

GEOTECHNICAL COURSE DATES:
 Rock Description
 27th September 2013

GEOTECHNICAL COURSE DATES:
 Geotechnical Foundation
 Design - 17th September 2013

Soil Description
 9th August 2013,
 4th October 2013

H&S COURSE DATES:
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 6th Sept' 2013, 18th Oct' 2013

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GEOTECHNICA 2013

THE EVENT REVIEW

The Low-Down on 2013's Largest Geotechnical Trade Show and Exhibition based in the UK

Also included:

- Refined-Soil Contract Success
- Eurocode in Geotechnical Investigation: The Debate
- Polyaromatic Hydrocarbons
- Controlled Fineness: 'Ultra-Fine' Cement





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NEXT COURSE DATES: 9th - 11th October 2013
13th - 15th November 2013

AVOIDING DANGER FROM UNDERGROUND SERVICES - £150 + VAT

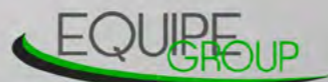
This one day course is aimed at anybody involved in specifying, instructing, managing, supervising or actually breaking ground. Important aspects include the use of real examples from the geotechnical industry and delivery by chartered advisors who are from within the industry.

This course is definitely not another CAT and Genny course and is the **only** externally verified course in the UK carrying the IOSH badge. The course is built around HSG47 and current industry best practice.

NEXT COURSE DATES: 6th September 2013
18th October 2013

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We Are Recruiting Throughout The UK

Environmental Scientifics Group (ESG) is the UK's leading provider of testing, inspection and compliance services. We operate across four divisions and offer an unrivalled range of technical expertise and accredited services. Our strong network of UKAS accredited laboratories are located across the UK and are supported by a centralised head office.

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Welcome

Welcome to the 23rd Edition of theGeotechnica - the UK's fastest growing online geotechnically focussed e-magazine.

The first article in this month's issue comes once again from Jeff Laverack of Holmes Media. This month Jeff writes to **theGeotechnica** as Maccaferri reveal the success of their reinforced-soil contract, whilst also detailing exactly what a reinforced-soil wall structure can offer you.

This month in theGeotechnica our cover article is a review of the recent Geotechnica 2013 - Geotechnical Trade Show and Exhibition. theGeotechnica is proud to report on what was deemed the most successful Geotechnica ever organised by the Equipe Group - with great visitor turnout and excellent discussions held at the Geotechnical Conference. The article can be found on page 13 of this month's issue.

On the 11th July a discussion session was held at Geotechnica 2013, the UK's Largest Geotechnical Trade Show and Exhibition. The debate posed the question of whether Eurocodes were being widely used for geotechnical projects at all levels in the UK. Full details are contained within **"For anyone with a vested interest in the development and implementation of Eurocodes, this article is a must-read."**

the article on page 17. For anyone with a vested interest in the development and implementation of Eurocodes, this article is a must-read.

In our fourth article, we have another excellent laboratory-oriented offering. Writing for theGeotechnica once more is highly valued contributor Hazel Davidson of Derwentside Environmental Testing Services. This month, Hazel discusses why polyaromatic hydrocarbons are so valuable.

Our final article this month again focuses on the construction side of our industry. Writing for theGeotechnica for the first time is Bill Price, National Commercial Technical Manager of Lafarge Tarmac Cement & Lime. In this month's article, Bill gives readers a highly insightful introduction to Ultrafine cements.

This month we have a number of recruitment advertisements being placed throughout the magazine, notably from Soil Consultants, Geotechnical Engineering, VJ Tech 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



REINFORCED-SOIL CONTRACT SUCCESS FOR MACCAFERRI CONSTRUCTION

Writing on behalf of geotechnical specialists [Maccaferri](#) once again is Jeff Laverack of Holmes Media. This month Jeff writes to *theGeotechnica* as Maccaferri reveal the success of their reinforced-soil contract, whilst also detailing exactly what a reinforced-soil wall structure can offer you.

A network of reinforced-soil retaining walls which will form part of the upgrading of the strategic A8 route in Northern Ireland is currently under construction by civil and geotechnical specialists, Maccaferri Construction, part of the Maccaferri Group.

Breakout panel

What is thought to be the first Island-of-Ireland installation of a particular type of concrete panel-faced, reinforced soil retaining wall system is currently under construction on the new A8 Belfast to Larne highway improvement project. Key transport corridor

improvement for NI

The A8 is one of the five Key Transport Corridors identified in the Regional Development Strategy and the Regional Transportation Strategy for Northern Ireland.

The Department for Regional Development is undertaking improvement works that will involve the realignment and upgrading to Dual 2 Lane All Purpose (D2AP) carriageway of the A8 between Coleman's Corner and Ballyrickard Road, at a construction cost of £105m. The new route includes the bypass of the villages of Bruslee and Ballynure.

This upgrade of approximately 14.5km of the A8 between Belfast and Larne as a partially on-line/partially off-line high quality dual carriageway, with associated hard strips, and will incorporate a number of grade separated junctions and the provision of a central median safety barrier.

Reinforced soil retaining walls
“Oxford based Maccaferri Construction is building a network of 16 reinforced-soil retaining walls...”

Oxford based Maccaferri Construction is building a network of 16 reinforced-soil retaining walls which form abutments and wing walls to 8

new structures which are being constructed as part of the new works.

The design and construction of the A8 project is being undertaken for Department for Regional Development (Northern Ireland) Roads Service by JV Contractors Lagan/Ferrovial/Costain [LFC].

LFC were particularly keen to work with Maccaferri Construction as the Company provides a fully indemnified, combined design and construct package - a service that is not readily available for reinforced soil, concrete panel structures on the Island of Ireland or in the UK.

The walls being constructed using the MacRes [R] system of large, concrete facing panels, installed in conjunction with high strength PARAWEB [R]



MacRes panels are hand placed to ensure accurate alignment.

geosynthetic reinforcement.

