theGeotechnica
November 2014 | Issue 35

Geotechnical design for precast piles

A look at the bearing capacity of driven precast concrete piles

Geological section automation
The use of Bentley Solutions's gINT

Underground utility detection
Standardisation for underground service detection

Tunnel pre-drilling
DAT instruments using pre-drilling instruments on Tunnel Boring Machines

EQUIPE GROUP
+44 (0)1295 670990 | www.equipegroup.com

Contents

Welcome

Welcome to the 35th Edition of **theGeotechnica** - the UK's fastest growing online geotechnically focussed e-magazine.

This month, once again, we have a fantastic line-up of insightful and informative articles that make for a must-read.

The first article of this month's issue comes from Gary Logan, Director of Sales at Bentley Systems, a global leader dedicated to providing architects, engineers, geospatial professionals, constructors, and owner-operators with comprehensive software solutions for sustaining infrastructure. This month Gary discusses the use of gINT during geological section automation.

Writing our second article of this month's issue is Piers Edgell, Senior Account Manager of Landmark® Information Group, a leading provider of land, property and environmental risk data and digital mapping. Piers looks at the introduction of the new PAS 128 specification that has been introduced to standardise underground utility detection, verification and location and looks at what it means to the industry.

The third article comes from Bob Handley, an Engineer in the Piling Division of Per Aarsleff (UK) Ltd, a subsidiary of Per Aarsleff A/S, one of Denmark's leading civil engineering contractors. In this article Bob reveals more about precast piles which were previously discussed in Issue 29 of theGeotechnica, back in April of this year.

Our fourth article this month comes from one of our regular contributors in DAT instruments, an Italian company that specialises in the design and production of advanced foundation instruments and software. In this article DAT instruments provide details on pre-drilling in tunnelling works and what equipment is out there to make the process easier.

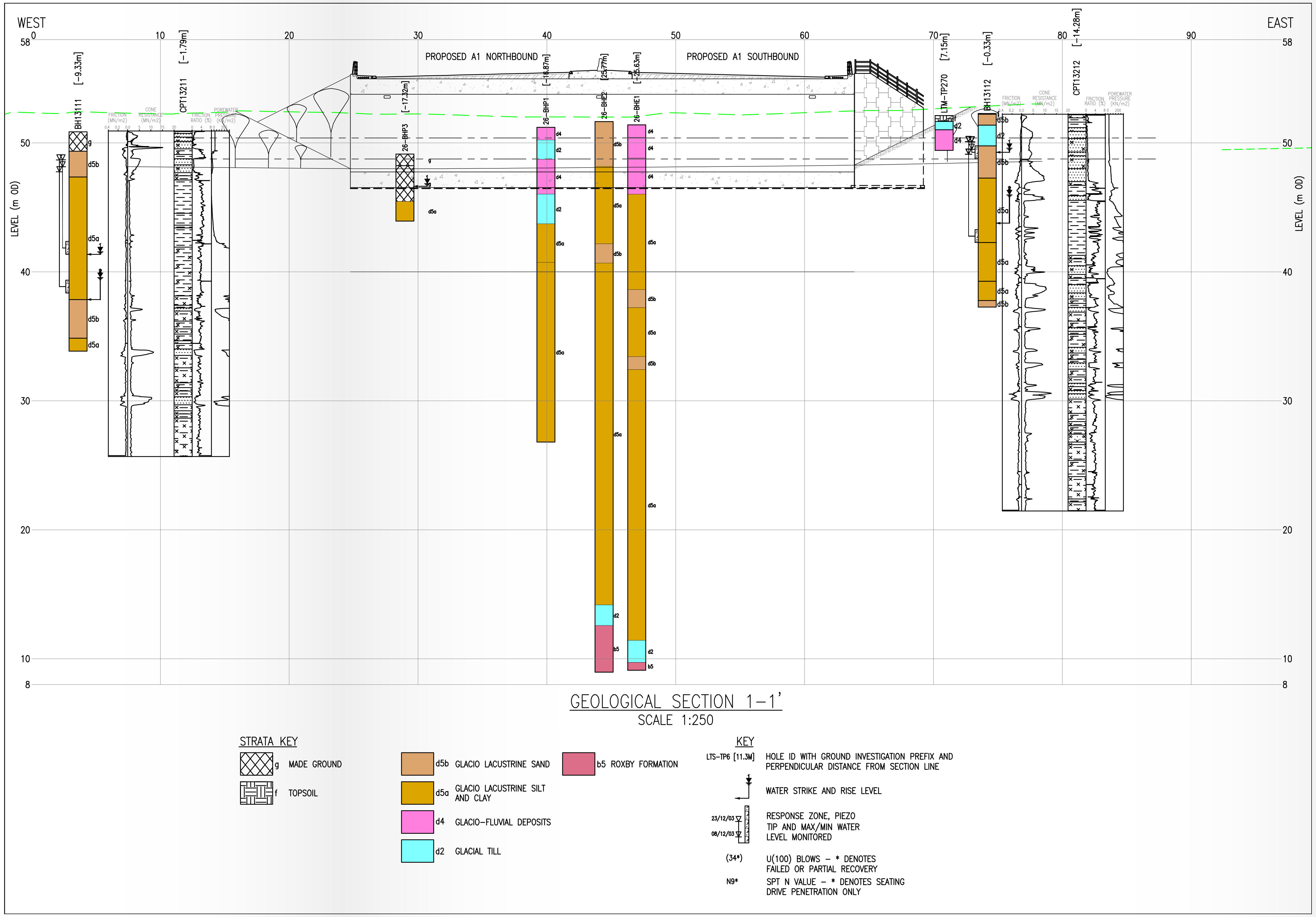
As with every new edition of the magazine, the Editorial Team here at **theGeotechnica** will be on the lookout for even more new, original and interesting content from all corners of the sector, and would actively encourage all readers to come forward with any appropriate and relevant content - whether it be a small news item or a detailed case study of works recently completed or being undertaken. If this content is media rich and interactive, then all the better. We are looking to increase the already large readership of the magazine through better social media integration and promotion, as well as improving content month on month.

Finally, for any content that is submitted we will ensure that an advertising space, proportionate to the quality of content provided, is reserved should you wish to place an advert in that single edition of the magazine. We hope you enjoy this month's edition of the magazine and are inspired to contribute your own content for the coming editions of **theGeotechnica**.

Editorial Team,
theGeotechnica

GEOLOGICAL SECTION AUTOMATION

*Writing for **theGeotechnica** this month is Gary Logan, Director of Sales at [Bentley Systems](), a global leader dedicated to providing architects, engineers, geospatial professionals, constructors, and owner-operators with comprehensive software solutions for sustaining infrastructure. This month Gary discusses the use of gINT during geological section automation.*



AECOM used gINT to visualize CPT profiles alongside conventional boreholes in cross sections.

