

GEOTECHNICAL COURSE DATES:
 Rock Description
 18th June 2013,
 27th September 2013

GEOTECHNICAL COURSE DATES:
 Geotechnical Foundation
 Design - 17th September 2013
 Soil Description
 31st May 2013,
 9th August 2013

H&S COURSE DATES:
 Avoiding Danger from
 Underground Services
 17th May 2013, 21st June 2013
 Safe Supervision of
 Geotechnical Sites:
 5th - 7th June 2013

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- Contaminant of the Month: Selenium
- Geotechnical Laboratory's Guide to AGS Data - Part 2

Issue No.
21
 May 2013



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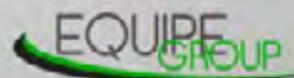
This one day course is aimed at anybody involved in specifying, instructing, managing, supervising or actually breaking ground. Important aspects include the use of real examples from the geotechnical industry and delivery by chartered advisors who are from within the industry.

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: 17th May 2013
 21st June 2013

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Welcome

Welcome to the 21st Edition of **theGeotechnica** - the UK's fastest growing online geotechnically focussed e-magazine.

This month in **theGeotechnica** we have an article on Marchetti DMT's dilatometer which was examined during the course of a technical seminar delivered at Equipe Training's offices in late February. The article is an overview of the presentation delivered at the seminar by Marchetti DMT's Dr Sara Amoroso.

The second article featured in this issue is also featured on this month's front cover. Although commonly used across a wide variety of civil and structural engineering applications, engineers

are often surprised to realise the full potential geogrids can bring to a project. This month Colin Thompson, National Key Account Manager at Tensar International, a global leader in ground stabilisation and soil reinforcement, guides readers of **theGeotechnica** through recent advancements in geogrid technology and the key benefits for engineers.

We also have two short press releases in this month's issue. The first focusses on the latest updates to European Standards, and is given to us by one of the UK's leading authorities on Eurocodes, Dr David Norbury of David Norbury Ltd. The second press release comes from the Equipe Group, who are delighted to announce

that Soil Engineering Geoservices, in partnership with Equipe Geosolutions, were awarded the Product and Equipment Innovation Award for the use of Equipe and Keynetix product KeyLogbook.

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

Finally we have another valuable contribution from Dr Roger Chandler, Managing Director of

"This month's contribution from Roger is the second in a series of articles that will act as a guide to AGS data for Geotechnical Laboratories."

Keynetix. This month's contribution from Roger is the second in a series of articles that will act as a

guide to AGS data for Geotechnical Laboratories. AGS Data is a crucial part of ground investigation works and producing the data is beginning to cause a problem for many companies across the sector. Roger's article will attempt to guide readers on how to retrieve and process the data correctly.

This month we have a number of recruitment advertisements being placed throughout the magazine, notably from Bridgeway Consulting, Dywidag Systems International, K4 Soils and ESG. We also have entries in the Directory and Jobs sections, with positions available at Geotechnical Engineering 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

Window Sample Driller Required

Bridgeway Consulting are looking to employ a qualified and experienced window sample driller for our busy **Site Investigation** department, based in **Beeston, Nottingham**.

You will be responsible for the safe operation of a **Window Sample / Handheld Window Sample Rig and Concrete Coring Rig** ensuring works are delivered on time and to budget whilst complying with the relevant quality standards.

Candidates should ideally hold **NVQ Level 2 in Land Drilling** (or working towards this award) and have at least five years experience.

Railway experience would be preferred, but is not essential as full track safety training will be given.

The role will entail some unsociable hours and a flexible approach to working time is essential as weekend working will be expected.

The package offered will be commensurate with qualifications and experience.

Please email a covering letter and CV along with salary expectations to:

jobs@bridgeway-consulting.co.uk

Closing date for applications

is 31st May, 2013



LABORATORY BASED JOB OPPORTUNITIES

K4 Soils Laboratory currently has vacancies for a Laboratory and Site Technician, based in Watford, Hertfordshire.