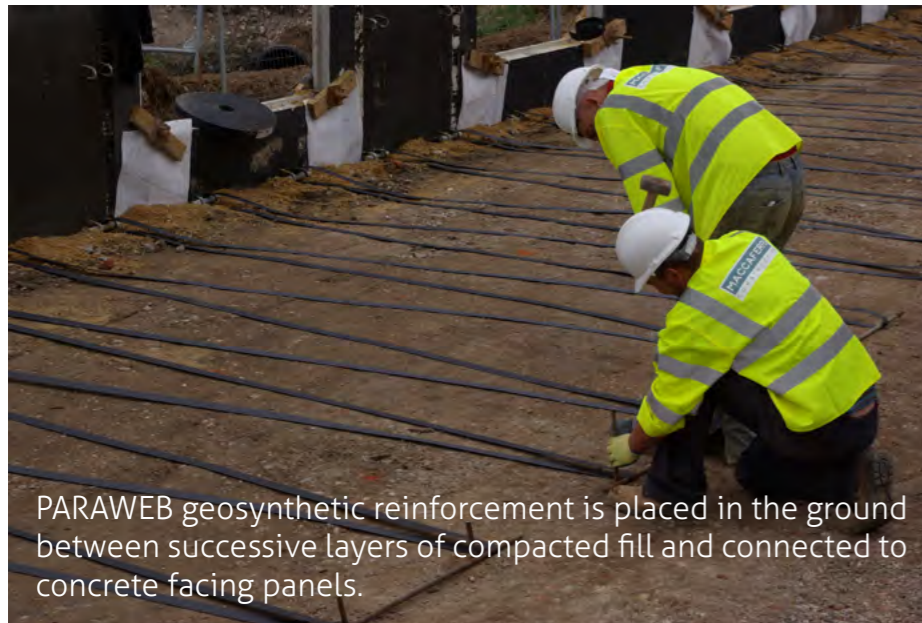
“First” for island of Ireland

“The MacRes/ PARAWEB, reinforced soil structure is a system extensively used outside the UK...”

The MacRes/PARAWEB, reinforced soil structure is a system extensively used outside the UK with

over 500,000sqm of walls completed worldwide. On the UK mainland, the system was recently used in the upgrading of the A13, Sadlers Farm interchange near Basildon, Essex however its use in the construction of the A8 Belfast to Larne Dualling scheme is thought to be an island of Ireland “first”.

PARAWEB is BBA Roads and Bridges Certified geosynthetic strapping for use with panel faced reinforced soil systems. The PARAWEB elements



PARAWEB geosynthetic reinforcement is placed in the ground between successive layers of compacted fill and connected to concrete facing panels.

are placed in the ground between successive layers of compacted fill and connected to concrete facing panels.

The strength of the PARAWEB geosynthetic reinforcement is adjusted to suit the design

“This makes the system simple to construct, as the standard concrete panels all have the same number of connection points.”

loads. This makes the system simple to construct, as the standard concrete panels all have the same number of connection points. This optimises the efficiency of the structure and allows the construction of very tall walls capable of withstanding high loads.

According to Maccaferri, there are clear engineering benefits in the use of polymer reinforcement over traditional steel strapping. Rather than increasing or reducing

the spacing to change the reinforcement strength as you would do with steel, different strengths of polymer strapping can be incorporated to increase the capacity. On the A8 project the strapping strengths varied from 27kN to 54kN.

The concrete facing panels are 1500mm x 1500mm x 170mm thick and are factory cast in steel moulds. A smooth, ex-mould finish was specified for the A8 project but textured/low relief face patterns can also be supplied. The un-pigmented panels are steel reinforced and have integral lifting eyes and strapping connection loops cast into each unit.

Installation

Installation commenced with the preparation of a 175mm thick, 450mm wide concrete levelling pad along the line of the panel wall. The first row of panels was placed in position in a castellated pattern - full height followed by half height and so on. Proprietary props were then used as temporary supports and the panels were also clamped together to

further ensure stability during initial backfilling.

“Strapping is looped through special attaching points cast into the reverse face of each panel at 750mm centres, typically four to each panel.”

Strapping is looped through special attaching points cast into the reverse face of each panel at 750mm centres, typically four to each panel.

Strapping is installed as a continuous loop laid into the backfill in lengths varying from 6.5-8.0m and temporarily held in position with steel pins to maintain position during backfilling. Strapping is supplied in lengths of 100m which can be linked together with a bespoke buckle arrangement.

A drainage layer 300mm deep is placed behind the panel as backfilling progresses. Backfill is granular SFHW 61/6J imported material which is fully compacted in accordance with the specification for highway works.

Subsequent courses of panels are placed in position using a specially designed lifting device attached to the boom of a tracked excavator and lift inserts cast into the tops of the panels. The top of the walls will be capped using specially made precast coping units with in-situ concrete backing.”

panels. The top of the walls will be capped using specially made precast coping units with in-situ concrete backing.

Construction works for the overall scheme commenced on site in August 2012, with the expected completion scheduled for March 2015. Installation of the reinforced soil bridge abutments/wing walls started in April and is due for completion in early 2014.

MacRes [R] is a Maccaferri system of large, concrete facing panels, PARAWEB [R] geosynthetic reinforcement, is manufactured by Linear Composites, also a Maccaferri subsidiary. ■



Backfilling continues in predetermined lifts as construction progresses.



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Geotechnica 2013



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The Event Review

Geotechnica 2013 -
The Numbers:

2 Days.

64 Exhibitors.

19 Speakers.

5 Sponsors.

12 Piece Jazz Band.

610 Attendees.

Celebrating its 5th Birthday, Geotechnica 2013 - the UK's Largest Geotechnical Trade Show and Exhibition – was once again a resounding success. Held at the later date of the 10th and 11th of July,

“...2013 saw Geotechnica move to a new and highly improved location...”

2013 saw Geotechnica move to a new and highly improved location, helping to make the event bigger and better than all four of its predecessors. Throughout 2013 the Equipe Group had been working hard to ensure that this year's event built on the success of previous incarnations, using their contacts to bring in the best possible speakers for

the Geotechnical Conference, whilst also employing a smarter marketing strategy to generate greater visitor numbers for the event. On reflection, it is safe to say that that hard work paid dividends. This hard work was greatly assisted by the move to a new venue, the Warwickshire Exhibition Centre, a few miles outside of nearby Royal Leamington Spa.

Although the time Geotechnica spent in marquees on the Upton Estate Showground will be remembered with great affection by many across the geotechnical industry, it was safe to say that the move to the WEC's facilities helped to push Geotechnica into new realms of success. The dedicated facilities offered by the WEC, along with the introduction of highly popular shell-scheme exhibition booths helped to make the event feel more professional and distinguished, whilst still keeping its home-grown charm and aesthetics.

With fantastic weather across the two days, Geotechnica 2013 once again saw a large number of attendees that maintained the positive, productive and bustling atmosphere that Geotechnica has become synonymous with since the events conception in 2009. As exhibitors began



“...the blazing sunshine set the tone for the rest of the event's duration.”

to arrive to set up their stands on the Tuesday, the blazing sunshine set the tone for the rest of the event's duration. With the shell schemes erected and the outside flooring laid by 7pm on Tuesday evening, all involved were able to sit back and admire their work – at least until the hundreds of visitors started rolling in at 9am the next day. With over 250 visitors pre-registered for Wednesday alone, everything was in place for 2013 to be Geotechnica's most successful event to date. And it didn't disappoint.

With over 610 registered visitors, alongside speakers and exhibitors, and with plenty of communication, promotion, networking and learning taking place between all attendees, Geotechnica's debut at the Warwickshire Exhibition Centre was a resounding success.

