

theGeotechnica

equip^e

inside this edition...

can new technology be used to increase

slope stability?

Geotechnical Engineering trial new
electro-osmosis electrode technology

also included...

- an environmental assessment of Ogoniland
- the first in a series looking at laboratory testing
- a review of The Löftstedt Report



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an introduction

Welcome to the April edition of **theGeotechnica**. With the warm weather we experienced through March and British Summer Time with us, there does seem to be an air of optimism amongst the UK geotechnical community.

Here at Equipe we are making preparations for our summer show Geotechnica. Now in its fourth year the show is going from strength to strength. Many of our previous exhibitors have signed on to be at this year's show and several new exhibitors have taken space. The technical presentations include some well know names including Professor Rory Mortimer, Professor Eddie Bromhead and Professor Paul Nathanail. This is becoming Britain's premier Geotechnical event so don't forget to mark the dates in your diary, 4th and 5th July.

In this months' issue of **theGeotechnica** we have another article from Kieran Dineen on the NEC form of contract. The NEC family of contracts will appear more often in the coming months and years being the ICE's preferred form of contract. Kieran continues his explanation of the contract and how it is intended to be used.

The Geotechnical section includes an article from Geotechnical Engineering Limited on the installation of electro-osmosis electrodes to control water content in a road embankment. This is a new technique which if it proves successful at this location it could help resolve many stability problems.

In the Training section we have an article on the direct shear test. This is the second in a number of articles we will be publishing to look at the tests we regularly schedule. This article, written by Chris Wallace of Geolabs, gives advice on what samples are considered to be suitable for the test, and some of the common reasons why they do not always give the results we think we should obtain.

In the Innovations section there is an article by Roger Chandler on how monitoring contractors can use AGS data in the data handling process. This makes for much greater accessibility of the data and enables interrogation of the data once obtained.

Emma Betts gives a review of The Löffstedt Report which intends to remove some of the pointless pa-

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perwork from health and safety - I hear many of you breathing a sigh of relief at this breath of fresh air from government.

Should you have any comments, views or suggestions on articles published or events within the geotechnical community, why not write or email the editorial team? We are always happy to publish the views of our readers provided they are not defamatory or blatant advertising.

Editorial Board,
theGeotechnica

innovative technology uses electricity to stabilise slopes geotechnical



Writing for **theGeotechnica** for the first time is Greg Adamson of [Geotechnical Engineering Ltd](#). Here, Greg discusses new technology that uses electricity to aid slope stability.

New technology is being used to stabilise failing slopes on the UK's road and rail networks. The companies behind the techniques are finalists in two national awards.

Thousands of embankments and cuttings exist within the UK's road and rail infrastructure. A system of maintenance has been in place for many years to highlight problem slopes and fix them. Established remediation methods for stabilising slopes include soil nailing, gabion baskets and slope slackening.

“...new innovative technology has been developed which is expected to revolutionise the way slope stabilisation is carried out.”

However, new innovative technology has been developed which is expected to revolutionise the way slope stabilisation is carried out.

Following research at Newcastle University in Electrokinetic Geo-synthetics (EKG), the company 'Elec-



trokinetic Ltd' was created as a commercial venture.

“EKG is the name given to a combination of patented materials and processes...”

EKG is the name given to a combination of patented materials and processes where an electrical potential difference is applied to fine grained soils which results in 'electroosmotic' flow of water towards the cathode leading to a drop in pore water pressure, cementation around the anode, changes in plasticity and consolidation of the soil; all of which contribute towards an increase in soil strength.

When applied to slopes made up of hetero- and homogeneous soils, dominated by fine grained materials, this technique is a suitable means of stabilisation where slopes have failed because of a mixture of over-steepness, low-strength soils and poor drainage.

In addition to the resultant strengthening of the soil, the installation of electrodes also allows certain other benefits. After the electrification process, the anodes are reinforced and converted into soil nails, benefiting from cementation or 'electrokinetic bond'. The cathodes also remain in the ground and act as passive drains.

“The physical changes to the soil can be enhanced by the introduction of conditioning fluids...”

The physical changes to the soil can be enhanced by the introduction of conditioning fluids to the anodes during electrification, although this has not been necessary on the sites worked on to date.

One of the challenges of applying the EKG technology was finding an efficient and effective way of installing the electrodes, which were typically 4 to 7m

in length and located on difficult sloping ground.

With 50 years experience, a reputation for innovation and a good track record for developing drilling rigs

“Geotechnical Engineering Ltd were contacted by Electrokinetic Ltd in 2007 to try and come up with a suitable methodology.”

for working on slopes, Geotechnical Engineering Ltd were contacted by Electrokinetic Ltd in 2007 to try and come up with a suitable methodology.

Geotechnical Engineering Ltd rose to the challenge and came up with a method of installing the electrodes

using one of their existing slope climbing drilling rigs, the P45, on a railway embankment at Greenford, London. The limitations of this approach became apparent at this time and Geotechnical Engineering Ltd entered into a period of research and development which resulted in the production of the P45K slope climbing rig, designed specifically for the installation of anodes and cathodes for the electrokinetic process.

The main feature of the design of the P45K is the side-mounted mast which enables the rig to introduce the anodes and cathodes at an array of angles. Like its predecessors, the P45k rig is mounted on a slope-climbing chassis enabling it to position itself on gradients in excess of 45°. When tracking onto position the rig is operated by remote control, it is fully guarded and complies with European safety legislation.

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innovative technology uses electricity to stabilise slopes geotechnical



With the exception of the Greenford trials, the first ever commercial Electrokinetic Slope Stabilisation project is currently near completion on the A21 in Kent. The P45K was successfully used to install the electrodes during the latter part of 2011. The great advantage here was that Geotechnical Engineering Ltd were able to install the electrodes without having to



“Any trees of a reasonable size were left in place with the P45K rig able to move between them...”

remove important vegetation from the site. Any trees of a reasonable size were left in place with the P45K rig able to move between them, leaving the overhead canopy virtually unchanged allowing natural habitats to quickly re-establish themselves. The topsoil remained in place and the project produced zero waste.

“The P45K rig has now started on the second project of this kind on an embankment on the M5.”