Experience is welcomed but not essential, as full training will be given.

If you are interested, then please email a copy of your CV to ken@k4soils.com



Sales Operations and Business Development (Internal)

DYWIDAG-SYSTEMS are market leaders in specialist geotechnical systems for the construction industry. Our products include: ground anchors, soil nails, threadbar systems and slope protection mesh.

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MARCHETTI DMT'S SEISMIC DILATOMETER

The following is an overview of the presentation given by Dr Sara Amoroso of [Marchetti DMT](#) on the Dilatometer, delivered on an Equipe Training Technical Seminar in February 2013. Sara's highly acclaimed PhD thesis looked at the use and interpretation of the seismic dilatometer to obtain geotechnical parameters.

With the pace of technological change it is not surprising that engineers are looking for more efficient ways of gathering the data needed for design. The seismic Dilatometer (SDMT) offers an optimal method to collect high quality data. As with the Static Cone Test by using direct push technology the results are obtained quickly in a useable format, allowing decisions to be made with respect to the investigation and design as the work proceeds.

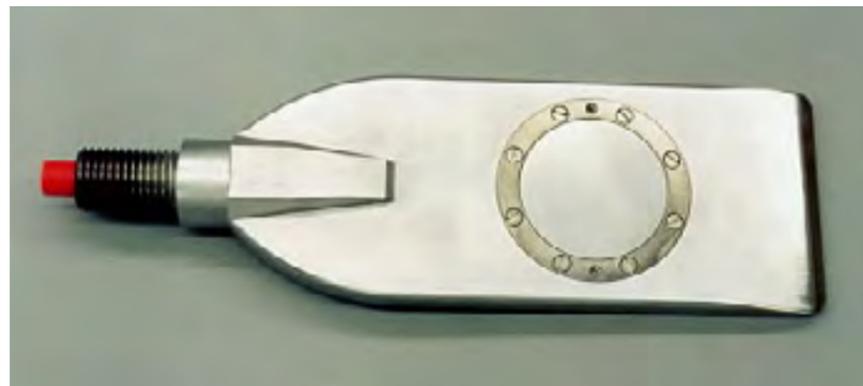
In the UK we have persisted with the use of the standard penetration test (SPT) which made its first appearance in 1902 and has now become an integral part of any site investigation. Many practitioners consider the test to be a poor representation of the ground stiffness

and this together with the variable energy ratio there is some uncertainty in the values obtained. The time seems right to consider more direct methods of obtaining the parameters needed for

"The time seems right to consider more direct methods of obtaining the parameters needed for design."

design. To this end it is worth considering the use of the Seismic Piezocone (SCPT) and the Seismic Dilatometer (SDMT) to determine these parameters.

The dilatometer comprises a flat stainless steel blade with a stainless steel membrane of 60mm diameter at its centre. The membrane is activated by



gas pressure delivered from the control box via a tube which passes down the rods which are used to push the instrument into the ground. These are standard cpt rods. The system is checked before inserting the blade into the ground and zero readings

"The mechanism works much in the same way as an electric switch, the switch starts in contact when at rest as pressure is applied from the gas cylinder the switch is opened."

obtained. The mechanism works much in the same way as an electric switch, the switch starts in contact when at rest as pressure is applied from the gas

cylinder the switch is opened. Contact is made again once the membrane has expanded by 1.10mm, the pressure difference needed to move the membrane 1.10mm is recorded. The pressure is then immediately released and the instrument is returned to rest and another reading taken. The instrument is then advanced 200mm into the ground and a further set of readings are taken. This continues until the required depth has been achieved.

"One of the appealing attributes of the DMT system is that the equipment requires little calibration..."

One of the appealing attributes of the DMT system is that

the equipment requires little calibration and can be checked in the field prior to each test. A correction is used for the non-zero rigidity of the membrane, this is determined using a short tube connected to the dilatometer blade in free air and is deducted from the field readings.