2013's Evening Charity Networking Event took inspiration from Geotechnica's venture to the Middle East in November of 2012, with a slightly more chilled atmosphere encouraged, in contrast to last year's incredibly well received 'Geotechnica Rocks!' Battle of the Bands contest. Moving from the previous hog roast and marquees to a finger buffet and well stocked bar at The Angel Hotel in nearby Royal Leamington Spa, the event was well attended and well received. This year's event did still feature live music ►►

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however, with 12-piece jazz outfit Hoot Jazz providing the evening's entertainment.

The conference speaker programme featured many names that were and still are at the top of their respected fields, names such as LQM Ltd's Professor Paul Nathanail, Loughborough University's Professor Neil Dixon and former Professor of Geotechnical Engineering at Kingston University - Professor Eddie Bromhead. Fortunately, the conference did not fall prey to its own hype, with all of the

"...all of the 19 speakers delivering insightful, educational and entertaining talks..."

19 speakers delivering insightful, educational and entertaining talks that not only educated the observers, but also sparked discussions and debates that are vital to the continuing development of our industry. This year's conference also featured an incredibly well received geotechnical debate, with Professor Nathanail joined on the panel by Independent Consultant Professor David Norbury and



GEOLABS Ltd's Technical Director Dr John Powell. The debate centred around the use and application of Eurocodes and British Standards across the geotechnical industry – a detailed report of this can be found on page 17 of this month's magazine.

"Overall, the general consensus from all exhibitors and attendees was that the event was a resounding success."

Overall, the general consensus from all exhibitors and attendees was that the event was a resounding success. The Equipe Group would like to

take this opportunity to thank all of those that exhibited, presented and attended this year's Geotechnica, and helped make it the most successful event yet. A special thank you must also be extended to this year's sponsors: Gold Sponsors Casagrande UK, Silver Sponsors Rockbit UK and MGS, and Bronze Sponsors Geotechnical Engineering and Clear Solutions International.

Plans are already being made for next year's event, alongside Geotechnica's second escapade abroad to Qatar in December of this year for Geotechnica ME 2013. We encourage any and all attendees to Geotechnica 2013 to join us out in Qatar for what is bound to be another beneficial event for the geotechnical industry. Details

of this event can be found at www.geotechnicame.com

Rest assured, Geotechnica 2014 will continue on from the success of this year's event, whilst maintaining and building upon its set of base principles: Communicate. Promote. Network. Learn.

The full Event Review, with full statistics and attendance figures will be available within the next week online at www.geotechnica.co.uk - keep your eyes peeled to the Equipe Group's pages on social media sites like [Twitter](#) (@EquipeGroup) and [Facebook](#) (Equipe Group) for further updates. ■

EUROCODE 7 IN GEOTECHNICAL INVESTIGATION: THE DISCUSSION

Based around a discussion session held at Geotechnica 2013 on Thursday 11th July



On the 11th July a discussion session was held at Geotechnica 2013, the UK's Largest Geotechnical Trade Show and Exhibition. The debate posed the question of whether Eurocodes were being widely used for geotechnical projects at all levels in the UK. The discussion session was led by an eminent panel comprising of Independent Consultant Professor David Norbury; Managing Director of LQM Ltd Professor Paul Nathanail and GEOLABS Ltd's Technical Director Dr John Powell. Peter Reading took the chair for the event.

The audience was made up of a good cross section of the geotechnical community including clients, consultants and contractors. A straw poll would indicate that most used parts of Eurocode but few work exclusively to them.

The discussion started with a member of the audience asking how our general perception of a suitable ground investigation might be changed by Eurocode 7 (For example, if the investigation is for Category 1 structures, such as housing). It was asked, is there anything wrong with digging some trial pits and putting down a number of dynamic sample boreholes to provide samples for testing?

“ Regularly practitioners obtain an assessment of allowable bearing pressure from SPTs and possibly Triaxial Tests on the core samples obtained in this way.”

Regularly practitioners obtain an assessment of allowable bearing pressure from SPTs and possibly Triaxial Tests on the core samples obtained in this way. It was generally agreed, by the audience, that this was a common form of investigation under these circumstances. We all want to do a good job

but often we are hampered by what the client will pay for; should the site investigation practitioner be doing more?

The panel also agreed that this was common practice. It is clear that the investigation methods do not strictly follow the guidelines given in EC7, but provided the decision on method is carefully thought through and documented this type of investigation would be perfectly fine. This should of course be backed up with experience of similar sites and foundation types. It would also be caveated that ground conditions should not be complex.

It was agreed that conditions which would be considered complex might include a high ground water table or if there was a risk of collapse or swelling - under these circumstances another approach may be required. It was agreed that in any event it was essential to carry out a full desk study to identify potential risks and in this way the investigation could be properly tailored to suit the site conditions. Such circumstances were considered by the panel to be exactly where EC7 would want investigation planning and execution to be. The discussion reminded the audience that the terminology used in Eurocode is different to that which British Standards have previously adopted. There are Clauses which are to be regarded as principles and others which have a strong compulsion using the word shall for the actions required. It was also stated that Eurocodes are British Standards,



The SPT Calibration Test: Determines the Energy Ratio of SPT Hammers.

The discussion moved on to consider the use of the SPT for design. It would seem that this is now the most commonly used test to determine ground strength and hence assess allowable bearing pressure. It was pointed out that much of the data used to translate the penetration resistance into an allowable bearing pressure is from work carried out decades ago. None of this research seems to have

“The Energy Ratio is a key part of the requirements given in BS EN ISO 22476 Part 3 (2005) and enables the penetration resistance to be normalised to an energy ratio of 60%.”

assessed the Energy Ratio. The Energy Ratio is a key part of the requirements given in BS EN ISO 22476 Part 3 (2005) and enables the penetration resistance to be normalised to an energy ratio of 60%. It is clear from testing carried out on hammers around the UK that there are considerable

differences in the performance of similar hammers. The discussion then looked at what might be used to be the acceptable tolerance for the equipment, whilst the Energy Ratio would be a good measure this is currently not the case. Eurocode only requires the Energy Ratio to be measured and recorded as an average value. This could mean that the maximum and minimum values could be significantly wide. It was suggested that this should be changed and a variation around the mean limitation of not more than 10% would be more useful.

Following this, the discussion moved on to the use of U100 samples for strength testing. A very simple question was posed to the panel: Can we still use these forms of sample? The consensus from the panel was that whilst samples taken in this form cannot be considered to be undisturbed, we have been using results from them for decades and as such they should still be considered a valuable database. Care must be taken when using these results and an appropriate characteristic value should be determined which takes

account of any uncertainty in the recorded values.

