theGeotechnica

equip

inside this edition...

the birth of the sonic revolution?

Coresource rolls out their new rig onto the Isle of Wight

also included...

- the future of the UK motorway network
- the increasing benefits of NVQs and new funding
- LiDAR scanning for geotechnical analyses

tel: 01295 670990
www.equipetraining.co.uk

issue no. 5
october 2011

Equipe Geotechnical Symposia

Awareness - Applications - Advances

Cone Penetration Testing for Onshore and Offshore Geotechnics

12th and 13th October 2011

at The Drilling Academy, nr. Banbury

FREE TO ATTEND

Programme

Day 1

08:45 – 09:15	Registration and Coffee
09:15 – 09:30	*Introduction* – **Julian Lovell**, Equipe
09:30 – 10:15	*Historic overview, what do we measure with PCPT/CPTU, deployment and measurement systems* - **Tom Lunne**, NGI
10:15 – 10:20	Comments and Questions
10:20 – 11:05	*CPTU data processing, corrections and accuracy, available standards and guidelines* **John Powell**, Consultant
11:05 – 11:15	Comments and Questions
11:15 – 11:30	Morning Break
11:30 – 12:00	*Marine soil investigations* - **Brian Georgious**, Gardline Geosciences
12:00 – 12:25	*Importance of quality control of data, onshore and offshore* - **Tom Lunne**, NGI
12:25 – 12:40	Comments and Questions
12:40 – 13:10	Demonstrations
13:10 – 13:35	Lunch
13:35 – 14:00	*Profiling and soil identification* - **John Powell**, Consultant
14:00 – 14:35	*CPTU derived parameters in sand* - **Tom Lunne**, NGI
14:35 – 14:50	Afternoon Break
14:50 – 15:35	*CPTU derived parameters in clay* - **John Powell**, Consultant
15:35 – 16:05	*Unexploded Ordnance – CPT for UXO*
16:05 – 16:20	Summing Up and Close

Day 2

08:30 – 09:00	Coffee
09:00 – 09:25	*Experience in other soil types (silt, chalk, peat ++)* - **John Powell**, Consultant
09:25 – 09:50	*Full flow penetrometers for increased accuracy in very soft clays* - **Tom Lunne**, NGI
10:00 – 10:35	*Other sensors; seismic cone, cone pressuremeter, nuclear density probes* - **John Powell**, Consultant
10:35 – 11:00	*Application of other sensors – geo-environmental, video cone, electrical resistivity* **Darren Ward**, In Situ Site Investigations
11:00 – 11:15	Coffee break
11:15 – 12:15	*Direct application of CPTU results: pile bearing capacity, compaction control, monitoring of reclaimed land, liquefaction potential* - **Tom Lunne**, NGI
12:15 – 13:00	*Applications of CPT for offshore design* - **Peter Allen**, Geomarine
13:00 – 14:00	Lunch and Equipment demonstrations
14:00 – 14:30	Examples and case histories - **Tom Lunne**, NGI
14:30 – 14:45	*Sampling with PCPT equipment* - **John Powell**, Consultant
14:45 – 15:30	Prepared contributions/questions from participants
15:30 – 15:45	Summing Up and Close

Speakers

Tom Lunne, Expert Adviser NGI, Discipline Leader of Offshore Soil Investigations, Offshore Geotechnics
Dr John Powell, Technical Director, Geolabs and Independent Consultant
Darren Ward, Managing Director, In Situ Site Investigations
Dr Peter Allan, Managing Director, Geomarine
Brian Georgious, Geotechnical Manager, Gardline Geosciences

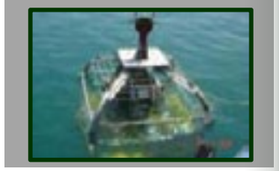
Event Sponsors

IN SITU SITE INVESTIGATION

GARDLINE GEOSCIENCES

geo marine

LANKELMA



www.equipetraining.co.uk

Equipe Training Limited, Home Farm Offices, The Upton Estate, Banbury, Oxfordshire, OX15 6HU

Tel: 01295 670990 Fax: 01295 678232 Email: info@equipetraining.co.uk

an introduction

Welcome to the October edition of **theGeotechnica**.

This month's edition of **theGeotechnica** is packed with interesting articles to suite everyone. Continuing our publication of the speakers talks from this year's Geotechnica we have Alex Kidd's review of the future programme for the Highways Agency and their plans for the road network going forward, this has to be some good news for site investigation practitioners.

In our Environmental section we have published the advice given by the AGS on the control of asbestos, a real issue for anyone who needs to work on brownfield sites. Along the same lines we also look at occupational health and safety and the responsibility of the employer to his staff. This article gives some valuable guidance on what the employer needs to provide. So if you are an employer this article is a must.

There is also some good news for those who are thinking of starting an NVQ or perhaps are considering a programme of NVQ's for their staff, our article under Training explains how funding is available for eligible candidates. This article also discusses the range of NVQ's which are now available.

This month under our Products and Innovations section we have a very interesting article on the use of LiDAR and how it can provide the ultimate in survey data. Whilst in the Drilling section we feature a new modified Sonic rig which is poised to challenge the UK Ground Source industry.

As you can see we have another great selection of articles but we are always looking for more so if you have something interesting to say, a case history or new technique which you would like to tell the world about, then let us know.

If you want to make a contribution of an article to **theGeotechnica** just send it to magazine@geotechnica.co.uk and provided it's content is applicable and not defamatory or blatant advertising we will publish your article.

Contents: What's in this issue?

Do not forget to place your advert with us, in today's tough times its important to let people know what you do and the best way to achieve this is by adverting your services to a receptive audience. **theGeotechnica** offers this platform at very competitive rates. We will also carry adverts for recruitment and items for sale or hire.

geotechnical

contents

Continuing in **theGeotechnica**'s series of articles inspired by the talks held at this year's Geotechnica is Alex Kidd's article on the future of the UK motorway network. Here, Alex discusses what is likely to change in the near future.

The Highways Agency is responsible for operation and stewardship of the strategic road network in England with an estimated value of over £81 billion at present day prices. It carries a third of all road traffic in England and two thirds of all heavy freight traffic. The two main activities are roads improvement and ongoing maintenance of the asset.

Following the Comprehensive Spending Review in October 2010 the Government announced plans to invest £2.3 billion on major improvements through to the end of 2014/15. This figure included £1.4 billion to commence 14 new schemes over the next 4 years. As part of this commitment there is a need to reduce

"As part of this commitment there is a need to reduce the cost of the schemes by 20%..."

the cost of the schemes by 20% against agreed baseline estimates. The majority of the schemes i.e. 11 out of 14 are Managed Motorways.

In addition, commitment has been given to continue work on another 18 schemes for potential construction in future spending review periods and a small number of these will be advanced through statutory processes and design work as "reserve" schemes. More information can be found on the HA website www.highways.gov.uk.

As well as major improvements HA manages the network by means of 13 Managing Agents who are each responsible for maintenance of the network in their specific area. In addition, sections of the network are managed by DBFO companies.

Scotland, Wales and Northern Ireland also have their own road projects, maintenance requirements etc. and details can be seen on their respective websites.

One of the most significant studies relating to costs published in the last few years is the Infrastructure Cost Review which was a wide-ranging investigation into how to reduce the cost of delivery of civil engineering works for major infrastructure projects.

Evidence confirmed that the UK appeared to be more expensive then the European peer group and that there are significant opportunities to reduce costs in

"Higher costs are mainly generated in the early project formulation and pre-construction phases and there are a number of contributory factors..."

delivery of infrastructure. Higher costs are mainly generated in the early project formulation and pre-construction phases and there are a number of contributory factors including :

- Stop-start investment programmes and lack of a visible and continuous pipeline of forward work;
- Lack of clarity and direction, particularly in the public sector, over key decisions at inception and during design;
- Management of large infrastructure projects and programmes within a quoted budget rather than lowest cost for required performance;
- Over-specification and tendency to apply unnecessary standards, using bespoke solutions rather than off-the-shelf designs which will suffice;
- Lack of targeted investment by industry in key skills and capabilities.

Addressing these issues is likely to deliver significant benefits in both performance and value for money.