Hours Become Seconds

A global provider of professional, technical, and management support services to a broad range of markets, AECOM delivers solutions that create, enhance, and sustain the world's built, natural, and social environments. The Fortune 500 company was engaged by the Carillion/Morgan Sindall Joint Venture (CMSJV) to be the lead designer from feasibility through detailed design of the A1 Dishforth to Leeming Improvement Scheme in North Yorkshire, United Kingdom. The USD 460 million scheme upgraded 22 kilometers of the existing A1 trunk road to a dual three-lane motorway with the aim to improve safety, reduce accidents, and provide extra road capacity for future growth. AECOM chose gINT, Bentley's geotechnical and geoenvironmental data management and reporting software, to manage and report all geological and geotechnical information. gINT saved up to six months (800-1,000 man-hours) in manual drafting time by enabling AECOM to produce geological sections in seconds rather than hours.

50 Years of Legacy Data

"One of the biggest challenges at the start of the project was finding a way to make use of the huge amount of legacy data."

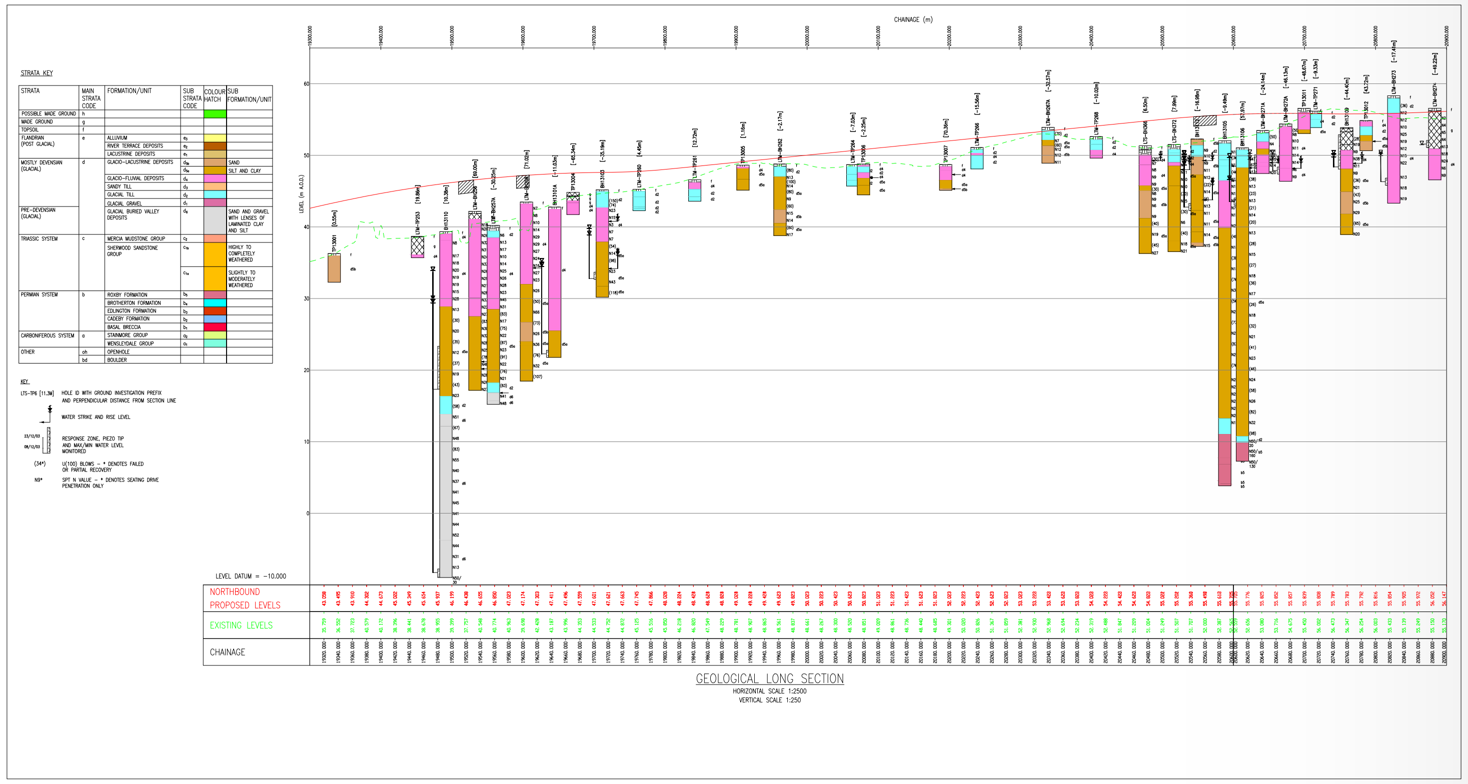
One of the biggest challenges at the start of the project was finding a way to make use of the huge amount of legacy data. Records from the ad hoc improvements made since the A1's opening included short-length roadway upgrades from single to dual carriageway, and roundabout replacements with grade-separated junctions. These projects included 10 different phases of ground investigations carried out by various contractors over the years. Together the legacy data comprised more than 900 exploratory holes – approximately 400 boreholes and 500 trial pits – along with associated laboratory testing data.

AECOM chose gINT to store and manage this historical data due to the easy and flexible way in which the data could be processed. With gINT software, engineers and geo-professionals can gather, manage, present, and report on subsurface data more

"Most of the historical data for the A1 was available as hard copy only..."

efficiently and with greater accuracy. Most of the historical data for the A1 was available as hard copy only, so a data entry team was employed to create electronic files from the paper records. The electronic records were entered into Excel tables compatible with the AGS (Association of Geotechnical and Geoenvironmental Specialists) file structure, which is the standard geotechnical exchange format used in many countries, including the U.K., Ireland, and the Middle East. This allowed easy validation and import into gINT.

Having more than 50 years of ground investigation data together in one readily accessible database proved to be invaluable ▸▸



to the scheme designers. The visualization and analysis of the historic data at an early stage of the project aided in optimizing the requirements of the scheme-specific investigation. Areas with discrepancies or insufficient data were targeted for further investigation.

When the scheme-specific ground investigations were undertaken, the number of exploratory holes stored in the database rose to 1,400. The gINT project database allowed users to retrieve data relating to any exploratory hole with a single click. The graphical output from gINT enabled users to visualize the geological data, and quickly and easily generate geological sections to any scale.

Producing Geologic Sections

Geological long sections (continuous profiles along the road alignment) were generated along the full length of the scheme. Cross sections were also produced to provide detailed information for specific locations, including 16 bridges and retaining structures, earthwork embankments and cuttings, 15 balancing ponds, and motorway communication

"Geological sections of specific structures were generated in DXF format and integrated with general arrangement drawings..."

structures. Geological sections of specific structures were generated in DXF format and integrated with general arrangement drawings, cross sections, and profiles. The sections showed the ground model and highlighted both the existing and proposed road surfaces. They incorporated schematic horizontal and vertical highway geometry produced from the 3D models created in Bentley MXROAD.