The P45K rig has now started on the second project of this kind on an embankment on the M5.

The cost of Electrokinetic Slope Stabilisation compares favourably with other more traditional methods and also has a hugely reduced carbon footprint. The latter is becoming more and more important as companies strive to become ‘greener’.

On both the A21 and the M5 sites there has been no need for traffic management on the public highway. The roads run along the top of these embankments and there is good access from below. Apart from the obvious cost savings, the lack of disruption to the general public and to site works is also a huge benefit.

As a result of these works Geotechnical Engineering Ltd and Electrokinetic Ltd have been shortlisted as joint finalists in the ‘Product Innovation’ category at both the 2012 Ground Engineering Awards and the 2012 Construction News Awards.

Electrokinetic Ltd are also joint finalists with Balfour Beatty Mott MacDonald for the ‘Environmental Sustainability’ category at the 2012 GE Awards and Geotechnical Engineering Ltd are finalists in the ‘Ground Investigation Specialist of the Year’ category at the 2012 GE Awards.

The winners will be announced later this year. ■



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Lankelma launches New Zealand seismic cone testing device geotechnical



Ground investigation specialist Lankelma is launching a new cone penetration testing service in New Zealand with the arrival of one of its 20T 6x6 CPT trucks in Christchurch in April.

“The rig, which will be operated by Lankelma staff, is suitable for a range of test environments...”

The rig, which will be operated by Lankelma staff, is suitable for a range of test environments and will be primarily dedicated to the works associated with the rebuilding of Christchurch following the devastating earthquake of February 2011.

The magnitude 6.3 earthquake severely damaged New Zealand's second city and was one of a number of seismic events to hit the region over the last two years. Buildings and infrastructure already weakened by a 2010 event collapsed, killing 185 people, and a wide area was affected by liquefaction. Rebuild costs have been estimated at between NZ\$20-30bn.

“The need to investigate and refine the understanding of regional ground conditions will form part of an approach to developing secure future infrastructure,” explains Lankelma Engineering Director Carlton Hall, who arrives in Christchurch during April.

“The rig is equipped with standard instrumentation which will enable soil classification and an assessment of liquefaction potential. However, we will also

be offering seismic test services to acquire the small-strain stiffness profile for the ground - which should assist in the detailed design of geo-structures.”

Hall says the 20T 6x6 CPT truck is heavier than most available in New Zealand and the additional reaction force should enable testing to penetrate the potentially weaker soils underlying dense beds of gravel.

Lankelma will combine its broad international CPT experience in gathering high quality engineering data with local expertise through its relationships with ground consultant KGA Geotechnical Ltd and international drilling contractor Webster Drilling and Exploration Ltd. ■

Additional notes:

Lankelma is a specialist geotechnical investigation contractor with a staff and equipment resource dedicated to cone penetration testing (CPT). High quality CPT services are offered using a range of geotechnical tools such as piezocone, seismic cone and pressuremeter to define ground conditions. Reports are customised to client needs and can range from the delivery of standard factual data to detailed interpretation of soil properties through the application of geo-statistics and CPT based analytical research.

For more information, contact Carlton Hall Tel: +44 (0) 1797 280050; Email: info@lankelma.com; or visit www.lankelma.co.uk



Lankelma sends 20 tonne CPT truck to Christchurch New Zealand to support the Christchurch Earthquake Recovery Project

Lankelma, with its strong base in the UK and Europe, offers CPT services worldwide and has a 20 tonne all-terrain truck available in Christchurch, New Zealand as of mid April 2012.

Lankelma offers high quality CPT services utilising a range of geotechnical tools such as piezocone, seismic cone and pressuremeter to define ground conditions. Reports are customised to client needs and can range from the delivery of standard factual data to detailed interpretation of soil properties through the application of geo-statistics and CPT based analytical research.

For more info contact carltonhall@lankelma.com or call our office on +44(0)1797280050

During 2011, Lankelma routinely worked in the UK and Europe plus overseas in Africa, China, Mauritius and Oman.



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Our approach is characterised by quality and driven by understanding



Writing for **theGeotechnica** once more are Kieran Dineen and Robert Gerrard from [Thomas Telford Training](#). Here, they speak about NEC contracts and what the main options are when using them.

Option structure

In Part 2 we looked at the different forms of NEC3 Contract currently published. There are main contracts, subcontracts, short contracts; contracts for buying goods, works or services on a 1-off, term or framework basis.

In the subsequent notes, we will focus on the more likely NEC3 Contracts to be used in this industry. Before we get into this there's just a few drafting conventions/principles to explain. The first is the Option structure found in the main contracts (not the short contracts). The ECC, ECS, PSC and TSC offer up a range of Options to select from that builds up the contract terms to suit the works or services. At the heart of the contract conditions are the core clauses, which contain the essential common terms. To this must be added a main Option, which will determine the particular payment mechanism. Finally, the selected sec-

ondary Options are combined with the core and main Option clauses to provide a complete contract.

This approach gives even greater choice to contracting parties to assemble the appropriate contract conditions to suit. The ECC, ECS, PSC and TSC offer different basic allocations of financial risk between the parties through the main Options.

The ECC main Options and a brief description of each is as follows:

- Options A and B: these are priced contracts with the risk of carrying out the work at the agreed prices being largely borne by the Contractor.
- Options C and D: these are target contracts in which the out-turn financial risks are shared between the Client and the Contractor in an agreed proportion.
- Options E and F: these are cost reimbursable types of contract with the financial risk being largely taken the Client.

The comparative availability of the main Options in ECC, ECS, PSC and TSC is shown in Table 2. ■

Option Title	ECC	ECS	PSC	TSC
A. Priced contract with activity schedule	✓	✓	✓	✓ with Price List
B. Priced contract with bill of quantities	✓	✓	x	x
C. Target contract with activity schedule	✓	✓	✓	✓ with Price List
D. Target contract with bill of quantities	✓	✓	x	x
E. Cost reimbursable contract	✓	✓	✓ Time Based	✓
F. Management contract	✓	x	x	x
G. Term contract	x	x	✓	x

Table 2. Availability of main Options in NEC3 Contracts.

