative welding processes ensure a reduction in defects and, therefore, extend the Kelly bar's useful life. "Increasing company profits while reducing costs and improving product quality," concludes Cantisani, "is common knowledge. The competitive environment we are in daily is awarding us, given our ability to reduce delivery time, the efforts, the prototypes, the physical testing the repetitions and the expenses connected to this iterative process. Analysing and testing our Kelly bars on a computer using FEM analysis is proving to be an excellent tool to reduce the time to market, decrease development costs and improve product quality".

## INFO



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## Equipment and Components

# Pushing the **development**

The new AUTO CDA is successfully working in Germany



**S**IP & T continues its work of strengthening the German market thanks to the valuable support of his agent BBD Spezialtiefbau und Baumaschinen Vertriebs GmbH providing automatic casing drive adaptor to make a major project of DEMLER Spezialtiefbau GmbH + Co. KG.

### **AUTO CDA: WHAT YOU NEED TO KNOW**

The automatic casing drive adaptor (AUTO CDA) is an interesting coupling system of lining casings that can be applied on all drill rigs and is able to increase safety and productivity in the execution of lining piles, eliminating the danger and waste of time due to the manual casings coupling phase. The safety issue, which is an obsession for the association of the European Foundations Enterprises, has focused its attention on the consequences for the industry of foundations resulting from the implementation of European Directive 2001/45/EC regarding minimum standards for the safety of workers which operate at high altitudes. A

"careful" Safety Plan seemed necessary and, therefore, the priority of a number of appropriate solutions to prevent and reduce the risks of falls from heights by workers during the assembly of drills and manoeuvring inherent to them to put them into operation. When tubular drilling (casings) operations are carried out, it is often necessary that some operations are executed at high altitudes by workers on the site. Before starting to drill, the casings that support the walls of the hole should be inserted into the ground; for this reason, the various elements are connected together securely through threaded sealing bolts in order to form a column which, in turn, must be bolted to the rotation head by means of a driver (twister). Once the pile has been installed, the column casing must be extracted from the ground and then must be disassembled element by element. In general, to connect the column casings to the driver, the sealing bolts are set manually and, for this purpose, the worker is forced to use devices such as a ladder, a rubber loader - used as a "working platform" - or safety harness.

Why are such widespread solutions not safe? The ladder can slip or slide on the muddy ground (during drilling, one cannot expect to have a clean and tidy surface); the worker could slip from the rung of the ladder (dirty boots); from an unstable position on a ladder, the worker must carry out his work with great physical effort; the driver of the rubber loader could make a wrong move endangering the life of the worker; safety harnesses could fail and therefore because the operator to fall. The use of these devices, as well as being very risky for the safety of operators, is highly unproductive since the entire team of workers - and the drill itself - cannot work until the column casing is connected to the carrier (in turn connected to the rotation head) or vice versa until the column casing is completely removed. For a number of years, manufacturers of drills, and their users, have tried to develop alternatives and adequate solutions to make work much safer and more productive from an economical point of view. With the automatic Twister, SIP&T stands by the road of concreteness, which has given desired results over time. A technological innovation targeted where clients highlight difficulties, resulting in a real and evident evolution of the product. The great desire to preserve and enhance its competitiveness, combined with the intention to protect the right to exclusivity, has led the specialist from Baronissi to patent "his invention". With the assistance of Eng. Francesco Cantisani, International Sales Director at SIP&T, we shortly illustrate the original design and creation by the company from Campania in the field of ducted piles and related management systems of lining casings by explaining the technological principles and practical benefits derived from it. The pipe casings are made of high quality steels and their use is intended for piling in grounds that require excavation protection to avoid the drilling pile from collapsing.



Two male/female coupling halves, which are applied to the ends of the individual elements of the pipe column, facilitate their junction. In this context, we find the recent technical development of the twister (driver) by SIP&T, made with an entirely mechanical system of engagement/release to lining casings that can be used on all machines for large vertical drilling. The system is able to increase safety and productivity in the execution of lining piles, thus eliminating danger and time wasted due to the manual phase of coupling. Thanks to it, today, drilling operators can connect the column casing to the driver without the use of human resources, therefore, directly from the operating cabin where they sit. After long research and development, the system described has now reached the stage of serial production and is successfully used on many sites.

#### **FASTER AND SMARTER FOUNDATION PILES**

Construction of the foundation for the viaduct began in July 2016 and included 24 drilled shafts socketed into shale. Most notable were 1500 mm diameter, up to 25 m long shafts installed on a 5.71-degree batter, using double walled sectional casing oscillated down to bearing strata. Demler provided the technical engineering and support required to operate the specialized equipment at a 5.71-degree angle, they used a Bauer drill rig BG39 Premium Line with a Laffer casing oscillator that was mechanically and hydraulically attached to the base of the rig. In addition, a 5.71-degree engineered framework provided rigid support in order to keep the casing oscillator on the correct inclination while drilling took place. The oscillator, the segmental casing and SIP&T AUTO CDA allowed the shaft to be advanced through the overburden materials. Despite the equipment challenges faced, the BG39 production overall was excellent in achieving the completion of this project ahead of schedule. Subsurface conditions consisted of stiff fat clays underlain by layers of soft lean sandy clays, clayey sands, and sand with gravel. The sand with gravel layer typically



Francesco Cantisani, Sales Director SIP&T

was present above the shale. The shale is highly weathered near the top of the formation and becomes progressively stronger with depth. It contains weakly cemented sand layers within the shale. Hard limestone layers and concretions are present intermittently throughout the shale. Groundwater was typically encountered approximately 6.096 mm below the surface elevation. The use of the oscillator, segmental casings and AUTO CDA was necessary in order to meet the technical requirements of the contract. The specifications required that the shaft excavation could not be advanced beyond the limits of the casing supported overburden. Unsupported or unshored excavation of the drilled shaft overburdens could have severe repercussions on the foundation system.

The 5.71-degree slope frame was necessary to maintain the required batter. The specifications allowed only a one degree +/- deviation from 5.71-degrees. Demler pointed out that, installation of the drilled shafts on 5.71-degree batter required a more delicate touch than the traditional driller's mentality of the more power the better. Equipment, and tooling designed to function vertically do not necessary operate efficiently on a 5.71 degree batter. Equipment and tools were structurally fatigued requiring constant care and field modifications.

The segmental casings required a high level of maintenance and care in order to keep the casing installation running

smoothly. It is important to note that maintaining plumbness of the shafts at a 5.71-degree batter presented a significant challenge and were critical for the success of the installation. The challenge of Mr. Weigand Lutz, Civil Engineer and Site Manager at Demler, was to increase the production speed while maintaining a high level of operator safety. The challenge has been widely won by using the AUTO CDA which allowed to achieve inclined piles automatically by connecting the casings elements and contributing significantly to their extraction from the piles without dangerous and long operations. Calculations in hand, the use of the AUTO CDA has increased by 10 times the connection speeds and disconnection of casing than the classic method heavily affecting the work completion date. Thanks to these results, the German company has decided to replace all conventional casing drive adapters with automatic ones of the SIP & T, believing to be able to achieve the same excellent results in its future projects. The cased drilled shaft installed on a 5.71-degree batter at the diameters and depths for this project may be a first of its kind, but not the first for Demler. They have been perfecting this construction method over time. Their work once again demonstrates the innovative abilities of drilled shafts foundation contractors who when presented with a daunting challenge find a way to rise (or drill down....) for the occasion.



# Safe casing drilling? Here is the solution



The automatic Twister, created by a company from Salerno, is an interesting coupling system of lining casings that can be used on all drill rigs and is able to increase safety and productivity in the execution of lining piles, eliminating the danger and waste of time due to the manual phase of coupling the casings

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### The condition...

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Screwing and fastening the column casing to the driver using a ladder

sary that some operations are executed at high altitudes by workers on the site. Before starting to drill, the casings that support the walls of the hole should be inserted into the ground; for this reason, the various elements are connected together securely through threaded sealing bolts in order to form a column which, in turn, must be bolted to the rotation head by means of a driver (twister).

Once the pile has been installed, the column casing must be extracted from the ground and then must be disassembled element by element. In general, to connect the column casings to the driver, the sealing bolts are set manually and, for this purpose, the worker is forced to use devices such as a ladder, a rubber

loader - used as a "working platform" - or safety harness. Why are such widespread solutions not safe? The ladder can slip or slide on the muddy ground (during drilling, one cannot expect to have a clean and tidy surface); the worker could slip from the rung of the ladder (dirty boots); from an unstable position on a ladder, the worker must carry out his work with great physical effort; the driver of the rubber loader could make a wrong move endangering the life of the worker; safety harnesses could fail and therefore cause



The use of a rubber loader as a "working platform" and safety harness are examples of inadequate means of access

the operator to fall. The use of these devices, as well as being very risky for the safety of operators, is highly unproductive since the entire team of workers - and the drill itself - cannot work until the column casing is connected to the carrier (in turn connected to the rotation head) or vice versa until the column casing is completely removed.

### ... and the solution

For a number of years, manufacturers of drills, and their users, have tried to develop alternatives and adequate solutions to make work much safer and more productive from an economical point of view.

With the automatic Twister, SIP&T stands by the road of concreteness, which has given desired results over time. A technological innovation targeted where clients highlight difficulties, resulting in a real and evident evolution of the product.

The great desire to preserve and enhance its competitiveness, combined with the intention to protect the right to exclusivity, has led the specialist from Salerno to patent "his invention".

With the assistance of Eng. Francesco

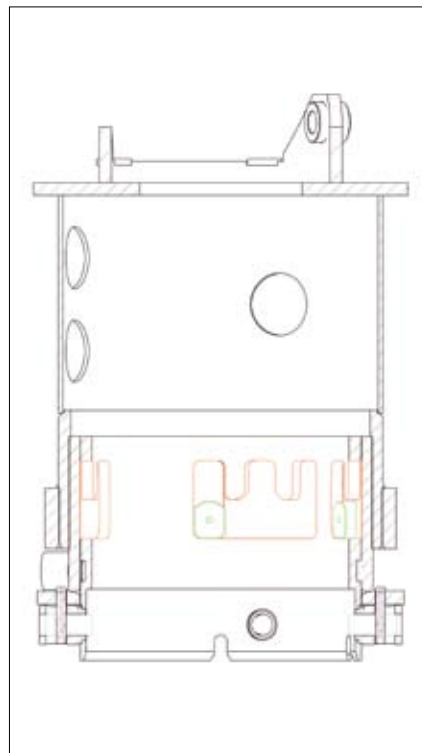
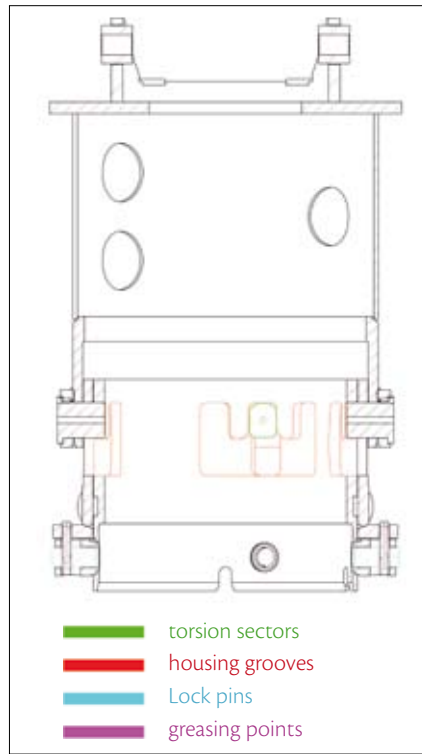


Cantisani, International Sales Director at SIP&T, we will illustrate the original design and creation by the company from Campania in the field of ducted piles and related management systems of lining casings by explaining the technological principles and practical benefits derived from it.