AECOM used Bentley MXROAD as an advanced, string-based modeling tool. Rob Addison, AECOM Senior Consultant, explained: "The existing topographical ground model was managed in MXROAD, the proposed highway alignments were designed in MXROAD, the cross-sections and the long-sections were output from MXROAD, and finally the sections, or 'fences', were output from gINT to the same scale via DXF and married up with the gINT section in CAD."

Visualizing Subsurface Conditions

These geological sections then assisted engineers and environmental specialists in the visualization and interpretation of ground conditions, formulation of a project ground model, consideration of ground condition constraints, and assessment of geotechnical and geoenvironmental risk. The easily customized gINT reports enabled a variety of geotechnical parameters to be plotted vs. depth or elevation, and powerful querying tools generated discrete subsets of data to be analyzed. For example, in an area where the route was underlain by soft alluvial soils, Cone Penetrometer Tests (CPT) revealed the exact soil

"gINT allowed these results to be visualized on profile and cross sections, which the designers used to delineate where improvements had to be made..."

composition and strength. gINT allowed these results to be visualized on profile and cross sections, which the designers used to delineate where improvements had to be made before road embankments could be built.

Addison noted: "I don't think this would have been possible without gINT. Historically, we would have done the CPT trace profiles in Excel with just a single borehole and a single CPT, but to actually plot it along a specific length of the scheme with all the different CPT traces showing – the cone resistance and the boreholes next to them – it was so much easier to visualize."

gINT also allowed users to easily export just the data needed for a specific area. "If you wanted to focus on just one balancing pond, you could easily export out the data for the boreholes that related to that pond or structure," Addison said. "It was very useful to be able to export out discrete packages of information that are specific and relevant to that structure, pond, or earthwork that you're working on." For example, in areas where groundwater monitoring indicated water levels would be above the base of planned retaining ponds, designers were able to base the water level and pond geometries presented in sections and plan the required dewatering.

Time and Cost Savings

gINT provided access to the legacy and scheme-specific data that informed production of geologic sections for roadways, embankments, ponds, and structures along 22 kilometers. Rather than draw geological sections manually in AutoCAD, as had been the practice in the past, AECOM was able to output sections from gINT in DXF format at any horizontal and vertical scale. The ability to output sections in seconds provided huge time and cost benefits throughout the project from feasibility through design.

For example, Addison estimated it would take a half-hour to draw each borehole manually in CAD – along with in-situ test results and

"To draw one set of long sections for the 1,200 exploratory holes along the route would take around 600 hours or four months elapsed time."

groundwater data. To draw one set of long sections for the 1,200 exploratory holes along the route would take around 600 hours or four months elapsed time. In addition, there were at least another 100 cross-sections at key locations such as structures, ponds, and sign gantries that would take another two months to draw manually. Addison estimated total time savings using gINT instead to be 800 to 1,000 man-hours, or about six months.

Construction of the A1 Dishforth to Leeming Improvement Scheme began in Spring 2009 and was completed in Summer 2012. The scheme met the needs of motorists as well as the cyclists, equestrians, and pedestrians who use the route. AECOM was later engaged to design the next section of A1 improvements, from Leeming

"While the project was completed in 2012, the investment and workflows implemented by the team using gINT, has ensured that the database of historical data was carried over to this next phase of development, which is now ongoing."

to Barton. While the project was completed in 2012, the investment and workflows implemented by the team using gINT, has ensured that the database of historical data was carried over to this next phase of development, which is now ongoing. ■

KeyLogbook®
digital logging solution

GE Ground Engineering Awards '13 WINNER

BOREHOLE AND TRIAL PIT LOGGING SOLUTION

KeyLogbook® revolutionises the way site data is captured, recorded and transmitted. Drillers and engineers no longer need to keep re-entering the same data repetitively. You will therefore reduce errors and make the whole process **simpler, faster, smarter, greener and more efficient**. The system records all site data at source and transmits it directly from site, saving time and money from the outset.

- Revolutionises the way site data is captured, recorded and transmitted
- Confidence that all data is complete
- AGS Data available immediately
- Accurate financial control
- Quicker, more efficient turnaround of logs and data
- Easier to maintain chain of custody
- NEW TRIAL PIT LOGGING FUNCTION

FULL PACKAGE AVAILABLE
FOR PURCHASE NOW
30 DAY FREE TRIAL AVAILABLE
FOR DOWNLOAD NOW

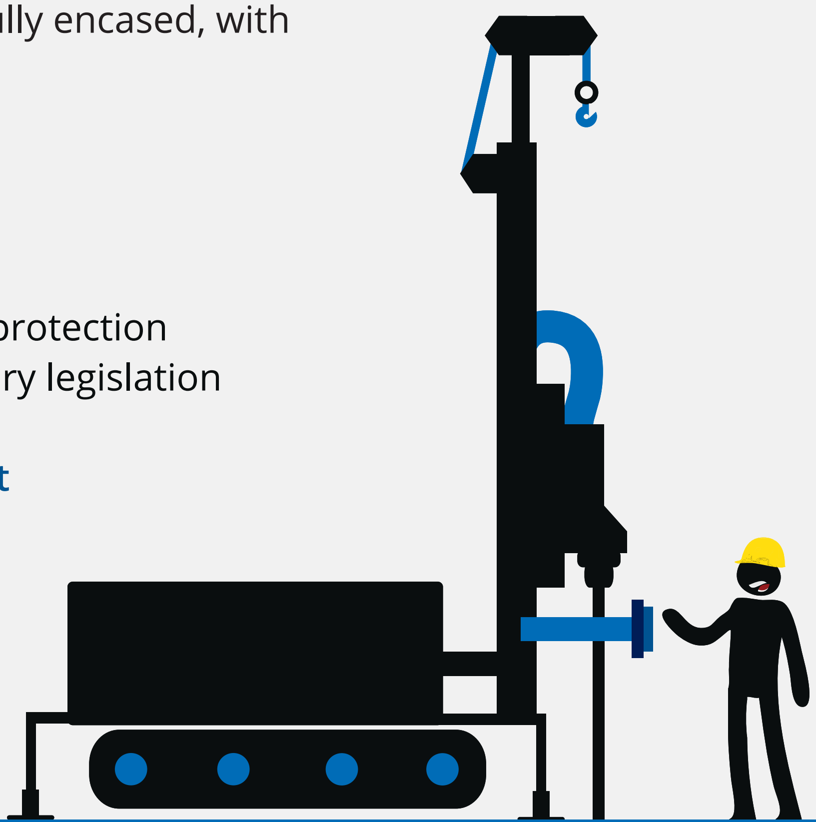
SAFER | G

THE WORLD'S FIRST SENSOR BASED ROTARY RIG GUARD

Introducing Equipe Geosolutions' latest product innovation: SAFER G. Primarily aimed at **land based rotary drilling rigs**, SAFER G is a **sensor-based guarding system** that allows for **increased access and productivity** whilst operating on site, removing the need for restrictive and fully enclosing guarding systems. A **less obstructive** method of guarding, the sensors operate outdoor in **all weathers** and function in even the most harsh conditions and environments including: Rain, sleet, snow, ice and associated low temperatures; Sun and associated high temperatures; Dust, dirt (including mud, soil, gravel, vegetation, etc); High volumes of water, air, mist, foam and other flush medium. The sensors are fully encased, with no moving parts and **ultra-robust**.

