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18th June 2013,

27th September 2013

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GEOTECHNICAL COURSE DATES:

Geotechnical Foundation Design - 17th September 2013

Soil Description

9th August 2013,

4th October 2013

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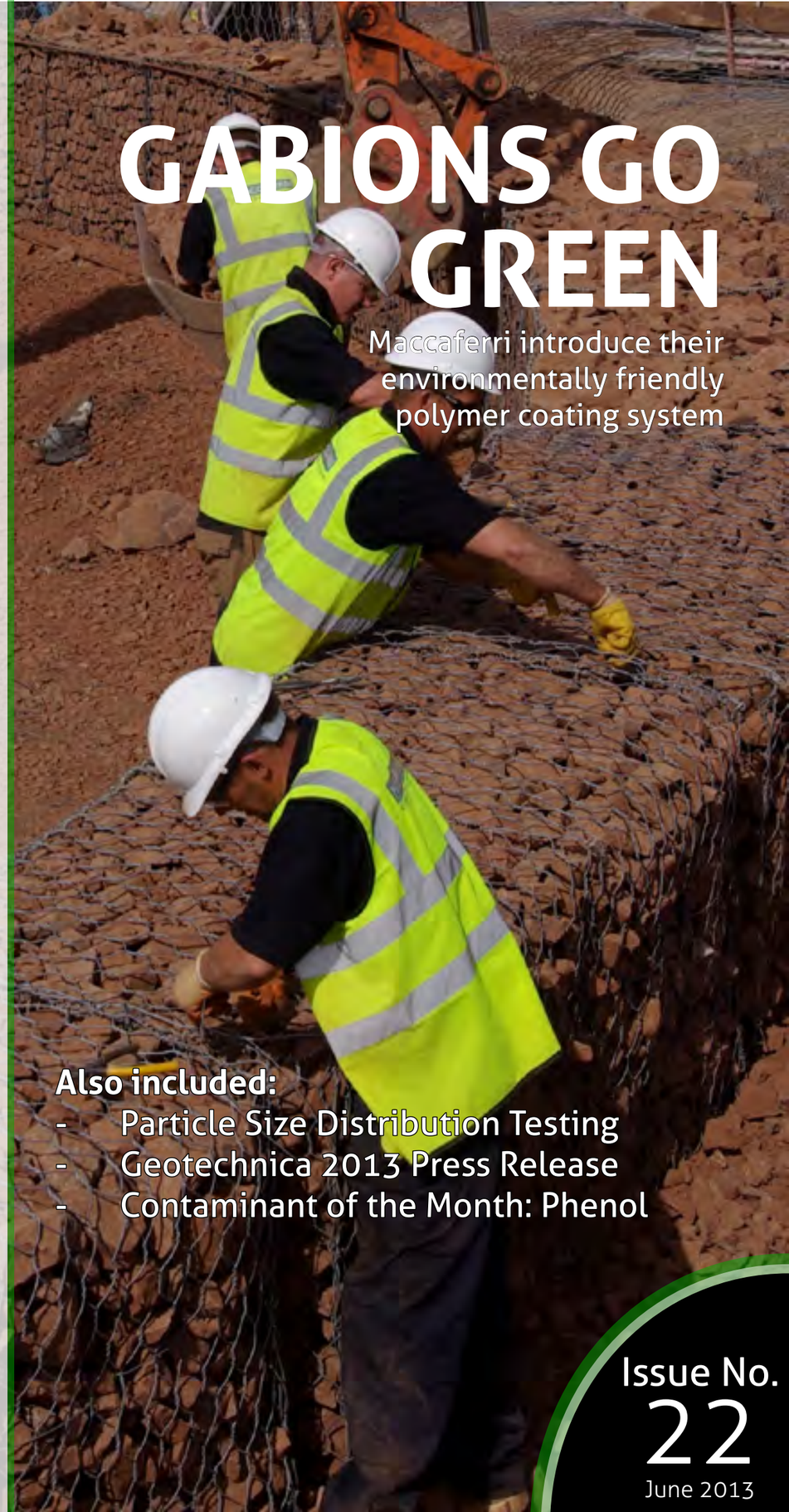

GABIONS GO GREEN

Maccaferri introduce their environmentally friendly polymer coating system

Also included:

- Particle Size Distribution Testing
- Geotechnica 2013 Press Release
- Contaminant of the Month: Phenol

Issue No.
22
June 2013

Contents

Welcome

Welcome to the 22nd Edition of theGeotechnica - the UK's fastest growing online geotechnically focussed e-magazine.

This month in theGeotechnica our cover article comes from Holmes Media's Jeff Laverack on behalf of geotechnical specialists Maccaferri. Jeff's article introduces Maccaferri's latest breakthrough regarding an environmentally friendly polymer coating system for their acclaimed gabion walls. Maccaferri have installed countless gabion walls across the country in recent times, and their new polymer coating will go some way to protecting the environment, being more environmentally friendly than the traditional double-twist wire mesh coatings.

The second article featured in this issue comes from regular and valued contributor Peter Reading, Technical Director of the Equipe Group. This month Pete discusses the use of particle size distribution testing and asks how accurate the test can really hope to be. Peter also provides advice on the correct methods of achieving samples suitable to be used in the distribution test. With the quality of sampling being one of the main issues surrounding the industry at the moment, this advice should prove invaluable to many of our readers.

We also have a particularly exciting press release from the Equipe Group regarding Geotechnica 2013. The UK's Largest Trade Show and Exhibition is a little under a month away now, and the press release in this month's magazine reveals the full line-up for this year's Geotechnical Conference – one of the main attractions since Geotechnica's conception in 2009. The press release also features an updated list of exhibitors, now including Bachy Soletanche, Soilmec and the Ground Source Heat Pump Association, amongst a multitude of the industry's biggest movers and shakers. Be sure to check page 17 for full details.