It was also pointed out that many of our tried and trusted relationship graphs use either SPT values where the Energy Ratio has not been recorded, or undrained shear strength where the method of sampling is unknown. It was agreed that there is an opportunity here for research to be undertaken to validate the data used in these relationships.

Further comment was made regarding the competency of personnel conducting the investigation works. There was significant comment that in tough economic times there was a tendency to cut corners and limit the size of the works. It was agreed that for the most part this was driven by the client who often does not want to pay

or see the point of carrying out extensive investigation works. There is a lack of drivers which would take the client down a more considered path. It is understood that the Planning Rules are currently being redrafted to take account of

"It is understood that the Planning Rules are currently being redrafted to take account of Eurocode."

Eurocode. It was considered that this might act as the driver needed to ensure that investigation works are fit for purpose. Alternatively the insurance industry may also become a factor, particularly if there were to be a failure due to poor quality information. Most present agreed that quality had

fallen but few could see this causing a step change unless some outside influence were to occur.

Summing up, all in attendance could see the benefit of Eurocodes / British Standards, which is considered to be a worthwhile document. There is some frustration that the document is slow in appearing and some key documents are still awaited. However those that are available give some excellent information and provide a good document to work with. They do not exclude any method from use but do require a well thought out planned methodology. All agreed they embody what we would consider to be a professional approach to ground investigation. ■



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POLYAROMATIC HYDROCARBONS

Why are these compounds important?

Writing for *theGeotechnica* once more is highly valued contributor Hazel Davidson of [Derwentside Environmental Testing Services](#). This month, Hazel discusses why polyaromatic hydrocarbons are so valuable.

Aromatic compounds originally meant 'fragrant', but are now defined as compounds based on the benzene molecule. Examples of this group of organic compounds, usually abbreviated to PAHs or PNAs (polynuclear aromatics), are commonly found on most sites due to the ubiquitous use of fossil fuels and their products.

"Any site where petroleum or coal were used or their products manufactured, is likely to contain PAHs..."

Any site where petroleum or coal were used or their products manufactured, is likely to contain PAHs, as they are introduced into the environment by incomplete combustion of the fossil fuels. By definition, they are formed from two or more fused benzene rings – benzene consisting of six carbons in a ring structure connected by resonating double bonds.

There are thousands of PAHs, but research performed in the USEPA laboratories

demonstrated that 80% of these can be attributed to sixteen compounds:

- Naphthalene
- Phenanthrene
- Fluoranthene
- Chrysene
- Benz[a]pyrene
- Indeno[1,2,3-cd]pyrene
- Acenaphthylene
- Fluorene
- Pyrene
- Benz[b]fluoranthene
- Dibenz[a,h]anthracene
- Acenaphthene
- Anthracene
- Benz[a]anthracene
- Benz[k]fluoranthene
- Benzo[ghi]perylene

"Naphthalene is the smallest molecule, consisting of just two benzene rings..."

Naphthalene is the smallest molecule, consisting of just two benzene rings, with the others gradually increasing in molecular size to the six ringed Indeno[1,2,3-cd]pyrene. Examples of structures are shown to the right.

Sampling and Site Safety
It is important samples are taken in glass containers, as plastic can cause some leaching of organics into the samples. Waters should be taken in a 500 ml coloured glass bottle/jar with a PTFE liner in the lid, and soils in a 250g glass jar, with all samples stored at 5 +/- 3°C.



PAHs are not particularly volatile, although naphthalene is classed as a semi-volatile, so some losses of this compound can occur from exposed areas on site. Greater risks can be from ingestion or skin absorption, so PPE should be worn by site personnel when handling soil contaminated

"Greater risks can be from ingestion or skin absorption, so PPE should be worn by site personnel..."

Greater risks can be from ingestion or skin absorption, so PPE should be worn by site personnel when handling soil contaminated



with PAHs

Toxicity

In terms of human health risk, PAHs are a cause of environmental concern due to the toxicity and carcinogenicity of some of the compounds, although this is not uniform across the range. Benzo(a)pyrene (BaP) is considered to be the most carcinogenic, and is therefore used as a marker compound by the regulators. The TDI for BaP is 0.02ug/kg bw/day with an EQS for surface water of 0.05 ug/l (although this will change in 2015 under the WFD revisions to 0.0001

ug/l). The current Soil Guideline Value (SGV) is 1.0 mg/kg for residential, but the proposed Category 4 Screening level (C4SL) is 5.3 mg/kg, although this is not yet in place. Other relatively carcinogenic PAHs include:

- Indeno(1,2,3-cd)pyrene,
- Benzo(b)fluoranthene,
- Benzo(k)fluoranthene,
- Benzo(a)anthracene,
- Dibenzo(a,h)anthracene,
- Chrysene

"The carcinogenic risk is chronic, not acute, and therefore the onset of symptoms can occur months or years after exposure."

The carcinogenic risk is chronic, not acute, and therefore the onset of symptoms can occur months or years after exposure. Care should always be taken to protect site personnel from exposure to PAHs.

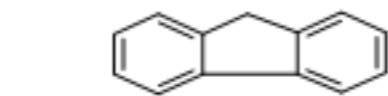
Analysis

Samples must be extracted using a solvent – this is commonly

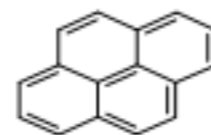
dichloromethane (DCM), and waters can be extracted using a liquid/liquid system or solid phase extraction (SPE). Soils can be extracted using a shake method, microwave or Soxtec, but they require drying prior to the solvent extraction. They can be oven dried with the risk of some loss of naphthalene, or chemically dried using anhydrous sodium sulphate (preferred method).

"Soils can be extracted using a shake method, microwave or Soxtec, but they require drying prior to the solvent extraction."

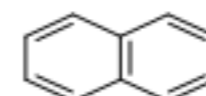
The most common method of analysis for PAHs is by GCMS (gas chromatography with mass spectroscopy), but it is possible to analyse just using GC (gas chromatography) providing a clean up is performed prior to analysis to remove coeluting compounds which may interfere with the results. GCMS using SIM (selective ion monitoring) is better, as