The Review identified that there is a clear opportunity to realise savings of at least 15% which could deliver sustainable benefits of £2 to 3 billion per annum based on a conservative estimate of £15 billion per annum for infrastructure renewals and capacity enhancement input in 2011-15 of which roads account for approximately 20%.
Subsequently the Government has now published an

"Government has now published an Implementation Plan closely followed by a construction Strategy..."

Implementation Plan closely followed by a construction Strategy and a Charter with the aim of changing behaviours and working practice for infrastructure delivery.

So what is the potential impact on geotechnical engineering and where can the industry help in providing savings of 15-20%? I would argue virtually everywhere given that the main elements of highway infrastructure rely on the ground i.e. pavements, structures, earthworks etc..

Some possible geotechnical efficiencies are:

- Better risk management;
- Improved investigation;
- Leaner construction;
- Fewer standards
- Sustainable design
- Qualified staff

Within the Highways Agency and sister organisations in Scotland, Wales and Northern Ireland geotechnical risk is managed using HD22/08. This has been in place since 1992 albeit with a couple of revisions to

bring it up to date and relies on a series of key documents i.e.:

- Statement of Intent
- Preliminary Sources Study Report
- Ground Investigation Report
- Geotechnical Design Report
- Geotechnical Feedback Report

All submissions are accompanied by a Geotechnical Certificate which states that solutions to all reasonably foreseeable geotechnical risks have been incorporated and this is signed off by the relevant Overseeing Organisation.

Although this is a well-honed process the question could be asked whether it adds any real value or whether it could be used more widely across industry ?

Risk is not simply related to new construction but is also relevant for the existing infrastructure and the methodology is set out in HD41 which complements HD22.

Investigation could be improved by a number of initiatives e.g.

- Strict adherence to BS EN 1997-2 and associated standards such as BS EN ISO 22475.
- Greater reliance on existing data e.g. HAGDMS but who will take responsibility for this information and its interpretation.
- More targeted investigations of high quality and greater use of in situ techniques.
- A single national specification for investigations.
- Greater use of national frameworks e.g Envi-

ronment Agency

Leaner construction could embrace some or all of the following:

- More use of alternative materials such as glass, compost, tyres, IBAA etc. which may not fit existing specifications but can be made to work if all parties are suitably engaged at an early stage.
- Enhance use of techniques such as stabilisation, helical piles, reinforced soil, soil nailing, spaced piles, pre-cast units etc..
- More cutting edge techniques such as fibre-reinforced soil, electro-kinetic geosynthetics etc.

"The introduction of Eurocodes has lead to a potential reduction in the number of standards within the DMRB..."

The introduction of Eurocodes has lead to a potential reduction in the number of standards within the DMRB and greater reliance on documents produced by BSI including PDs e.g. PD 6694 and BS 8006:2010. The overall aim is to move away from standards development within the HA.

There remains a degree of uncertainty as to what is meant with respect to sustainable design in the field of geotechnical engineering although reduction in the use of concrete, steel, aggregates must be a step in the right direction? The concept of carbon calculation has been introduced by the HA in IAN114 based on work undertaken at the University of Bath but still very much in the data gathering phase at present. We also need to be aware of ongoing issues with respect to climate change.

Finally we need to consider the quality of staff to be employed on geotechnical activities. HA requirements are currently enshrined in HD 22 and HD41 where both the DGA and GMLE roles relate to the geotechnical adviser originally set out in SISG 1993. The recent introduction of RoGEP in June 2011 will require changes to these documents to embrace the new definitions and qualifications. Hopefully other clients will follow suit.

So in summary there would appear to be plenty of opportunities for innovation and efficiency savings within geotechnical engineering over the coming years and hopefully industry will rise to the challenge. ■

Providing new information on regulations surrounding abestos in soil for **theGeotechnica** and its readers are Seamus Lefroy Brooks and fellow members of the AGS.

The AGS is active in establishing industry guidance for asbestos in soils. The CLWG and LPWG have formed a small sub-group to discuss what guidance and advice should be provided for our Members, and to contribute to the work that is currently being undertaken by other groups and associations on this issue.

This article is intended to give Members an awareness of the present situation; what has happened, what is being done and what may be happening in the future. It has been suggested that many of our members, while insured for investigating and providing advice on contaminants, have specific exclusions to their professional indemnity policies in regard to claims relating to asbestos, and this may possibly have indirectly led to a lack of training and awareness about the risks of asbestos in soils.

LEGAL ASPECTS

Attempts by government agencies and independent organisations to define "safe" or "minimal risk" threshold concentration values, either for fibres in soil or for fibres in air, have been thwarted by the scientific evidence that death can be caused by a single fibre.

The current legal rule in relation to Mesothelioma is that any "material increase in risk" is sufficient for legal liability. In a recent appeal court ruling the exposure was judged to be just 18% higher than background levels.

Kitted up: Asbestos contaminated soil

REGULATIONS

The UK, in 1931, was the first country to establish laws regulating exposure to asbestos, primarily to protect the health of factory workers.

Currenty UK Statute is dominated by the Control of Asbestos Regulations (CAR) 2006 which were implemented under the provisions of the 1974 Heath and Safety at Work Act and bring together the three previous sets of Regulations covering the prohibition of asbestos, the control of asbestos at work and asbestos licensing. However, while these regulations are relevant for asbestos in soil, they do not define limits or best practice and there is currently no specific published guidance from either the HSE or the Environment Agency.

"...while these regulations are relevant for asbestos in soil, they do not define limits or best practice..."

TRAINING

The British Occupational Hygiene Society (BOHS) have a series of asbestos-related proficiency qualifications that cover the identification, sampling and management of Asbestos in Buildings.
The development of specific training and qualifications for the contaminated land industry is being actively considered by various bodies and will need to include consideration of the following issues:

- background of asbestos; including health effects
- recognition of debris in soil that may contain asbestos
- procedures to be followed when soil that may contain asbestos is identified
- safe packaging, labelling and handling of soil samples that may contain asbestos
- the nature of operations that could result in exposure to asbestos
- proper use, handling and disposal of personal protective equipment (PPE)
- personnel decontamination
- equipment cleaning

FIELDWORK AND SITE WORK MANAGEMENT

All personnel either organising fieldwork or inspecting and/or handling suspected asbestos-contaminated soil or being exposed to soil-disturbing activities at sites where there is a risk of asbestos-contaminated soil being encountered must be able to demonstrate an appropriate level of awareness of the risks associated with asbestos-contaminated soil.

The first step is to identify the potential for asbestos at a site by studying the site history and to exercise an appropriate level of caution. Asbestos may be expected within the demolition rubble from former buildings, in association with buried heating pipework and ducts, or simply within fly-tipped materials. Asbestos Containing Materials (ACM) have been in use since 1834 but were most widely used between the 1950's and the 1980's. The use of ACMs was not banned until 1999.

"Asbestos may be expected within the demolition rubble from former buildings..."

The potential for fibre release from ACM in damp soil may be limited, but if the site is dry and dusty, fibres may readily become airborne.

In addition to artificially damping down dust down drilling or trial pitting activities, the following PPE can be considered:

- Boots that can be easily washed down.
- Disposable overalls(type 5) fitted with a hood
- High efficiency disposable particulate air respirator (FFP3)
- Disposable Gloves
- Goggles

Possibility: Taking samples

Any suspect fibrous material or any cement / board type products which have evidence of fibres within them should be considered to potentially contain asbestos and samples must be taken for subsequent laboratory confirmation. All samples should be double-bagged with both the sample container and outer bag labelled as potentially containing asbestos so that the laboratory can take all the necessary precautions to prevent exposure to their staff.

"All samples should be double-bagged with both the sample container and outer bag labelled..."

Asbestos may occur as:

- Sprayed coatings and wrapped lagging used for thermal & fire protection,
- Insulating boards, wallboards and ceiling tiles used for fire protection, thermal and acoustic insulation
- Profiled and flat roofing sheets, partitioning boards and decking tiles
- Bitumen products, mastic pads, roofing felts gutter linings
- Ropes and yarns
- Cloth mats, fire blankets
- Millboard and paper, general heat insulation

- Flooring, thermoplastic, PVC floor tiles, mastics, sealants etc
- Textured coatings e.g. artex
- Bakelite

LABORATORY ANALYSIS

"...a large proportion of soil samples are put through laboratories without any formal screening..."