The final article of this month's issue comes from regular and valued contributor Geraint Williams of ALcontrol Laboratories. Continuing his valuable series of articles on contaminants, this month Geraint examines Phenol – its properties, uses, toxicity, as well as a thorough analysis of the element.

This month we have a number of recruitment advertisements being placed throughout the magazine, notably from Soil Consultants, Geotechnical Engineering and ESG. We also have entries in the Directory and Jobs sections, with positions available as a drilling specialist for the Equipe Group as well as Gardline Geosciences.

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

Once again, for any content that is submitted we will ensure that advertising space, proportionate to the quality of content provided, is available for that single edition of the magazine. From then on, if you have submitted content, you will receive a discount on all further advertisements placed within theGeotechnica.

We hope you enjoy this month's edition of the magazine and are inspired to contribute your own content for the coming editions of theGeotechnica.

Editorial Team,
theGeotechnica

GABIONS GO GREEN

MACCAFERRI INTRODUCE THEIR ENVIRONMENTALLY FRIENDLY POLYMER COATING SYSTEM

*Writing on behalf of geotechnical specialists Maccaferri is Jeff Laverack of Holmes Media. This month Jeff writes to **theGeotechnica** as Maccaferri unveil their latest innovation - an environmentally friendly polymer coating system to compliment their well-established gabion walls.*

Geotechnical specialist Maccaferri, best known for its wire-mesh Gabions used in retaining wall construction, has introduced a new, environmentally friendly protective coating for its double-twist wire based products, which has improved technical performance and environmental compatibility, over traditional coating systems.

The new, specifically formulated PA6 coating is an organic based, extruded polyamide material which has improved adhesion characteristics, enhanced resistance to mechanical damage and better cold temperature performance. Resistance to hydrocarbon pollutants is also significantly enhanced together with long term strength and elasticity.

"According to Maccaferri, the organic polyamide, PA6 coating is also far more environmentally friendly then traditional wire coatings..."

According to Maccaferri, the organic polyamide, PA6 coating is also far more environmentally friendly then traditional wire coatings as it contains no pthalates, heavy metals or other ozone depleting chemicals. Furthermore, unlike PVC, it doesn't emit hydrogen chloride during burning.

Extensive accelerated testing has shown that, compared with traditional PVC or HDPE coatings for double-twist wire products, the new PA6 system is 50% harder and is 25% more malleable, even after long-term exposure to UV. As well as this, results showed that PA6 gave a three-fold improvement in coating-to-wire adhesion, significantly more resistance to impact and abrasion damage, and achieved a 30% improvement in design life.

Enhancement rather than alternative

"Although offering better performance, PA6 is not seen as an alternative to PVC coated double-twist wire products, but more an enhancement. We see it being used when PVC or HDPE coated products do not provide users with the required design life, environmental or technical performance." said David Crowther, Maccaferri Technical Manager. "Maccaferri will continue to manufacture PVC coated products for use in less demanding applications". He added.

Simplicity, strength and durability

"Woven double-twist mesh Gabions have been a feature of the UK's industrial landscape for well over a hundred years."

Woven double-twist mesh Gabions have been a feature of the UK's industrial landscape for well over a hundred years. These simple, stone filled wire baskets have been used by civil engineers and contractors to stabilize vulnerable embankments, build retaining structures, line fast flowing watercourses and prevent coastal erosion.

Their substantial mass and flexible mesh construction means that woven mesh Gabion walls can accommodate large differential settlement without sustaining damage. Their un-bound stone infill also prevents the build-up of damaging hydrostatic pressures behind the wall and, because of these qualities, engineers throughout the world have made gabions their retaining wall solution-of-choice.

In recent years, welded mesh Gabions have become available and are mainly used in architectural and cladding applications where differential settlements are minimal and no flowing water is present.

Environmental compatibility

From an environmental perspective, the use of natural material as infill makes Gabions a natural choice in areas of visual and ecological sensitivity. Fill materials are typically quarried durable rock or, in architectural applications, even off-cuts of quarried stone or slate. Recycled crushed concrete is also a popular choice as the re-use of waste material as structural fill offers environmental advantages.

"Recycled crushed concrete is also a popular choice as the re-use of waste material as structural fill offers environmental advantages."

In Worcestershire, Architects, Howl Associates incorporated an array of sweeping, free-standing Gabion walls in the design of the recently opened Kidderminster Crematorium for Client, Dignity Funerals Plc.

Here, the building is set in an open, semi-rural landscape. Its curved geometry is defined by 'thick' rendered walls beneath large over-sailing roofs

An array of sweeping, free-standing Gabion walls was incorporated in the design of the new Kidderminster Crematorium

A huge slender, free-standing Maccaferri Gabion wall – thought to be the biggest in the UK - has been built to screen outdoor filming areas at the BBC Roath Lock studio in Cardiff.

Maccaferri Gabions were used to create space for the UK motorway network's first car-share lane at junction 26, M62/M606.

"To direct people around the building a series of 'external rooms' was created using 2700mm high, free standing Gabion walls."

that provide covered areas for visitors to the chapel. To direct people around the building a series of 'external rooms' was created using 2700mm high, free standing Gabion walls. These help to define views both into and from the building and soften the visual impact on the surrounding landscape.

The carefully selected infill stone addressed 'end of life' sustainability criteria for this BREEAM rated building, as it could readily be reused.