### Automatic Twister - Mechanical

The pipe casings are made of high quality steels and their use is intended for piling in grounds that require excavation protection to avoid the drilling pile from collapsing. Two male/female coupling halves, which are applied to the ends of the individual elements of the pipe column, facilitate their junction.





In this context, we find the recent technical development of the twister (driver) by SIP&T, made with an entirely mechanical system of engagement/release to lining casings that can be used on all machines for large vertical drilling. The system is able to increase safety and productivity in the execution of lining

piles, thus eliminating danger and time wasted due to the manual phase of coupling. Thanks to it, today, drilling operators can connect the column casing to the driver without the use of human resources, therefore, directly from the operating cabin where they are seated. After long research and development,

the system described has now reached the stage of serial production and is successfully used on many sites.

**Operation sequence**

The twister (Fig. 1) is in “standby” position, which means it has no lining coupled. The torsion sector is in the central housing grooves and the check pins are released. The clamping process of pipes (Fig. 2) is as follows: the female coupling of the twister is centred and inserted into the male coupling of the lining to connect, whilst the torsion sector moves from standby to operating mode by connection, without distinction, to the extremity of one of the two external housing grooves. The check pins are inserted simultaneously ensuring the perfect connection between the two couplings. At this point, the rotary may transmit clockwise or anti-clockwise rotation and push downwards to slide the linings deep down. On completion of excavation operations and in order to extract the column casing from the pile (Fig. 3), all you have to do is stop rotation and lift the torsion sector, which will place itself on the upper part of one of the two external housing grooves; the column casing will thus be extracted with the aid of the hydraulic piston stroke or the pull down winch of the drill. Release of the twister from the pipe will occur once the torsion sector is placed in its original standby position, namely the central one with regard to the three housing grooves.

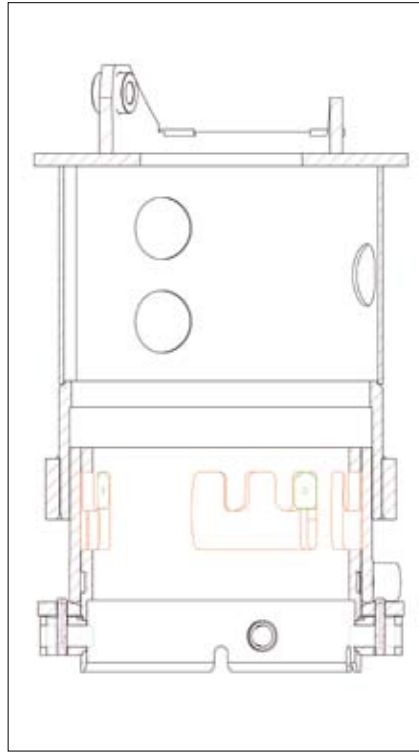
**A look to the future**

The connection system described has been developed and tested on site thanks to the collaboration of various drilling companies. As you can imagine, this journey has taken years and a great human and financial effort was necessary. SIP&T has had to deal with setbacks and forgot adequate solutions and approaches in the prototype stage that were inadequate in the implementation phase. However, it has finally succeeded to develop a safe and efficient system, which is, today, in daily use on





Fig. 3



many sites.

Application of such a system can make a significant contribution to improving safety in the field of special foundations and, above all, in creating piles.

This particular locking system increases productivity, the various elements of the column casing can be assembled and disassembled much faster when carried out mechanically. Moreover, very long casing elements may be used (connection of long casing elements is impossible with the use of a simple ladder, a rubber loader or a safety harness). Lastly, it is obvious that there are savings in costs on personnel, which can be used elsewhere on the site.

This locking system, controlled and operated from a distance, is an example of technical innovation that contributes to improving the safety and productivity in the works of special foundations. ■













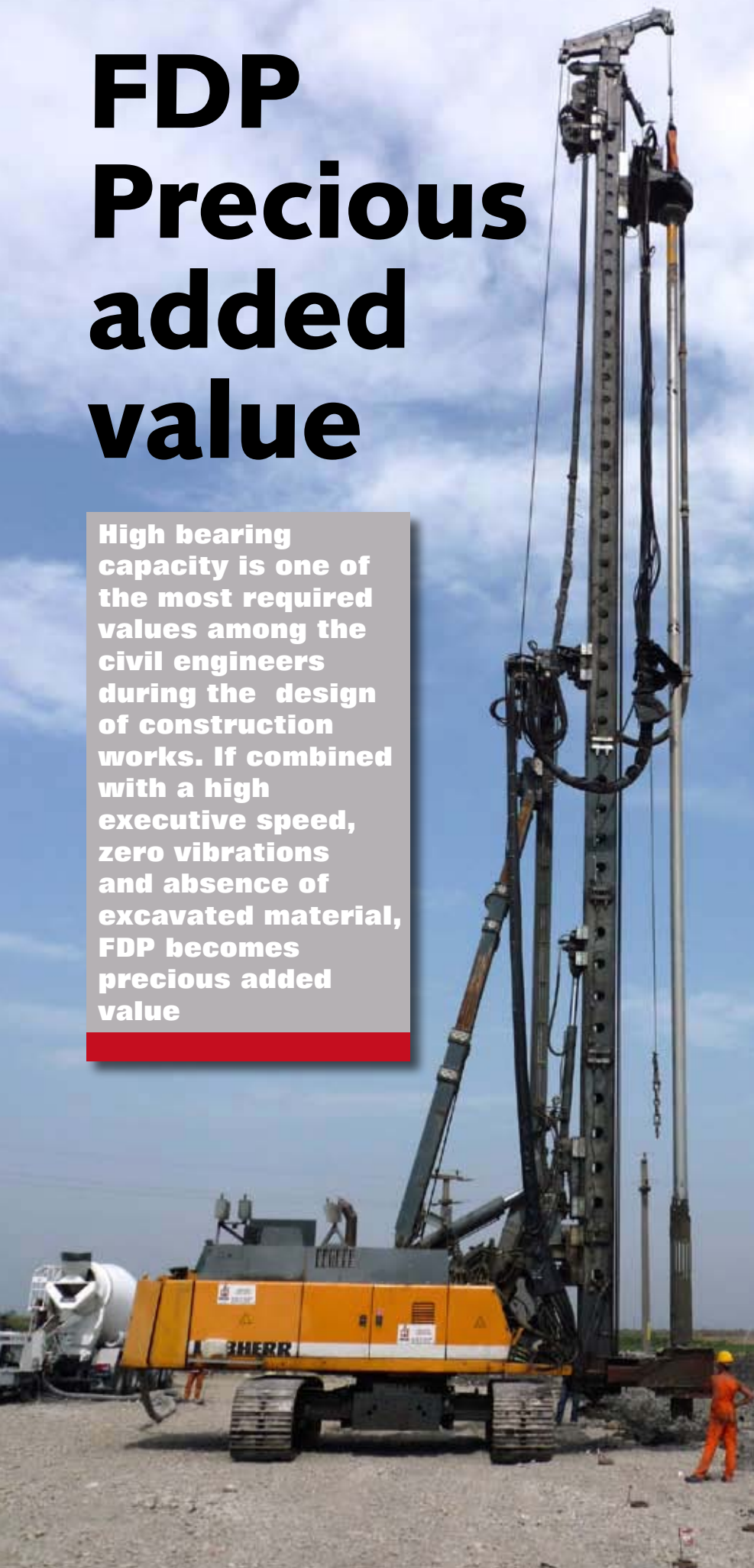
# FDP Precious added value

**High bearing capacity is one of the most required values among the civil engineers during the design of construction works. If combined with a high executive speed, zero vibrations and absence of excavated material, FDP becomes precious added value**

**S**atisfying the demands of our society requires important political and technical choices. The topic of infrastructure is part of the decisional debate, both locally and nationally. Choosing the right planimetric and altimetric diagram, integrating it with existing infrastructure, the need to mitigate environmental impact, limiting in-situ interference, and reducing emissions into the atmosphere are some of the performance requirements that need to be met and combined at the same time. In this context, the role of underground construction assumes a relevant value. Administrators, engineers and companies are thus involved, each at different times and stages, in the planning, design, construction, operation and maintenance of the work. The technical solutions to be taken require engineers expertise and experience, combined with contractors tradition and innovation. FDP (Full Displacement Piles) is a pile-foundation technology that aptly summarises the characteristics described above. In this article, we will illustrate how it is used by Edrasis Construct Group srl (branch of Edrasis - C. Psallidas SA - Greece), which used the FDP manufactured by SIP&T to develop piles for wind farms in Calarasi-Romania.