Job Opportunities in New Zealand

Equipet is the sole agent for a geotechnical consultancy based in Auckland, New Zealand who are looking to set up an office in Christchurch to play an active role in the rebuilding of the city. There are a number of positions which we require to fill and details are provided below. The consultancy wishes to employ engineers from the UK to staff the office and for the right individuals to join the company on a permanent basis. This is a really exciting opportunity for anyone who wants to be involved with rebuilding one of the world's major cities in a vibrant and diverse country.

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We are looking for at least one and possibly two geologists with site investigation experience and knowledge of borehole logging systems. The successful candidate should have a sound knowledge and plenty of practical experience of logging rotary boreholes and trial pits. The successful individuals will be able to think on their feet and be able to work independently, whilst being an integral part of the office team. A good knowledge of drilling and sampling methods will be essential.

All roles will attract a competitive salary, use of a company vehicle and contributory pension. A bonus is also offered subject to performance. Annual leave will be 4 weeks plus 10 statutory days - plenty of time to enjoy the fishing, skiing and hiking offered in the locality.



For more information on great opportunities, send a CV to: pete.reading@equipetraining.co.uk

Here at **theGeotechnica**, we are striving to keep up to date with worldwide issues in our industry. With that in mind, **Alcontrol's** Geraint Williams compiles an environmental assessment of Ogoniland.

Background

At the request of the Federal government of Nigeria, the United Nations Environmental Programme (UNEP) conducted an independent investigation of the environmental and public health impacts of oil contamination in Ogoniland as well as a review and assessment of suitable remediation options. The history of oil exploration and production in Ogoniland is a long, complex and often painful one that to date has become seemingly intractable in terms of resolution

“The assessment has been unprecedented and now provides the scientific basis on which long overdue and concerted clean-up can begin.”

and future direction. The assessment has been unprecedented and now provides the scientific basis on which long overdue and concerted clean-up can begin. It provides the government, stakeholders and the international community with invaluable information on the scale of the challenges and priorities for action in terms of remediation.

Ogoniland is a group of four Local Government Areas in Rivers State of Nigeria. Taken together there are close to a million people living in about 1000 square kilometres. Oil exploration in Ogoniland commenced in the 1950s and extensive production facilities were established during the subsequent three decades. These operations were largely handled by Shell Petroleum Development Company (SPDC). They drilled more than 100 wells and constructed a number of flow lines, manifolds and flow stations. In addition to

the production facilities, a number of oil export trunk lines pass through the area.

“Following a campaign of widespread public unrest, SPDC ceased oil exploration and production activities in 1993.”

Following a campaign of widespread public unrest, SPDC ceased oil exploration and production activities in 1993. While no production has taken place since this time, the oilfields and installations remain dormant but have never been fully decommissioned. Further spills have been due to oil bunkering (the tapping of oilfield infrastructure to procure oil illegally) or where artisanal refining of crude oil takes place using primitive stills. It was outside the scope of the UNEP report to identify the cause of individual spills, whether these are the result of corrosion or illegal extraction.

While the project was eventually approved in 2007, administrative and contractual delays meant that the fieldwork could not start until late 2009, with the first set of samples submitted in May 2010. The project was fully implemented by UNEP and led by the Post Conflict and Disaster Management Branch in Geneva where all technical and financial management

“UNEP recruited a team of international experts, who worked side-by-side local experts, academics and support teams comprised of logistics, community liaison and security staff.”

was co-ordinated. UNEP recruited a team of international experts, who worked side-by-side local experts, academics and support teams comprised of logistics, community liaison and security staff. They were con-

fronted with a unique challenge: lack of trust between actors; political tensions between communities, regional and national government; security considerations and technical and logistical challenges. The report details how the team carried out their work, where the samples were collected and the findings that they have made.

At the planning stage, to assure the quality of analytical data, it was decided that the majority of samples would be submitted to a laboratory with international standing with an extensive level of associated accreditation.

“Alcontrol laboratories, based in the UK, had worked with UNEP and other international agencies over many years.”

Alcontrol laboratories, based in the UK, had worked with UNEP and other international agencies over many years. It provides millions of tests per year, with more than 2000 employees in 30 laboratories across 11 European countries. Alcontrol supports a global customer base.

“The project was extremely complex...”

The project was extremely complex. The fieldwork was varied and involved assessing hundreds of impacted sites based on information provided by Nigeria's National Spill Detection Agency, the Department of Petroleum Resources, Ministry of Environment, SPDC and satellite imagery. Importantly, the list of sites was supplemented on an ongoing basis with information received directly from local residents.

Key findings

Detailed soil and groundwater investigations were conducted at 69 sites, which ranged in size from 1,300 square metres to 79 hectares. Over 4000 samples were

collected and tested for a range of oil related contaminants. The report was subjected to a rigorous international independent peer-review and was finally published on 4th August 2011.



Contamination of soil and water in Ogoniland is extensive. Most of the contamination is from crude oil although contamination by refined product was found at three locations. Two-thirds of those sites that were subjected to detailed assessment exceed Nigerian national standards.

Remediation by enhanced natural attenuation (RENA) was the only technique observed during the assessment and has proven ineffective in most cases. This treatment technology applies to the surface layer only. Some areas, which appear relatively unaffected at the surface, were found to be heavily impacted at depth. In 49 cases, elevated levels of hydrocarbons were detected in soil at depths of at least 5m. At 41 sites, groundwater was severely impacted by hydrocarbon contamination.

“The drinking water in at least 10 Ogoni communities is heavily impacted...”

The drinking water in at least 10 Ogoni communities is heavily impacted, posing a significant threat to

public health. In one community, at Nisisioken Ogale, in western Ogoniland, drinking water is contaminated with benzene at levels over 900 times the World Health Organisation guideline value. This warranted immediate action.

“The study concludes that the control, maintenance and decommissioning of oilfield infrastructure in Ogoniland are inadequate.”

The study concludes that the control, maintenance and decommissioning of oilfield infrastructure in Ogoniland are inadequate. Industry best practice and SPDC’s own procedures have not been applied.

Outcome and recommendations



“The remediation phase... could prove to be the world’s most wide-ranging and long-term clean-up exercise.”