Unless a formal screening is requested by the person commissioning the laboratory testing, the laboratory will simple carry out a visual check. There is an issue here in that a large proportion of soil samples are put through laboratories without any formal screening and it has been conjectured that significant percentages of made ground samples are passing through both geotechnical and analytical laboratories with undetected asbestos.

Most labs provide a tiered approach involving screening, identification and quantification:

- Basic screening: examined under an optical microscope with magnification of x2 to x5
- Detailed screening: ditto with magnification of x10 to x40
- Identification: Polarised Light or Phase Contrast Microscopy (PLM or PCOM)
- Quantification: Gravimetric (typical LoD 0.1%) *
- Quantification: Sedimentation and Fibre Counting (typical LoD 0.001%)

*The Gravimetric quantification method is currently being phased out.

Bagged: Contaminated soils

EXISTING GUIDANCE

Current UK workplace regulations for asbestos in air have a single Control Limit (max. concentration of fibres in the air averaged over a 4 hr period) for all types of asbestos of 0.1 fibres per cm3 (100 000 f/m3). The World Health Organisation indicate that 1000 f/m3 is associated with a 10-6 to 10-5 risk of lung cancer in a population where 30% are smokers and 10-5 to 10-4 risk of Mesothelioma.

ICRCL Guidance Note 64/85 "Asbestos on Contaminated Sites" (1990) is still the most current guidance for asbestos in soil and suggest asbestos fibres should be <0.001% w/w.

Waste Soil containing >0.1% w/w asbestos is classified as hazardous waste.

"The key issue in assessing risks from asbestos in soil relates to modelling the exposure."

The key issue in assessing risks from asbestos in soil relates to modelling the exposure. It is not possible to use the CLEA model to calculate exposure and no reliable quantitative relationships between factors which affect asbestos fibre concentration in air and asbestos concentrations in soil are known.

There is some consensus between the UK (ICRCL), Dutch and Australian Guidance on the use of a threshold of 0.001% as a threshold for asbestos in soil. The Dutch Guidelines consider the risk from Chrysotile to be ten times less than Amphibole asbestos but the HSE, WHO, the Australian DoH and the USEPA have chosen not to distinguish between different asbestos fibre types.

contents

"For bound asbestos there is recognition that the potential generation of asbestos fibres is much lower..."

For bound asbestos there is recognition that the potential generation of asbestos fibres is much lower and hence Dutch and Australian guidance use a threshold ten times higher than that for friable asbestos.

The USEPA use a method based on direct measurement during vigorous activity to assess the soil by measuring ambient air concentrations. A measurement approach is also used in the Dutch guidance.

NEW GUIDANCE

It is believed that the Environment Agency and the HSE have in recent years collaborated to prepare new draft guidance for asbestos in soils in the form of a document entitled 'A Study to Derive Soil Guideline Values for Asbestos in Soil'.

It was rumoured that this draft guidance recommended use of a strategy based on the Dutch approach for the assessment of soil contamination with asbestos. However, the EA have seemed reluctant to publish this document, and despite a recent Freedom of Information request by the EIC it is now not expected to emerge, being instead superceded by a forthcoming update to the HSE document HSG248 (2005) 'Asbestos: The analysts' guide for sampling, analysis and clearance procedures'. Public consultation on this HSE document is awaited.

THE FUTURE

"The AGS are supporting a current EIC incentive to develop best practice industry guidance..."

The AGS are supporting a current EIC incentive to develop best practice industry guidance with input from the EA / HSE / HSL/ BOHS and CL:Aire. A CIRIA project has also been launched with similar goals so we may at present end up with two (or more!) pieces of industry guidance. For the immediate future there is planned to be a workshop organised by CL:Aire in association with EIC & BOHS at the Manchester Conference centre on the 1st November 2011. ■

drilling

contents

Coresource Ltd. is an Isle of Wight based land drilling company servicing the UK and Europe. Newly formed in July 2010, the company has taken the last year to customize a compact crawler mounted state-of-the art drilling rig which was delivered to the Island in June 2011. Steve McLoughlin, Director or Coresource and Steve Thorpe, Geologist for BGS speak to **theGeotechnica** about the use of the new sonic drill rig to help unravel some of the complex Isle of Wight geology.

The geology of the Isle of Wight is possibly one of the most fascinating and diverse in England. The level of folding and faulting has resulted in a number of rocks being up-ended and eroded back to create the amazing variety, seen at places like Alum Bay and Whitecliff Bay, where the vertically stacked beds of Upper Cretaceous and Palaeogene strata clearly show the

"The geology of the Isle of Wight also presents various geohazards..."

different depositional history of the island. The geology of the Isle of Wight also presents various geohazards, with landslides being a major concern to many island dwellers. The area around Ventnor and Niton is particularly prone with numerous active landslides that cause road and building damage on a yearly basis.

The British Geological Survey were invited to oversee the drilling of a borehole at Niton. The unique difference about this drilling was that the rig was a sonic drill, capable of drilling much quicker than a normal rotary setup.

Work on the Isle of Wight

The drilling rig used was a modified Sonic SDC 450, manufactured by Sonic Drilling of Vancouver. The 450 has a smaller footprint rig than the SDC550, but is equipped with the same 50k Sonicor drill-head. Powered by a CAT C7 engine generating 250 HP of peak power, what makes the rig unique is not only its potential speed, but its environmental friendliness. Equipped with rubber caterpillar tracks and a semi-sealed drilling fluid circulation system, the rig can be moved onto location, drill one or more wells, creating less site impact than conventional rotary mud flush rigs.

The rig carries 110m of 5-1/2" (139.7mm) Sonic drillpipe, or 280m of 3" (76.2mm) drillpipe. The design remit was to give as much versatility to the drilling package as possible, while retaining flexibility. The rig is equipped with a telescoping rod-rack walkway which elevates the working position of the assistant driller so that he can safely and effectively handle the drill rods from the rod-rack without difficulty.

The rig was put through coring trials at Niton on the Isle of Wight where a 95m cored borehole was made. Large portions of the southern side of the Isle of Wight are what is locally termed "the Undercliff". The Undercliff is the largest inhabited area of landslide in Europe. Although, historically, there had been significant drilling activity it had all taken place on the Undercliff landslip areas, to date there had been no drilling of the undisturbed formation.

The BGS runs a drilling program as part of its in-house services, but the opportunity to see a sonic rig in action was too good to miss. It also allowed the BGS the chance to offer any advice to the drillers in

"... seeing core and being able to identify the strata is one of the core skills of many BGS staff."

terms of core retrieval, curation, storage and transport. Finally, seeing core and being able to identify the strata is one of the core skills of many BGS staff.

Steve Thorpe, explained that the drilling site was chosen because the geology provides some insight as to why landslides occur in this area. Steve McLoughlin, added that conventional wisdom was that the primary reason for the existence of the landslips was a slip-plane created by the interface of the notorious Gault Clay with overlying Greensand. To test this theory a borehole was drilled at Niton to obtain core of the undisturbed formations.

At work: New Sonic rig

The sequence comprises Upper Cretaceous Chalk (here the West Melbury Marly Chalk Formation) overlying the Upper Greensand, both of which are permeable and allow surface and groundwater to flow freely between them. These two units are then underlain by the Gault Clay, a stiff grey highly plastic mudstone which is impermeable and acts as a barrier to water passage. This means that the water must find an exit route and this is usually along the upper surface of the Gault Clay to the cliff edge where seepage can be seen. The water raises the pore pressure in the Gault Clay and reduces its strength thus creating an ideal sliding medium on which the overlying rocks move outward, thus causing failure of the cliff.

The core was taken in relatively challenging strata, and included Lower Chalk, Upper Greensand and Chert Beds, Gault Clay and Carstone. All cores were taken using a modified double wall 5m long SWF core-barrel with PDC core bit and equipped with a plastic core retaining sleeve which produced 112.8mm diameter core.

The Chalk was cored at a rate of 5 metres in 15 minutes. Subsequent examination of the core showed that there was a 4" thick massive chert section within the Chalk which the rig had no difficulty in coring.