## **No Soil Removal**

Compared to driven piles, drilling pile presents the problem of the hole's walls collapsing. The solution to this inconvenience requires the use of casings, bentonite and polymers. With the technology of compaction piles, the tool penetrates into the soil, loosens and thrusts it against the walls of the hole (a condition quite similar to the driven pile technology), but without waste material and therefore keeping clean the construction site. Long applied especially in Northern Europe, this type of piles has experienced considerable development in recent years, given the increasingly high cost of disposing of debris. The foundation piles (diameter 600 mm – depth 20 m) at the Calarasi site involved the use of the Soil Displacement method, i.e. lateral soil compaction. This method does not involve removal of the soil and therefore offers an alternative to drilled piles. The soil is compacted thanks to a special rotating tool, which, depending on the project, can have





different diameter. The piling operation and simultaneous soil compaction improve its thickness compared to the initial conditions, with a substantial improvement of the pile's tip and lateral resistance of the foundation. The absence of material removal, actually, requires that the soil's volume be pushed laterally and in depth, improving the overall geo-technical resistance. Edrasis installs FDP piles with diameters ranging between 300 and 800 mm at a depth of 40 m, using concrete with a fluid consistency, if necessary mixed, to obtain the appropriate workability. This technology can be used in any kind of soil with little or medium strength, and the presence of any groundwater does not represent a hindrance. It also can be used in unstable soils without casings, because the method does not involve any "open excavation". Operationally, once the machine has been positioned, the procedure involves excavation with the tool rotating and in continuous movement. The blade loosens the soil and the special tool connected to a battery drill compacts it, making it possible to reach the project-defined depth. After reaching the required depth, the pile is cast by injecting concrete that crosses the drilling rods (which are hollow inside) and the tool features an opening to drain and distribute the concrete. The casting takes place simultaneously with the soil extraction of the drill rods and tool. The operation is controlled by the machine operator with the aid of a computer-based system that automates the tool's lifting movement. In this way, the concrete fills the volume previously occupied by the soil (now compacted), forming the pile. The injection of concrete is continuous and controlled simultaneously



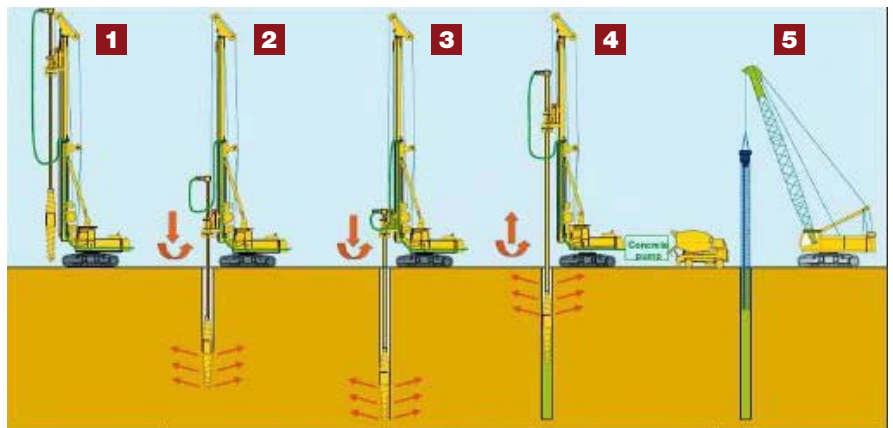
## GEO-TECHNICAL CHARACTERISATION

For the geo-technical characterisation of the soils involved in construction, the company used the results of geogostic surveys conducted in-situ (CP-TU tests, surveys, piezometer application and Lefranc tests) and lab tests. The data obtained have made it possible to outline the geological and geo-technical characteristics of the soils involved in the construction work. Below the topsoil layer with minimal thickness, we encounter up to 4.80 m from the ground level, a fairly consistent level of medium-fine silty sand. From the depth of about 4.80 m from ground level up to 7.20 m, the situation is less homogeneous: clay-silty soils of average consistency display several sandy inter-layers. Next, we find a layer (1.40 m thick), of medium-fine, poorly silty sand. From the depth of about 8.60 m up to 11.20 m, the material is predominantly cohesive (silty clay)

with frequent sandy inter-layers. Below the cohesive layer, we encounter a layer 8.00 m thick of medium-fine, poorly silty sand. Finally, at a depth of 19.20 m up to 35.00 m, we encounter clay soils again with average consistency and with frequent sandy inter-layers.

### LOAD TESTS

The FDP piles (diameter: 600 mm) were reinforced along their stem (20 m workable length). The traction load tests performed up to a value of about 2.5 times the maximum working load confirmed the correct sizing, which required a maximum displacement of the pile under traction load of no more than 2 mm. The load tests below show a highly rigid behaviour of the pile due to side friction, when tested under operating loads. This is due to the executive technology that does not involve "breakage" mechanisms during the formation of the pile.



#### Executive procedure

1. Positioning of tool tip at the centre of the pile and levelling of the auger and its mast;
2. Beginning of excavation with the tool in rotation and continuous and automatic movement. The soil is "loosened" by the blade and compacted (thanks to the shape of the tool) around the hole of the "displacement body";
3. Extending the drilling rods, we can extend the excavation to

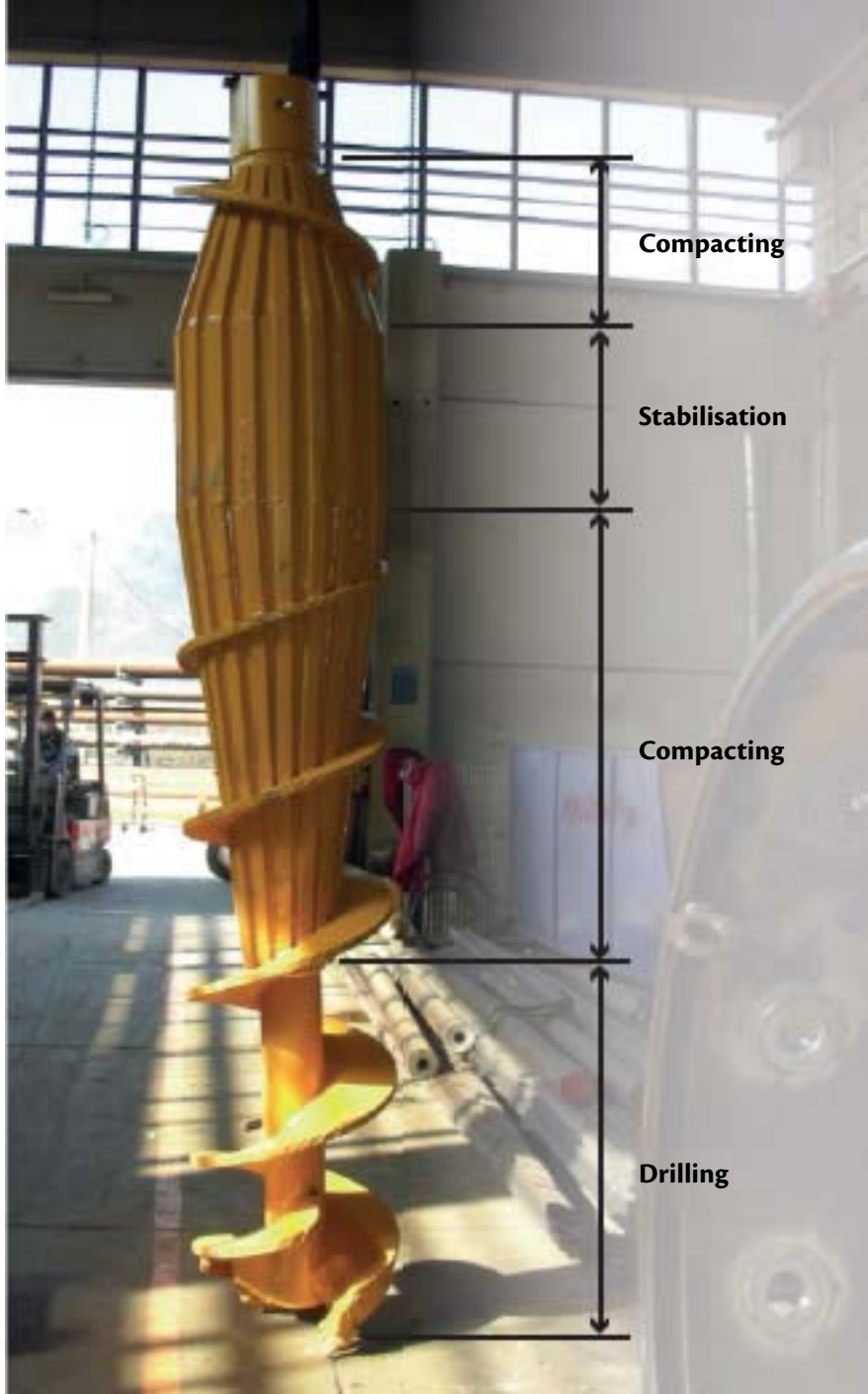
greater depths (reaching as far as 40 m, obviously, according to the type of machine);

4. Having reached the final depth, the operator commands the opening of the tool's tip and proceeds with pile casting (entirely automatic process via computerized system). During casting operations, the concrete is placed through the hollow rod and fills the volume previously occupied by soil. The injection of concrete is continuous and controlled simultaneously with the

gradual lifting (extraction) of the tool. The FDP pile, therefore, never has an open hole to fill up with concrete, but the concrete itself creates the space to fill, always pushing upwards with a positive pressure on the tool base.

5. Once casting is complete, we proceed after careful cleaning of the pile head with installation (if required) of the metal reinforcement (possibly with the aid of a special vibrator) or introduce by gravity appropriate steel cages or profiles.





### The auger and the tool used by Edrasis

The Liebherr piling rig, which in this case is the FDP version, is a multifunction machine that is able to apply multiple piling technologies. More specifically, the LRB 155 can drill piles dry or with bentonite sludge, reinforced piles, CFA piles, FDP piles, piles with rotary double head, twin mix, and can drive sheet piling and circular iron rods by employing a high frequency vibrator. The machine is equipped with a process data recording system that certifies the work and issues a report graph for each pile drilled, ensuring the total absence of interruptions during casting or fractures. With an operating weight of up to 68 t (mass varies depending on the type of technology), it is possible to reach a maximum depth of 25 m with FDP configuration and has a torque of the rotary head of 220 kNm. The Liebherr diesel engine (450 kW - 603 hp) running at 1900 rpm uses a proportional load sensing and cross sensing hydraulic system. The drill is available with pull-down winch. Equipped with a main winch with a 160 kN pull, it features a large drum for winding of the rope on a single layer, which ensures a steady lifting force and limited wear of the rope. The undercarriage is hydraulically extendable during working phases and retractable to reduce its size during transport. The FDP tool by SIP&T is manufactured by a robust, central hollow rod, that carries the concrete up to the tip. The underlying drilling element and top compaction one can have different lengths to better adapt the tool to the ground's conditions. Consequently, the tool length can vary from a minimum of 3-3.5 m to a maximum of 6-7 m. The drill tips are interchangeable and use different types of equipment to maximise the tool's performance. SIP&T supplied the hollow extensions for the concrete casting and the FDP tool to Edrasis in two different models, with traditional cylindrical barrel and the innovative modular version. Both are designed to reduce the demand for torque/thrust, increase productivity and limit transportation and disposal costs.

with the gradual lifting of the tool. As such, the pile never has an open hole to fill, but the concrete itself creates the space to fill, always pushing upwards with a positive pressure on the tool base. The pile's metal reinforcement is installed once the casting is complete.

### The Soil Displacement advantages

This technology has the undeniable advantage of not producing any debris. The work plan of the site remains clean and because no material is removed, there is no need for landfill disposal, and the normal cost for bentonite sludge not required with FDP piles is an added advantage. But there are other benefits as well, because this technology guarantees an increase between 30% and 40% of the pile's side friction compared to piles drilled with other systems and, consequently, offers a

higher load-bearing capacity. Compared to other Soil Displacement techniques, FDP ensures a reduced consumption of concrete (about 10% less than with CFA) and does not present phenomena of over-excavation which, when done with construction, can lead to deterioration of the mechanical properties of the soil close to the piles. Another aspect that should not be underestimated, especially when working in urban areas, is that the tool penetrates into the soil gradually, without causing vibrations and noise. Finally, the sequence guarantees a higher daily production and makes the pile cost-effective compared to all other types of piles. The non-removal of soil also makes it possible to work in contaminated areas such as refineries, industrial areas and waste dumps.