ΔA = correction to external pressure which must be applied to the membrane in free air to collapse it against its seating (i.e. A-position)

ΔB = correction to internal pressure which in free air lifts the membrane center 1.1 mm from its seating (i.e. B-position)

ΔA & ΔB are used to correct the A & B readings into P_0 & P_1

By measuring ΔA & ΔB a good indication of the equipment

condition is obtained and therefore the quality of the data. If a large difference is measured between the before and after test correction values of ΔA & ΔB the membrane should be change.

The initial values of ΔA , ΔB (before inserting the blade) must be in the ranges:

- $\Delta A = 5 - 30$ kPa
- $\Delta B = 5 - 80$ kPa

Inaccurate ΔA , ΔB are virtually the only potential source of DMT instrumental error, which makes it an ideal field tool. Any inaccuracy in ΔA , ΔB would propagate errors to all the readings taken A, B of a test sequence, it is therefore essential to make these checks before starting the test.

In particular it is essential to obtain accurate ΔA ►►

and ΔB when making tests in soft soils (Δ liquid clays or liquefiable sands) where the measured values of A, B may be small.

Small inaccuracies in ΔA , ΔB are negligible in medium to stiff soils ie ΔA , ΔB are small compared with A, B.

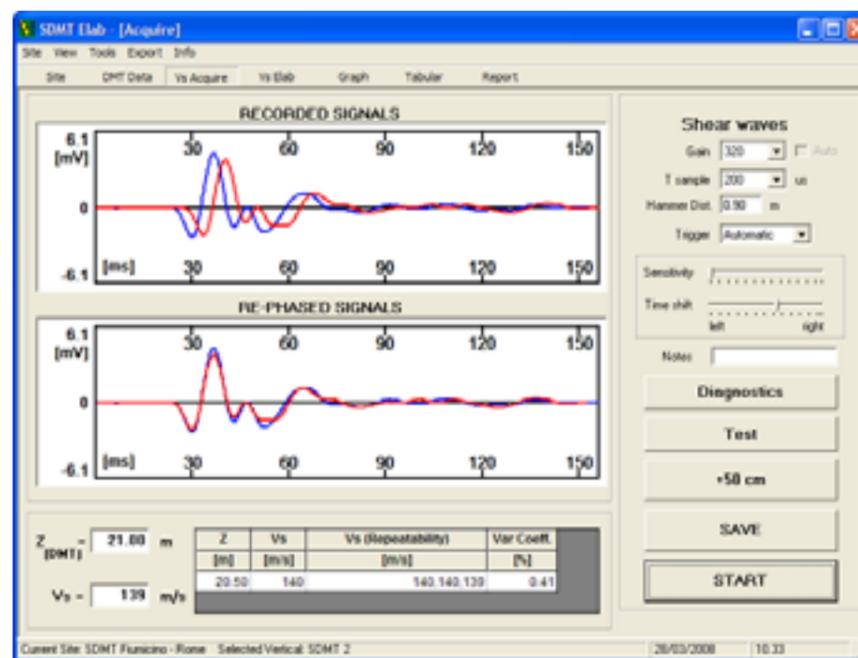
“Using the DMT can provide a range of parameters. These are derived from relationships which have been developed from soil mechanics theory..”

Using the DMT can provide a range of parameters. These are derived from relationships which have been developed from soil mechanics theory. The parameters which can be obtained are given in the table below.

This range of parameters makes the instrument a powerful tool.

The output from the measurements made in the field for a test in clay is given in the four graphs above and

Parameter	Description
M	Constrained Modulus (at Σ'_v)
Cu	Undrained Shear Strength
Id	Material Index
Kd	Horizontal Stress Index
γ	Bulk Unit Weight
σ'_v	Effective Vertical Stress
Ko (clay)	In situ Earth Pressure Coefficient
OCR (clay)	Overconsolidation ratio
ϕ (sand)	Friction Angle
Ch, Kh	Consolidation/Permeability Coefficient
Uo (sand)	Pore Pressure



need no further analysis.