The remediation phase, based on the recommendations of the UNEP’s report, could prove to be the world’s most wide-ranging and long-term clean-up exercise. The report calls for a combination of approaches: individual spill sites can be cleaned up within five years, while the restoration of heavily impacted mangrove stands and intertidal creek areas will take up to thirty years.

Due to the wide extent of contamination in Ogoniland there will not be a single remediation technique

“A combination of approaches will therefore need to be considered.”

appropriate for the entire area. A combination of approaches will therefore need to be considered. Reforms of national government regulation, monitoring and enforcement, and improved practices by the oil industry are also recommended in the report.

A proposed Ogoniland Environmental Restoration Authority would oversee implementation of the study’s recommendations. The authorities’ activities should be funded with an initial capital injection of US\$ 1 billion, contributed by the oil industry and the government to cover the first five years of the remediation

“The report also recommends creating a Centre of Excellence in Environmental Restoration in Ogoniland...”

work. The report also recommends creating a Centre of Excellence in Environmental Restoration in Ogoniland to promote learning and benefit other communities in the Niger Delta.

Reactions to the report

Following receipt of the UNEP report, President Goodluck Jonathan is reported to have constituted a

“It is anticipated that a transition project, leading to full-scale clean up, will commence this year.”

committee to review its findings. It is anticipated that a transition project, leading to full-scale clean up, will



“The Government of Rivers State provided clean drinking water to the communities...”

commence this year. The Government of Rivers State provided clean drinking water to the communities whose water wells were proven to be impacted by oil spills. UNEP has therefore welcomed the State Government’s intervention to address this critical issue.

SPDC Managing Director Mutiu Sunmonu has responded to the UNEP report in a video on the Shell

“This report make a valuable contribution towards improving the understanding of the issue of oil spills...”

Nigeria website. He says: “This report make a valuable contribution towards improving the understanding of the issue of oil spills and the environment in Ogoniland and we pledge to work with the government, UNEP and others on the next steps.”

In conclusion, for the first time, there is systematic and scientific evidence available on the nature, extent and impacts of oil contamination in Ogoniland. The report also provides clear operational guidelines as to how that legacy can be addressed. ■



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The Löffstedt Review - common sense safety? safety issues



Writing for **theGeotechnica** for the second time, Emma Betts, an independent chartered occupational safety professional at [EB Safety](#), discusses The Löffstedt Review, and what the results may mean for the rest of the industry.

In line with the current national move towards simplification, refocus and change, a programme of rationalisation of the present health and safety regime in the UK is currently underway. Driven by the Government

“...this programme will hopefully refocus health and safety onto the things that really matter...”

this programme will reform the system and will hopefully refocus health and safety onto the things that really matter; reducing rates of work related death, ill health and supporting those companies and individuals that want to do the right thing.

An independent review was commissioned by the Government in March 2011 and was chaired by Professor Löffstedt, Director of the King's Centre for Risk Management at Kings College, London. The findings of the Review, 'Reclaiming Health and Safety for all', were published in late November 2011. The main aims of the Review are simply to reduce bureaucracy, simplify health and safety legislation and requirements and shift the focus of enforcement onto the higher risk activities and severe health and safety breaches.

“Reactions to the Review have generally been positive...”

Reactions to the Review have generally been positive, with most commentators being pleased at Professor Löffstedt's conclusions. The Health and Safety Executive (HSE) welcomed the Review calling “insightful” and “good for workers and employers”. Judith Hackitt, Chair of the HSE said “we must have a system of health and safety which enables employers to make

sensible and proportionate decisions about managing genuine workplace risk” and “simplifying and streamlining the stock of regulations, focussing enforcement on higher-risk businesses, clarifying requirements, and rebalancing the civil litigation system – these are all practical, positive steps.”

Five key recommendations were put forward. The following outlines what they are and offers suggestions as to what they might mean for the Geotechnical industry as a whole.

Firstly a review of existing regulations is recommended, which would include the exemption from health and safety law for self-employed people whose activities pose no risk of harm to others. The review found that while the use of “so far as is reasonably practicable” was generally supported throughout industry, there was confusion amongst businesses over what it

“It was also noted that some regulations are over used...”

actually means in practice. It was also noted that some regulations are over used and result in a lot of unnecessary paperwork and bureaucracy, some regulations need clarification and review and although Approved Codes of Practice (ACoPs) were generally accepted as good some are now out-dated, too lengthy, far too technical and over complicated. The Review has recommended that the HSE reassess all its ACoPs and the initial phase of this review will be completed in June 2012. This will hopefully provide some clarity on what is planned, when changes can be anticipated and may provide the Geotechnical industry with much needed guidance on how to apply the current health and safety regulations in a simple, pragmatic and non-bureaucratic manner.

The Löffstedt Review also recommended that the Government should work more closely with the EU Commission, especially at the time of a planned review of EU Health and Safety legislation in 2013. This would help to ensure both new and existing health and safety

legislation is both risk based and evidence based. In terms of how this could affect the Geotechnical industry, if fully implemented, it has the potential to ensure any new legislation is more focussed on the actual risks within the industry and is developed using evidence and case studies of past experiences rather than diktats from Europe.

“The key recommendation for businesses across all industries is the simplification of the regulatory framework.”

The key recommendation for businesses across all industries is the simplification of the regulatory frame-



Many regulations lead to unnecessary paperwork.

work. It is obvious that complying with some of the regulations is a major burden on businesses and can in extreme cases be a barrier to growth and development. The Review found that there was a general belief throughout sectors that there are too many regulations and that this causes confusion for businesses, especially small and medium sized organisations. The Review went on to suggest the HSE undertake a programme of sector-specific consolidation of the regulations, which would be completed by April 2015. There are proposals to cut current regulations by approximately 35%, this can only be a positive step towards making it easier to understand and successfully implement future health and safety legislation.

The Review also focussed its investigation on the regulation and enforcement of health and safety at a national level. While the HSE is the national regulatory body responsible for promoting better health and

safety in the UK, enforcement of these regulations is shared with local authorities. In the past this has led to much inconsistency in the implementation of regulations across authorities. The Review recommends that the legislation be changed to give the HSE the authority to direct all local authority health and safety inspection and enforcement activity. This will potentially lead to greater consistency of implementing regulations and will hopefully ensure the right areas are targeted for inspection, i.e. the high risk activities and workplaces.