### The first model is divided into four sections:

- a drill tip on which the equipment best suited to the soil texture is installed. As with the CFA tools, the compaction tool comes with cable gland and central or side opening



door for concrete injection.

- a lower, spiral conical section with right-hand screw that carries the soil to the surface and starts compaction
- a cylindrical central section for stabilisation that stabilises the ground laterally and forms the actual non-drained diameter at 120 kPa and in this case too, beyond this limit, soil compaction proves difficult. The second model, the innovative modular one, ensures better consolidated land reservation, though the blade's pitch must be adapted to the nature of the soil, to allow increased lift and compaction of the debris against the walls of the hole. It has several drilling/compaction tips assembled on the same stabilisation section. In addition to the conical shape that facilitates penetration into the soil, the intermediate blade facilitates transportation of debris and compaction of hard clayey soils and moderately dense and inconsistent soils.

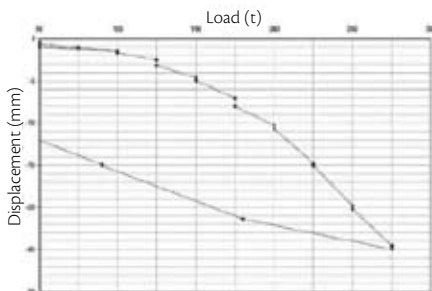
The short-pitch version is preferable for organic fine sands that are very inconsistent, while the average pitch version is better suited for compaction.

- An upper, spiral conical section with left blade that stirs the falling debris, pushing it against the walls and the stabilisation section of the tool

It guarantees an excellent penetration into dense and inconsistent soils (especially sandy soils with density up to 65%; over this limit, compaction of inconsistent soils becomes



**LOAD - DISPLACEMENT DIAGRAM**



FDP pile - traction load test

difficult) and hard cohesive soils (with sand and medium clay cohesion).

### Conclusions

The initial project involved the use of drilled piles with a diameter of  $\phi 1000\text{mm}$  in construction, but we opted to use reinforced FDP piles with a diameter of  $\phi 600$  instead. The production rate was about 8-9 piles

per day, with an average drilling time of 25-30 minutes. Load tests carried out have confirmed the excellent behaviour in terms of side friction of these piles, also by virtue of the kind of stress (traction) and the nature of the soils, characterised largely by poor mechanical features of resistance. Therefore, the pile shows excellent characteristics in terms of execution and performance. ■

Number Layer	Depth		$\gamma$ [kN/m <sup>3</sup> ]	$\gamma'$ [kN/m <sup>3</sup> ]	$\phi$ [°]	$c'$ [kPa]	Stratigraphic description
	from	to					
1	0	5.0	18.50	8.50	36	0	Fine-medium silty sand
2	5.0	7.0	19.00	9.00	28	5	Silty clay
3	7.0	8.5	18.50	8.50	38	0	Fine-medium silty sand
4	8.5	11.0	19.00	9.00	28	5	Silty clay
5	11.0	19.0	19.00	9.00	39	0	Fine-medium, poorly silty sand
6	19.0	35.0	20.00	10.00	32	10	Silty clay and clayey silt with sandy inter-layers, interspersed with sandy layers









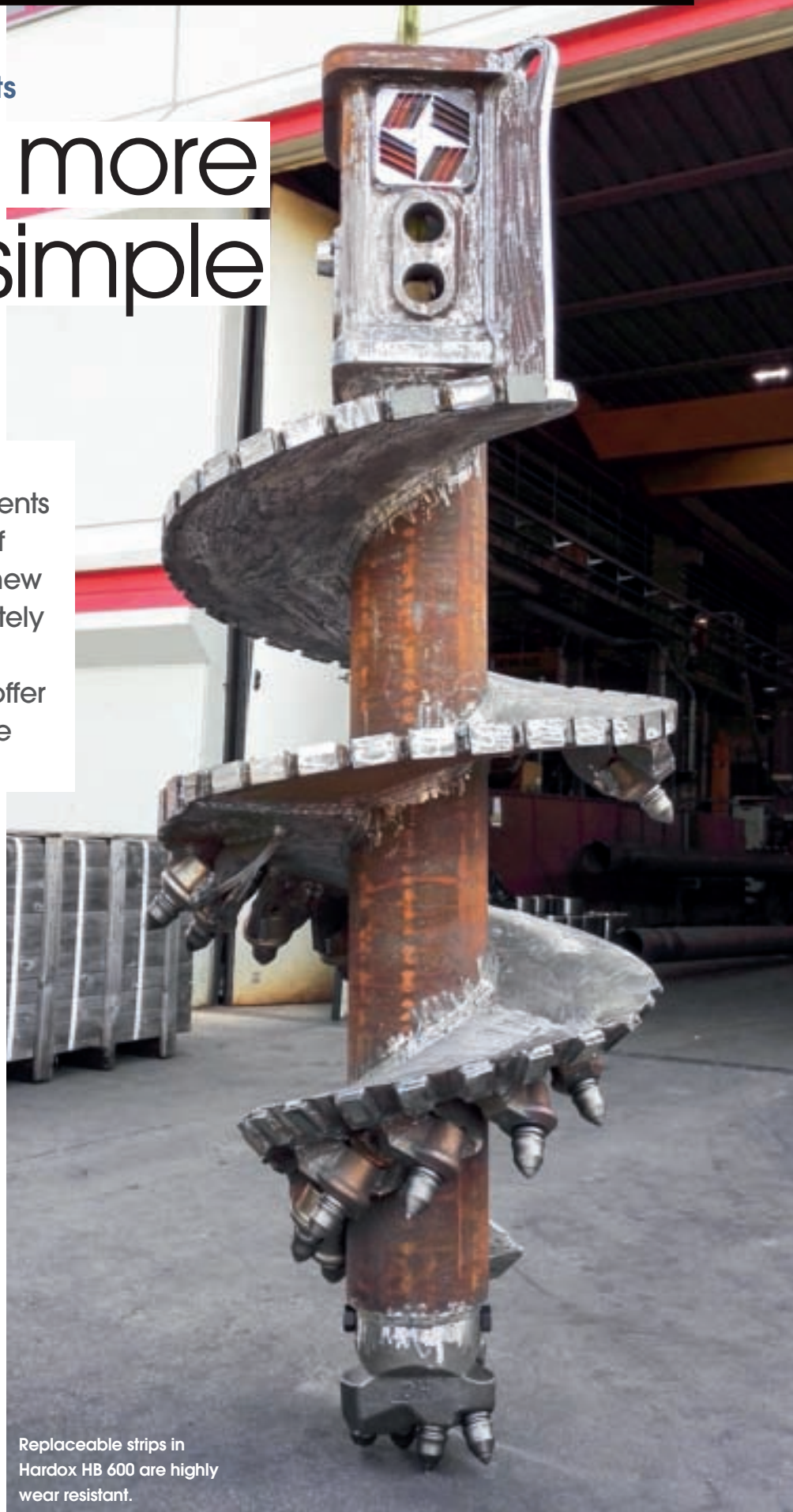


Equipment&Components

# Much more than a simple auger

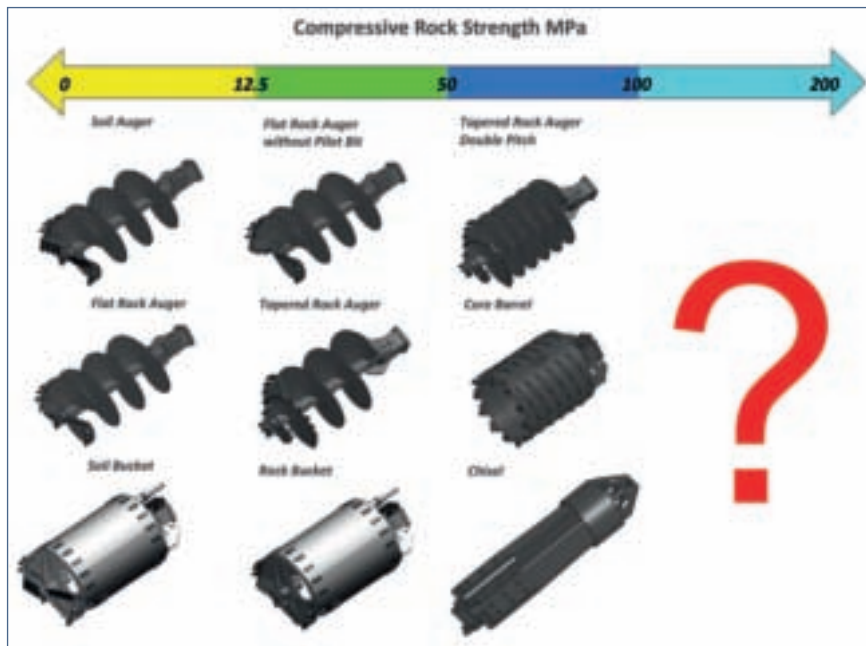
The new rotary drilling tool developed by SIP&T represents an innovation in the field of large vertical piling. It is a new generation auger, completely re-designed and manufactured in order to offer higher drilling performance in very hard rock strata

Since 1991 the purpose of SIP&T has always been to manufacture a wide range of rotary tools with highest level of reliability and performance in the field of vertical foundations. The search for high performance, combined with the search forever better reliability, has always been the real and recognizable philosophy of SIP&T in construction sites around the world. Numerous efforts have been made, over the years, by SIP&T engineers and workers to offer to customers the best power tool suitable to the excavation. This concept combined with the competent advice received from our customers and drill operators, together with the continuous activity and research of our technicians in all type of work on construction sites and in soils around the world, has recently led to the creation of our new range SHD, which for us means simply SUPER HEAVY DUTY. However, we believe that drilling is a complex and difficult process where the theoretical knowledge must be reflected in the practice and execution. In order to obtain the best of the new hydraulic innovations installed



Replaceable strips in Hardox HB 600 are highly wear resistant.





on the machine and transfer properly to the ground, we have created a new and complete range of drilling tools and accessories. The SHD Line tools has been introduced as product line with the goal of even better satisfying various requirements of customers. In details, the line is manufactured accordingly to the different rigs torque and soil-rock hardness. Such line of drilling tools has some basic principles, which are dealt with utmost priority, such as quality, high performance, greatest reliability, highest safety levels, lowest maintenance, long lifetime, customized design. Short delivery time can be met even for special tools or components. Highly flexible production line, experienced technicians pleased to assist clients on site and extensive stocks are prerequisites for this. Client satisfaction is key criteria for all tools and components we make.