Nearby boreholes which had been constructed by the local water authority had shown the Upper Greensand to be a challenging drilling environment, however, the Sonic drill continued coring with no sign of slowing down. The remainder of the Upper Greensand – some 35 metres was cored at similar rates of penetration down to the Gault Clay. There had been some concerns, based on hearsay, that the Sonic drill would have difficulties in the clay formation, however, the upper Gault formation proved to be saturated and amorphous, while the lower Gault, having been isolated from water was dry and consolidated. Neither of these clay types slowed the rate of progress. At no time during the job did a single 5m core take more than 15 minutes to drill. The final horizon to be cored was the Carstone which was cored at similar rates to the rest of the drilling.

"The Sonic rig has demonstrated that it is capable of drilling complex and difficult strata..."

The Sonic rig has demonstrated that it is capable of drilling complex and difficult strata and provide full recovery of the entire cored sequences. Proving Sonic drilling is a useful technique to enable the identification of the stratigraphic sequence and at a much quicker rate than conventional coring methods.

The idea of drilling the borehole was to provide data to the islands expert geologists and the BGS alike to allow them to inform the decision makers where to drill holes into the cliff to dewater it. This will reduce the groundwater in the rocks themselves and therefore reduce the risk of future landslides. The core is now in the hands of the British Geological Survey where it is being subjected to detailed analysis and we and the islanders await their findings. ■

how healthy is your business?

safety issues

contents

Writing for **theGeotechnica** *for the fourth time,* Tom Phillips*, an independant chartered occupational safety professional from* RPA Safety Services*, offers advice to businesses about their duty to prodive adequate health and safety training to all of their staff.*

When I say health, I don't mean financial health, but employee health!

I would also argue the two are inextricably linked though, and that the occupational health of your business has a financial impact greater than the sum total of the costs related to 'accidents'. Around 2.1 million people are currently suffering from a work related illness and every year, lost time due to occupational health failings are four times that related to accidents.

In addition to the financial impact, there is a legal responsibility. We mustn't forget the importance of Health, as outlined in the Health and Safety at Work Act. Duties of the employer are also explicitly outlined in many of the general regulations such as the control

"Pressure is also growing through the commercial route because if you can't demonstrate you have a robust occupational program, you will soon find yourselves unable to tender for work..."

of noise at work regulations and COSHH. Pressure is also growing through the commercial route because if you can't demonstrate you have a robust occupational program, you will soon find yourselves unable to tender for work with main contractors and local government. For example if you wish to apply for CHAS registration, then health surveillance is a major hurdle to overcome.

So how much focus do businesses place on the health of their staff? Estimates from the Health and Safety Executive, suggest the balance for focus of resources within the construction supply chain are 95% safety and 5% Health – despite the disparity in knock on costs.

Firstly it is important to define what we mean by

"Unlike safety, health issues are more likely to be chronic in nature rather than acute."

health. Unlike safety, health issues are more likely to be chronic in nature rather than acute. Symptoms gradually get worse through repeated exposure to hazards over a period of time, where safety issues tend to happen as an immediate and direct result of contact with a hazard. It is this fact that causes companies to focus mostly on safety and why employees are less likely to take the control measures seriously.

Typical examples of health issues encountered within the geotechnical industry would include occupational hearing loss through repeated exposure to loud noise, diminished lung function through long term exposure to dusts or musculoskeletal injuries caused by repetitive lifting of heavy items using awkward postures – to name but a few. It could equally apply to stress or the musculoskeletal results caused through the prolonged use of computer equipment. Of great concern at the moment, with impending focus on asbestos levels in soil and the increasing use of reclaimed materials, are the long term effects of exposure to asbestos – an occupational health issue which claims over 5000 lives a year.

"Main contractors are becoming more proactive in assessing the health performance of their contractors..."

Main contractors are becoming more proactive in assessing the health performance of their contractors because they are being tasked with doing so by the Health and Safety Executive and by their clients. With the majority of civils projects being commissioned by public sector bodies, or those who answer directly to them, the pressure is on to recognise moral obligations toward health. There is a growing trend for main contractors to demand proof that occupational health checks are being carried out by contractors before work starts and there are even moves afoot to incorporate these records with CSCS cards. In the future it could mean no health checks, no work!

So what do you need to do? We suggest a business a health check!

Consider those elements which affect employee health and ask yourself if you are happy with the control measures you have in place and their effectiveness? This should not apply solely to site staff but also to laboratory and office employees who are equally likely to suffer ill health at work. I always find it concerning that the majority of emphasis is on site safety with laboratory staff often treated as second class citizens, when it comes to health and safety.

"Once we have identified the hazards, the law then demands we address them."

Once we have identified the hazards, the law then demands we address them. If control measures are unlikely to eliminate the hazard or reduce it's emission to acceptable levels, then we will need to monitor employee health. We are not allowed to assume that personal protective equipment is working, we have to make sure, as far as we can, that it does and monitor effectiveness through occupational health.

So what might a successful health management process look like? Let's take exposure to dust as an example, encountered by laboratory staff as a result of sieving and grading – a commonly demanded geotechnical test.

Initially the type of dust produced has to be identified. General 'dust' has quite a relaxed control limit but if the dust incorporates crystalline silica then this can be as low as 0.1mg/m3 – almost at the limits of measurement. Once identified, monitoring the amount in the air using sampling equipment becomes important. This requires specific equipment and is generally undertaken by occupational hygienists.

"Extraction normally becomes necessary, in fact almost mandatory..."

Control measures must then be considered. Extraction normally becomes necessary, in fact almost mandatory, with the use of half mask respirators being discouraged in favour of effective engineering controls. The extraction then needs to be effectively maintained and examined every 14 months by a competent person and re-sampling should then be carried out to determine the effectiveness.

If masks are required, then the staff who wear them must be fit tested by specialists to ensure they are effective. This is fairly simple and is a necessary part of the Approved Code of Practice (ACoP), but generally neglected by employers.

Finally, there must be an effective health surveillance program for the laboratory staff. Spirometry testing to ensure lung function is being maintained would be applicable in this particular case, with any staff show-

Fitting: Dust masks

how healthy is your business?

safety issues

ing reduced capacity referred to a specialist physician for further investigation.

So what happens if a company fails to comply with these occupational health requirements? Cases of occupational disease are notifiable through the RIDDOR regulations and HSE inspectors are obliged to visit companies, which report a new case of an occu-

"Failure to implement suitable control measures and health monitoring systems is enforceable..."

pational disease. Failure to implement suitable control measures and health monitoring systems is enforceable, with prohibition notices issued to prevent further occurrence. This then becomes a matter which requires declaration on client assessment forms, often double checked by clients using the HSEs online prosecution database to ensure honesty.

Can a company get away without reporting? There is a high likelihood of being caught and prosecuted for failure to report if you don't, as those suffering from

"The medical evidence from the diagnosing physician will be requested by the claimants' solicitors, as will evidence of your occupational health measures."

work related ill health will be entitled to make a civil claim. The medical evidence from the diagnosing physician will be requested by the claimants' solicitors, as will evidence of your occupational health measures. Your insurers will be asked to provide evidence of cover and will begin their own investigation as they already assume you are carrying out your legal obligations. Should you be found to be in contravention, you may find your insurance cover withdrawn or your premium dramatically increased for the future.

So having read this article, how healthy do you consider your business? ■

contents

With over 35 years experience as a chartered geologist, Pete Reading now finds himself a technical director of Equipe Training. Here Pete writes once again for **theGeotechnica** *about the value of NVQs, the range of qualifications available, and also new funding available to candidates.*

In the drilling world the NVQ has been around for some time and is now a prerequisite to obtaining a CSCS card for the disciplines of Land Drilling at both Lead Driller and Drilling Support Operative (what we know as the second man). But what about NVQs for other geotechnical and geo-environmental personnel such as site supervisors, geotechnical laboratory technicians, environmental laboratory technicians, CPT operatives and field technicians? All these personnel can achieve NVQ qualifications relevant to their job roles.

"...over the past year, we have seen a rise in demand for NVQs for laboratory and field technicians..."

We are all familiar with the more traditional NVQs where the CSCS card is the driver for companies and individuals to seek the qualification. However, over the past year, we have seen a rise in demand for NVQs for laboratory and field technicians, at both Level 2 and Level 3. In addition, the first Level 3 NVQ for Occupation Site Supervision has been awarded. The drivers for carrying out these NVQs are not so obvious.