The final recommendation is based on findings following a review of the ‘compensation culture’ in the UK. The Review suggests that in some cases employers are driven by the fear of being sued, rather than the principles of good risk management. With this in

“...the Review recommends that the use and misuse of Pre-action Protocols needs to be investigated...”

mind the Review recommends that the use and misuse of Pre-action Protocols needs to be investigated and that there should be a change to the regulations that impose a strict liability on the employer.

In conclusion, while some commentators suggest this Review has not gone far enough, others believe that it is a positive step in the right direction. Any reforms that aim to reduce the burden of health and safety legislation on businesses, streamline and improve current health and safety regulations and rebalance the civil-litigation system have to be a huge step forward. At EB Safety we strongly believe that health and safety does not need to be complicated, should not be a bureaucratic exercise creating mountains of unnecessary paperwork and should not become a barrier to getting the job done. Health and Safety is in essence the application of common sense, and should be so deeply embedded into the culture of any company that compliance with legislation should be second nature. ■

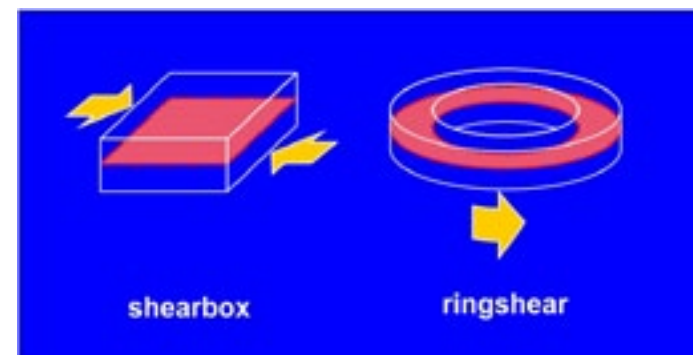
Writing on behalf of [GEOLABS Limited](#), Chris Wallace writes for **theGeotechnica** about shearbox testing, and what you should be aware of if you are involved with them.

The direct shear test, often called a shearbox test, is, on the surface, an apparently simple test. However, there are a few points that can catch out everyone in the chain: from the person specifying the test, to those taking the samples, the technician performing the test to the engineer interpreting the results.

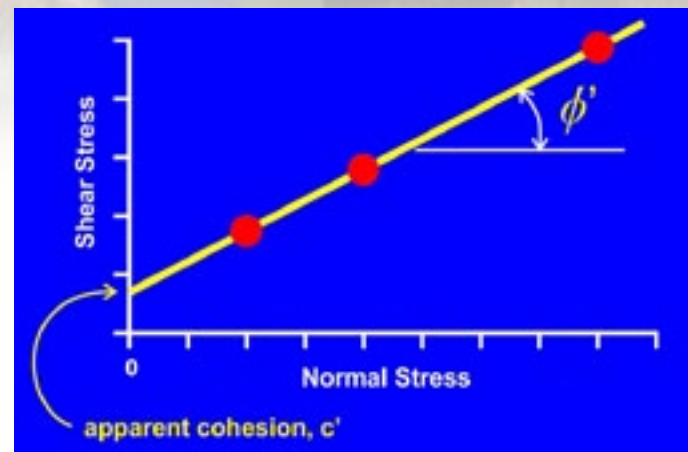
Why a shearbox test?

“Primarily, the shearbox test gives you the shear strength at a defined normal (vertical) stress.”

First, why do you want a shearbox test at all? Primarily, the shearbox test gives you the shear strength at a defined normal (vertical) stress.



When multiple tests are performed at different normal stresses (usually three) two important parameters can be derived: apparent cohesion (c') and angle of friction (ϕ' or ϕ_i). Note that these parameters have dashes after their symbols: they are effective stress parameters as they are tested slow enough to be drained (even though they appear in the ‘Total Stress’ section of BS1377 since pore pressure is not measured).



These parameters can be used in a variety of situations such as investigating slope stability, designing foundations and calculating lateral stresses on retaining walls. This gives rise to our first ‘catch point’:

Catch Point 1

You need a number of tests on different specimens to get c' and ϕ_i

For the person specifying the test this means you will need to provide the laboratory with (usually) the three normal stresses required to perform the tests. If you have not done this, and you are lucky, the laboratory will notice this as soon as they receive the schedule and pester you for it! If you are unlucky, nobody notices until the technician (who has come in at the weekend to make sure the deadline is met) goes to start the test and realises he doesn’t have the essential information and nobody is around to ask.

In theory you could get c' and ϕ_i from a line drawn through just two points on a shear stress v normal

“However, the potential variation between specimens from the same sample would not be obvious from just two points...”

stress plot. However, the potential variation between specimens from the same sample would not be ob-

vious from just two points: you would always have a perfect fit. At least with three points you are much more likely to spot a rogue point caused by a fissure or unseen piece of gravel that is skewing the underlying result.

For the person taking the samples on site, multiple tests mean you’ve got to take enough material: more on this coming up.

What sort of shearbox test?

So you’ve decided you do need a shearbox. Now you need to decide what sort of shearbox. There are four main types of shearbox tests:

- 1) Small shearbox: 60 x 60 mm (20 mm high)
- 2) Large shearbox: 300 x 300 mm (150 mm high)
- 3) Ringshear: annulus 100 mm dia. (5 mm high)
- 4) Rock shearbox: <150 mm square shear plane

Rock Shearbox

The easiest choice is the rock shearbox: if you’ve got rock then it’s got to be a rock shearbox!



The rock specimen, wired securely so the shear plane is immobilised, is embedded either side of the shear plane in Plaster-of-Paris, grout or concrete. This allows the specimen to be sheared (once the wires are cut) in one of two forms of apparatus:

- 1) Hoek Shearbox
This is a portable device that can be used in the field. The normal stress is applied by a hydraulic hand pump with a pneumatic reservoir to hold the pressure steady. The shear stress is also developed with a hydraulic hand pump, which is its downside. The test can only be run comparatively quickly via the manual action of the pump lever, so if the shear plane is sensitive to

rate effects (due to, say, clay infilling) the test would essentially be undrained and the shear strengths misleading.