## RESEARCH AND DEVELOPMENT REASONS

Of the thousands of rotary drilling tools built by SIP&T since production begun in the 1991s with the first Conical Rock Auger, many of these are still in operation all over the world. One of the reasons for this high level of reliability is that our own engineers are firmly in control of the entire process, from design and development to production and comprehensive testing prior to delivery. Perfect matching of drilling rigs, drilling tools and soil conditions

is a crucial factor for the success of SIP&T rotary drilling tools. This is why all drilling tools are designed and manufactured within the SIP&T production plans. From choice of materials to compliance with manufacturing quality and permitted tolerances, all individual processes are continuously monitored and documented by the in-house certified Quality Assurance Department. Many of the ideas, requirements and wishes of our customers are frequently incorporated into our continuous improvement processes. The rotary drilling tools technology represents a world apart; the possibility to transfer the rotary torque through a Kelly bar, maybe at 100m depth, to an auger able to destroy and collect the rock is a topic to be considerably followed up! The right interpretation of Material Technology Science, the application of many simple mechanical principles and the introduction of Special Technologies for the soil treatment represent the only way to face and solve the ground drilling matters, from soft but cohesive soils (i.e. plastic clay) to very hard and abrasive ones (i.e. granite with compressive rock strength higher than 200 MPa). The picture below represents a short schema of drilling tools chosen in base of compressive rock strength to be drilled. It should be noted that not only the compressive rock strength (UCS), but also the degree of fractures and number of joints in the rock mass as well as the material's resistance

to tensile, frictional, shear and abrasive forces are also factors that influence both rock drillability and tool durability. One of the most important question for SIP&T was: which type of drilling tool should be applied when the rock strength is more than 100 MPa?

Drilling penetration into rock becomes more difficult with increasing hole diameters and rock compressive strength. In piling applications, hard rock formations have to be cut and excavated prior to the installation of the foundation piles and/or piled retaining walls.

Commonly, conventional rotary drill tools are used for bored piles in medium to very high strength rocks. For harder rock formations different methods have to be adopted as much larger cutting energy and force input are normally required to break the material at the rock tool interface. Nowadays there are four methods to penetrate rocks with strengths exceeding 100 MPa:

- 1) Roller Bit Core Barrel made by different components such as the stator, the rotor, the compressed air system to recover the drilled material and a periferic cutting surface made by roller cutter with very strong inserts.
- 2) Full Face Cutter is very similar to the above described tool, but with a full drilling head in order to cover the whole drilling surface with roller bits; also in this case the material recovery is made by a flushing process through



The geometry of the chisels arrangement is optimized for reaching excellent cutting performance.





The flights pitch has been specifically designed to get better output characteristics for the high torque drilling rigs in order to improve material handling.

compressed air.

- 3) DTH – Drill: the down-the-hole drill is pneumatically driven on the bottom of a drill string; the DTH hammer is one of the fastest ways to drill hard rock. The system requires a high-capacity air compressor for operating the hammer and for transporting broken rock flakes and rock dust.
- 4) MHD – Drill: this method uses multiple single hammers (Multi-Hammer-Drill), a standard Kelly box enables a quick and easy exchange of the drilling tools without changing the Kelly bar into drill rods. The air connection for running the hammers and for flushing the chippings is located next to the Kelly box. Due to the air flow, the chippings are transported upwards in the annular space into the collection box. Similar to a conventional drilling bucket, the basket is emptied after every cycle.

It is easy to verify that the techniques described above are very costly in terms

of money because of the use of sophisticated customized mechanical components manufactured in agreement to the pile diameter, type of rock to be drilled, characteristics of the drilling rig. Moreover, it needs to analyze the environmental impact: dust is one of the worst environmental impacts created by above technologies. In remote areas dust emissions might be more acceptable than in suburban areas, however dust is a serious occupational health and safety risk and should be reduced to a minimum. Usually there are two effective actions to reduce dust during operations: a) Drilling under water, which requires a minimum drill depth to accommodate sufficient pressure head for dust suppression. Penetration rates are usually slower than drilling under water. b) Using a dust collector. Dust collectors are effective in reducing dust; however production rates will be slower due to regular dust removal. For all these reasons, SIP & T has developed a new tool to be applied in case of rocks with

high compressive strength, avoiding to equip the drilling rig with all the necessary components to the four techniques described above, and greatly reducing the environmental impact

#### PRA-S LINE IN DETAILS

Designed to handle the most difficult drilling conditions, this auger is the evolution of years of drilling experience; it has been studied to work in very hard rock strata having a Compressive Strength more than 100 MPa. The geometry of the chisels arrangement is optimized for reaching excellent cutting performance, the flights pitch has been specifically designed to get better output characteristics for the high torque drilling rigs in order to improve material handling.

Auger main features are:

High and fast drilling capacity - optimized cutting geometry yields fast drilling rates, due to its flight which increases in diameters progressively and its special chisels and holders, this auger displays excellent ripping characteristics.

Low and easy maintenance - replaceable strips in Hardox HB 600 are highly wear resistant while the special setting angle allows the Betek round shank chisels to sharpen themselves as they turn.

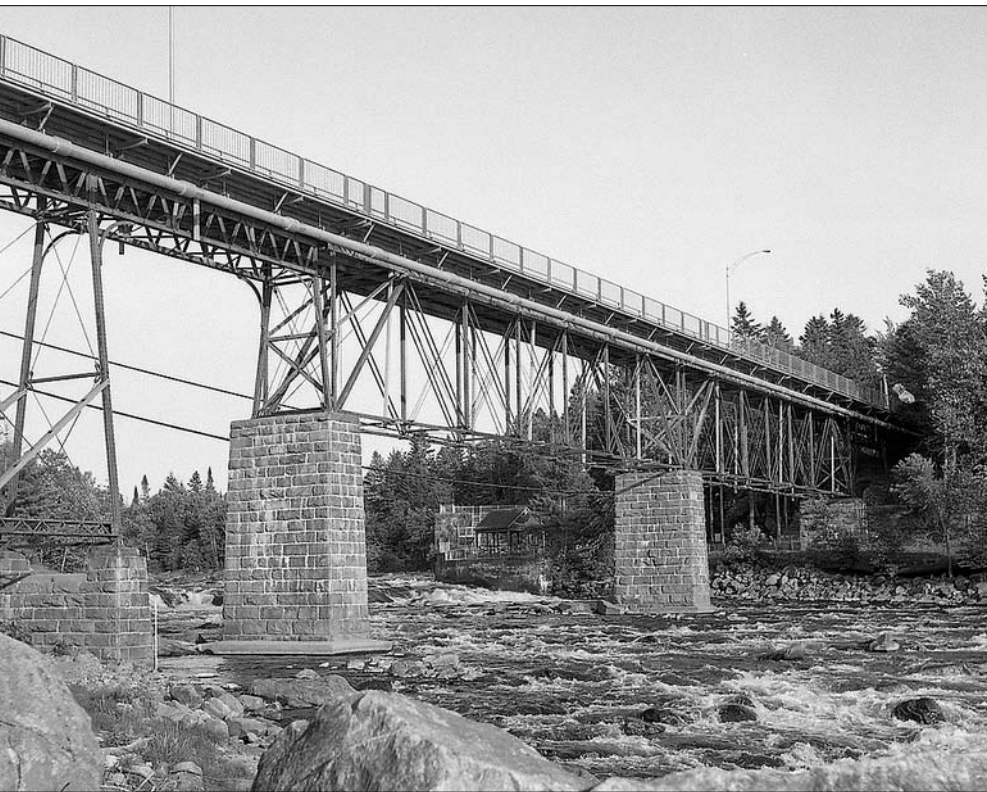
High operational reliability - quality and design that come with 25 years of experience in the design and production of rotary drilling tools.

In conclusion, rock drilling for piling applications using conventional drill tools is usually limited to rock strengths of 100MPa compressive strength (UCS) or less. The PRA-S Line presents an alternative hard rock drilling method which is suitable to penetrate rock when conventional drill tools become either ineffective or reach refusal. Over the last year, many piling contractors are excavating linear meters of extremely high strength rock in excess of 200MPa compressive strength (UCS) using innovatively designed and built PRA-S Line. This special auger is achieving up to ten times faster production rates than conventional drill tools and up to four times faster production rates than air roller core barrels in similar rock formations and are therefore attractive options for hard rock drilling requirements for bored piles.





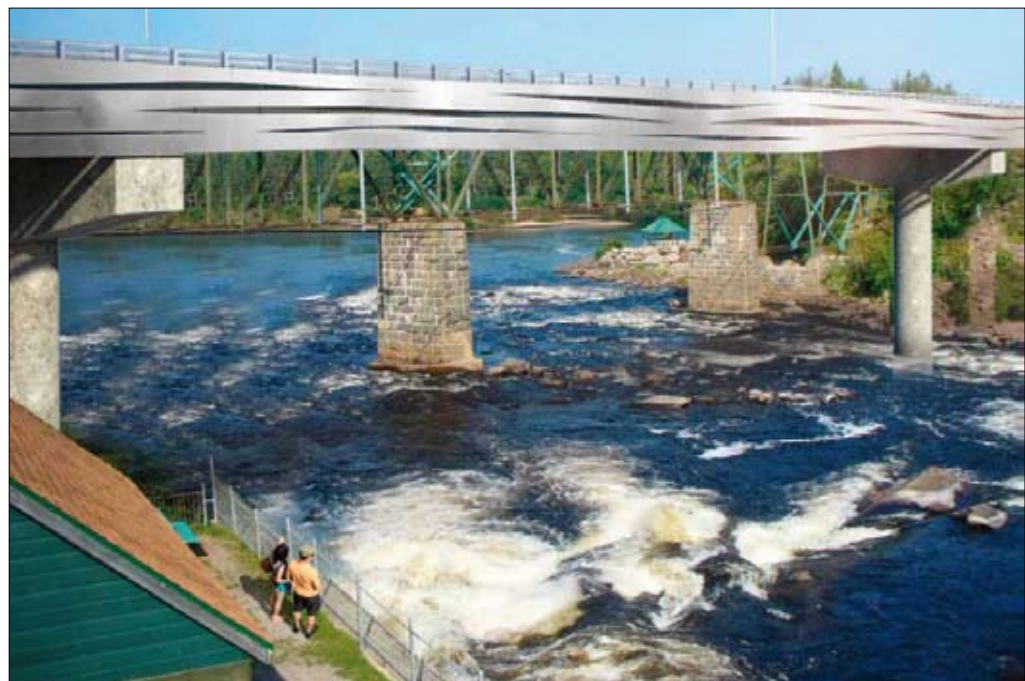




**This new bridge - that will be opened to traffic in December 2017, is one of largest civil engineering projects in Canada has a value of \$ 32 million - will solve all traffic problems arising from property development of the past decade of the surrounding Shannon north of Quebec City**

# The construction of the new Gosford Bridge

**T**he Gosford old bridge, as superb civil engineering work, has a huge asset value based on its historical interest, its architecture and location. The old bridge was built 137 years ago for the passage of trains carrying timber from the forests Portneuf and was later converted to the single and alternate pass cars also including a bike path and walkway. The Ministry of Transportation in Quebec (MTQ) considers such bridge as a true monument, because it is one of the last examples made with reticulated metal structures and Pratt type metal beams assembled to its base. Oddly enough, before deciding where to build the new bridge, the MTQ technicians have studied every corridor on the Shannon territory between the Valcartier military base and area of Sainte-Catherine-de-la-Jacques-Cartier to realize that more than a century and



Gosford Bridge was built 137 years ago, in 1879. The new two-lane bridge will be built just to the east of the current structure



a third ago their ancestors had made the best choice placing the old bridge there. Actually, the best place for the new bridge is properly there, near the old one tells the engineer Bruno Beauregard coordinator for the great works of bridges, who states that its position will not upset the habits of local population. New bridge has been designed and will be built to be as non-invasive as possible, moreover its cost at the end of construction will be less than \$ 30 million instead established in the first tender step.