THE BENEFITS OF SAFER G

- Improves rig **productivity**
- **Improves reliability** in personnel protection
- **Complies** with safety and machinery legislation
- Fully compatible with **all rig types**
- Creates a **safer work environment**



equipe

Keynetix

For more information, contact Equipe Geosolutions:

info@equipegroup.com
www.equipegroup.com
+44 (0)1295 670990
+44 (0)1295 678232

Equipe Group
@EquipeGroup
EquipeGroup

equipe

For more information, contact Equipe Geosolutions:

info@equipegroup.com
www.equipegroup.com
+44 (0)1295 670990
+44 (0)1295 678232

Equipe Group
@EquipeGroup
EquipeGroup

UNDERGROUND UTILITY DETECTION STANDARDISATION

Writing for ***theGeotechnica*** *this month is Piers Edgell, Senior Account Manager of* [Landmark® Information Group](), *a leading provider of land, property and environmental risk data and digital mapping. Piers looks at the introduction of the new PAS 128 specification that has been introduced to standardise underground utility detection, verification and location and looks at what it means to the industry.*

During the summer, a new industry standard was launched at the Institution of Civil Engineers that aims to provide a clear and definite provision for those who are engaged in the detection, verification and location of utilities – whether they are active, dormant or even unknown utility services.

The specification, which the British Standards Institution has termed as 'PAS 128:2014', aims to not only set clear provisions for those operating in this space but will ultimately lead to more effective planning and far safer execution of ground/civil works, street excavations and utility-based activities.

Most organisations are today fully aware of the risks related to corporate manslaughter, negligence claims or civil damages and therefore

"It pays to ensure as much research and due diligence is undertaken at the outset to determine potentially hidden or unknown risks..."

'forearmed is forewarned'. It pays to ensure as much research and due diligence is undertaken at the outset to determine potentially hidden or unknown risks, which could makes themselves known as a land development or site excavation commences. This is where PAS 128 is set to make a real difference.

With no agreed or published UK standards related to the detection, verification or location of underground services, PAS 128 aims to provide clarity in the service provided and methods employed, as well as offer consistency in the

"It is also a way of safeguarding land professionals from potential risks or 'unknowns' that may be hidden under ground."

approach to data capture. It is also a way of safeguarding land professionals from potential risks or 'unknowns' that may be hidden under ground.

PAS 128 is made up of four levels of differing survey types. These have been defined as the following:

- Survey type D - desktop utility records search, whereby utilities are identified through the analysis of paper and digital records or reports, such as those available from Landmark;
- Survey type C - site reconnaissance, where existing records are validated by the visual inspection of physical evidence observed during a site visit;
- Survey type B - detection, where utilities are detected using geophysical techniques; and
- Survey type A - verification, where underground services are located via a manhole, inspection chamber or through excavation.

"The range of survey types have been designed to take a categorised approach, meaning that differing levels of data may be required for differing projects..."

The range of survey types have been designed to take a categorised approach, meaning that differing levels of data may be required for differing projects, so the Survey type can be selected depending on the confidence levels required. Survey type D requires the least effort in the sense that desktop utility reports can be easily accessed from the office, while at the other end of the scale, survey type A requires full physical investigations at the site to determine whether any utilities are present.

"The way in which the appropriate survey level is selected will be based on a number of factors..."

The way in which the appropriate survey level is selected will be based on a number of factors, such as the density of services within the area in question, and it might well be the case that more than one survey is selected once initial desk-based research draws its conclusions.

"With no formal standardisation previously in place for the detection, verification or location of underground utilities, we fully encourage our customers that operate in the construction, engineering and built environment sectors to contact the BSI to obtain a copy of the PAS 128 standard."

Here at Landmark, we fully welcome the new PAS 128 specification as it aims to provide consistent and clear best practice in identifying underground utilities. With no formal standardisation previously in place for the detection, verification or location of underground utilities, we fully encourage our customers that operate in the construction, engineering and built environment sectors to contact the BSI to obtain a copy of the PAS 128 standard.

As well as demonstrating that as much research has been undertaken at the outset from a personnel security point of view, it will also help firms manage risk in other areas of their business. For example, having a clearer understanding of what utility features lie below the surface may help them to avoid implications such as cost of damages should an asset be inadvertently hit. Or, coming across unknown cabling, pipework, water supplies or other utilities may create delays in a project, which has the potential to incur financial penalties. These are commonly overlooked, yet can reflect negatively on a consultancy's reputation if unforeseen delays occur on a project.

Understanding the features that lie below the surface is therefore crucial before any excavations commence. Detailed Utilities Reports are available that collate all utility information into a single source, providing a clear outline of what is below the surface.

As recommended in Survey type D, this level of due diligence provides valuable information that will help reduce the risk of potential litigation if damage is caused, the project is delayed, or any added danger to the workforce occurs.

The desktop utility search reports from Landmark form the basis of the detection process outlined in PAS 128. By accessing such reports, it demonstrates that reasonable steps have been taken to ensure that as much is known about a site at the outset.

Ultimately, the more comprehensive and reliable information that can be gathered, the better informed everyone is to understand the 'known' risks and minimise the 'unknown' risks to an ALARP level. Data is key and by achieving a PAS compliant survey, you can avoid potential project delays, injuries or service disruption. ■

THE GEOTECHNICAL ACADEMY

On-the-ground practical development for geo-professionals

The Geotechnical Academy is a partnership between Geotechnical Engineering Ltd & Equipe Training, providing unique, high quality vocational geotechnical **CPD** development for early career engineering professionals

Group 8 Enrolling now for Dec 2014

Interested? For further information:

Contact Amanda Thompson on: 01452 527743

amanda.thompson@geoeng.co.uk

Or visit our website: www.geotechnicalacademy.co.uk

◇ peer support ◇ mentoring ◇ debate & discussion ◇ practical sessions ◇ demonstrations ◇ knowledge transfer ◇ confidence building ◇ external lecturers

geotechnical

Equipe Training

equipe

CPD APPROVED equipe EQUIPE TRAINING LIMITED

CPD Approved Courses for Geotechnical Academy Alumni

Specifying Site Investigations

This one day course will look at the various methods available to carry out intrusive and non intrusive investigation. Whilst the course will concentrate on geotechnical methods some geo-environmental methods will be briefly discussed. The course will look at the aims of SI and categorise the various stages in an investigation.