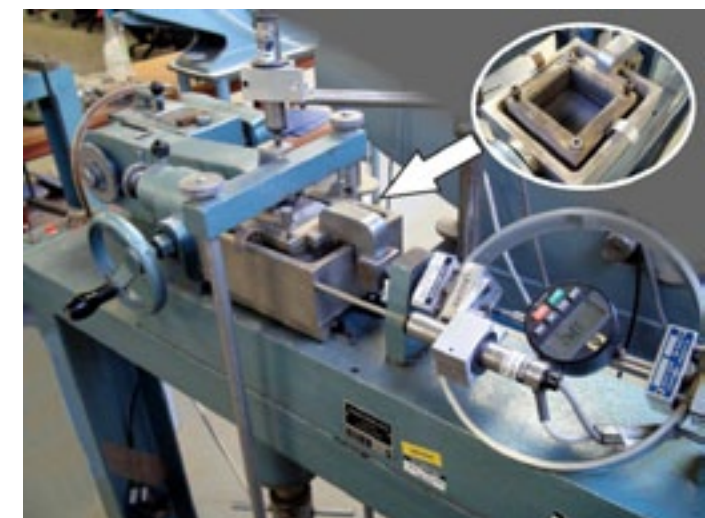
2) Modified Laboratory Shearbox
This method uses a 300 mm large shearbox adapted to take specimens embedded to be 150 mm square. The test can be run in a controlled manner, data logged, at a shear rate conforming to the 0.1 mm/min limit specified in the ISRM (1985).

Rock specimens can be as small as around 50 mm diameter, with at least 20 mm either side of the shear plane.

“Large specimens can be reduced in size, so there is no upper limit to size.”

Large specimens can be reduced in size, so there is no upper limit to size. The only requirement is that before test there is a discontinuity: this can be a natural fissure, or be created by a hammer blow, point load test or cutting, depending on the purpose of the test.

Small Shearbox (60 x 60 mm)



This is the most common form of shearbox test, usually performed on a 60mm square cross-section:

Specimens can often be prepared from a good quality

100 mm diameter sample, and a small shearbox will cost much less than a large shearbox on the same material type. The downside is that there is an upper limit of 2 mm particle size (due to BS1377:Part 7:Clause 4.4.1:1990 setting a maximum particle size restriction of one tenth of the specimen height of 20 mm in the

“If testing undisturbed specimens, around 150 mm length of 100 mm diameter sample is usually enough to get three specimens...”

small shearbox). If testing undisturbed specimens, around 150 mm length of 100 mm diameter sample is usually enough to get three specimens; allow more if gravel is present and the technician has to discard unsuitable material.

Large Shearbox (300 x 300 mm)

The large shearbox carries on from where the small shearbox left off, right up to 20 mm particle size. Its size is also its catch point:

Catch Point 2 Take sufficient sample

A large shearbox requires around 30 kg per specimen! Good news for courier companies, but not for likes of you and me. So the ideal is 90 kg of passing 20 mm material to perform a set of three tests to determine c' and ϕ' . However, all is not lost if the sample has already been taken by the time you've come to schedule

“Providing the gravel is not too weak and doesn't significantly degrade during remoulding and testing, we can reuse the material...”

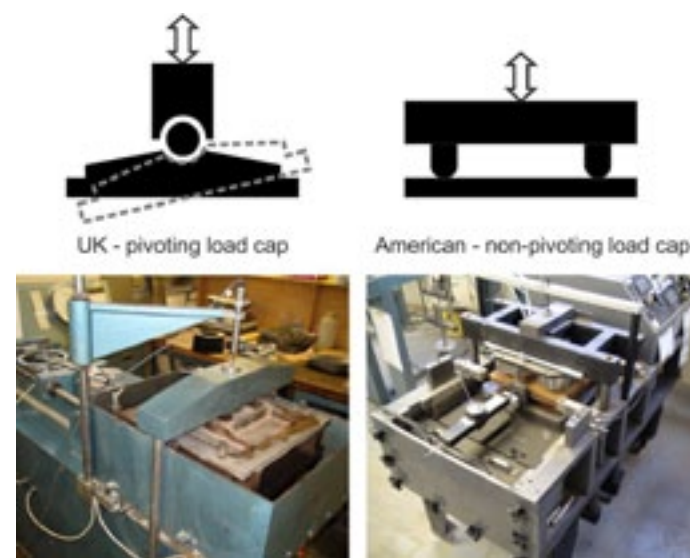
it and there isn't 90 kg. Providing the gravel is not too weak and doesn't significantly degrade during re-

moulding and testing, we can reuse the material after each shearing run, preferably replacing the middle third with untested material. This ensures that the main contributor to the shear strength, the material on the shear plane is virgin and completely unaffected

“This reduces the requirement down to around 50 kg.”

by previous testing. This reduces the requirement down to around 50 kg. Still more than you've got? Re-use all the material for each specimen. This cuts the requirement down to 30 kg, but any degradation of the gravel could reduce the measured shear strength. Money saved on the sampling and transportation could cost dearly if the target parameters aren't met! Another implication of material reuse is that the material might need to be air-dried back to its original moisture content between runs, adding significantly to the turnaround time in the laboratory.

There are two principal types of shearboxes: UK style pivoting load cap (BS1377) and American style non-pivoting load cap (ASTM).



These variations can affect the shear strengths measured due to the additional restraint from a fixed load cap. At Geolabs we have UK and American style shearboxes, but have modified our American style

box to permit the loading cap to be fixed or pivoting. An unmodified ASTM specification shearbox will not meet BS1377 requirements:

Catch Point 3 Ensure the style of shearbox used meets your specification

Ringshear

Different to the previous types of shearbox, the ringshear test can only be used to meaningfully measure the residual shear strength, and it is only performed

“With the other types of shearbox one half of the box is drawn across the other half and the resistance measured.”

on remoulded material. With the other types of shearbox one half of the box is drawn across the other half and the resistance measured. The first run determines the peak shear strength. But what about if you're investigating a slope failure and you're worried about what will cause it to move again? The residual shear strength is what you want. After the peak run the two halves of the shearbox can be returned to their starting positions, and the shear repeated. The shear strength on the second run will likely be lower than for the first run: the soil fabric has been disturbed and larger particles straddling the shear plane will have been displaced.