Further upstream of about 10 mt to the east of the old bridge, the new one will be made of two lanes, conventional steel beams, concrete slab with a length of 166 mt, width of 10 mt, height on the level of river of 10 mt and will be slightly lower than that existing. It will be elegant and modern, with clean lines that will perfectly merge with the surrounding landscape; its unique distinctive trait will be external barriers on the sides made of corrugated steel. Even its foundations must satisfy the aesthetic needs, they are being actually re-realized bored piles instead of the traditional driven piles. Much attention has been paid to the environmental impact of such work, in detail everything will disturb as little as possible the passage of fishes in the Jacques Cartier River. For safeguarding of wildlife, water is filtered to remove all suspended solid particles; even more environmental teams assist the project by transporting salmon upstream of the work area in order to avoid damaging their reproduction.

### Soil & Foundation Structures

The environment in which Gosford bridge is being achieving is the town of Shannon in the park of San Gabriel along the Jacques-Cartier River north-east of Quebec City. From the geological report site have emerged rock counters with values of Rock Quality Designation RQD (%) between 0 and 100 and the resulting values of Rock Compressive Strength (RCS) up to 204 MPa, as consequence it is clear the presence of very hard rocks as classified in literature. Following, the most representative soil sequence is the following.



Delmag RH34 with SIP&T rotary tools during drilling operation

PROFONDEUR (m)		NIVEAU (m) GÉODÉSIQUE	DESCRIPTION	NIVEAU D'EAU 2014-11-07	ECHANTILLONS		ESSAIS IN SITU ET EN LABORATOIRE				
		TYPE ET NUMERO			ÉTAT	RECUPERATION (%)	N ou RQD (%)	TENEUR EN EAU ET LIMITES D'ATTERBERG (%)		AUTRES ESSAIS	
							W <sub>p</sub>	W <sub>L</sub>	W <sub>u</sub>	▲ C <sub>u</sub> (kPa) ▼ C <sub>cu</sub> (kPa)	△ C <sub>v</sub> (kPa) ▽ C <sub>vc</sub> (kPa)
							10	20	30	30	60
							40			● N <sub>60</sub> (coups/300 mm)	90
											120
0.30	159.64		Soil organique		CF-1	85	2				
1.0			Till : 0,30 à 1,50 m : sable brun, un peu de silt à silteux, traces de gravier. Présence de cailloux et de blocs. 1,50 à 6,10 m : sable graveleux à sable et gravier gris-brun, un peu de silt. Présence de cailloux et de blocs. Compacité moyenne à dense.		CF-2	50	Refus				
2.0				CF-3	50	Refus					
3.0				CF-4	85	Refus					
4.0				CF-5	50	Refus					
5.0				CF-6	75	Refus					
6.10	153.54				CF-7	70	45				
7.40	152.24		Roc : gneiss granitique de qualité moyenne		CF-8	65	17				
9.0			Roc : gneiss granitique. Présence d'une famille de fractures subverticales et d'une autre famille de fractures inclinées de 40 à 60° par rapport à l'horizontale. Qualité du roc bonne à excellente.		CR-9	100	53				
10.0				CR-10	100	70					
11.0				CR-11	100	100					
12.0				CR-12	100	100					
13.0				CR-13	100	84					
14.0				CR-14	100	95					
15.0				CR-15	100	90					
13.66	145.98			Fin du forage à 13,66 m de profondeur							

REMARQUES : Le niveau de l'eau souterraine a été observé à 5,05 m de profondeur dans le tube d'observation le 7 novembre 2014.

MÉTHODE DE FORAGE : Rotation de tubes de calibre NW dans les sols; carottage du roc avec carotier diamanté de calibre NQ

Part of the geological report which indicates a values of RCS equal to 204 MPa-RQD (%) of 100



Up to 12 mt depth: sand and sandy gravel, some silt traces; presence of pebbles and boulders; compactness classified as medium-very dense; gneiss metamorphic rock; fractured rock; presence of thin layer of gravel and silty sand at the bottom of an organic soil; Significant existence of pebbles and boulders with a compactness classified as dense to very dense.

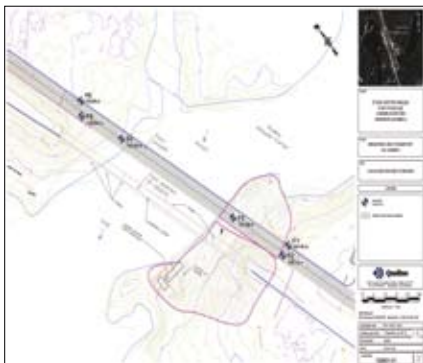
From 12 up to 19.76 mt depth: sands silt and traces of gravel; presence of a layer of silt depth between 1.0 and 1.3 mt; compactness classified as loose very loose; pebbly sand with presence of siliceous material, blocks and empty stones that characterize the compactness as very “loose” until thick; gneiss granite of medium and excellent quality.

It is important to stress Rock Quality Designation values RQD (%) merged from different depths:

Depth 6.50 m	RCS 158 MPa	RQD (%) 95-100
Depth 8.50 m	RCS 204 MPa	RQD (%) 100
Depth 9.50 m	RCS 161 MPa	RQD (%) 90-80
Depth 12.50 m	RCS 153 MPa	RQD (%) 96
Depth 14.50 m	RCS 165 MPa	RQD (%) 95-100

The project includes a number of six bored piles OD.2.6 m, which have features shown in below figure and table:

Drilling places	Bored pile number	Bored pile depth (m)	Geodetic level (m)
South river piles	F-1	10.2	164.95
	F-2	12	166.12
Central south piles	F-3	19.76	157.68
Central north piles	F-4	16.61	153.48
Nord river piles	F-5	13.66	159.64
	F-6	10.52	158.95



Location of the six bored piles

The base of each bored pile is set on bedrock by developing a length between 10.20 and 19.76 mt. The upper part of the pile is contained in a permanent metal sheet for an average length of 8 mt which joins to the under consolidated rock. After the execution of many preliminary load tests, foundations adopted for the viaduct were those of drilling type of large diameter equal to 2.6 mt.

**SIP&T role**

In August 2015 the foundation piling company MSE Group have ordered to SIP&T spa through ML AIR & Talbot Inc. (the official SIP&T distributor for Canadian market) all rotary drilling tools used for the bridge execution; goods have been delivered to the jobsite at the end of September 2015.

All Items have been manufactured in Super Heavy Duty version, with special technical details due to the huge pile diameter 2.6 mt. Below the list of tools supplied:

- **Double bottom bucket for Rock** - for Rocks with a RCS range of 12.5 – 50 MPa and a RQD (%) range of 25-50;
- **Conical rock auger** - for Rocks with a RCS range of 12.5 – 50 MPa and a RQD (%) range of 25-50;
- **Core Barrel** – for Rocks with a RCS range of 50 – 100 MPa and a RQD (%) range of 50-75;

- **Roller Bits Core Barrel** – for Rocks with a RCS range of 100 MPa and a RQD (%) of 100;
  - **Cross Cutter Core Barrel** – for Rocks with a RCS range of 50 – 100 MPa and a RQD (%) range of 50-75;
- Several consumable spare parts to avoid waste of time during drilling operation. The selection of these specific tools is not random but it comes up as result of SIP&T high experience that represents a worldwide benchmark for the rotary drilling



Conical Rock Auger OD 2,6 m - SHD type



Rock bucket OD 2.6 m - SHD type

tools and kelly bar production applied to the vertical foundation engineering. In detail, after having studied the geological relation, SIP&T supplied tools with high performance in hard rocks with a massive level of RCS and RQD (%).

After a short introduction phase, the local rig operator achieved an average net drilling rate with Delmag RH 34 of 0.8 m/h in granite with compressive strength ranging from 153 to 204 MPa. After drilling 80 m (90 m<sup>3</sup>) in rock, all Betek



Delmag RH34 using Rock Bucket





Core barrel with Roller Bits OD 2.6 m - SHD type



Chisels replacement on Core Barrel Cross Cutter OD 2.6 m - SHD type

chisels were still in good condition and no need for their replacement, especially the roller bits appeared in excellent condition as well. This results is truly impressive, particularly when compared with the usual wear coefficient of around 0.5 rock rollers/m<sup>3</sup> of loosened rock when using locally manufactured second hand rock roller bits. The result were very positive and highly promising for MCS Group and SIP&T team. We also proof the importance and benefit of know-how transfer and the utilization of global synergy effects.

### Applied Technologies

The construction method, used for the execution of bored piles especially in water, has been widely used by the MSE Group in many similar works in other parts of Canada. The drilling with rotary and kelly bar has been proved to be the most suitable system in relation to the type of rocks detected into the site. The MSE equipment,

including tools provided by SIP&T, have shown their special qualities: high potential and at the same time high degree of reliability. The excavation of the piles was performed with the drilling rig Delmag RH 34 having the following specifications:

DELMAG RH 34 Piling Drilling Rig	Data Sheet
Stroke	17,500 mm
Max. Casing length	6,000 mm
Max. Force Pull	530/420 kN
Max. Force Crowd	420/330 kN
Max. Speed Working	5.5/28.5 m/min
Max. Line Pull	320/250 kN
Max. Rope Speed	71 m/min
Transport Weight (with Kelly K495/3-27 and Rotary head)	101,250 kg
Interlock Kelly type K495/3-27	6,800 kg
Rotary Head Torque	0-335 kNm
Revolutions	0-26/55 rpm

A drilling fluid prepared with polymers has been used, recommended for the minimal environmental impact, and led to a careful study of the land and the drilling method. The optimal dosages were defined through numerous tests led in the laboratory and on site. The placement of the steel cage has been one of the most delicate and complex phases of the entire production process. The weight of the cage, the use of longitudinal bars and non-destructive tests to be performed on each completed pile, required the use of special lifting systems and a laying technique in place that would ensure compliance with the quality and safety requirements. The main and the service pontoons have been specially designed and equipped to operate in the various production stages and with the possible tides variations. MSE Group has worked closely with the main contractor taking equipment, staff and line of work programs aligned to the construction site needs, at the early stage of construction site equipment and set up work.