Seismic Dilatometer

By simply incorporating two geophones into the rod behind the blade the dilatometer can be used to measure shear wave velocity. Energy is generated from a hammer and a plate to propagate a translational shear wave at surface which then enables the first arrival of this wave to each of the geophones to be determined. Analysis of the shear waves enables the properties in the table below to be determined.

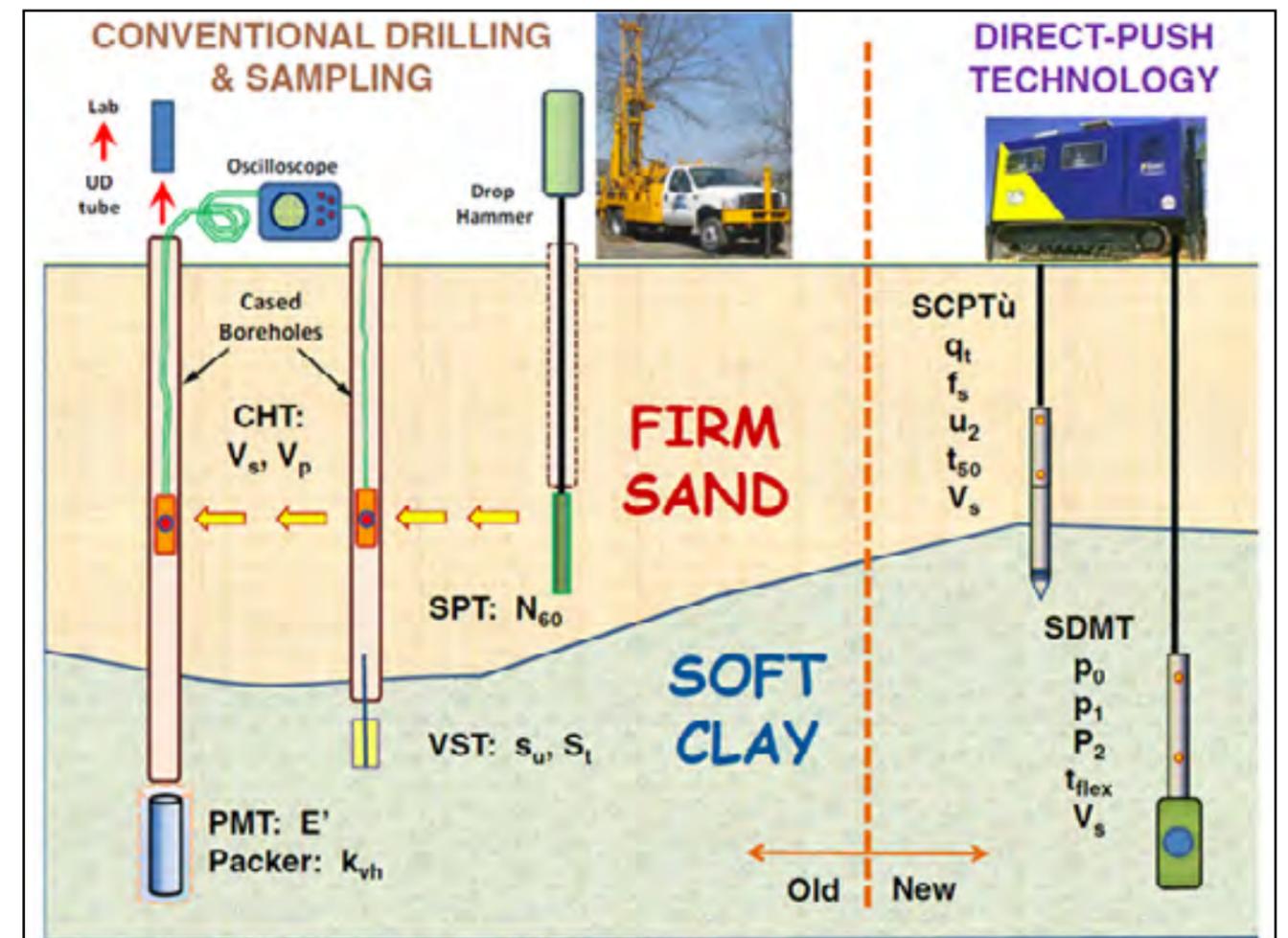
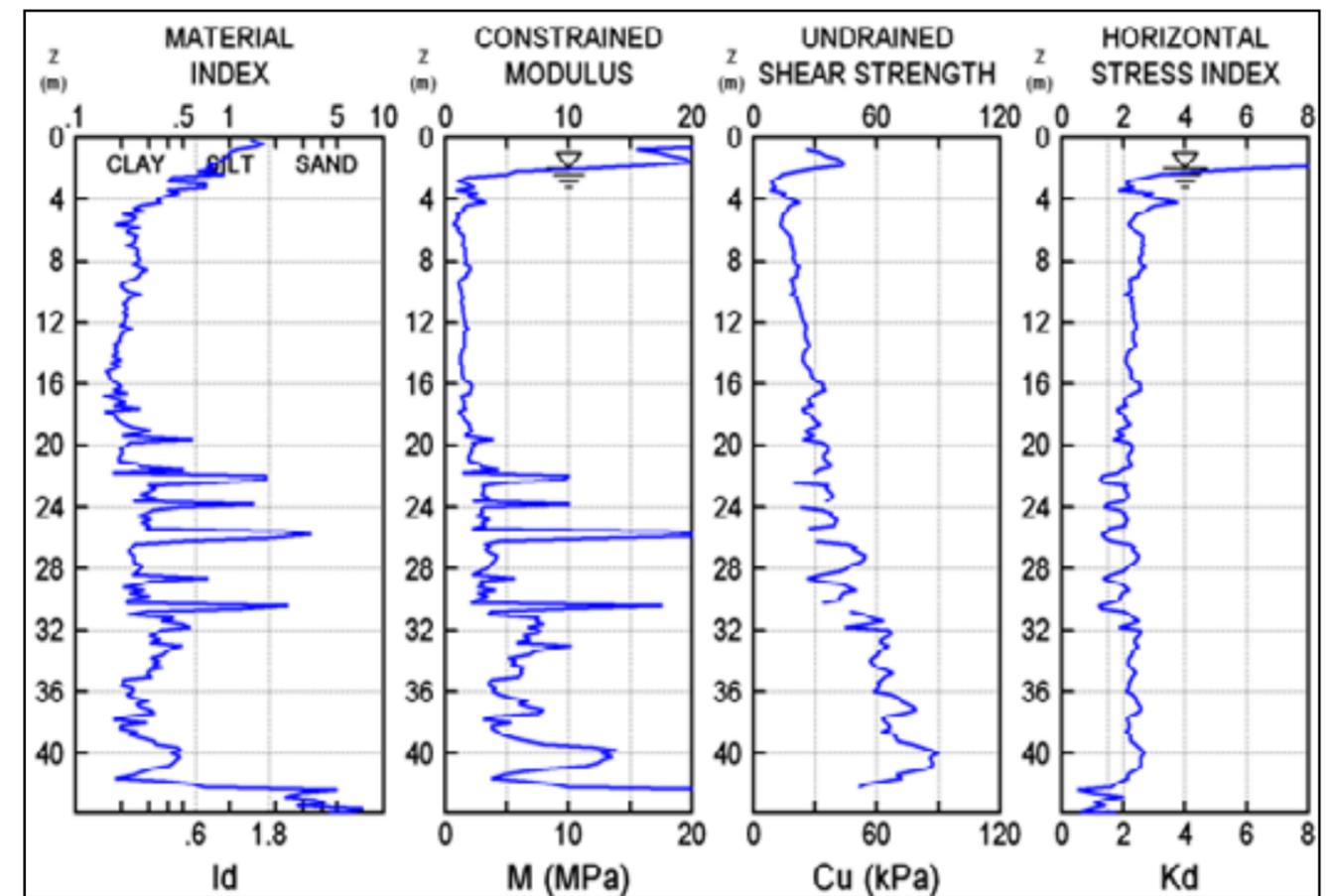
It is clear that this instrument either in the DMT or seismic DMT format is a powerful tool