“This procedure is repeated until the shear strength drops no further – this is the residual shear strength.”

This procedure is repeated until the shear strength drops no further – this is the residual shear strength. Sounds good, but there's a small flaw: each time the direction is reversed, the particles can realign them-

selves, possibly giving a bit more 'bite'.

The solution to repeated changing direction is simple: don't! Instead of going back and forth with a square section, go round and round in the same direction with an annulus (ring): this is the principle of a ringshear test.



Aside from large research apparatus, the ringshear test is generally performed on an annulus 100 mm outer diameter, 70 mm inner, and 5 mm deep, which has been filled with remoulded fine grained soil.

“Since the ring can keep going round in the same direction, the shear plane can become polished...”

Since the ring can keep going round in the same direction, the shear plane can become polished, with all the particles aligned towards the shearing direction. This helps give the lowest residual shear strength and so it is often the best choice for slope stability problems, but it can't be used to test gravely soils, hence:

Catch Point 4 Choose the most appropriate residual strength test type

In the Laboratory

The test has been fully specified, the most appropriate

test type requested, the test pressures have been provided, and we've got enough material to do the test. Home and dry? – not necessarily.

First of all there is the preparation. The technician might be pleased that they have a 'nice' stiff clay: easy to trim, easy to smooth top and bottom to a mirror-like finish – that's the problem! That already low permeability material has just had all its voids filled at the top and bottom surfaces it needs to drain through.

“It is good practice to use a very fine wire wool to just 'dull' the surface...”

It is good practice to use a very fine wire wool to just 'dull' the surface, unclogging it, so the test consoli-

dates as quickly as the material type will allow. Not only can this keep consolidation durations to a minimum, the rate of displacement for the shearing stage is calculated from the consolidation, so that will be at its optimum also.

“The consolidation lets us calculate the time to peak, but the technician has to estimate the displacement at peak in order to work out a strain rate.”

Next we have the shearing stage. The consolidation lets us calculate the time to peak, but the technician has to estimate the displacement at peak in order to work out a strain rate. This is where an experienced

technician is invaluable. Test too slowly and you still get a valid result, but you could be paying for excessive test durations. Even worse, test too fast and the result may look fine, but the result could be invalid. The formula given in BS1377:Part 7:Clause 4.2.2.5:1990 is based on the shearing condition being drained, and hence the pore pressure being equalised throughout the specimen when the peak occurs. If an overly aggressive strain rate (too fast) has been used, there is a distinct possibility that at the shear plane the particles have gone past their densest packing and are trying to move apart. The pore pressure consequently drops and, with the normal stress remaining constant, the

“This would result in higher shear strength than if it were run at an appropriate speed.”

effective pressure rises. This would result in higher shear strength than if it were run at an appropriate speed. That embankment doesn't seem so safe now, does it? So...

**Catch Point 5
Use a laboratory you can trust**

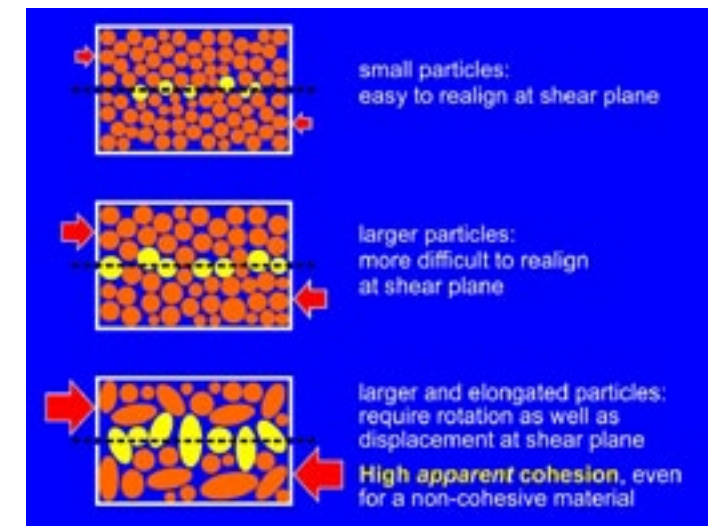
Get to know the laboratory you use. Make sure they understand your requirements and really know their

“The laboratory being UKAS Accredited for the testing you require should go a long way towards giving you confidence in their abilities...”

testing. The laboratory being UKAS Accredited for the testing you require should go a long way towards giving you confidence in their abilities, but a good laboratory should also relish the opportunity to guide you through that tricky project!

Back in the Office

Your results have come back from the laboratory but, hey, wait a minute, your clean angular gravel has come back with c' of 20 kPa - there must be a mistake: there was no clay in it. Actually not – no mistake! What this is telling us is that if we could test it with zero normal stress (essentially testing just the specimen without the top loading cap) we would still measure a significant resistance. This is due to the comparatively large gravel particles having to rearrange themselves (displacing and rotating) to create a shear plane between the two halves of the shearbox. This rearrangement requires force: force that generates a shear strength, even at zero normal stress.



The larger and more angular the particles, the more force is required to move them, and the greater the shear stress that is developed. This is why the cohesion is reported as apparent cohesion: a non-cohesive material won't bind together, but the result may appear to show cohesion:

**Catch Point 6
Sands & gravels can have significant apparent cohesion**

That rounds-up this foray into shearbox testing. Watch this space for further articles, including Effective Stress. ■



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monitoring contractors' guides to AGS data products and innovations



Dr Roger Chandler, Managing Director of [Keynetix](#) and member of the AGS data management committee talks to **theGeotechnica** once again. This month, he speaks to us about the problems that monitoring contractors face when producing AGS data.

10 years ago in March 2002, CIRIA and AGS released project report 82 "The AGS-M format – for the electronic transfer of monitoring data". The report's listed authors are Mike Black from Crossrail, Tim Spink from Mott MacDonald and myself. The AGS-M format was incorporated without change into AGS 3.1 and was also included in AGS 4 with only minor modifications.