Traditionally most employers use an in-house system of assessment of competency for their laboratory and field technicians. Some would argue that the UKAS accreditation is sufficient however this does not recognise the level of competency of the individual technician but provides an assessment of the company's ability to carry out tests in accordance with a documented method using suitably calibrated equipment. Now the NVQ system gives us a system by which the ability and competence of the individual can be assessed and recognised. The system also enables career progression with NVQs at both Level 2 and 3 being available.

But it takes more than just the award of an NVQ to an employer to encourage them to embark on the NVQ system for their technicians, so what are the drivers that are encouraging employers to go down this route? Since the publication of Eurocode 7, there has been a steady adoption of the principles of the codes, one of these is that each person who carries out a task should have an externally measurable level of competence, (BS EN ISO 22475 part 2). By enlisting technicians onto the NVQ process employers are making a statement to their clients and employees that they are embracing the ethos of the Eurocode philosophy. This sends out a positive message that sets the laboratory apart from others, which in these difficult times is a differentiator which gives clients some added value.

"...what are the drivers that are encouraging employers to go down this route?"

"The whole system will also demonstrate to UKAS that the employer is improving his staff competency levels..."

In the laboratory there is an added benefit that the NVQ can be used to give some structure to the laboratory hierarchy. This is particularly relevant where both Level 2 and Level 3 qualifications are undertaken. The whole system will also demonstrate to UKAS that the employer is improving his staff competency levels using an external assessment system.

NVQ Laboratory Training

The driver for a supervisory NVQ should be a little easier to determine; under CDM regulations every supervisor must be suitably trained and competent and this year has seen the first completion of a Level 3 Occupational Working Supervision NVQ within the geotechnical industry. This NVQ is the only qualification to provide a measure of the competency of the individual who is carrying out this very important role. The NVQ process has been with us for many years and has a proven track record for providing a qualification and measure of competence for many who have not progressed down an academic route either before or during their career.

"This NVQ is the only qualification to provide a measure of the competency of the individual who is carrying out this very important role."

NVQs delivered into the geotechnical and drilling industry have been created and developed to better represent the industry and are delivered as an OSAT, On Site Assessment and Training, NVQ. Very importantly, this means the NVQ is assessed in the workplace and the candidate is visited by the assessor. Assessment techniques such as visual observation and questioning are used to assess competency as well as taking into account prior learning and work history. Throughout the process, the assessor works with the NVQ candidates to produce evidence against set criteria within units of competency which make up that individual's NVQ. The training part of the NVQ is based upon the candidate's ability to meet the criteria and is completed where areas require strengthening. As a condition of funding at least 8 hours of training must be identified and undertaken.

"Very importantly, this means the NVQ is assessed in the workplace and the candidate is visited by the assessor."

Each NVQ has a series of mandatory units covering very important topics such as health and safety, communication skills, document control and interpersonal skills. The NVQ is completed by the individual choosing a combination of further optional units which can be adapted to his specific job role and work environment. For example, laboratory and field technicians can cover both manual and automated test methods, sample preparation and sampling methods as well as equipment maintenance.

Hands on: NVQ Training

In conclusion, the NVQ system is a very powerful method to prove competency of an individual and the assessment and training process assures the qualification is relevant. The geotechnical and drilling industry is embracing the system as it looks at the individuals job role in it's entirety and satisfies both employers' and client's responsibilities and duty of care to use trained and competent staff. Other drivers such as compliance to Eurocode cannot be under estimated and should be embraced to improve the standards all round.

For companies which are contemplating putting their staff through the NVQ process; Equipe would be happy to discuss the opportunity of funded NVQs which for many could mean FREE NVQ's. ■

Field Instrumentation in Geotechnics

16th and 17th November 2011

at The Drilling Academy, nr. Banbury

FREE TO ATTEND

Programme

Day 1

08:45 – 09:15	Registration and Coffee
09:15 – 09:30	*Welcome and Introductions* – **Pete Reading *et al***
09:30 – 09:50	*Introduction of Participants* (audience participation)
09:50 – 10:05	*Engineering is a Risky Business* – **Pete Reading**
10:05 – 11:20	*Systematic Approach to Planning Monitoring Programmes*, **John Dunnicliff**
11:20 – 11:35	Morning Break
11:30 – 11:45	MOGE & *GIN*, **John Dunnicliff**
11:45 – 12:45	*Overview of Hardware – Part 1*, **John Dunnicliff**
12:45 – 13:15	*Monitoring the Performance of Infrastructure Embankments*, **Dr Andrew Ridley**
13:15 – 14:00	Lunch Break
14:00 – 14:45	*Vibrating Wire Instruments – an Overview*, **Tony Simmonds**
14:45 – 15:15	*When, where and how to specify vibrating wires + Case Study*, **Rory O'Rourke**
15:15 – 15:30	Afternoon Break
15:30 – 16:00	*Ensuring appropriate monitoring specifications*, **Mike Devriendt**
16:00 – 16:30	*Training and Competence*, **Nick Slater**
16:30 – 16:45	Summing Up and Close

Day 2

08:45 – 09:00	Coffee
09:00 – 10:00	*Overview of Hardware – Part 2*, **John Dunnicliff**
10:00 – 10:30	*Tottenham Court Road / The Shard*, **Aidan Laimbeer**
10:30 – 10:45	SAA Demonstration
10:45 – 11:00	Morning Break
11:00 – 12:00	*Workshop - Planning a Monitoring Programme for an Embankment on Soft Clay* **John Dunnicliff**
12:00 – 12:30	*Use of Robotic Total Stations in Geotechnical Applications*, **Nick Russill**
12:30 – 13:30	Lunch and Equipment demonstrations
13:30 – 14:35	*Load, strain and stress applied + Blackfriars Case Study*, **James Gale**
14:35 – 15:05	*Other Technologies*, **Tony Simmonds**
15:05 – 15:20	Afternoon Break
15:20 – 16:10	*Wireless technologies moving forward*, **Grant Taylor**
16:10 – 16:40	*Data handling, storage and web based monitoring Systems,* **Dr Roger Chandler**
16:40 – 17:00	Summing up and close

Speakers

John Dunnicliff, Independent Instrumentation Consultant
Dr Andrew Ridley, Managing Director, Geotechnical Observations
Tony Simmonds, International Projects Manager, Geokon Inc.
Rory O'Rourke, Managing Director, Datum Monitoring
Mike Devriendt, Associate, Arup
Nick Slater, Business Development Manager, ITMSoil
Nick Russill, Managing Director, TerraDat
Aidan Laimbeer, Commercial Manager, Sol Data
James Gale, Strainstall
Grant Taylor, Geosense Division Manager, MGS
Dr Roger Chandler, Managing Director, Keynetix

Event Sponsors

GeO Geotechnical Observations
Strainstall
itmsoil
GEOSENSE






www.equipetraining.co.uk

Equipe Training Limited, Home Farm Offices, The Upton Estate, Banbury, Oxfordshire, OX15 6HU

Tel: 01295 670990 Fax: 01295 678232 Email: info@equipetraining.co.uk

does your laboratory pass the data entry challenge?

contents

Roger Chandler, Director of Keynetix, continues his seriesof articles for **theGeotechnica**. Here, Roger discusses the benefits of effcient data entry for laboratories.

Many years ago I came up with the two golden rules of data entry at one of our user group meetings and these two rules are now widely quoted in data transfer presentations both by me and others. Recently I have added a third rule, and a simple challenge, on which the majority of laboratories fail.

The first rule is "only enter data once"

This golden rule can be used in all aspects of your daily work and is very simple. If you enter an item of data in a system you should be able to transfer it out of that system and into another one if needed. Hence you shouldn't need to type the data again.

"If you enter an item of data in a system you should be able to transfer it out of that system and into another one if needed."

If you look at any of your business processes within your company I would bet that this rule is broken many times each day, not just with laboratory data but for all types of information.

The second rule is "get someone else to do it"

This rule is usually seen as an attempt at humour but it is even more important than the first. Typing data into a system is expensive. Not only does it take time to enter it but there should also be considerable time taken to check that no mistakes were added during the entry process.