worth looking at more closely. It is able to provide many of the parameters we require.

“By pushing the DMT into the ground we cause much less disturbance than many of our conventional techniques...”

By pushing the DMT into the ground we cause much less disturbance than many of our conventional techniques, in addition there is little or no change in stress and more particularly reduction is stress before the test is carried out thus giving good quality insitu parameters, which would fall within class 1 as defined in BS EN ISO 1997 Part 7 and 22475 Part 1.

The speed of the test and the production of results on site are a great advantage which if used in conjunction with other exploratory holes to confirm the lithology will provide an ideal design tool. ■



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ENGINEERING DESIGN IN MIND: GETTING TO GRIPS WITH GEOGRIDS

Although commonly used across a wide variety of civil and structural engineering applications, engineers are often surprised to realise the full potential geogrids can bring to a project. Here, **Colin Thompson**, National Key Account Manager at [Tensar International](#), a global leader in ground stabilisation and soil reinforcement, guides readers of *theGeotechnica* through recent advancements in geogrid technology and the key benefits for engineers.

Soil stability is hugely important in the modern construction industry. When working on a large scale project there can be huge volumes of earth to be retained or ground to be stabilised before even the earliest stages of the building construction process can begin...

When working on a large scale project there can be huge volumes of earth to be retained or ground to be stabilised before even the earliest stages of the building construction process can begin – and this is where geogrid technology becomes invaluable.

Commonly manufactured from polymer materials such as

polypropylene or polyethylene, geogrids are – as the name suggests – grid shape structures used to reinforce or stabilise soil and other materials in applications such as earth retaining walls and unbound aggregate layers below roads, railways and other structures.

The materials and capabilities of geogrid technology have come a long way since the first geogrid was patented by Dr Brian Mercer in the 1950s. Mercer went on to found Netlon in Blackburn in 1959, later to become Tensar International, and his innovation is still at the heart of much of the technology used in the industry today.

Building upon the original ideas of Mercer to meet modern needs, in 2007 Tensar's research and development team introduced the next generation of stabilisation geogrid, TriAx®. Opposing the notion of the traditional



“...the revolutionary TriAx® is a hexagonal structure with triangular apertures, allowing for multi-directional load distribution.”

biaxial grid, which disperses load predominantly across two directions, the revolutionary TriAx® is a hexagonal structure with triangular apertures, allowing for multi-directional load distribution.

When used in road sub-base applications, or in sub-ballast stabilisation of rail tracks, the aggregate particles interlock within the triangular geogrid apertures and the efficient, deep rib profile of TriAx® confines the aggregate to create a mechanically stabilised layer with exceptional performance. In this particular application, the product has proved so successful that it has achieved entry into the Network Rail accepted products catalogue for use in rail applications across the UK.

Numerous tests and trials have been conducted to assess the performance of TriAx® in mechanically stabilised layers subject to repeated wheel loadings, in particular at the Transport Research Laboratory (TRL). These have confirmed the increase in traffic carrying

“These have confirmed the increase in traffic carrying capability compared to a non-stabilised layer.”

capability compared to a non-stabilised layer. This benefit enables engineers to design more economically by reducing pavement layer thickness or extending pavement life.

Load bearing trials with TriAx® geogrid at the Building Research Establishment (BRE) also showed outstanding results in distributing static loading to increase load bearing of a layer. This is of real benefit in many applications such as working platforms for cranes or piling rigs.