Soil Description Workshop

From 2007 new European Standards have started replacing the British Standards (Codes) under which investigations in the UK have been carried out. UK working practice will have to change to meet these new requirements but few practitioners are aware of the changes or the timetable. The workshop will comprise a series of lectures on the changes, and lectures on soil description followed by practical sessions describing soil samples.

Rock Description Workshop

From 2007 new European Standards have started replacing the British Standards (Codes) under which investigations in the UK have been carried out. UK working practice will have to change to meet these new requirements but few practitioners are aware of the changes or the timetable. The workshop will comprise a series of lectures on the changes, and lectures on rock description followed by practical sessions describing rock and compiling mechanical logs of rock core.

In Situ Testing

The course will cover both the theory and the practice of various In Situ Testing techniques used on typical geotechnical projects. In addition the courses will consider the effect that Eurocodes will have on the UK's current practice. This course provides an overview of in situ tests used in common practice and some of the more specialist tests together with their advantages and limitations.

Instrumentation and Monitoring

The course comprises a comprehensive one day appreciation of the complete process involved in Instrumentation and Monitoring in the geotechnical environment. The course provides an overview of the current guidance documents and their requirements. The course will consider the design of both individual installations and the installation of suites of instruments in the wider site contex.

Basic Foundation Awareness

This one day course will provide a general overview of foundation design. It will include an assessment of the use and choice of shallow foundations and piles. It will cover the derivation of bearing capacity formula and their use. Exercises will be carried out to calculate the working loads and settlement of simple foundations. The methods used to calculate these will be in accordance with those described in Eurocode.

THE GEOTECHNICAL ACADEMY

A collaboration between

geotechnical equipe

IOSH Working Safely on Geotechnical Sites

This one day course is developed by industry specialists within RPA Safety Services and Equipe Training as a foundation to site safety. Its aim is to impart the core safety skills required of those working on geotechnical sites by building on their existing specialist technical skills. After attending the course, candidates should be able to identify hazards on site, understand basic safety legislation, participate fully and confidently in site safety consultation and manage priority risks to a sufficient standard.

IOSH Avoiding Danger from Underground Services

Partnering with RPA Safety Services once again, Equipe provide another IOSH certified health and safety course. This one day course is aimed at anybody involved in specifying, instructing, managing, supervising or actually breaking ground and really addresses the problems and risks related to underground services, which may be encountered during both planning and execution of geotechnical projects.

IOSH Safe Supervision of Geotechnical Sites

Equipe has partnered with RPA Safety Services, an independent occupational health and safety specialist, to provide a unique IOSH certified course for the Drilling and Geotechnics industry. The three day course is certified by IOSH, is specifically focussed on the geotechnical industry and provides a totally unique and relevant Health and Safety course for managers and supervisors.

15% off Equipe Courses for Academy Alumni

Visit our websites for more details:

www.geotechnicalacademy.co.uk
www.equipegroup.com

DRIVEN PRECAST CONCRETE PILES

*Writing for **theGeotechnica** this month is Bob Handley, an Engineer in the Piling Division of [Per Aarsleff (UK) Ltd](), a subsidiary of Per Aarsleff A/S, one of Denmark's leading civil engineering contractors. In this article Bob reveals more about precast piles which were previously discussed in [Issue 29 of theGeotechnica](), back in April of this year.*

"Old British Standards"

Historically the geotechnical design of bearing piles has utilised the concept of a global factor of safety and BS 8004:1986 Code of practice for foundations recommended that this should be in the range 2.0 to 3.0 depending on a number of considerations:

- Piling technique.
- Quality and quantity of site investigation data.
- Load testing regime.
- Settlement specification

The factor of safety employed in pile design is intended to safeguard against failure of the pile/soil interaction that provides the resistance to the applied load, and to ensure that pile settlement characteristics are within acceptable limits in the service condition. Typically design for driven precast concrete piles would use a global factor of safety at the lower end of this range in combination with a dynamic load testing regime, for the following reasons:

- The pile is manufactured under quality assured factory conditions and arrives at the pile location preformed; consequently the risks associated with placing fresh concrete in the ground are absent. The pile can be inspected prior to driving and the successful achievement of the design pile toe level and/or driving resistance can be safely acknowledged as a demonstration of pile shaft integrity on completion.

- Even with relatively basic site investigation data, a reasonable estimate of pile length can be made. The records of resistance to penetration on probe piles installed in working pile locations can be compared with reported soil conditions. Piles may be installed to a calculated embedment or length, to a dynamic resistance or set, or to a combination of both. In variable soil conditions the precast concrete pile can be driven on until the design resistance to penetration is achieved, as opposed to say forming a CFA pile without first seeing the spoil that has been excavated.

"In variable soil conditions the precast concrete pile can be driven on until the design resistance to penetration is achieved..."

- "A driven pile is a tested pile".

"New British Standards"

BS EN 1997-1:2004 Eurocode 7 Geotechnical design General rules and its associated National Annex published in 2007 adopts a different approach using partial factors.

"Eurocode 7 currently allows the designer to adopt one of three design approaches..."