Cliff-face screening for BBC Wales

At BBC Wales' new Roath Lock studios in Cardiff, a much larger free-standing Gabion wall – thought to be the biggest in the UK - has been built to screen the site and provide an acoustic barrier around external filming areas.

"Both architect and client were keen to use Gabions as the structural medium to create a 'cliff face' appearance..."

Both architect and client were keen to use Gabions as the structural medium to create a 'cliff face' appearance using locally sourced sandstone paving off-cuts as the infill material.

Vertical features in the wall were created using structural steel columns clad with timber and different colours of stone were placed in the Gabion baskets to form distinctive horizontal bandings and enhance the natural aesthetic.

Civil engineering perspective

Gabions were used in a more traditional civil engineering application in the construction of the UK motorway network's first car-share lane at the M606/M62 junction near Bradford, West Yorkshire.

"Here, Gabions create a 450m long road-side retaining wall to support existing grassed slopes which had to be cut back to create space for the new car-share lane."

Here, Gabions create a 450m long road-side retaining wall to support existing grassed slopes which had to be cut back to create space for the new car-share lane.

In the rail sector a soil nailed, Gabion retaining wall was used to help boost capacity of the busy London to Oxford Rail Line where it passes through an historic bottleneck near Northolt.

Engineers were able to increasing line capacity by widening an existing, 3.0m high embankment to allow the installation of an addition track. All within what was an already narrow, rail corridor.

A conventional battered slope was not viable due to space restrictions, so Consulting Engineers, Atkins devised a near vertical, 3.0m high retaining wall comprising stone-filled, woven Mesh Gabions in combination with an array of integral, 14.0m long soil nails.

"The soil nails were installed and grouted after the wall was completed by drilling through pre-formed apertures in the Gabion Baskets."

The soil nails were installed and grouted after the wall was completed by drilling through pre-formed apertures in the Gabion Baskets. This process allowed back-filling behind the wall as construction of the Gabions progressed.

Wider range

Although Maccaferri will continue to manufacture PVC coated products for use in less demanding applications, the new PA6 coating is available on its entire range of double twist wire based products including Reno [R] erosion protection mattresses, Terramesh [R] and Green Terramesh [R] soil reinforcement systems as well as the Company's range of rock-fall protection meshes. ■

For further information, go to www.maccaferri.co.uk. where you can download technical documents on PA6, register for a CPD presentation or request design software.

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PARTICLE SIZE DISTRIBUTION TESTING

How accurate is it?

*Writing for **theGeotechnica** once again is Peter Reading, Technical Director of the Equipe Group. This month Pete discusses the use of particle size distribution testing and asks how accurate the test can really hope to be. Peter also provides advice on the correct methods of achieving samples suitable to be used in the distribution test.*

The particle size distribution test is probably the most scheduled test in the geotechnical engineer's arsenal of basic tests. Traditionally we have used all types of sample for this test - from tubs to bulk bags and tube samples, yet in many cases it is unrepresentative of

"From my time in laboratories it would seem that this test is misused and misunderstood..."

the material insitu. From my time in laboratories it would seem that this test is misused and misunderstood, having seen samples scheduled for the test with samples comprising of a 500g tub with gravel of 60mm to a bulk bag of three house bricks!

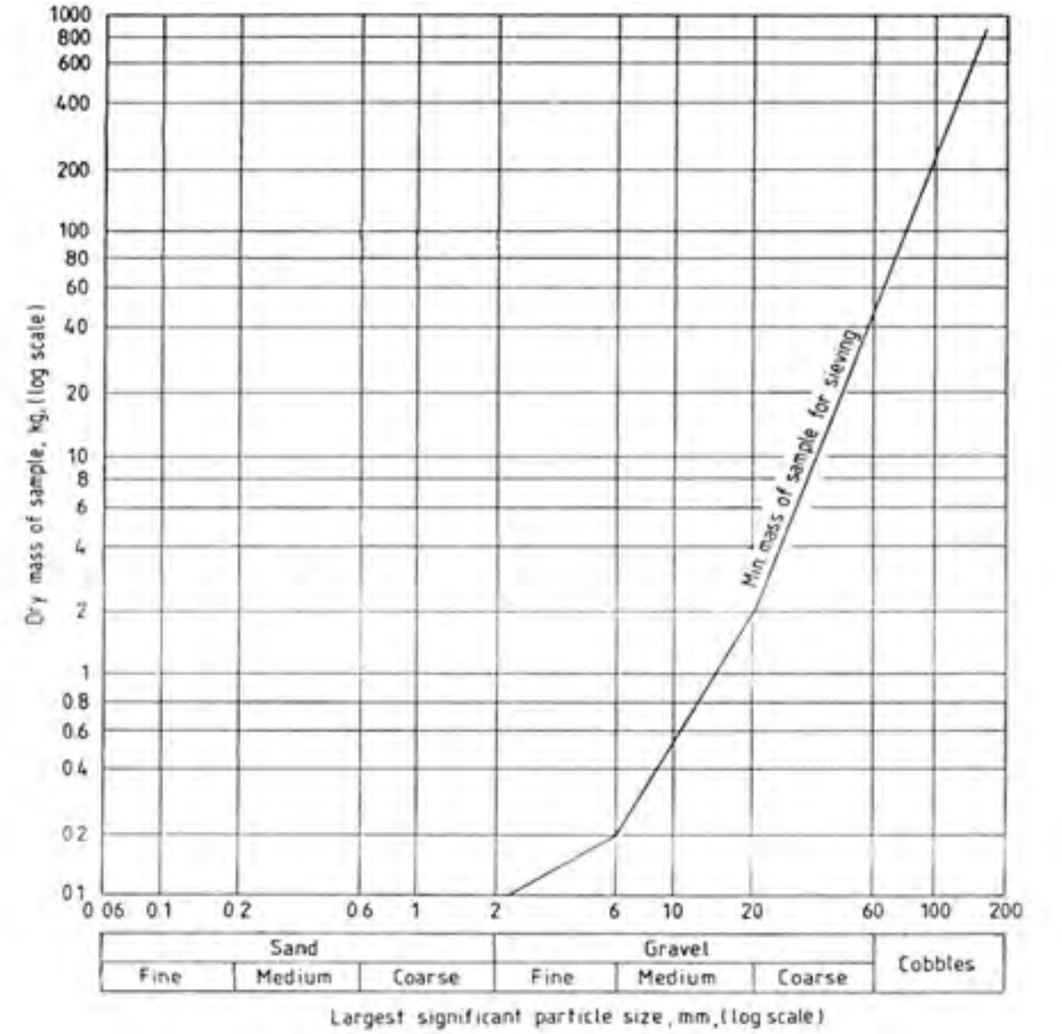
The test itself is relatively easy to carry out. It requires a nest of sieves with apertures of various sizes arranged with the largest aperture at the top, reducing in size at each sieve with the smallest at the bottom - all resting on a catch tray. It is normal practice to split the sieves at the 5mm sieve with larger diameter sieves, 450mm being used for the coarser gravel particles and a smaller 200mm diameter sieve nest for the sand size particles. It is important that the sieves are regularly checked to ensure they are not damaged in any way. Care should also be taken not to overload the sieves because this can stretch the mesh, particularly in the finer sieve sizes. The standards give details of the maximum weight considered suitable for each sieve. If there is too much material the total mass can be divided using riffle boxes until the amount on each sieve is below the maximum. The weight retained on each sieve size is recorded and from this taking account of any riffling of the sample the percentage of material passing each sieve size is obtained and plotted on a grading curve where the particle size is plotted to a log scale.