"...monitoring contractors are still having problems producing AGS data for clients."

However 10 years after its launch, monitoring contractors are still having problems producing AGS data for clients. This article explores the reasons why and suggests one of the easiest ways for monitoring contractors to produce AGS data.

What is the problem?

AGS is a transfer format, and like most transfer formats it should be invisible to the day to day user.

"You do not need to understand HTML to use a web browser..."

You do not need to understand HTML to use a web browser, or Windows Clipboard file format to use Cut and Paste so why should you need to read through the AGS guide to understand how to transfer AGS data to your client?

The majority of SI contractors who are required to produce AGS data do so using software products such

as HoleBASE which have an AGS export option built in. However most of the software packages used by monitoring contractors do not directly support the AGS format and this results in the contractor having no option but to ultimately revert back to Microsoft Excel, our default tool of panic. Using Excel is not the problem. However starting from a blank spreadsheet and trying to produce error free, correctly structured, AGS data without any help can be difficult. To start with you need to understand what groups and headings are required.

Groups and Headings

The AGS data is structured into sets of data that define specific objects, these are referred to as "groups". To transfer monitoring data you need to primarily include the following five groups; Project, Location details, Instrument details, Readings and Events. If you structure an Excel template in accordance with these groups and use off-the-shelf software tools to produce the AGS file then the process of entering and creating AGS data is easy.

Project Data is simply a list of parameters required to describe the project. These can easily be set up on the first spreadsheet of your workbook, a subset of data is shown below.

Project ID	DLR23099
Project Name	Quinley Gasworks
Project Contractor	Keynetix
Project Date	28/03/2012

Location and Instrument details contain all the information on the physical position of each instrument together with which direction the measurements are taken in, effectively all the data that is logged when you install the instrument.

This information is actually contained within two groups within the AGS file but for ease of use this data is usually entered on a single spreadsheet within a workbook as shown below. It is important to note that each location can have more than one instrument

installed – in the example below BH1 (the location) has two Piezometers instruments (P1 and P2).

Location ID	Location Type	Local X	Local Y	Local Level	Monitoring ID	Distance from Location	Install date	Type	By	Serial No
LP1	INST	123.65	456.91	1.45	LP1	0	28/02/2012	MSET	KYN	SER1346423
LP2	INST	125.76	456.14	1.68	LP2	0	28/02/2012	MSET	KYN	SER1356434
LP3	INST	127.87	455.37	1.91	LP3	0	28/02/2012	MSET	KYN	SER1366445
LP4	INST	129.98	454.6	2.14	LP4	0	28/02/2012	MSET	KYN	SER1376456
BH1	CP	136.31	452.29	2.83	P1	3.6	01/03/2012	EPIE	KYN	PIZ2464
					P2	17.3	01/03/2012	EPIE	KYN	PIZ2465

For simplicity the example above does not include the measuring direction details.

However this is an area that causes a lot of confusion. You can define up to 3 measurement directions (referred to as directions A, B and C). If your instrument only measures in 1 direction then you use the A options, 2 directions use A and B and 3 directions use A, B and C.

Location ID	Monitoring ID	Distance	Type	Date	Time	By	Level
LP1	LP1	0	MSET				
LP2	LP2	0	MSET				
LP3	LP3	0	MSET				
LP4	LP4	0	MSET				
LP5	LP5	0	MSET				

To ensure you are using the right headings you should refer to the example AGS file that relates to your type of monitoring instrument at <http://www.ags.org.uk/site/datatransfer/example.cfm>.

"By setting up your Excel templates to only cover one type of instrument, data entry will be considerably easier..."

By setting up your Excel templates to only cover one type of instrument, data entry will be considerably easier for staff as the number of options will be reduced.

The most important monitoring group within AGS contains the readings. By separating the readings data from the project and location information in your spreadsheet the process for completing a monitoring round is simplified further.

"It is even better if you provide a template with all the required reference data..."

It is even better if you provide a template with all the required reference data for each round of monitoring (shown in grey below). The process is simply a case of entering the date, time, reading, any remarks and a few additional fields for each instrument.

As can be seen from the example outlined in this article, by having a sensible structure to your Excel template, data entry can be quick and easy. However to produce error free AGS data from these spreadsheets it is best to use a program like KeyAGS Professional. This program installs an Excel add-in that enables you to read AGS data directly into Excel and write AGS data from Excel templates identical to the one described in this article.



monitoring contractors' guides to AGS data products and innovations



We are committed to making the transfer of monitoring data in the AGS format easy. Keynetix have therefore agreed to produce monitoring templates free of charge to any customers that purchases KeyAGS during April 2012.

With free professionally created templates and simple point and click AGS creation directly from Microsoft Excel, there should be no reason for monitoring contractors to fight AGS data creation any longer. ■

For more information visit:

www.ags.org.uk

www.keynetix.com/keyags



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FOR IMMEDIATE RELEASE

Keynetix Release Further Upgrades to their Leading Geotechnical Laboratory Management Software

Keynetix – home of the UK's most widely used geotechnical laboratory management system KeyLAB; today announced further improvements to their already pioneering software.

Included in 16 major improvements made to KeyLAB 2.1 is a full AGS administrator for AGS 3.1 and AGS 4, and features that allow data entry staff to view everyone's tests; also the internal communication between KeyLAB 2.1 and remote databases has now been reconfigured allowing you to save data 5 times faster than before.

The system whilst requiring user privileges to see individual projects and assets also allows individual labs to set up their own equipment lists, tests and attach photos to their test results and has an expanded number of tests available for free download from the Keynetix knowledgebase.

Whilst KeyLAB 2 has already been reported by its existing customers as flexible and showing a return on investment within 6 months; the additional benefits simply make it even more value for money. Peter Keeton of ESG says "ESG has been a KeyLAB development partner since the first version and I have been impressed with the level of investment that has gone into this new version, we look forward to using it".

Keynetix are delighted to announce that all existing KeyLAB 2 and KeyLAB 1 customers with maintenance contracts will be receiving the upgrade at no additional cost. For a full list of improvements please see the KeyLAB upgrade pages at www.keynetix.com/keylab

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About us

Keynetix Ltd is a software developer for the geotechnical and environmental industries.

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