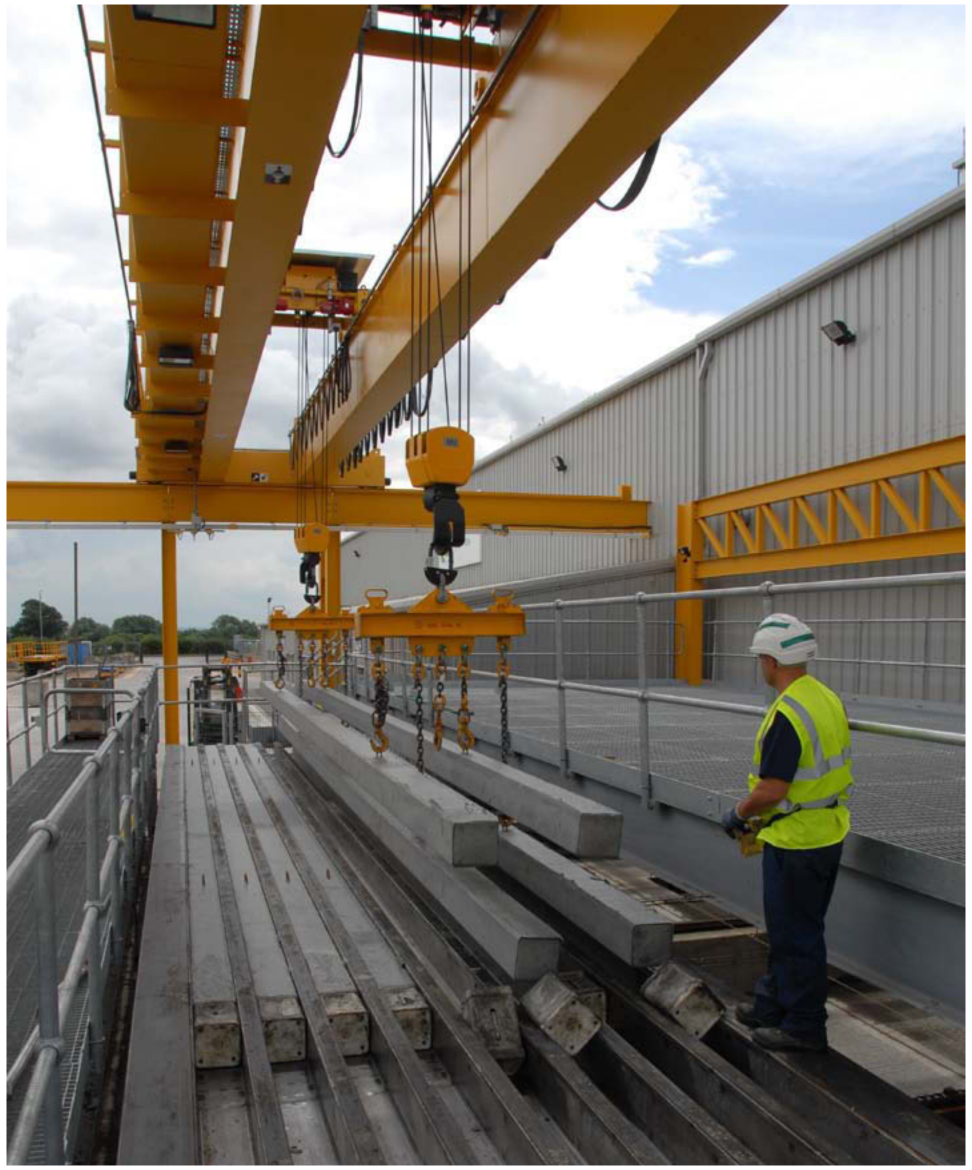
Eurocode 7 currently allows the designer to adopt one of three design approaches to the manner in which the partial factors applied to the actions are combined with the partial material and resistance factors applied to the pile resistance provided by the soil. The choice of design approach is dictated by the National Annex and for bearing pile design in the UK Design Approach 1 has been adopted. This process requires the pile designer to consider two combinations of factored actions (partial factor sets A1 and A2). For bearing pile design combination 1 generally governs the structural design of the pile whereas combination 2 governs the geotechnical design.

Eurocode 7 allows the designer a number of different ways of deriving characteristic values of pile resistance including the use of static or dynamic load tests on piles, the use of direct ground test results (e.g. cone penetration tests), set measurements and calculation based on soil properties obtained by intrusive ground investigation.

"In the case of load tests, set measurements and direct ground tests correlation factors are applied to the mean and minimum values of resistance..."

In the case of load tests, set measurements and direct ground tests correlation factors are applied to the mean and minimum values of resistance to derive characteristic values and these will vary according to the extent of testing and measurements.

In the UK design by calculation is the norm and Eurocode 7 requires the application of a model factor to the



calculated ultimate resistances to derive characteristic values. A reduction in the model factor from 1.4 to 1.2 is permitted if a preliminary pile is load tested to the calculated ultimate

> **"The benefits of this will depend on the scope of piling works being large enough to justify the cost of the preliminary static load test."**

resistance. The benefits of this will depend on the scope of piling works being large enough to justify the cost of the preliminary static load test.

Once characteristic values of resistance have been established the relevant design values can be derived by application of the partial factors applicable to load combinations 1 and 2 (Sets R1 and R4). Lower values of the R4 factors are permitted if a minimum 1% of piles are proof load tested or if settlement can be reliably predicted, or when settlement is of no concern.

Design values of pile resistance are compared with design values of actions (loads) applied to the pile to ensure that a geotechnical (GEO) and structural (STR) ultimate limit state is not exceeded. Verification of serviceability limit states (i.e. settlement or deflection) is normally demonstrated implicitly by the verification of the ultimate limit state, but may require explicit verification in itself.

A change for the better or the worse?

> **"The declared purpose of the Structural Eurocodes was to provide a set of unified calculation methods to assess the "mechanical resistance" of structures, provide a basis for specifying contracts for construction work and serve as a framework for harmonising technical specifications. "**

The declared purpose of the Structural Eurocodes was to provide a set of unified calculation methods to assess the "mechanical resistance" of structures, provide a basis for specifying contracts for construction work and serve as a framework for harmonising technical specifications. Individual members of the EU would be free to determine certain parameters within their National Annexes to the various standards.

Unfortunately, in the case of bearing piles generally and driven piles in particular, the compounded effect of the Eurocode 7 partial factors has led to an increase in the overall design factor of safety compared to the global factor of safety that has been acceptable under BS 8004.

Safe working load	500kN
BS 8004 FOS	2.0 (dynamic load testing regime applied)
Required ultimate resistance	1000kN

Eurocode factor A2	1.15 (based on 50/50 permanent/variable load)
Model factor	1.4 (without a preliminary load test)
Eurocode factor R4	1.7 (on base resistance without proof load tests)
Required ultimate resistance	1369kN

Consider this example (above) of a driven precast concrete pile which is predominantly end bearing, driven to a set and is effectively self-testing:

The increase in required soil resistance resulting from designing to Eurocode 7 is 37%; this would mean an increase in section size from 250mm square to 300mm square. To restore the BS 8004 status quo would require a preliminary load test (model factor 1.2) and at least 1% proof load tests (R4 factor 1.5) with a resulting requirement for 1035kN soil resistance. Either option impacts heavily on the sustainable and economical use of driven piles.

Some might question the wisdom of a global factor of safety as low as 2.0 but the reality is that this has been the norm for the driven precast concrete sector of the UK piling industry for the last 30 years without any evidence that the safety standards of construction have been compromised across the board.

4 The Future

All parts of Eurocode 7 are currently under review by a number of "evolution" (working) groups managed by CEN Committee TC 250/SC7. Fortunately the UK is well represented, holding the Chair of SC7 and with expert representation in EG7 Pile Design and EG8 Harmonisation. There is recognition that the current range of permitted design approaches is too broad and that in the UK driven piling design has been adversely affected by the combination of partial factors.

Watch this space! ■

PRE-DRILLING IN TUNNEL WORKS

Our fourth article this month comes from one of our regular contributors in DAT instruments, an Italian company that specialises in the design and production of advanced foundation instruments and software. In this article DAT instruments provide details on pre-drilling in tunnelling works and what equipment is out there to make the process easier.

DAT instruments have designed and launched a product aimed to work in tunnelling projects. The product combines accurate electronic equipment with long performance sensors to face pre-drilling activities, with the purpose of investigating the ground to be dug and the vault of a tunnel when a Tunnel Boring Machine (TBM) is in operation.

Underground works, especially tunnelling works, must consider all soil strata. Continuous monitoring of the geological pattern is required to quickly acquire soil information and deliver the best result on time, not only during the excavation by the TBM but also during the process of soil investigation, above the tunnel vault. Here is where DAT instruments, specialist within the production of drilling and piling electronic monitoring instrumentation, had the opportunity to install a datalogger on a small drill rig, placed on the TBM. The purpose was to pre-drill the soil before the TBM excavation, allowing a faster and longer daily dig.