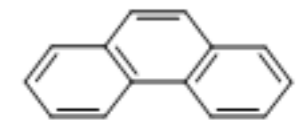
Fluorene



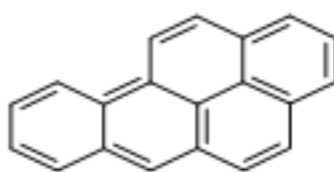
Pyrene



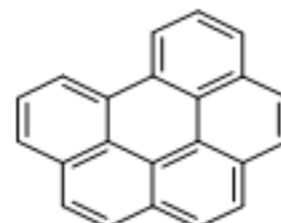
Naphthalene



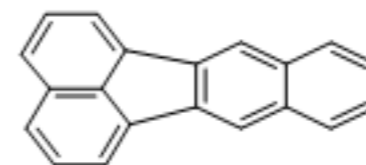
Phenanthrene



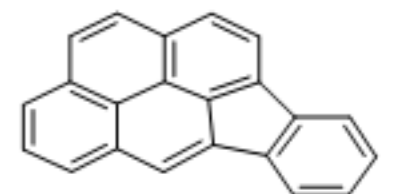
Benzo(a)pyrene



Benzo(ghi)perylene



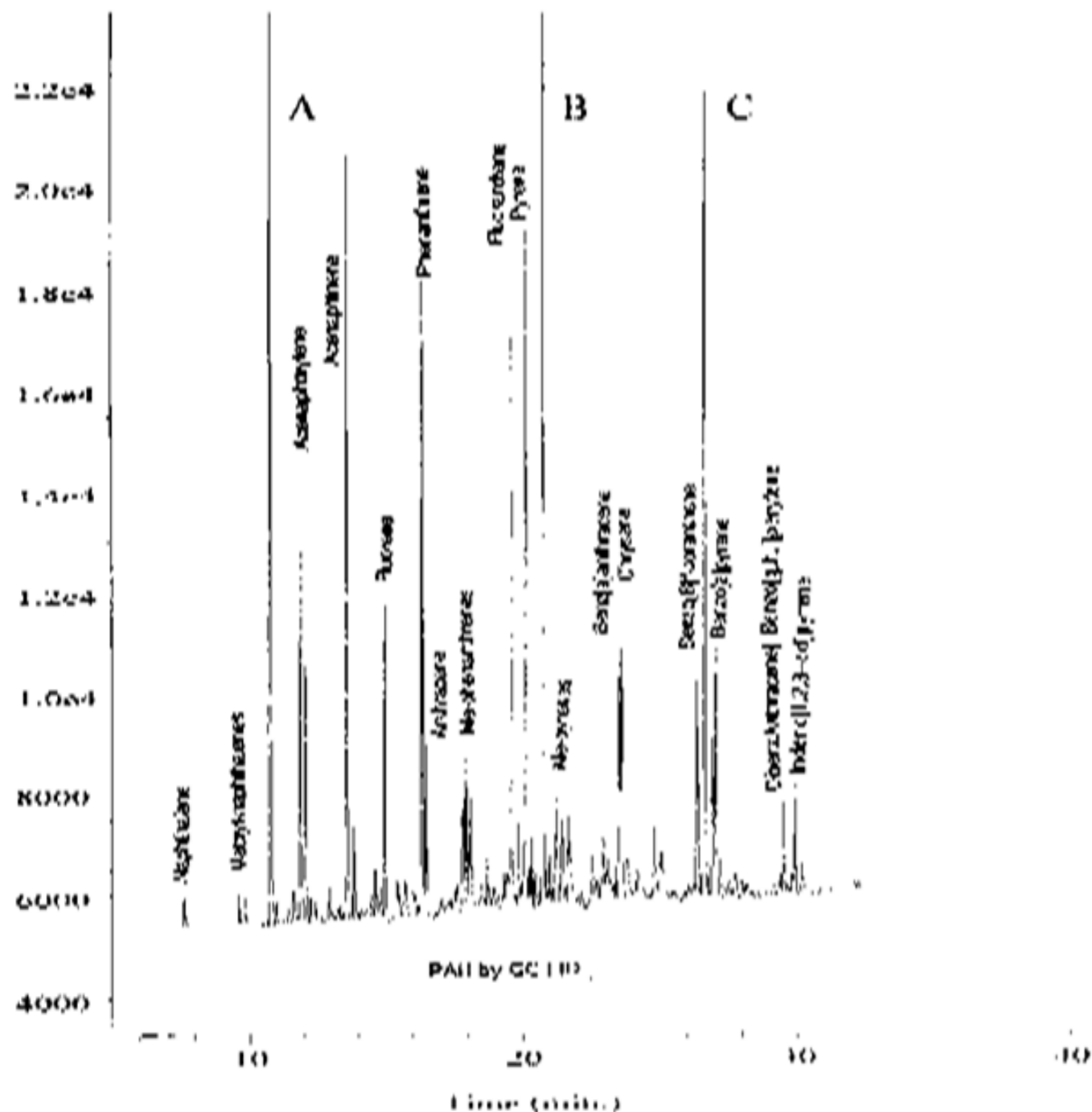
Benzo(k)fluoranthene



Indeno(c,d 1,2,3)pyrene



Fig. 1. GC/MS chromatogram of PAHs in a waste sample.



“...it only looks for the compounds of interest and will ignore any other compounds which may be present...”

it only looks for the compounds of interest and will ignore any other compounds which may be present, so does not require a clean up.

It is important to appreciate the differing options available when requesting PAHs:

- Speciated PAHs – all 16 compounds individually quantified
- Total 16 PAHs – the sum total of the 16 compounds with no speciation
- Total aromatics – as stipulated in the TPHCWG, which will include many other aromatic compounds, not just the 16
- Any of the above plus coronene – this is an additional PAH significant in the waste

industry

The distribution of PAHs derived from petroleum is different from those derived from coal, as coal products are likely to contain higher concentrations of the more carcinogenic PAHs. In some countries, this is why surface road planings derived from bitumen (petroleum derived) can be used again, but those derived from coal tar

“Some laboratories can offer a PAH Double Plot Ratio Analysis to determine the likely source of the PAHs.”

cannot. Some laboratories can offer a PAH Double Plot Ratio Analysis to determine the likely source of the PAHs.