### Quality and Safety

The yard has been organized and is proceeding according to the quality system in force in Canada, establishing, in agreement with the Ministry of Transportation Can-

ada, any procedure related to each stage of MSE Group operations. Strict quality checks are conducted on the manufacture of steel pipes, on the pontoons and on the operations of the piles construction. The pile integrity is tested by using

the non-destructive testing SCL (Crosshole Sonic Logging) that uses sound waves to reproduce the pile. This method has been used to complete the Gamma-Gamma registration system to furtherly define the nature and extension of any possible damage. A Mini SID camera (Shaft Inspection Device) is used for visual inspection, which highlights the cleanness of pile basis. In conclusion, the concrete mixture is self-compacting with 35% of Portland cement, which



Delmag RH34 during drilling operation

is replaced by granulated slag. It was finally set up in the yard a special Department of Industrial Security to follow the prevention and application aspects of the Safety Standards for each phase of the work entrusted to the MSE Group.

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## SIP&T works in Sri Lanka on Waterfront Project



### A huge project

Sri Lanka is an island nation off the Southeastern coast of the Indian subcontinent. After the 2004 tsunami, new planning regulations were approved in the coastal areas which have led to the construction of impressive tourist facilities for the country's economic recovery with a GDP value that grows from year to year. Today, Sri Lanka has the highest per capita income in South Asia, equal to over 6,000 US dollars, which is almost double that of India. The Waterfront Resort project was founded on this context: a multi-faced project which consists of a luxury hotel with over 1,000 rooms, a conference centre with a capacity of 2,500 guests, as well as entertainment facilities, swimming pools and casinos spread over an area of 14,000 m<sup>2</sup>. A 37,200 m<sup>2</sup> international shopping centre, 245 luxury condominiums, apartments, offices and 2,500 parking spaces will be added to these buildings. The total cost of the project is 522 million dollars to be invested in 5 years. The target completion date is 2018. An ambitious complex which makes it difficult to assess the impact it will have on the social fabric of the country. In fact, these types of integrated resorts cannot be compared in Sri Lanka, even though they are very popular in the Asia-Pacific regions. Not having

SIP&T Kelly bars and rotary tools are the protagonists in the construction of one of the most luxurious complexes on the entire planet, the Waterfront Resort in Sri Lanka.

John Keells Holdings (JKH) - one of the largest groups listed on the Colombo Stock Exchange, the capital of Sri Lanka - has been awarded the work for the construction of what will be a regal complex among the most luxurious in the world: the Waterfront

Resort. The works will be carried out by a consortium led by Hyundai Engineering and Construction, the Korean Keangnam Enterprises and the local Nawaloka Piling. The latter wanted to be flanked by the Italian company, SIP&T, for the implementation of the Kelly bars and the necessary tools for the piling stage.





**Upali Dharmadasa,  
Chairman and owner of  
Nawaloka Piling**

business models available from which to extract forecast data leads to great uncertainty on the return on investment carried out by a consortium led by Hyundai Engineering and Construction with a 65% share of the project (equivalent to 339 million dollars), the Korean Keangnam Enterprises with 25% (equivalent to 130 million dollars) and the local Nawaloka Piling with 10% (equivalent to 52 million dollars).

## Drilling specialists

Created in 1993 by Upali Dharmadasa, Nawaloka Piling is now a company par excellence in the piling sector and is involved in all major infrastructure projects in Sri Lanka. The company's mission is summarised in handling any challenge by creating a highly competitive environment in terms of quality, advanced technology and human resources. In addition, management is very sensitive to environmental and social issues because

« The perfect sizing of the kelly bar requires a careful study of soil, the precise knowledge of the maximum torque applicable to the kelly bar itself and the adequate tool to be connected to the equipment, for rapid and safe progress »



*Lucia Ladalardo, SIP&T Sales Department*

it is convinced that success inevitably affects respect towards nature and the growth of the entire population of the country. "The quality of a building greatly depends on what has been built underneath and in my case, the pilings" says Mr. Dharmadasa. We are building the Waterfront Resort in compliance with applicable regulations on buildings in a seismic zone, with the use of seismic isolation devices for all major projects. Day after day we strictly

monitor the high standard of quality and executive precision for both to be maintained".

## Bored piles

Once the soil geological report was analysed and the loads involved were noted, the project choices were aimed at bored pile foundations being used, which is an element in common in most works. Overall, 1,196 piles must be made with a diameter ranging between 600 and 1,800 mm, at an average depth of 30 m and a total length of 35,880 m. Nawaloka is producing the piles with last generation European rigs with very high torque values of up to 400 kNm. It should be noted how the stratigraphy of the subsoil of the works in question consists of various layers of rock such as limestone, gneiss, marble, quartzite and granite. Rocks classified as very hard and whose average compressive strength ranges between 110 and 300 mPa. Furthermore, banks of rock with compressive strength of over 220 mPa, with almost continuous frequency, are found at a depth ranging between 24 and 30 m. Lucia Ladalardo, SIP&T Sales Department, explains



**Some Drills during the works. The company is using machines constructed in Europe which develop very high torque values**



**Some rock samples taken from the site.**



**Pieces of rock extracted with the bored pile.**





“When such values are noted, the traditional drilling techniques are significantly difficult, basically due to the problems related to the type of tools and the sizing of the kelly bars. All this slows down the works and leads to low productivity, excessive fuel consumption by the drill and its components possibly breaking due to the high stresses involved. Furthermore, using a wrong tool enhances its damage or in any case, having to restore the cutting edges too often. An even more delicate issue is that related to the kelly bars that are compatible with the rigs used. An incorrect size results in them breaking, which would have a negative impact, especially from an economic aspect since the kelly bar is in integral part of the rig with a significant cost.” Thanks to the presence enjoyed by SIP&T in Sri Lanka for many years and in such a complex context, it has



**Interlocking Kelly Bar for different types of rigs and for a depth of 30 m. Once the soil geological report was analysed and the loads involved were noted, the project choices were aimed at bored pile foundations being used, which is an element in common in most works. Overall, 1,196 piles must be made with a diameter ranging between 600 and 1,800 mm, at an average depth of 30 m.**



**SIP&T has also provided the Sri Lankan site with Tri-Blade Core Barrels, which thanks to their special shape, allow to break the cored rock by the Roller Bits and gather it inside.**

**Core Barrels Roller Bits that have rotating spherical caps as cutting edges made with tungsten carbide inserts which are highly resistant to abrasion and can pulverise rock.**

developed unique rock tools, paying attention to the type of tool and its equipment. In detail, among others, Roller Bits Core Barrels have been provided, which are cutting edges of the rotating spherical caps made with tungsten carbide inserts which are highly resistant to abrasion and can pulverise rock. As a support, to split the rock by pulling the pole, the Italian company has decided to provide a Tri-Blade Core Barrel, which thanks to its special shape, allows to break the cored rock by the Roller bits and gather it inside. Considering the maximum depth to be reached is 30 m and the rigs with a long must, the kelly bars were made in three sections.

A solution which gives increased strength and lightness compared to the four sections.

### **The design is based on the research**

Ladalaro emphasises “The perfect sizing of the kelly bar requires a careful study of the soil geological report, the precise knowledge of the maximum torque applicable to the kelly bar itself and the adequate tool to be connected to the equipment, for rapid and safe progress. Prior to all this there must be a design that considers all the indicated parameters, with the addition of the mechanical characteristics of the materials used.” Modern software supplied to the SIP&T technical department has in fact allowed accurate “stress analysis” simulations to be performed, using the finished parts method, and therefore, the critical points of each kelly bar have been identified and advanced technical solutions have been adopted from using special materials.

Solutions that have proven to be successful on site. After a short training phase, during which the operators of the rigs were explained what torque and thrust to apply, the average net rate of drilling was 0.8 m/h in granite, with compressive strengths of over 220 MPa. In addition, after having drilled 80 m (90 m<sup>3</sup>) of rock, all the rollers were in good condition. An impressive achievement, especially when one considers that it takes an average of 10 hours to drill 0.8 m of rock with a traditional core barrel. Using rigs of different manufacturers, kelly bars and tools proved to be particularly reliable and effective. This generated a balanced system, thereby achieving high productivity and minimised problems arising from the structural subsidence of the various components.