Sieve tests are only used on material from 63mm to 63

"Coarser particles are usually measured by hand although it is possible to obtain sieves with larger apertures."

micron in size. Coarser particles are usually measured by hand although it is possible to obtain sieves with larger apertures. Finer particles stop behaving purely by gravity and require a sedimentation method to obtain the size distribution. If a sample contains clay and/or silt it will require washing to remove the finer soils – whilst being tedious, this is relatively easy to accomplish with a good water supply and suitable sieves to wash the sample through.

However although this test is popular it will often produce unrepresentative results, this is not through any shoddiness from the laboratory but primarily through poor sampling techniques. Commonly the laboratory will report that there is insufficient



"This is generally the result of the specifying engineer not being aware of the actual size of sample taken in the field..."

material for the test to be representative. This is generally the result of the specifying engineer not being aware of the actual size of sample taken in the field and probably not being familiar with the amount of material required for the test. The actual amount needed is dependent on the largest particle size present. Table 1 gives the recommended masses of sample required based on the largest particle size in accordance with BS EN ISO 1997 Part 2.

It is clearly evident that for many tests a significant amount of material will be needed. In order to achieve these volumes it is necessary for the sample to come from a relatively large hole if it is going to fulfill the criteria. Typically this will be from a Trial Pit or Cable Tool Borehole. In both cases the common sample type adopted will be a bulk sample. Rotary Boreholes will struggle to

"... sonic boreholes do recover all the material from the hole, whilst this may be disturbed by the sampling process the method will retain all particle sizes..."

recover granular soils however sonic boreholes do recover all the material from the hole, whilst this may be disturbed by the sampling process the method will retain all particle sizes and in general does

not break up the particles during sampling.

Great care is needed if a suitable sample representative of the insitu material is to be obtained from either Trial Pits or Boreholes. When sampling from Trial Pits typically the operator will be instructed to dig a bucketful of the stratum and tip it onto the existing spoil

"This process is flawed from the start. If the excavator is grabbing sample in a deep scoop it will invariably mix the soil and possibly mix together very different stratum."

heap from here the engineer will proceed to scoop up the soil into a large plastic bag or tub. This process is flawed from the start. If the excavator is grabbing sample in a deep scoop it will invariably mix the soil and possibly mix together very different stratum. By tipping onto the spoil heap even more mixing will take place, and perhaps more importantly segregation of coarser material will take place as it tumbles down the heap. In this state it will be impossible to obtain a representative sample of the soil.

It is suggested that in order to avoid this, sampling should be made as discrete as possible, scooping material in thin layers from the pit to be sure that the samples come from the layer of interest. The material obtained should be tipped onto a board or tough plastic sheet to enable the engineer to gather all of the material from the stratum. If there is more material than required then the heap should be coned and quartered and then full quarters should be placed in the sample bag - it may be necessary to use more than one bag to achieve the

"In this way a representative sample should be achieved. It is essential the sampling strategy is discussed with the operator, and a method of operation agreed."

required amount. In this way a representative sample should be achieved. It is essential the sampling strategy is discussed with the operator, and a method of operation agreed.

If the sample is to be taken below the water table it will be difficult to achieve a representative sample without decanting the whole sample into a settling tank. In this scenario it is advisable to allow the finer soils to settle out and then begin decanting the water. Once this is done the procedure above can be used to obtain the sample.

"Sampling from a cable tool borehole is also fraught with difficulty."

Sampling from a cable tool borehole is also fraught with difficulty. The physical act of advancing the borehole using heavy tools dropped under gravity will tend to break up coarser particles such as flint into smaller pieces therefore even before the sample is out of the borehole its particle size will be altered. In granular soils it is normal to add water to the borehole to aid progress as the shell or bailer is removed from the borehole with the sample retained inside, water will wash from the shell or bailer and take with it finer soils. Therefore even before the sample is out of the hole it is likely the particle size distribution has been significantly affected, reducing the coarser soils to finer soils and removing finer soils from the bottom of the grading curve.