Secondly this rule can be related back to the first rule. If that data has already been entered into a system then the "only enter data once" rule should already be in effect and the data could have been imported into the borehole logging program. If this had been done then neither the engineer nor the data entry clerk had to type it in, resulting in significant time savings.

The third rule and data entry challenge.

The third rule is simply a different way to present the two rules already defined and it is: "Only enter the data that you created".

To illustrate this rule I will use the example of sample data and laboratory results. In this example there are two companies, the client who is on site creating the samples and the laboratory that are creating results for the samples. Hopefully when the two pieces of this puzzle are fitted together they will join easily and we will be able to determine which samples had which results recorded.

According to our 3rd rule, who should enter the sample data?

The client should create the data because they created the sample, and because they already understand the first two rules they passed this data to the laboratory.

So who should enter the test results?

Not too difficult I hope. The lab should of course enter the results as they created the tests and, therefore, should enter the results. (Note to consultants:- you should not need to re-enter this data into your system!)

So now the rules of the challenge have been laid out here is the challenge itself:

The Challenge

Does your lab ever have to enter your client's sample references into your laboratory system or worksheets? If you have answered "yes" then I am afraid you have failed the challenge. Don't worry you are in good company. The majority of labs are still spending a small fortune manually typing data into their systems or spreadsheets despite the majority of their clients being able to send the data in AGS format and geotechnical laboratory management systems such as KeyLAB 2 being available.

"The majority of labs are still spending a small fortune manually typing data into their systems or spreadsheets..."

The launch of the AGS4 data format has increased the opportunity to get your clients to schedule and provide full sample information and chain of custody electronically and in the next issue I will cover how laboratories can make the most of this new capability. In the meantime I look forward to hearing from anyone who failed the challenge on what stopped them passing it.

Dr Roger Chandler is the Managing Director of Keynetix and started work on KeyLAB in 2000 having witnessed first hand the number of times data was entered into client laboratory spreadsheets. Keynetix have released KeyLAB 2 this month. For more information visit www.keynetix.com/keylab ■

2mm at

LiDAR scanning for geotechnical analyses
products and innovations

contents

Writing for **theGeotechnica** for the first time is Adrian Wilkinson, Geotechnical Director of QuarryDesign Ltd. Here, Adrian discusses remote geological and geotechnical mapping using a long-range high-density LiDAR scanner.

In many situations (high quarry faces, highway / railway cuttings and coastal cliffs to name a few), the collection of representative geological and geotechnical data has been difficult to obtain safely and thus in some situations the analysis and subsequent design criteria could be flawed.

This paper outlines an integrated approach to geotechnical data collection using a long-range high-definition LiDAR (Light Detection and Ranging) scanner and specialised geotechnical analysis software to acquire and interpret rock-mass data from distances of up to 1,700m from the feature being assessed.

The approach outlined in this paper, not only provides for remote geotechnical data collection, but also enables highly detailed "surveys" of the faces to be obtained that can be retained as a permanent record of the condition of the faces on the day of the assessment. Comparing successive LiDAR scans also enables detailed monitoring of rock faces and soil slopes to be undertaken in situations where traditional surveying techniques would be challenging.

"Comparing successive LiDAR scans also enables detailed monitoring of rock faces and soil slopes..."

LiDAR Scanning

LiDAR scanning is continually improving with ever faster acquisition speeds, reduced beam divergence, reduced rotational step sizes and increasing ranges. It should be noted that not all LiDAR scanning equipment has the same working abilities. For example, exceptionally high-resolution short-range scanners are being used in Formula 1 racing (to obtain 3D models of cars for computer wind-tunnel simulations) and medium-range 360º scanners are used for internal building and factory surveys. Enhanced-range and Long-range scanners are being employed to undertake coastal erosion monitoring and landslide risk analyses for strategic infrastructure in mountainous areas and the latest 3,000m range scanner from Optech has been developed to work in glacial environments. It is one of Optech's ILRIS_3D_ER scanners that QuarryDesign are employing within the quarrying industry and are using on an increasing number of civil engineering and natural slope features. In essence LiDAR depends on knowing the speed of light, approximately 0.3 meters per nanosecond. Using that constant, the instrument can calculate how far a returning light photon has travelled to and from an object using the equation Distance = (Speed of Light x Time of Flight) / 2. This is done in the following way:

"In essence LiDAR depends on knowing the speed of light, approximately 0.3 meters per nanosecond."

- First, the Laser generates an optical pulse. o The pulse is then reflected off an object and returns to the system receiver.

- A High-speed counter measures the time of flight from the start pulse to the return pulse.

- Finally, the time measurement is converted to a distance by using the formula above.

The acquired distance and bearing data is then downloaded and processed in to local xyz coordinates. Once converted into xyz format, it can then be further processed by stitching together multiple scans to produce a composite model and if survey control points are available, it can be orientated to ordnance grid and datum in the same manner as traditional surveys.

The high density of points that a LiDAR scan produces are commonly referred to as a "pointcloud" and can be processed with either an RGB colour value (Figure 1) from an associated calibrated digital camera, or a greyscale reflected intensity value (Figure 2) from the amount of returned light being recorded back to the scanner after being reflected from the contact feature.

Figure 1 – "Point-Cloud" processed in colour

Figure 2 –" Point-Cloud" processed in "reflectance intensity"

The "point-cloud" can then be subsequently triangulated to create a mesh or wireframe digital surface model (DSM) (which may include vegetation and buildings), or a digital terrain model (DTM) where points above an interpolated ground surface are removed. From these DSM's or DTM's, the relevant data (break-lines, cross sections, meshes, or xyz points) can be exported into other suites of software for the production of plans, or for further geological and geotechnical investigations or analyses.

Geological Mapping

With the high quality models that LiDAR scanning produces, geological features can be delineated, digitised (Figure 3) and exported into geological modelling or GIS software (Figure 4). In the example below, a series of joints have been digitised, but this could easily have been bedding, fold apexes, faults or any of the wide variety of geological features present in a rock face or soil slope.

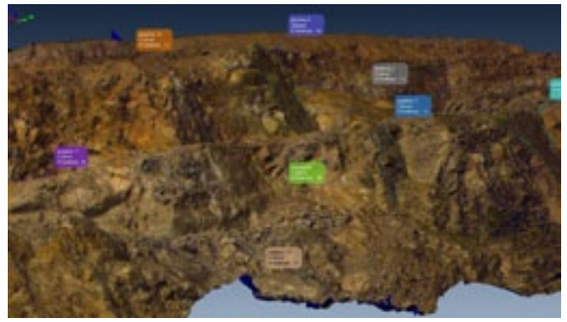


Figure 3 – Geological features (joints) digitised from "point-cloud"

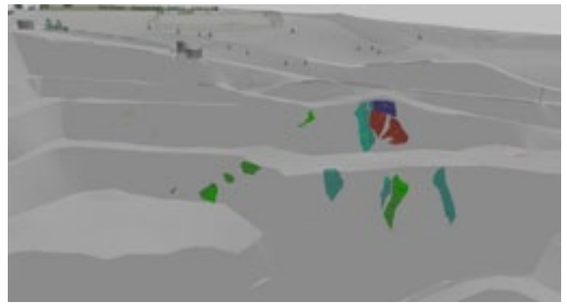


Figure 4 – Geological features viewed in LSS

In addition, it has been found that in certain circumstances, different strata can return different quantities of the originally transmitted light (i.e. they are pro-

cessed with different reflected "intensity" values). For instance, clays, shales and vegetation generally exhibit low intensity values, with a greater amount of the light being absorbed than being reflected. Whereas granites tend to exhibit higher reflected "intensity" values with more light being reflected than absorbed.