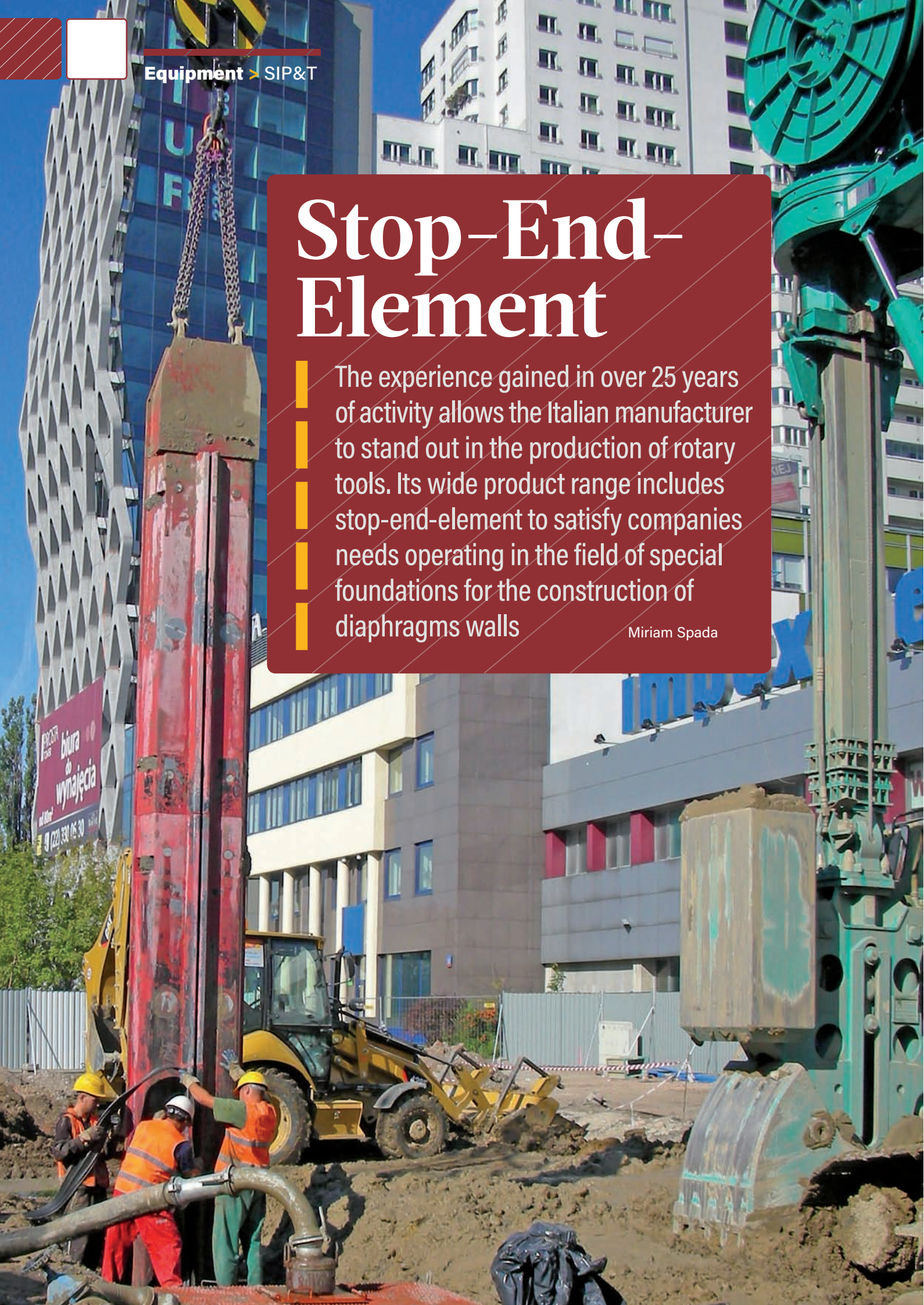




# Stop-End-Element

The experience gained in over 25 years of activity allows the Italian manufacturer to stand out in the production of rotary tools. Its wide product range includes stop-end-element to satisfy companies needs operating in the field of special foundations for the construction of diaphragms walls

Miriam Spada





## DIAPHRAGM WALLS

**D**iaphragm walls are concrete or reinforced concrete walls constructed in slurry-supported, open trenches below existing ground. Concrete is placed using the tremie installation method or by installing pre-cast concrete panels (known as a pre-cast diaphragm wall). Diaphragm walls can be constructed to depths of 100 meters and to widths of 0.40 to 1.50 meters. Diaphragm wall construction methods are relatively quiet and cause little or no vibration. Therefore, they are especially suitable for civil engineering projects in densely populated inner city areas. Due to their ability to keep deformation low and provide low water permeability, diaphragm walls are also used to retain excavation pits in the direct vicinity of existing structures. If there is a deep excavation pit at the edge of an existing structure and groundwater is present, diaphragm walls are often used as the most technically and economically favorable option. They can be used for temporary support or as load-bearing elements of the fi-



nal building. Diaphragm walls can be combined with any anchor and bracing system. Diaphragm wall panels are also used in deep, load-bearing soil layers as foundation elements to carry concentrated structural load in the same way as large drilled piles do. These foundation elements are known as "Barrettes". If diaphragm are socketed into impermeable soil layers of sufficient thickness or if they are combined with seal slabs (grout injection or tremie concrete slabs) almost watertight excavation pits are created. After reducing the initial groundwater level within the excavation, only small amounts of residual water will penetrate.

## DIAPHRAGM WALL CONSTRUCTION

- ▶ Preliminary excavation to 1.0 - 1.5 meters below ground elevation to install guide walls
- ▶ Prior to diaphragm wall excavation, cast-in-place or pre-cast concrete guide walls are placed. These braced guide walls stabilize the soil in the upper diaphragm level and provide a stable guide-way for the grab. In addition, they also support the diaphragm wall reinforcement and provide sufficient bearing for the hydraulic jacking system to remove the Stop-End Pipes. The space between both guide walls serves as a storage space for the stabilizing fluid
- ▶ Individual panels are excavated with a grab, at deeper levels, earth walls are stabilized by a bentonite slurry. In order to prevent inflow of groundwater the diaphragm walls are either lined with naturally occurring material having low water permeability or else artificially constructed sealing slabs are installed
- ▶ Stop-End-Element Installation. To separate the single concreting



- phases, stop-end-elements are installed at both panel fronts. These have the same width as the panel's wall thickness and are removed after initial concrete setting. The remaining trapezoidal joint provides a very good interlock between the individual concrete panels. This flat steel panel element contains one or two elastic joint tapes, which remain in the setting concrete after the joint element has been removed. Removal of the element can only take place after the adjacent panel was completely excavated. The plan stop end is extracted by the side, after the excavation of the adjacent panel. This is the biggest advantage of this joint: you can take off it after days from the concreting operation. It allows flexibility in the organization of the job site.
- ▶ Slurry Refreshing
- ▶ Placing of Rebar Cage
- ▶ Concrete Placing by tremie method. Simultaneously with placing concrete, slurry is pumped from the panel to be refreshed and re-used





in the next panel excavation. Since the slurry is replaced by concrete, this method is called "Double-Phase Method"

- Removal of Stop-End Element after concrete setting using hydraulic pipe extractors

## STOP-END-ELEMENT MAIN FEATURES

During production of cast in situ concrete diaphragm walls, the most important factor, especially to achieve a watertight joint, will be the use of the right stop end elements. They contain the concrete on the lateral side meanwhile they create a particular casting profile that offers a high seal against water infiltration. Stop End Elements are coupled together through special steel shafts even better special o-ring ensure a perfect seal

between the areas of the diaphragm. They are made of sheet metal welded and its special profile is achieved by a process of press bending and finally an internal reinforcing structure increases its strength and avoids the risk of deformation. The excavation of a follow-up panel is carried out by clamshell grab, with the help of a special flat chisel if needed, both guided by the channel in the pipe. While digging, these tools clean the exposed side of the pipe. The trapezoidal design of the Stop End Elements, and its constructive characteristics, allows a spontaneous lateral movement after the excavation, making a delayed extraction very easy.

The continuity of two following panels is guaranteed even in the presence of small vertical deviations, because the excavation is guided along the stop-

end element. With this method as opposed to other working system, there is no urgency to remove the stop-end element. It can be left in place for days or even weeks before extraction. A water stop can be added to the stop-end element to improve water tightness between joints. For this purpose, a special rubber seal will be mounted on the side of Stop End Element which will come into contact with the concrete. The lateral movement of the stop-end element during extraction leaves the water-stop fixed in the concrete. SIP&T can supply Stop End Elements in various widths and lengths. They are easily jointed each other through special steel. The Stop End Elements are: head element that is used for their lifting and extraction, intermediate elements and element shoe (Starter). In addition, to facilitate the use of Stop End Elements, SIP & T manufactures a chisel cleaner kit (dedicated to the cleaning of the channel guide) and a Platform Suspension Jig (dedicated to the support of Stop End Element during installation).

## HYDRAULIC EXTRACTOR AND POWER PACK

As soon as the concrete begins to set, hydraulic extractors pull out the stop end elements. They have been designed for the extraction of diaphragm wall stop-end-element having a width from 400 to 1500 mm and length up to 100 meters. SIP&T unit is operated by an independent power pack and it is composed of heavy-duty base frame with two trapezoid sliding columns maneuvered by four hydraulic rams. The system is complete with locking system pins to ensure the stop end element to the sliding frames and to prevent dropping of the column. A remote control panel to operate the unit is also available as an optional supply.

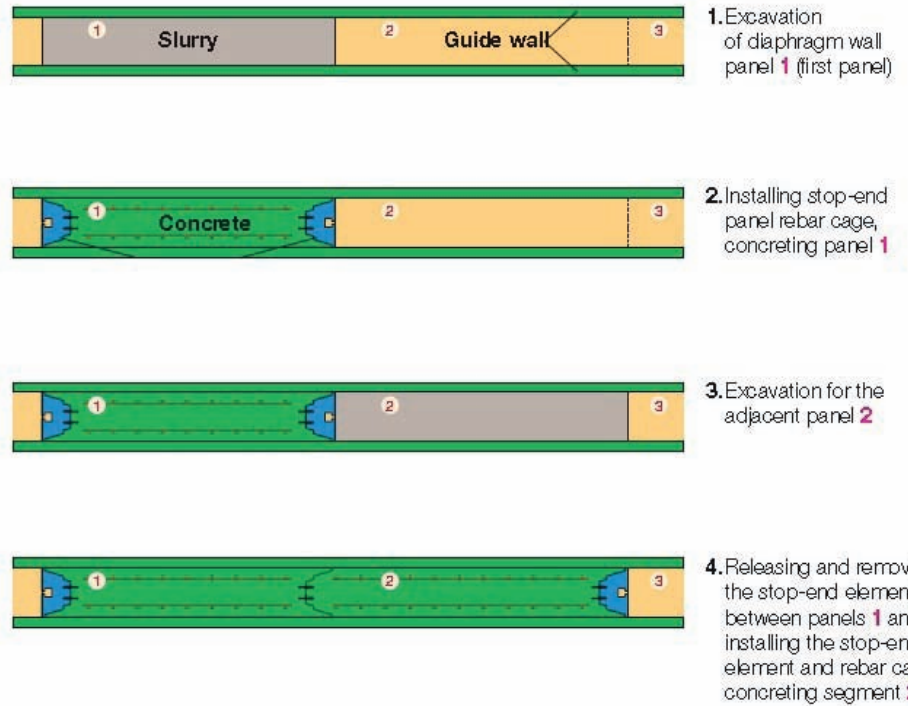


## INSPECTION

Grabs can be equipped with electronic devices (inclinometers) to control and monitor the vertical deviation along two or three axes. The ultrasound devices, which measures the distance between a lowered sonde inside the excavation and the panel sides, provide a "Profile" of the excavation. By this method, you have to stop the excavation of panel.

## REMARKS

The diaphragm walling technique offers improved verticality tolerances to CFA or rotary bored piling and delivers a smoother finish. Walls can be made extremely stiff and therefore better resistant to deflection. The advantages of using diaphragm walls as permanent structures are many, but there are also some disadvantages. Various shape of wall can be achieved with this method (for example, provisions for other lines). Diaphragm walls are applicable to any ground conditions. The range of construction is wide and the application goes from silt to rock. Inner city environment: diaphragm wall and secant piles are commonly used in congested areas. They can be installed in close proximity to existing structures with minimal loss of support to existing foundations. In addition, construction dewatering is not required, so there is no associated subsidence. Excellent waterproof: over cutting joint is possible without changing the underground water table level. High cost: Diaphragm wall are more expensive than other method. Nevertheless, the cost is lower when diaphragm walls are used as a permanent structure. It is used for projects under construction as a permanent support. Moreover, it has been used on several metro projects with no internal structure inside. Not



economical for small & shallow basements. Requires special equipment. They are unsuited to strong soils con-

ditions where penetration is slow and difficult due to the use of the slurry trench method. ◀



















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