With good drilling practice this can be at least partially minimized by the driller. The driller is an important part of any investigation and sampling process and should be made aware of the need to obtain a sample unaltered by the sampling process and to use techniques which will minimize break up and loss of the sample. The correct way of sampling in granular soils is to fill the hole with water. The shell or bailer should be used with a pumping action to "suck" the soil into it. The shell or bailer should have a clack which seals the bottom of the tube if this is the case the driller will be able remove soil and water along with all the fines. Although this method may not eliminate all the potential errors it will considerably reduce them. The engineer should be aware of the potential for error when assessing the results. In particular it is not possible to remove a piece of gravel more than about 60mm diameter from a 150mm diameter

"In any event using a heavy handed approach to break up particles should be avoided during the sampling process."

borehole. In any event using a heavy handed approach to break up particles should be avoided during the sampling process.

Perhaps the best way of sampling granular soils from depth would be to use sonic methods. This method has the advantage of not requiring water to be added to the hole and recovering the whole lithological column with the minimal disturbance.

In any event it is important that the designer is aware of the limitations of the sampling method and at least attempts to use the most appropriate method for the use to which he is putting the test results. If he is looking to assess the Uniformity Coefficient which uses the particle diameter at the 10% and 60% points on the graph then it is essential that the sample is as representative as possible. ■

GEOTECHNICA 2013
WILL YOU BE THERE?

The following is the latest press release and update from the Equipe Group on Geotechnica 2013, the UK's Largest Geotechnical Trade Show and Exhibition. This year's event will take place on the 10th and 11th of July at the Warwickshire Exhibition Centre.

As readers of theGeotechnica may all be aware by now, Geotechnica 2013 is fast approaching. Having moved to the Warwickshire Exhibition Centre for 2013's show, the Equipe Group have seen a massive increase in interest from different areas of the geotechnical and drilling sector – from Clients to Contractors, Trade Associations

"... more people than ever are interested in being a part of Geotechnica."

to Universities – more people than ever are interested in being a part of Geotechnica. With fresh enquires about Geotechnica 2013 coming in every day the attendance at this year's show is shaping up to be the best ever. With this in mind, now is the time to ensure that your company is represented at this year's event.

BOOK YOUR COMPANY'S PLACE NOW

Whilst the Trade Show portion of the exhibition is shaping up nicely, perhaps even more exciting is the line-up for this year's Geotechnical Conference titled: Geotechnical Challenges in the 21st Century. This year's Conference will feature a number of incredibly impressive speakers from across the Geotechnical, Piling, Environmental and Drilling sectors in order to appeal to every corner of our industry.

Day one of the Conference will feature a Keynote speech from Tim Chapman, Director at one of the UK's biggest geotechnical consultants, Arup. Returning to Geotechnica's Geotechnical Conference once again is esteemed slope stability specialist, Professor Eddie Bromhead. Joining Eddie in Session 1, titled 'Will climate change mean a design change?', will be Professor Neil Dixon of Loughborough University, as well as Ian Walsh of the Chartered Institution of Highways & Transportation.

Session 2 will be dedicated to the piling industry, examining the challenges that are facing the sector in the 21st Century. This session will feature presentations from Jim DeWaele, Managing Director of Keller and also Chairman of the Federation of Piling Specialists, as well as Technical Director of Stent (BBGEL), Tony Suckling.

The final session of day one will focus specifically on Health and Safety and where the industry currently stands on keeping its workforce as safe as possible. Representing the HSE will be Principal Inspector Ian Simpson, who will focus on the HSE's stance on policing the industry. Tom Phillips of RPA Safety Services will then follow Ian, discussing the re-drafting of HSG 47 – Avoiding Danger from Underground Services.

Day two will begin with Session 4: Improving Parameters for Design with Technology Advances. This session will be kicked off by Carlton Hall of CPT specialists Lankelma – Carlton will be discussing the

GEOTECHNICAL CONFERENCE:
GEOTECHNICAL CHALLENGES IN THE 21ST CENTURY

Geotechnica 2013
www.geotechnica.co.uk

Wednesday 10th July

Introduction: Welcome to Geotechnica 2013

09:30 - 09:45 Peter Reading
Technical Director, Equipe Group

Keynote Address

09:45 - 10:30 Tim Chapman - *Managing Risk: Where the client sits*
Director, Arup

Session 1: Will climate change mean a design change?

10:30 - 11:00 Professor Neil Dixon - *Slope stability in a changing climate*
Loughborough University

11:00 - 11:30 Professor Eddie Bromhead - *Coastal Slope Engineering - Do we defend or retreat?*

11:30 - 12:00 Ian Walsh - *Do we need to rethink pavement design?*
Road Consultants and Chartered Institution of Highways and Transportation

Session 2: Piling into the 21st Century

14:00 - 14:30 Jim DeWaele - *Challenges for Piling*
Managing Director, Keller & Chairman of the Federation of Piling Specialists

14:30 - 15:00 Tony Suckling - *Managing Safely - A Piling Contractor's View*
Technical Director, Stent (BBGEL)

Session 3: Health and Safety - Where now?