"There are two major benefits by using this instrumentation: monitoring soil structure even 70m at the front of the TBM and investigation of soil above the tunnel vault."

There are two major benefits by using this instrumentation: monitoring soil even 70m at the front of the TBM and investigation of soil above the tunnel vault.

Thanks to the small drill on which it is installed, the datalogger allows to test and explore the ground in front of the TBM, recording the diagraphy before the dig of the tunnel. In this way the building company perfectly knows the characteristics of ground that

it is going to dig and the best equipment to be used, avoiding choosing cutting tools based on best guesses and increasing the productivity.

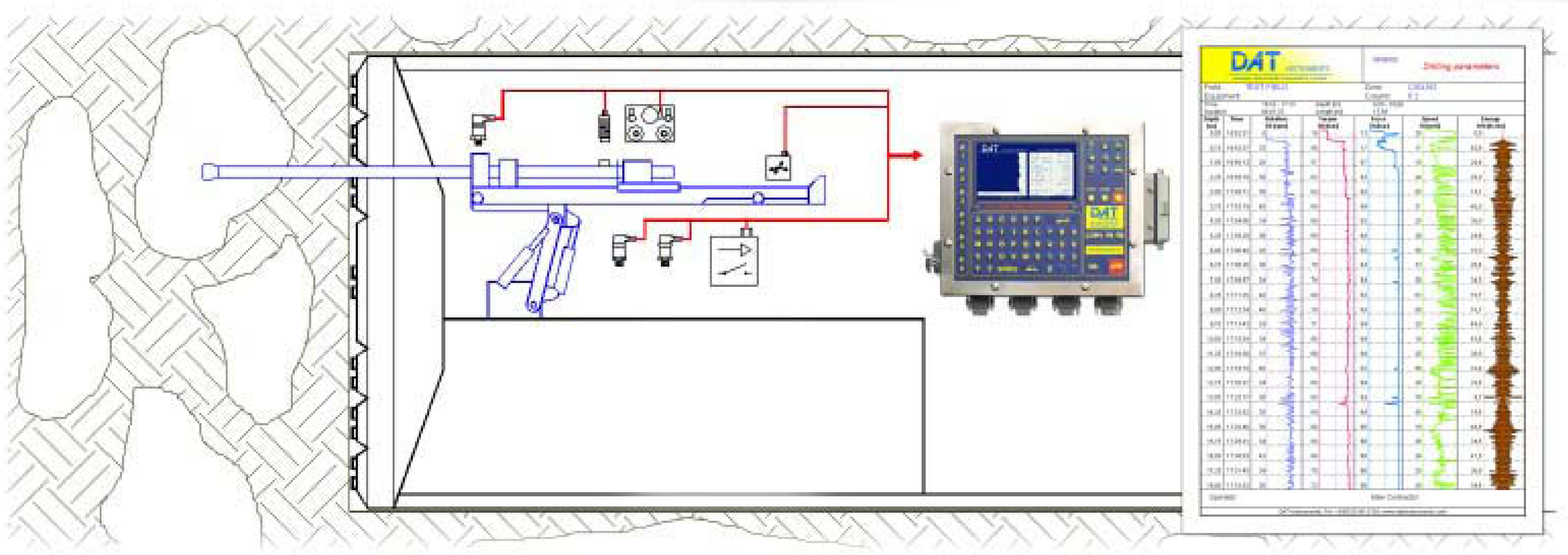
At the same time the TBM auxiliary drilling machine can be used to test the vault of the tunnel (that operation usually does not reach 5m of depth) aimed to define the type of soil to be encountered, to choose the best coating to be taken and to determine the final type of sensors that will monitor the

"Last but not least: the data logger provides an opportunity to certify the work..."

tunnel during the entire life of the structure. Last but not least: the data logger provides an opportunity to certify the work, allowing you to deliver to the project manager a detailed description of each dig.

From a technical perspective the datalogger created by DAT instruments for this particular type of processing is the JET 4000 AME / J, equipped with a special set of sensors that allows data transfer through USB pen drive and to process the parameters using the software JET S 104. There are several parameters recorded by the DAT instruments equipment, including: drill depth, rod feed force, rod feed speed, rotation torque and rotation speed; mast inclination axes X and Y (optional); drilling fluid pressure, date and start/end time of work and duration of work, calculation of relative energy of the ground.

Assistance and worldwide support: Although the dataloggers and sensors



Pressure sensors on the TBM.

are highly sophisticated electronic instruments, they are not delicate. All products DAT instruments are made keeping in mind the work site where they will operate, with a large use of stainless steel and latest generation polymer resins that ensure maximum strength and durability. However, the Italian company has developed a service that leaves no room for doubts and uncertainty and has as main objective the proximity to the customer and his site problems. As stated by Amedeo Valoroso, owner of DAT instruments: "We have local distributors all over the world with high-level technical assistance, capable of carrying out any installation and support customers during the use of the instrumentation. Reseller technicians are formed directly by us and are continually supported by Italian experts. They are always ready to intervene in the work site for any client's needs. In fact DAT instruments has always been available to solve problems by phone, e-mail or Skype. However today our service has evolved, with the opportunity to realize video conferencing with operators in the pipeline. It is possible to install and configure the software remotely, in order to make life easier in the work sites. It is also possible to provide education and training."

A successful example - the BBT: Among the many successful applications recorded by DAT instruments in the specific field

"... the intervention in the Brenner Base Tunnel or Brenner Base Tunnel (BBT), appears one of the most significant because of the importance of the work at European level..."

of tunnelling, the intervention in the Brenner Base Tunnel (BBT), appears one of the most significant because of the importance of the work at European level but also for the specific commitment of the Italian company that with his staff has followed all the stages of the building, installation assistance.

The Italian technicians were involved in the pre-drilling of the service tunnel built transversely to the main rail tunnel linking Italy to Austria. A gallery of 10 kilometers with a width of about 6-7 m. In this site the data logger was installed on a small drill that had the task of testing the waters to about 70 m, anticipating the work of the TBM of 20-25 m

At the same time the drill, rotating 90°, carried out surveys of the entire of the tunnel providing precise diagraphies of the ground ahead of the TBM. ■

Directory

borehole surveying software

GEOMEM
24 John Huband Drive, Birkhill, Angus, DD2 5RY
United Kingdom
Tel: 01382 329 011 **Fax:** 01382 230 256
Email: tech@geomem.com

consultants

GROUND TECHNOLOGY
Ground Technology Services, Maple Road, Kings Lynn, Norfolk, PE34 3AF
Tel: 01553 817657 **Fax:** 01553 817658
Email: mail@groundtechnology.co.uk

drilling contractors

APEX DRILLING SERVICES
Sturmi Way, Bridgend, CF33 6BZ
Tel: 01656 749149
Email: thomas.martin@apex-drilling.com