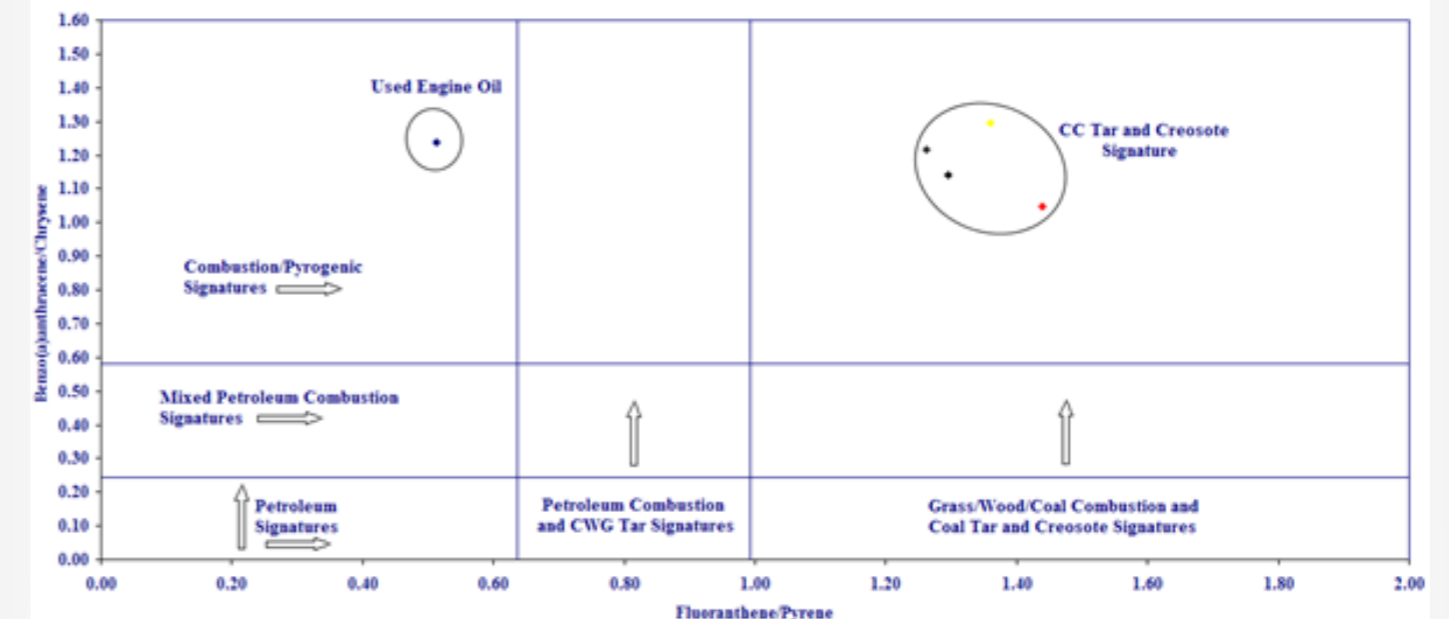
Because of these various options, it can be useful to consult your laboratory before deciding on the correct analysis for your site.

Summary

“PAHs are organic contaminants composed of varying numbers of benzene rings, with sixteen of them listed as priority pollutants.”

PAHs are organic contaminants composed of varying numbers of benzene rings, with sixteen of them listed as priority pollutants. They are introduced into the environment by the incomplete combustion of fossil fuels, petroleum and coal, and some species are classed as carcinogenic, with Benzo(a)pyrene being considered the most carcinogenic for human health risk assessment. Analysis is performed using solvent extraction, followed by gas chromatography, and mass spectroscopy (GCMS) as the preferred method. Because of their ubiquitous nature, almost all sites should involve analysis for PAHs. ■

PAH Double Ratio Plot BAA/Chr vs Fl/Py



CONTROLLED FINENESS: 'ULTRAFINE' CEMENTS

Writing for *theGeotechnica* for the first time is Bill Price, National Commercial Technical Manager of Lafarge Tarmac Cement & Lime. In this month's article, Bill gives readers a highly insightful introduction to Ultrafine cements.

We are all familiar with Portland cement (CEM I), and we are becoming increasingly familiar with the growing range of sustainable low CO₂ cements, such as CEM II and CEM III that are often used in structural concrete applications.

However, there is another type of cement that is produced in the UK which is probably much less familiar to readers of *theGeotechnica*; 'Ultrafine' cements which are specifically produced and formulated for use in grouts in geotechnical engineering and in other specialised applications. This article explores the properties of these products, highlights their differences from

conventional cements and shows one ideal application.

"The most common use of ultrafine cement grouts in geotechnical engineering is for strengthening porous or fissured soil and bedrock..."

The most common use of ultrafine cement grouts in geotechnical engineering is for strengthening porous or fissured soil and bedrock, or for reducing water flow through the ground. The latter is particularly important for tunnels and mine workings.

The ideal grout should have:

- Low viscosity
- The ability to completely fill voids
- Resistance to wash out
- Freedom from bleed and segregation (even under pressure)
- Predictable setting and hardening characteristics
- High strength and low permeability in the hardened state

Another key parameter is the maximum cement particle size (D₉₅). This is kept as low as possible because together with the particle shape the particle size controls the minimum

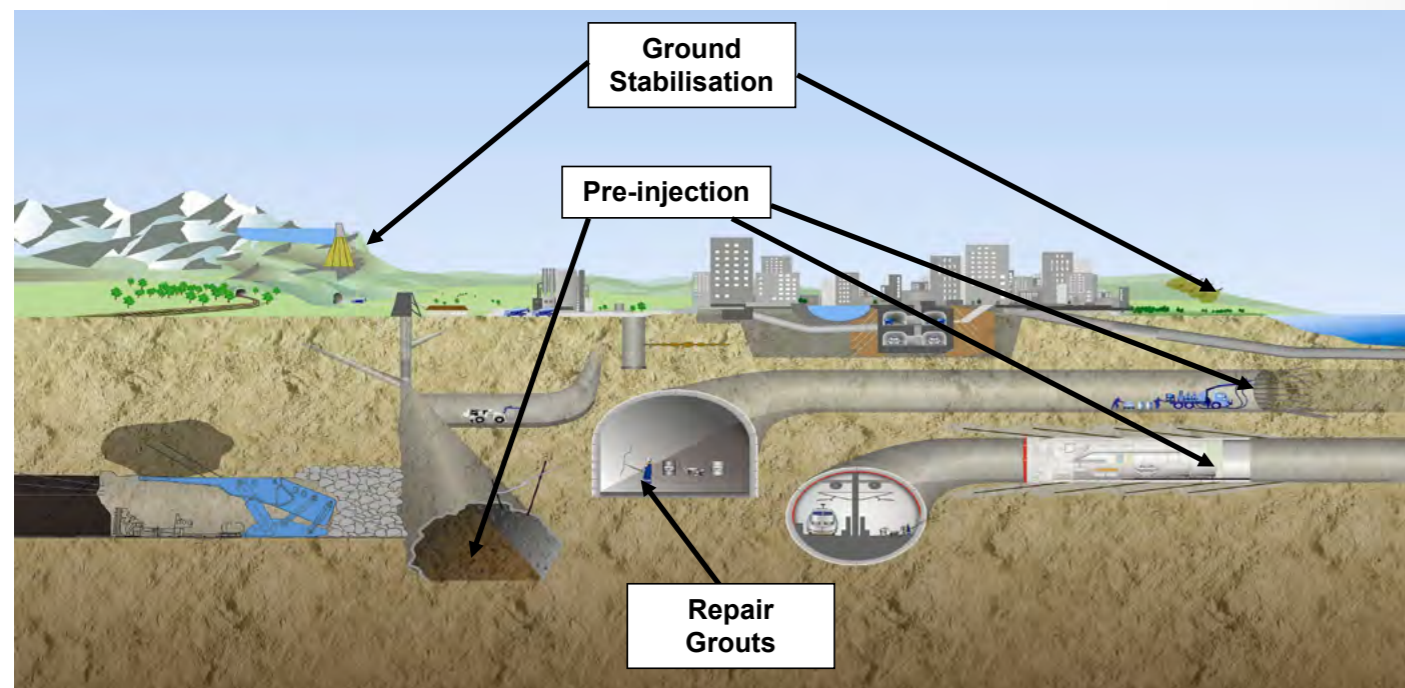


Figure 1: Typical applications for ultrafine cements.