15:00 - 15:30 Ian Simpson - *HSE Policing the Industry - A model for the future*
Inspector, HSE

15:30 - 16:00 Tom Phillips - *HSG 47 Redrafted (Avoiding Danger from Underground Services)*
RPA Safety Services

Thursday 11th July

Introduction: Welcome to Day 2 of Geotechnica 2013

09:30 - 09:45 Peter Reading
Technical Director, Equipe Group

Session 4: Improving Parameters for Design

09:45 - 10:15 Carlton Hall - *Best use of cone penetration techniques*
Engineering Director, Lankelma

10:15 - 10:45 Francesca Buselli - *Seismic Dilatometer Testing*
Geotechnical Engineer, Marchetti DMT

10:45 - 11:15 Dr Kieran Dineen - *Geothermal Design - Getting it Right*
Commercial and Technical Director, Terra Firma Ground Investigation

Session 5: Conceptual/Ground Models and BIM - New concepts, but what do they provide?

11:15 - 11:45 Professor Paul Nathanail - *How reliable is the model?*
Director of Land Quality Management Ltd & Professor of Engineering Geology at the University of Nottingham

11:45 - 12:15 Dr Roger Chandler - *Data reliability - The foundation of the model?*
Managing Director, Keynetix

12:15 - 12:45 Gary Logan - *What can graphics do for you?*
Director of Sales, Bentley Systems

Session 6: Debate - Geotechnical parameters, design and investigation - Will we ever use Eurocode?

14:30 - 15:30 Panel:
Dr John Powell
Technical Director, GEOLABS Ltd
Peter Reading
Technical Director, Equipe Group
Dr David Norbury
Director, David Norbury Ltd
Professor Paul Nathanail
Director of Land Quality Management Ltd & Prof. of Engineering Geology at the Uni of Nottingham

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Seismic Cone Test and its value in contributing to the design process. Following Carlton will be a representative from Marchetti DMT in Italy, who will discuss the many forms of the Dilatometer and the Seismic Dilatometer. Dr Kieran Dineen of TerraFirma Ground Investigation will finish up Session 4 with a presentation on Geothermal Design and how to get it right.

Session 5 will focus on new concepts such as Conceptual Models, Ground Models and BIM. Professor Paul Nathanail of the University of Nottingham will begin the session by discussing how reliable these types of models can be. Dr Roger Chandler of Keynetix will follow Professor Nathanail, asking if data reliability can be the foundation of the model, whilst Gary Logan of Bentley Systems rounds off Session 5 discussing what graphics can do for you.

"An exciting new addition to this year's Geotechnical Conference will be an open floor debate titled: Geotechnical parameters, design and investigation – Will we ever use Eurocode?"

An exciting new addition to this year's Geotechnical Conference will be an open floor debate titled: Geotechnical parameters, design and investigation – Will we ever use Eurocode? With a panel consisting of Dr John Powell of GEOLABS Ltd, Independent Consultant Professor David Norbury, Professor Paul Nathanail and

"... the debate will look at the value of Eurocode and how the industry can comply with Eurocodes, whilst also taking steps forward to ensure the industry growth in all areas."

Equipe's own Peter Reading, the debate will look at the value of Eurocode and how the industry can comply with Eurocodes, whilst also taking steps forward to ensure the industry growth in all areas.

If you have any questions that you would like to put to the panel regarding Eurocodes, please email your questions to: magazine@geotechnia.co.uk

If you're still not convinced about exhibiting or attending Geotechnica as a visitor, here's some more information on how the Equipe Group intend on making this year's event bigger and better than ever:

Exhibitors Presentation Area

In previous years presentations have been limited to technical talks about the industries latest innovations, case studies and specialist knowledge transfer. However this year the organisers are providing exhibitors the opportunity to deliver presentations focused on their own company's services and products on a separate stage to the technical talks. Got a new service or product that you want to show off to multiple clients at the same time? The Exhibitors Presentation Area is the perfect opportunity to do this.

Dedicated Catering Facilities

Want to entertain prospective clients? In previous years a bacon-butty or a hot-dog was about as flashy as the catering got. However this year the Warwickshire Exhibition Centre has its own dedicated kitchen and restaurant for you to meet and greet prospective customers in, serving an array of hot or cold foods.

Improved Evening Charity Networking Event

Networking and communicating with new people is one of the main aspects of Geotechnica as a whole, but this year's Evening Charity Networking Event will present an even greater opportunity to discuss all things geotechnics with an array of personnel from the industry.

"... the Networking Event is being held at The Angel Hotel in nearby Leamington Spa – only 10 minutes' drive from the exhibition venue..."

This year the Networking Event is being held at The Angel Hotel in nearby Leamington Spa – only 10 minutes' drive from the exhibition venue – where a finger buffet, bar and jazz band will be awaiting all attendees. Tickets are priced at a mere £20, and the event presents the perfect opportunity to network, meet new people and create new contacts.

CONTAMINANT OF THE MONTH:
PHENOL
PROPERTIES, USES, TOXICITY AND ANALYSIS

*Writing for **theGeotechnica** once more is **Geraint Williams** of Alcontrol Laboratories. This month, Geraint discusses the properties, uses, toxicity and analysis of phenol.*

Phenol (CAS No. 108-95-2) is a benzene derivative containing a single hydroxyl substituent (C6H5OH). Other names of this particular molecule include benzenol, carbolic acid, hydroxybenzene, monohydroxybenzene, monophenol, oxybenzene, phenic acid, phenyl hydrate, phenyl hydroxide, phenylic acid and phenylic alcohol. The term phenol is often applied not only to a specific compound but to a class of compounds. A member of this class may have other groups, in addition to the hydroxyl group directly bonded to its benzene ring. Only phenol itself is considered here.

Properties and Uses

Phenol is a colourless to pink crystalline solid at room temperature. It is water soluble and a weak acid. Phenol is soluble in most organic solvents and has a water solubility of 84,100 mg L-1 at 25°C (Environment Agency, 2008).