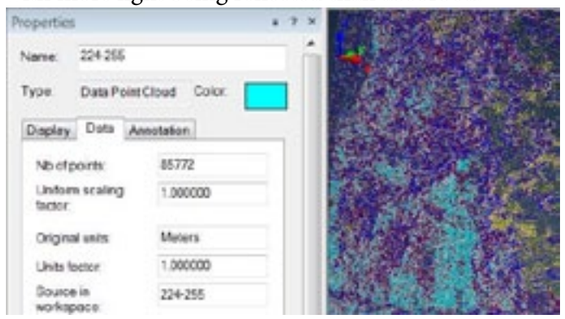


Figure 5 – Geological mapping based upon reflected "intensity" bands

In a similar manner, different grades of weathering of the same material can return different intensity values, with the more weathered material returning lower intensity values than the less weathered material. "Groups" of similar intensity points representing similar grades of weathering can be separated and coloured making the visual analysis easier (Figure 5). The number of points within each group of similar coloured bands can also be summed and expressed as a relative percentage of the total number of points (in effect, producing a point sampling method based upon the exposed surface of each grade of weathered material).

This can be especially informative when coupled with another new technology, namely that of Hyperspectral

"Where LiDAR is an "active" remote sensing technology... Hyperspectral Imaging (HIS) is a "passive" system..."

Imaging (or Imaging Spectroscopy). Where LiDAR is an "active" remote sensing technology (i.e. it sends out a light beam of known wavelength and records the flighttime and reflected intensity). Hyperspectral Imaging (HIS) is a "passive" system and records the light intensity (radiance) for every pixel for different contiguous spectral wavelengths. The advantage of using (HSI) over normal digital imagery is that the HSI images beyond the visible spectral range This allows detection of not only the chemical properties of the pixels of the material being imaged but also the physical properties as well (i.e. moisture content).

"This technology has been successfully used to map kaolin concentrations across a quarry face..."

This technology has been successfully used to map kaolin concentrations across a quarry face and is especially powerful when used alongside LiDAR with LiDAR scans creating the spatial model (where it is) and HSI determining its spectral signature (what it is).

Geotechnical Mapping

In addition to geological mapping of the strata, LiDAR scans can also be used to obtain geotechnical data in the form of discontinuity data (dip, dip direction, spacing, persistence and roughness). This can obviate the need for traditional (potentially dangerous) methods of discontinuity data collection using a compass-clinometer (Figure 6).

Figure 6 – Traditional discontinuity mapping

Figure 7 – "Manual" software LiDAR discontinuity mapping

Discontinuity data can be obtained by either,"manually" digitising each joint plane and recording its dip and dip direction (in Figure 7); or by utilising "automated" software (such as Split-FX) specifically written to obtain geotechnical data from collected "point-clouds". There are advantages and disadvantages to both methodologies, and a sensible approach is to adopt an automated analysis reinforced by a manual analysis, or vice versa depending on your inclination.

"With a manual "point-cloud" analysis, the Engineer has the same control that they would have had in the field..."

With a manual "point-cloud" analysis, the Engineer has the same control that they would have had in the field (had they been collecting the data with a compass-clinometer); and with the added benefit that the readings will not be restricted to low "safe" faces and not restricted to the height of the Engineer. However, this manual process can be slow to undertake and, as is human nature, can be influenced by what the Engineer thinks are the joint sets (i.e. if he sees three sets, he will preferentially record the dip and dip direction on the joints that match those sets).

One of the many advantages of an "automated" method such as Split-FX, is that it produces far more data and can reduce the potential "human" influence of the Engineer. Split-FX imports directly xyz "point-clouds", which can be orientated to a magnetic, true or ordnance grid; and then meshed to a user defined number of points per triangle. Next, the software joins together as a polygon, all adjacent triangles with similar orientation (Figure 8). These polygons are then plotted on a stereonet as "discontinuity readings". With quarry face data, this generates a "shotgun" scatter with blast induced joints also being recorded which widens the distribution of the documented joint orientations. However, Split-FX also expresses the area of each measured joint, with larger circles representing larger exposed joints (Figure 9).

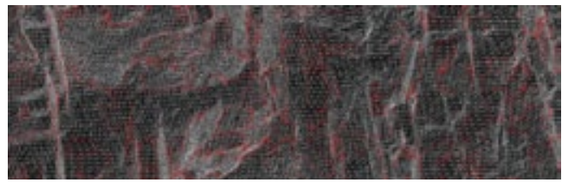


Figure 8 – Split-FX triangulated mesh and "polygon" discontinuities

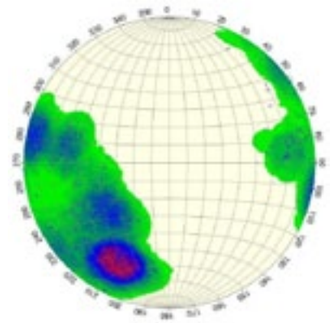


Figure 9 – Split-FX Stereonet of polygons

"Split-FX imports directly xyz "point-clouds", which can be orientated to a magnetic, true or ordnance grid..."

By aiming each scan to ensure all discontinuity orientations are obtained; a composite data set can be produced for each geotechnical domain. Data from Split-FX can be exported into RocScience's DIPS kinematical analysis software and from there into RocPlane, Swedge, or Slide. In the image below (Figure 10), a total 2,621 discontinuity readings have been analysed. What is particularly interesting about this data is the structural information that was gathered. Three obvious (to the eye on site) subvertical joint sets were identified (trending N-S, W-E and SW-NE). What became apparent during the analysis was a set

of lower angled discontinuities also orientated N-S and SW-NE.

It was therefore concluded, that the N-S and SW-NE aligned discontinuities represented subvertical compression jointing;q`11 and that the lower angled normal and reverse faulting resulted from documented orogenic events affecting these strata.

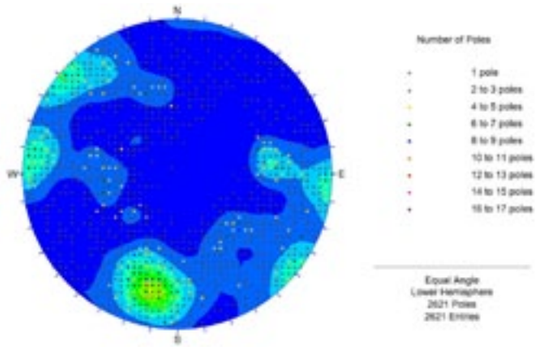


Figure 10 – LiDAR "point-could", Split-FX interpreted data imported into RocScience's DIPS program

As shown above, data obtained by the LiDAR survey can be used to determine the potential modes of failure (Kinematical analysis); and moreover, to calculate "Factors of Safety" and/or "Probabilities of Failure" for a given failure mechanism. Date is exported from DIPS into RocPlane, SWedge and Slide and produces accurate face / slope profiles. Furthermore, the enhanced survey detail obtained by LiDAR surveying also greatly increases the Engineer's ability to analyse the potential trajectories of rock-fall. The images below (Figures 11 and 12) show a "traditional" rock-face survey and associated Rockscience 2D

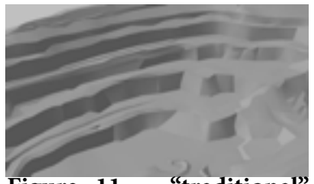


Figure 11 – "traditional" rock-face Survey

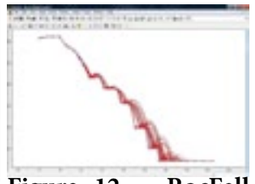


Figure 12 – RocFall analyses on "traditional" survey

Rocfall analysis.

When the high-definition LiDAR derived images (Fig 13 /14) are compared to the traditional survey of Fig 11, the LiDAR data shows the detailed variability of the rockface topography.

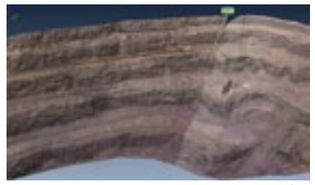


Figure 13 – LiDAR rock-face Survey

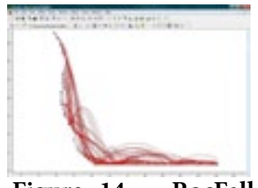


Figure 14 – RocFall analyses on LiDAR survey

The overhangs and ledges on the detailed LiDAR survey can clearly be seen to be playing a major part in the potential trajectories of rock-fall. These could easily have been missed on "simpler" cross-sections and the resultant remediation measures under-designed (for example rock-traps). Recent software developments (notably in the United States) have used long-range high-definition LiDAR surveys to assess the potential locations and hazards associated with landslides and rock-fall onto public highways, railways and other infrastructure.