"Conventionally, it is often assumed that, the size of the minimum fissure that can be penetrated is about 3 times the maximum particle size of the cement."

pore or fissure size that can be penetrated by the grout.

Conventionally, it is often assumed that, the size of the minimum fissure that can be penetrated is about 3 times the maximum particle size of the cement.

Additionally, the grout should remain fluid for the desired period of time and be free from excessive bleed (to ensure that the cement particles remain in suspension).

Conventional practice is to assume that the smallest groutable crack width will be three times greater than the maximum particle size in the grout. Consequently, cements with the very finest grain size (often with 95% or more of the particles (D₉₅) being smaller than 10 µm), are used for injection into hard rock, with

"For more open fissures or porous soils, cement with a slightly larger higher D₉₅ is acceptable."

tight joints and fissures. For more open fissures or porous soils, cement with a slightly larger higher D₉₅ is acceptable. In comparison the D₉₅ of a typical CEM I may be as high as 50 µm.

Applications of Ultrafine cements

Other applications of high fineness cements outside geotechnical engineering include floor levelling compounds, fine-grained repair materials and other formulated products. There is a wide range of products with different fineness levels and using one with a fineness somewhere between the extremely fine rock grout cement and the coarser conventional cement, is usually the best solution. In fact, any application where a very fine grained product is required (for example concrete work-tops for kitchens or industrial facilities perhaps), might benefit from the use of an ultrafine cement.

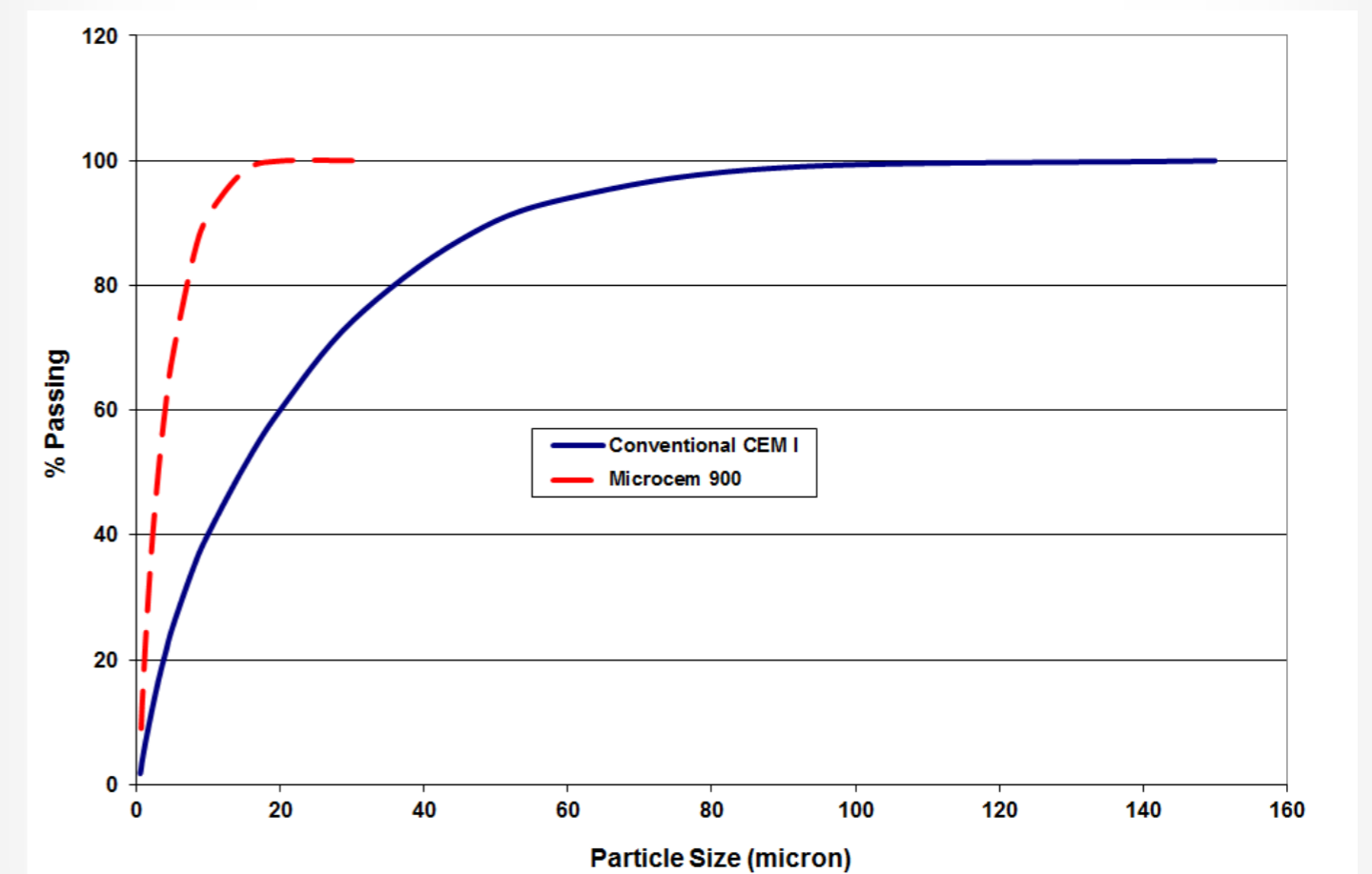


Figure 2: Comparison of typical PSD curves of Microcem and a conventional CEM I Portland cement.

The manufacture of Ultrafine cements

Producing cement that fulfils these exacting requirements demands a different production process to conventional cement, with far more emphasis on the milling process and control of the particle size distribution.

Although strictly speaking, such cements do not fall within the remit of BS EN 197-1, they are based on Portland cement clinker and in most ways behave the same as Portland cement (CEM I). Ultrafine Portland-slag formulations are also available from some manufacturers.

One exception to this similar behaviour, however, is the setting time. Very fine cements would, of course, be expected to set relatively quickly and if allowed to hydrate.

However, the setting time may need to be engineered to be faster or slower than the normal range for EN 197-1 cements depending on where

the product is being applied. To this end, specially formulated organic additives can be added rather than relying entirely on conventional calcium sulfates (gypsum) to regulate the set. The ultimate strength of ultrafine cements may often be higher than conventional cement.

“Ultrafine cements are very technically sophisticated products...”