Phenol is produced naturally but the major sources are from an anthropogenic origin. Phenol occurs naturally in coal tar and is formed during the natural decomposition of organic materials. Phenol is produced during the combustion of coal, wood and municipal wastes and is a component of vehicle exhaust and cigarette smoke. It is a common soil contaminant at former gas works and coking plants.

"It is a common soil contaminant at former gas works and coking plants."

The major releases to soil include the spreading of animal manures and sewage sludge, and the historic manufacture of coal gas and coke (ECB, 2006)

"Phenol is mainly used as an intermediate in organic synthesis."

Phenol is mainly used as an intermediate in organic synthesis. Phenol serves as a raw material for the production of phenolic resins and bisphenol A (an intermediate in the manufacture of epoxy resins). Other important uses include the production of caprolactam (an intermediate in the manufacture of nylon), aniline and other common organic chemicals (IPCS 1994). It is also used to make adhesives, paint, rubber, ink, dyes, perfume and soap. Several pharmaceutical products such antiseptic, anaesthetics, throat lozenges and ear drops also contain phenol, as well as disinfectants (HPA 2011).

Although volatile in a pure form at room temperature, phenol strongly partitions to water and its volatilisation from water to soil appears to be a slow process and is not a significant source of atmospheric contamination (ASTDR, 2008). Based on its physical-chemical properties, it will be weakly bound by soil organic matter and therefore leach readily from soil to ground and surface water (ECB, 2006; Environment Agency 2008).

"Based on its physical-chemical properties, phenol will be weakly bound by soil organic matter and therefore leach readily from soil to ground and surface water."

A review of available data indicates that phenol rapidly biodegrades in soil under aerobic and anaerobic conditions (EC 2006; ATSDR 2008). Elevated concentrations of phenol in soil and coal tar wastes may give rise to toxic impacts on the microbial population, suggesting that optimal degradation conditions are not always achieved.

Toxicity

Phenol has been shown to cause liver and kidney damage, neurotoxic effects and developmental toxicity in laboratory animals (Environment Agency, 2009). The oral tolerable daily intake (TDIoral) is based on a reproductive and developmental toxicity study in rats (Environment Agency, 2009). The two-generation rat study of Ryan et al. (2001) was considered by the Committee on Toxicity (COT) to be critical in the assessment of the risks posed by ingested phenol. The no observed adverse effect level (NOAEL) of 70-93 mg kg-1 is the basis of the oral tolerable daily intake (TDIoral) of 700 µg kg-1 bw day-1 adopted by the Environment Agency. Hsieh et al. 1992 have reported abnormal findings in animals at lower doses. However, due to the study limitations, ▶▶

the COT did not consider the Hsieh study appropriate for derivation of a TDI.

A Health Criteria Value for inhalation of phenol based on mutagenic (and thus carcinogenic) potential for which it is assumed there is no threshold would take the form of an Index Dose (IDinh), with the associated requirement to reduce exposure to as low as reasonably practicable (ALARP).

"... no evaluations that would be appropriate to adopt as a basis for such an Index Dose are currently available..."

However, no evaluations that would be appropriate to adopt as a basis for such an Index Dose are currently available (Environment Agency, 2009). The inhalation tolerable daily intake (TDIinh) of 10 µg kg-1 bw day-1 is based on limited occupational epidemiology data from a study reported by Shamy et al. (1994) and applies to non-mutagenic endpoints only.

The adult inhalation mean daily intake (MDIinh) for phenol is estimated at 40 µg day-1. The adult oral mean daily intake (MDIoral) is approximately 350 µg day-1 (Environment Agency, 2009). The MDI for food within the original TOX report (2003) was 600 µg day-1. European Food Standards Agency (2013) estimated exposure to phenol from food contact materials is likely to be 0.3 mg to 0.6 mg/person/day.

A review undertaken in the

Land Use	Soil Guideline Value (mg/kg dry weight) [1,2]
	Phenol
Residential	420
Allotment	280
Commercial [3]	3,200 (38,00)

[1] Figures are rounded to one or two significant figures

[2] Based on a sandy loam soil with 6% SOM

[3] Based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health effects following long-term exposure provided for illustration only).

Environment Agency's report Supplementary information for the derivation of SGV for phenol found no suitable data on plant uptake of phenol by fruit and vegetables relevant to the CLEA model. SR7 indicates phenol to have an octanol-water partition co-efficient (log Kow) of 1.48. As a result, it can be predicted that phenol will easily enter plant roots in the transpiration stream, and should travel through root cell membranes into the xylem for transport to the rest of the plant. However, the actual behaviour of phenol will vary between plant species and uptake and accumulation are likely to be reduced by bacterial and plant metabolism (Environment Agency, 2009).

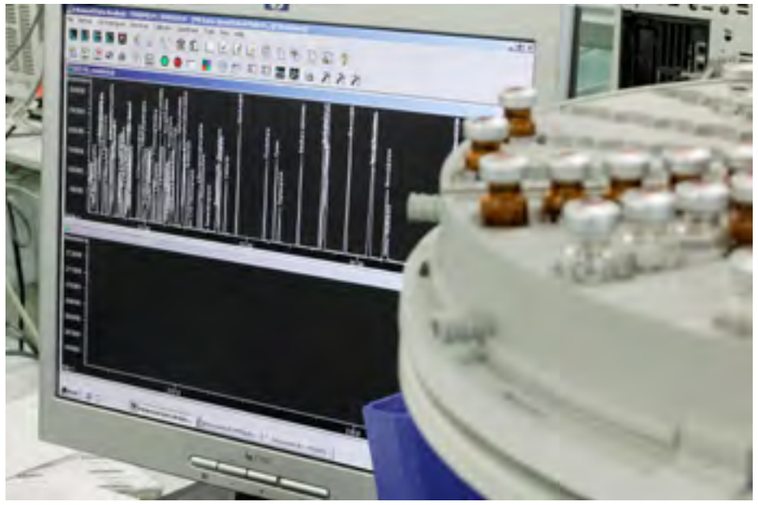
Soil Guideline Values

SGVs for phenol are presented according to generic SR3 land uses in the Environment Agency Report SC050021/Phenol SGV.