"Recent software developments have used long-range high-definition LiDAR surveys to assess the potential locations and hazards associated with landslides and rock-fall onto public highways, railways and other infrastructure."

QuarryDesign is working with a US based company (Lodex Engineering with their software RMS "rock-fall mitigation system") to provide 3D simulations of the potential trajectories of rock-fall (as shown in figure 15).

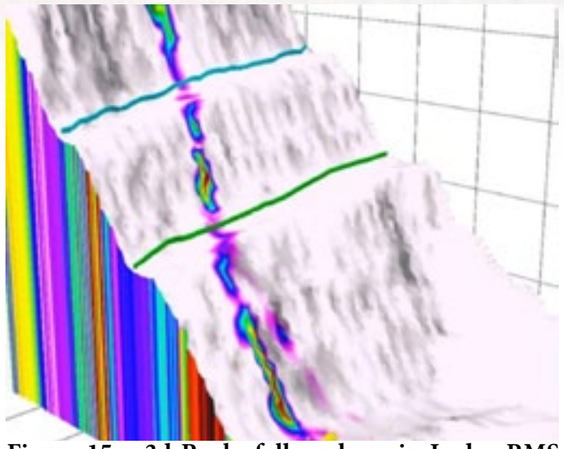


Figure 15 – 3d Rock -fall analyses in Lodex RMS based upon on a LiDAR survey

One of the exciting potentials of this new software is that it can account for the "breaking-up" of larger blocks into smaller fragments and project their potential trajectories as well as for the whole block. In addition, it also demonstrates the mitigation effect of rock traps and fences. Finally, it is influenced by whole sections of the quarry face and not just single cross-section locations. The path of the trajectory (Figure 15) is clearly oblique to the quarry face and would not have been predicted in a 2D analysis. In the new 3D approach, sloping ledges are accounted for and can be shown to cause rock-fall to bounce tangentially across as well as down a quarry face.

Monitoring

As LIDAR scanning produces a rapid detailed survey of a given quarry face or slope, it can be undertaken on a periodic basis to accurately measure and record potential changes in slope geometry. Using LiDAR surveying techniques, it is possible to monitor the performance of rock faces and soil slopes; and to calculate the volumes and rates of any developing rock-fall, circular failures, coastal retreat or wind erosion of sand faces. (Figure 16 below, shows a controlled rock-fall event post survey; with the raw survey data on the left processed in RGB colour and a comparison with the pre rock-fall event on the right with source and accumulation of the rock-fall being highlighted in red and green). This type of monitoring can be rapidly and accurately set-up with the use of fixed survey stations (Figure 17).

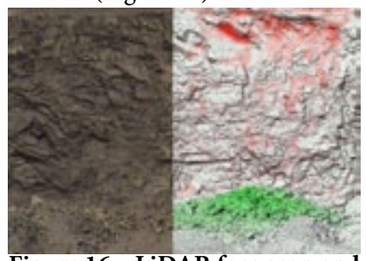


Figure 16 – LiDAR face scan and rock-fall origin (red) and accumulation (green)

Figure 17 – "Fixed" survey station

Additionally, with the average spacing of the fractures being obtained from the "point-cloud" analysis (described above in the Site Investigation section), then the correct rock-fall seeding location and block size can be determined and used in the 3D rock-fall software (shown in Figure 15).

Conclusion

In conclusion, long-range high-definition LiDAR surveying techniques can be used as part of an integrated approach to geological and geotechnical mapping; and to enable more accurate data to be collected significantly quicker and more safely. Furthermore,

"...advances in both computer processing power and software engineering are enabling more complex and realistic simulations to be undertaken...."

advances in both computer processing power and software engineering are enabling more complex and realistic simulations to be undertaken. This approach removes the potential risk to the Engineer and enables the rock face / soil slope design criteria or remediation advice to be more accurate. ■

directory

To advertise in theGeotechnica could not be easier; just send us your advert in PDF format or in Microsoft Word and we will insert it into our advertisement places. Rates for advertising space are given below. All adverts placed by Drilling Academy™ members will benefit from discounted rates.

If you would like to book space for 3, 6 or 12 months or for more information please contact Equipe on Tel: 01295 670990 or Email us at magazine@geotechnica.co.uk

2011 Advertising Rates (£) - All rates are given excluding VAT.

Advert Size	Standard Rate	Member's Rate	3 Months	6 Months	12 Months
Full Page	£550	£500	POA	POA	POA
Half Page	£310	£280	POA	POA	POA
Quarter Page	£160	£145	POA	POA	POA
Small	£55	£50	POA	POA	POA

borehole surveying equipment

consultants

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

drilling contractors

DYNAMIC SAMPLING UK
37 Kingsway Industrial Park, Kingsway Park Close, Derby, Derbyshire, DE22 3FP
Tel: 01332 224466 **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

SAMSON DRILLING SERVICES
35 Wheatsheaf Drive, Ynysforgan, Swansea, SA6 6QE
Tel: 07831 602083
Email: paul.osborne@horizoncreative.co.uk

TERRA FIRMA GROUND INVESTIGATION
Rowan Tree Farm, Blackwell Hall Lane, Ley Hill, Buckinghamshire, HP5 1UN
Tel: 01494 791110 **Fax:** 01494 791108
Email: enquiries@terrafirmagi.co.uk

drilling equipment

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

environmental specialists

field instrumentation

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

STRAINSTALL
9-10 Mariners Way, Cowes, Isle of Wight, P031 8PD
Tel: 01983 203600 **Fax:** 01983 291335
E-mail: enquiries@strainstall.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

geothermal equipment

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

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

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 TRAINING
The Paddocks, Home Farm Offices, The Upton Estate, Banbury, Oxford, OX15 6HU
Tel: 01295 670990 **Fax:** 01295 678232
Email: info@equipetraining.co.uk

****AS NEW METRIC DIAMOND PRODUCTS****

T2 56 Core Bits and Reaming Shells
1 x Impregnated Coring Bit (soft matrix)
1 x Impregnated Coring Bit (hard matrix)
5 x Impregnated Reaming Shell

T2 76 Core Bits and Reaming Shells
2 x Surface Set Coring Bit
2 x Impregnated Coring Bit
4 x Impregnated Reaming Shell

T2 101 Coring Bits
2 x Surface Set

86mm Casing Shoes
2 x Surface Set
2 x Impregnated
3 x TC

****AS NEW DCDMA DIAMOND PRODUCTS****

P Core Bits
1 x Surface Set (120mm o.d. / 87mm i.d.)
1 x TC (125mm o.d. / 92mm i.d.)

****AS NEW WIRELINE DIAMOND PRODUCTS****

HQ Coring Bits (96mm o.d. / 63mm i.d.)
1 x Surface Set (SP4-5)
1 x Surface Set (SP5-6)

NQ Coring Bits (76mm o.d. / 48mm i.d.)
2 x Impregnated
1 x Surface Set – Stepped

For more information and item prices, please contact Equipe Training
Tel: 01295 670990 **Fax:** 01295 678232 **Email:** info@equipetraining.co.uk

SITUATIONS VACANT

Site Investigation Lead Drillers

Excellent Rates of Pay

Experienced Rotary Drillers required for Site Investigation. Off Shore and Deep Borehole Drilling - Conventional and Wireline.

- *Minimum 5 Years Experience*
- *NVQ Level 2 (Rotary Geotechnical)*
- *Full Driving Licence*

Please forward your CV to:
keith.spires@equipetraining.co.uk

APPLiED GEOLOGY

Engineering Geologists

Due to increasing workloads we are seeking to recruit the following staff:

Newton-le-Willows: Senior/Principal Engineering Geologist required to manage ground investigation, geotechnical and contaminated land projects. MSc in Engineering Geology/Geotechnics and at least 6 years of relevant experience required.

Kenilworth: Engineering Geologist/Geotechnical Engineer required with at least 4 years of site investigation and routine geotechnical assessment/design experience.

Please submit your CV and covering letter to John Cartwright, Applied Geology Limited, Unit 23 Abbey Park, Kenilworth, Warwickshire, CV8 2LY. Tel. 02476 511822. NO AGENCIES.

john.cartwright@appliedgeology.co.uk www.appliedgeology.co.uk

Applied Geology has a commitment to equality of opportunity for all.

theGeotechnica

Driving our industry forward...

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