►►

So, what does this mean for engineers? In temporary access road creation, geogrids such as TriAx® offer a host of benefits. Their use on remote wind farm locations, such as Europe's largest wind farm site, a 250 tower project at Fantanele Cogealac, Romania, has helped to keep construction of the continent's largest green energy sites cost-effective and environmentally friendly. Using TriAx® geogrids at Fantanele Cogealac allowed for vehicles carrying equipment and machinery within the site to increase their loads despite poor ground conditions, thus reducing the number of journeys required and ensuring less environmental harm from vehicle emissions. In fact using TriAx® geogrids can cut construction CO2 emissions by up to 50%, when compared against a non-stabilised aggregate solution.

"The ability to allow reduced road layer thickness means that less aggregate needs to be transported to the site..."

The ability to allow reduced road layer thickness means that less aggregate needs to be transported to the site,

reducing the number of vehicle journeys on local roads, which translates into both cost and environmental savings.

Engineers looking to specify geogrids will no doubt benefit from the upcoming implementation of the Construction Products Regulations (CPR). CPR will ensure that reliable information on construction products in relation to their performance is provided in a 'common technical language' and by adopting uniform assessment methods of performance. Unlike the Construction Products Directive (CPD), which it replaces, the regulation is mandatory for all EU member states. CE Marking of products indicates compliance with the CPR requirements.

Some critics have argued that enforcing compliance with harmonised standards for product characteristics could stifle innovation in both product development and application. However, the CPR seeks to overcome this by creating an alternative route to CE marking that encourages innovation. This is European Technical Approval (ETA) route. ETA allows manufacturers who develop products which go beyond the relevant harmonised standard to obtain

the required CE Marking.

The above ETA route has been followed by Tensar for its innovative TriAx® stabilisation geogrids. The current harmonised standard relevant to geogrids in roads and similar areas lists product characteristics relevant to geogrids acting as reinforcement in a tensioned membrane mechanism. Tensar proved to the satisfaction of the European Organisation for Technical Approvals (EOTA) that its TriAx® geogrid performs a stabilisation function by confining the aggregate layer into which it is placed, and increasing the modulus of the layer. This is distinct from reinforcement function and led to the award ETA certification for TriAx®.

"The new harmonised CPR system may make the task of specifying geogrids even easier, allowing for simple and precise specification of appropriate products."

The new harmonised CPR system may make the task of specifying geogrids even easier, allowing for simple and precise specification of appropriate products. There is, however, still a wide range of choice on the market, and given the sheer breadth of applications which geogrids can perform within, it makes sense to speak to an expert at an early design stage and obtain an application suggestion from experienced professionals. ■



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.

ESG prides itself on its innovative nature, customer focus and drive to continually improve. Our people are at the heart of what we do, and we employ more than 1,200 people who serve over 7,000 customers.

In response to the current and future workload, together with planned expansion of the business, ESG's Geotechnical Division are recruiting a range of specialists in a number of locations throughout the UK. Technical staff include **geologists, engineering geologists, environmental scientists and geotechnical engineers.**

We are seeking candidates for the following posts:

- **Industrial Placement** technical staff working predominantly in the Southeast of England
- **Graduate** technical staff throughout the UK
- **Senior** technical staff in Wales and Southeast England
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ESG is an equal opportunities employer.

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UPDATE ON EUROPEAN STANDARDS

The following is the latest press release and update on European Standards given to *theGeotechnica* by one of the country's leading Eurocode experts, Dr David Norbury of [David Norbury Ltd](http://www.drnorbury.co.uk). The update consists of the following details:

Please be aware that the following BS EN ISO Standards have recently been published.

"The implementation process starts immediately and the relevant sections of BS 5930 are considered as withdrawn as noted below..."

The implementation process starts immediately and the relevant sections of BS 5930 are considered as withdrawn as noted below.