Ultrafine cements are technically very sophisticated products and the quality control regime differs from that applied to conventional cements. In addition to the normal checks, regular measurement of the full particle size distribution using laser diffraction granulometry, monitoring both the D_{95} and the narrowness of the particle size distribution are carried out. Frequent checks on setting time and bleed characteristics, using tests related to the site

use of the products rather than the normal EN 196 cement test methods, are also an essential part of the quality control process.

Simply speaking, mixing of injection grouts on site is usually carried out in a high-shear colloidal mixer, which promotes good internal cohesion and low bleed. It is also important to avoid over-mixing that could lead to unwanted heat build up in the grout (typically the cement content of grout is much higher than concrete) and reductions in fluidity and setting time. The grout is then transferred to an agitator tank for storage up to 30-40 minutes. From the agitator tank, grout can be injected using high pressure piston pumps into the rock.

An example of an Ultrafine cement – Lafarge Tarmac Microcem

Lafarge Tarmac Microcem is the only commercial Ultrafine Portland cement currently

produced in the UK and has been produced since 1994. It was produced initially in response to the demands of

“...the product performance has evolved with time...”

the mining industry, but the product performance has evolved with time and it is now increasingly used for geotechnical engineering. It is available as both a packed and a bulk product.

Lafarge Tarmac Cement produces its Microcem range of controlled fineness cements at its Barnstone special cements works in Nottinghamshire. Interestingly, the Barnstone works which opened in 1875, was the first works in England to utilise a rotary kiln. The Microcem is produced by very finely grinding clinker from the Cauldon works together with selected set regulating admixtures, in a dedicated closed-circuit mill with a high efficiency separator. The high efficiency separator (which continuously returns the coarser particles to the mill for further grinding) is a key factor in maintaining efficient production and produces a narrow spread of particle sizes.

Fineness testing is carried out very frequently (sometimes as often as one test every four tonnes), in order to adjust the milling regime and maintain the desired fineness. The specific surface area (Blaine) can be as high as 1000 m²/kg compared to around 300-450 m²/kg for a typical CEM I cement, and products with a range of



Figure 4: The Lafarge Tarmac Barnstone works where Microcem is produced

different finenesses, suitable for differing applications, are available. The production of such high fineness materials requires much more milling than conventional CEM I, which when combined with the organic set regulation additives and the intensive testing regime, increases the cost of production relative to conventional cement.

The Ultrafine cement market

Sales volumes of ultrafine cements are very low by normal cement industry standards, as geotechnical grouts are often used in relatively low volumes (compared to structural concrete), but they are high value and sophisticated niche products. As might be expected, the carbon footprint of Ultrafine cement is similar, or slightly higher, than conventional Portland cement, but given the small quantities used on a typical project in comparison with concrete and other common construction materials, its contribution to the overall carbon footprint of a project is usually very small.

Ultrafine cement based grouts are a relatively recent

introduction to the range of geotechnical grouting materials in a market where chemical grouts have traditionally

“They are now starting to replace chemical grouts in many aspects of geotechnical engineering...”

dominated. They are now starting to replace chemical grouts in many aspects of geotechnical engineering due, in part, to their higher strength and reduced chemical hazards. In essence they combine the strength of structural cement grouts with the injectability of chemical grouts.

Whilst the use of Ultrafine cements in the UK had historically declined alongside the reduction in mining activity, increased emphasis on tunnelling and underground structures in urban construction projects (such as Crossrail and HS2) has delivered steady increases in sales volumes over the last five years and is a clear indicator of a growing interest in ultrafine cements. ■



Figure 3: Using the Malvern Granulometer to determine the particle size distribution of an ultrafine cement.

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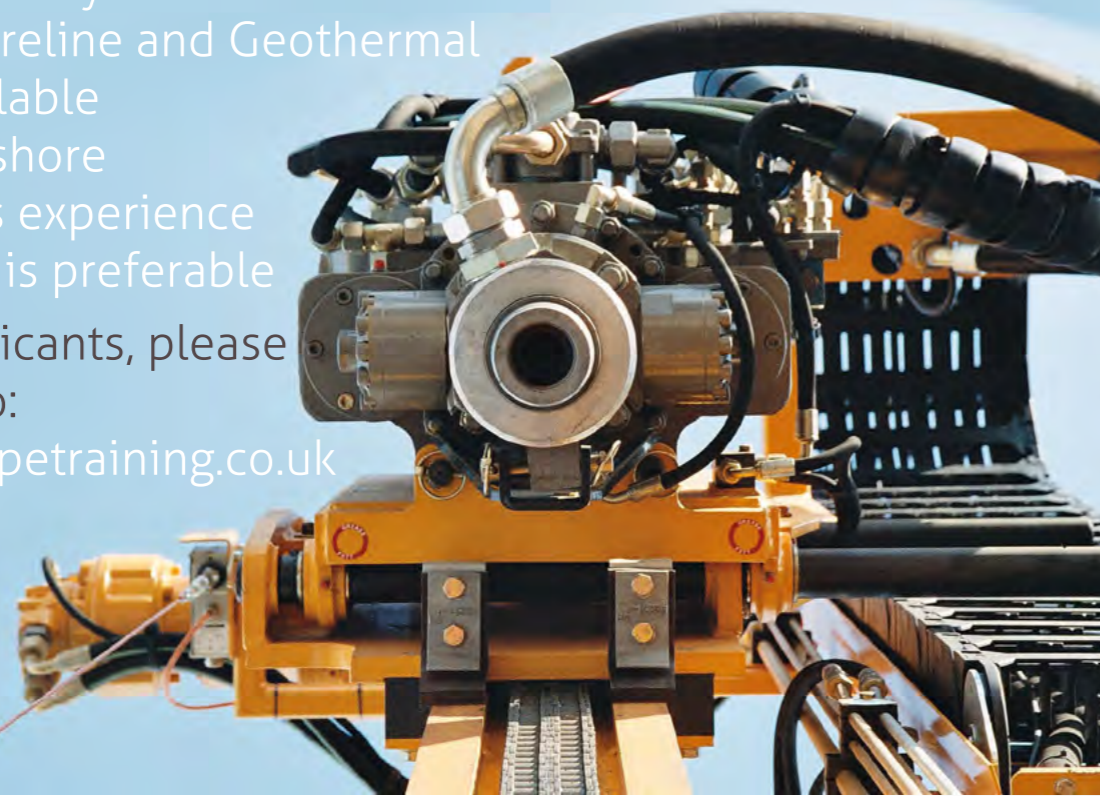
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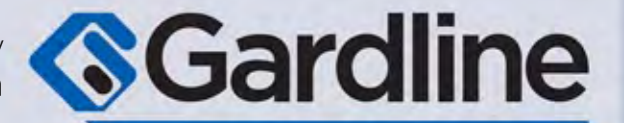
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