The SGV document describes the proportion of exposure attributable to each individual pathway. In summary:

- consumption of homegrown produce and attached soil makes the greatest contribution to total exposure for the residential and allotment land use scenarios;
- inhalation exposure from soil contamination makes a small contribution to total exposure for the residential and allotment land use scenarios;
- background exposure is a significant contributor to total exposure for the residential land use scenario;
- dermal exposure drives the risk to health from soil contamination for the residential land use scenario because of the significantly lower potential threshold of toxicity for phenol via the non-oral route (the TDIinh is 70 times lower than the TDIoral);
- consumption of homegrown produce drives the risk for the allotment land use scenario because of the dominance of this exposure pathway;
- background exposure via the inhalation pathway makes a significant contribution to risk for the residential land use scenario, though its contribution to total exposure is small (Environment Agency, 2009).

For residential and allotment land uses, SGVs are based on estimates representative of exposure of young children



because they are generally more likely to have higher exposures.

Phenol can be absorbed through the skin in toxic amounts but no authoritative assessments of dermal toxicity have been identified (Environment Agency, 2009). In the absence of pathway specific toxicity information dermal exposure has been compared to TDIinh. A dermal absorption factor of 0.3 for phenol was derived from studies undertaken by Skowronski et al. (1994).

Analysis

"The analysis of phenol is usually undertaken by high performance liquid chromatography (HPLC) or by Gas Chromatography Mass Spectrometry (GC-MS)."

The analysis of phenol is usually undertaken by High Performance Liquid Chromatography (HPLC) or by Gas Chromatography Mass Spectrometry (GC-MS).

Typical limits of detection for HPLC are 0.01 mg/kg for soils and 0.5 µg/l for waters. GCMS provides limits of detection of 1 mg/kg for soils and 0.5µg/l for waters.

For further information, please contact:

Alcontrol Laboratories
Units 7 & 8 Hawarden Business Park
Manor Road
Hawarden
Deeside
Flintshire
CH5 3US

T: +44 (0) 1244 528 700
E: hawarden.sales@alcontrol.com
W: www.alcontrol.com

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Tel: 020 8811 2880 **Fax:** 020 8811 2881
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Email: geotech@geoeng.co.uk

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Unit 37, Longfield Road, Sydenham Industrial Estate, Leamington Spa, Warwickshire, CV31 1XB
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Email: rgi10@aol.com

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Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

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The Peter Vaughan Building, 9 Avro Way, Brooklands, Weybridge, Surrey KT13 0YF
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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

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Tel: 01737 814221 **Fax:** 01737 812557
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EB SAFETY
Tel: 01926 642465 **Mob:** 07881858271
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Tel: 020 8811 2880 **Fax:** 020 8811 2881
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GEOLABS
Bucknalls Lane, Garston, Watford, Hertfordshire, WD25 9XX
Tel: 01923 892 190 **Fax:** 01923 892 191
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Tel: 01923 711288 **Fax:** 01923 711311
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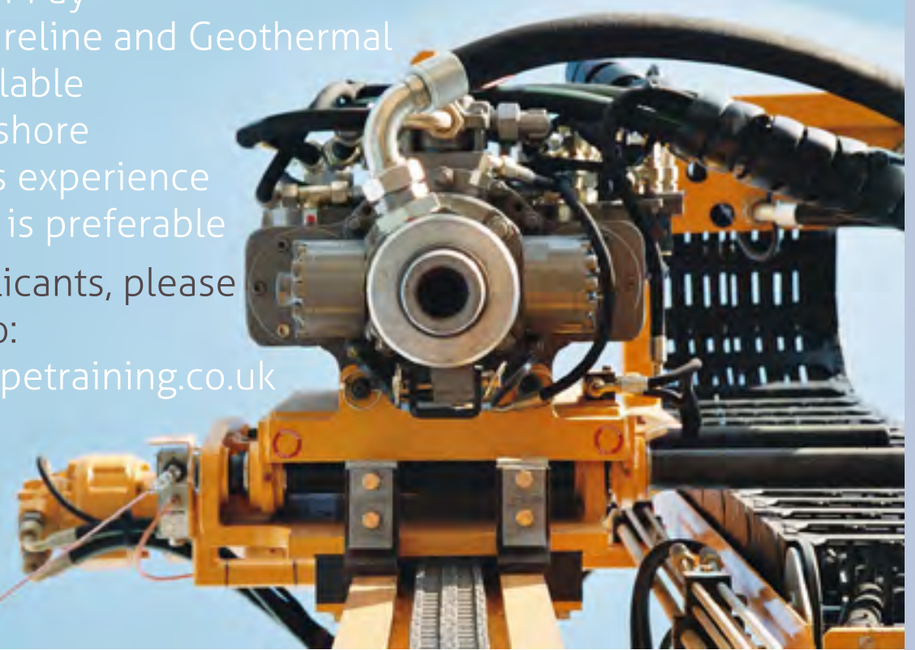

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Gapton Hall Industrial Estate
Great Yarmouth, Norfolk
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