BOREHOLE SOLUTION SITE INVESTIGATION
13 Great North Road, Buckden, St Neots, Cambridgeshire, PE19 5XJ
Tel: 01480 812457 **Mob:** 07969 715655
Email: boreholesolutions@gmail.com

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

DYNAMIC SAMPLING UK
Unit 8 Victory Park Way, Victory Road
Derby, DE24 8ZF
Tel: 01332 771104 **Mob:** 07836 365533
Email: info@dynamicsampling.co.uk

GEOTECHNICAL ENGINEERING
Centurion House, Olympus Business Park, Quedgeley, Gloucester, GL2 4NF
Tel: 01452 527743 **Fax:** 01452 729314
Email: geotech@geoeng.co.uk

RGI GEOTECHNICAL INVESTIGATION
Unit 37, Longfield Road, Sydenham Industrial Estate, Leamington Spa, Warwickshire, CV31 1XB
Tel/Fax: 01926 886329 **Mob:** 07748871546
Email: rgi10@aol.com

drilling suppliers

DRILLWELL
Unit 3, Rotherham Close, Killamarsh, Sheffield, S21 2JU
Tel: 0114 248 7833 **Fax:** 0114 2487997
Email: sales@drillwell.co.uk

field instrumentation

GEOTECHNICAL OBSERVATIONS
The Peter Vaughan Building, 9 Avro Way, Brooklands, Weybridge, Surrey KT13 0YF
Tel: 01932 352040 **Fax:** 01932 356375
Email: info@geo-observations.com

geophysics

EUROPEAN GEOPHYSICAL SERVICES
22 Sansaw Business Park, Hadnall, Shrewsbury, Shropshire SY4 4AS
Tel: 01939 210 710 **Fax:** 01939 210 532
Email: eurogeophys@europeangeophysical.com

TERRADAT
Unit 1, Link Trade Park, Penarth Road, Cardiff, CF11 8TQ
Tel: 08707 303050 **Fax:** 08707 303051
Email: web@terradat.co.uk

geotechnical software

KEYNETX LTD
Systems Park, Moons Park, Burnt Meadow Road,
Redditch, Worcestershire, B98 9PA
Tel: 01527 68888 **Fax:** 01527 62880
Email: sales@keynetix.com

geotechnical specialists

GEOTECHNICAL ENGINEERING
Centurion House, Olympus Business Park, Quedgeley, Gloucester, GL2 4NF
Tel: 01452 527743 **Fax:** 01452 729314
Email: geotech@geoeng.co.uk

GEOTECHNICAL OBSERVATIONS
The Peter Vaughan Building, 9 Avro Way, Brooklands, Weybridge, Surrey KT13 0YF
Tel: 01932 352040 **Fax:** 01932 356375
Email: info@geo-observations.com

SOILS LIMITED
Newton House, Tadworth
Surrey, KT20 5SR
Tel: 01737 814221 **Fax:** 01737 812557
Email: southwest@soilslimited.co.uk

ground protection

health and safety

EB SAFETY
Tel: 01926 642465 **Mob:** 07881858271
Email: ebetts@ebsafety.co.uk

laboratory services

ALCONTROL LABORATORIES
Units 7 & 8 Hawarden Business Park, Manor Road, Hawarden, Deeside, Flintshire CH5 3US
Tel: 01244 528 700 **Fax:** 01244 528 701
Email: hawarden.sales@alcontrol.com

CHEMTEST
Depot Road, Newmarket, CB8 0AL
Tel: 01638 606 070 **Fax:** 01638 606 071
Email: peter.noone@chemtest.co.uk

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

GEOLABS
Bucknalls Lane, Garston, Watford, Hertfordshire, WD25 9XX
Tel: 01923 892 190 **Fax:** 01923 892 191
Email: admin@geolabs.co.uk

K4 SOILS LABORATORY
Unit 8, Olds Close, Watford, Hertfordshire, WD18 9RU
Tel: 01923 711288 **Fax:** 01923 711311
Email: office@k4soils.com

site investigation

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

training and education

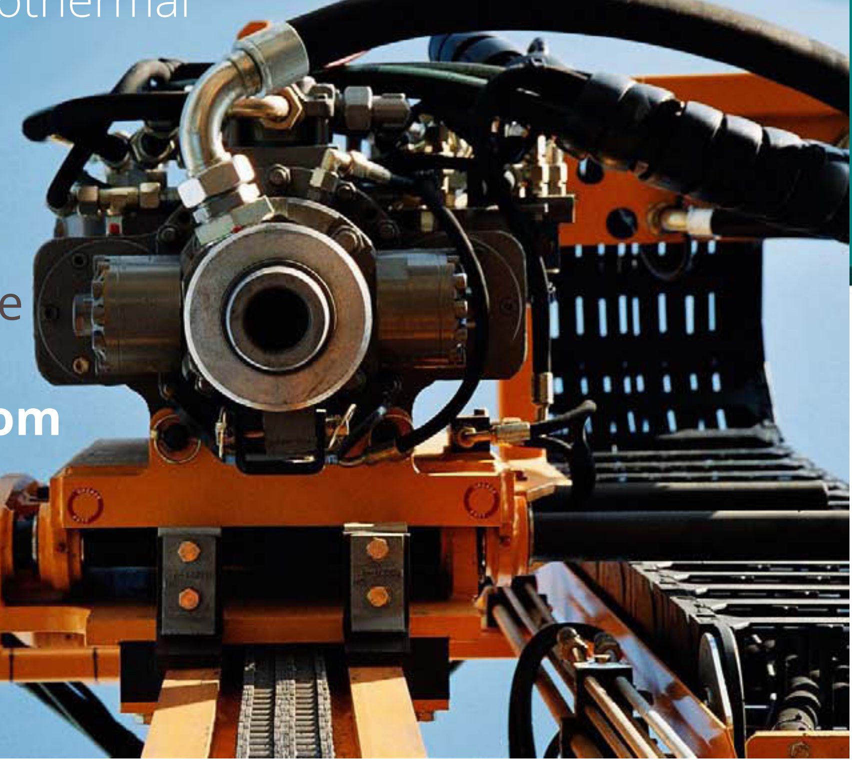
EQUIPE GROUP
The Paddocks, Home Farm Offices,
The Upton Estate, Banbury, Oxford, OX15 6HU
Tel: 01295 670990 **Fax:** 01295 678232
Email: info@equipegroup.com

Rotary Drillers

We have vacancies available for experienced Lead Rotary Drillers, both in the UK and Worldwide.

- Excellent Rates of Pay
- Conventional, Wireline and Geothermal
- positions all available
- Onshore and Offshore
- Minimum 5 Years experience
- and NVQ Level 2 is preferable

All interested applicants, please forward your CV to:
keith.spires@equipegroup.com



theGeotechnica

Driving our industry forward...

Equipe Group
The Paddocks, Home Farm Drive
The Upton Estate
Banbury, OX15 6HU