Ground Investigation and Testing - Field Testing

BS EN ISO 22476-1 Electrical Cone and piezocone penetration tests Published February 2013. Moving into implementation phase For



details see *theGeotechnica* [Issue 16](#) from November 2012.

Ground Investigation and Testing – Geohydraulic tests

BS EN ISO 22282-1 General Rules Published October 2012; moving into implementation by removal of BS 5930 clauses 25.4, 25.5, 27 and 28 For details of the contents of all six parts, see the summary in *theGeotechnica* [Issue 16](#) from November 2012.

BS EN ISO 22282-2 Water permeability test in borehole without packer Published October 2012; moving into implementation by removal of BS 5930 clauses 25.4, 25.5, 27 and 29.

BS EN ISO 22282-3 Water pressure test in rock Published October 2012; moving into implementation by removal of BS 5930 clauses 25.4, 25.5, 27 and 30

BS EN ISO 22282-4 Pumping tests Published October 2012; moving into implementation by removal of BS 5930 clauses 25.4, 25.5, 27 and 31

BSENISO22282-5 Infiltrometer

tests Published October 2012; moving into implementation by removal of BS 5930 clauses 25.4, 25.5, 27 and 32

BS EN ISO 22282-6 Closed packer systems Published October 2012; moving into implementation by removal of BS 5930 clauses 25.4, 25.5, 27 and 33

"A summary of the contents of these standards is given in Powell and Norbury in *theGeotechnica* [Issue 16](#) from November 2012."

A summary of the contents of these standards is given in Powell and Norbury in *theGeotechnica* [Issue 16](#) from November 2012.

For details of the other Eurocode 7 standards both published and upcoming, see http://www.drnorbury.co.uk/html/attachments_to_part_2.html ■

UPCOMING COURSES - 2013

- SOIL DESCRIPTION WORKSHOP - 31st May 2013, 9th August 2013
- ROCK DESCRIPTION WORKSHOP - 18th June 2013
- GEOTECHNICAL FOUNDATION DESIGN - 17th September 2013
- IN SITU TESTING - 24th May 2013
- EUROCODE 7 - THE GEOTECHNICAL CODES - 14th June 2013

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KEYLOGBOOK TRIUMPHS

AT 2013's GE AWARDS

April 25th 2013 saw the highly prestigious Ground Engineering Awards return to The Grosvenor House Hotel on Park Lane in London. The GE Awards are the **"The GE Awards are the highest accolade companies can attain in the geotechnical industry..."**

highest accolade companies can attain in the geotechnical industry, and with names such as Balfour Beatty Ground Engineering, Bachy Soletanche and BAM Ritchies sponsoring 2013's event, it is easy to see why it is such an important date on the geotechnical industry's calendar.

"This year saw an excellent group of thoroughly deserved winners, which the Geotechnica is delighted to reveal, included Equipe Geosolutions."

This year saw an excellent group of thoroughly deserved winners, which the Geotechnica is delighted to reveal, included Equipe Geosolutions. After being

nominated in conjunction with Soil Engineering Geoservices for the Product and Equipment Innovation Award, the two companies walked away with 3 awards between them, with Soil Engineering Geoservices also snapping up the Ground Investigation Specialist of the Year Award, as well as the prize for the best UK Project with a Geotechnical Value up to £1 Million.

The Product and Equipment Innovation Award was awarded for Soil Engineering's implementation and use of KeyLogbook, a digital data collection product developed by Equipe Geosolutions and geotechnical technology specialist, Keynetix. KeyLogbook is fast becoming the most valuable innovation to hit the geotechnical industry for the last 5 years, with interest in the product increasing week on week, the GE Award is testament to the time and effort invested in developing the system by Equipe and Keynetix, as well as the continued support of Soil Engineering.

There to receive the award on behalf of Equipe Geosolutions was the man responsible for the creation of KeyLogbook, Keith Spires. After spending the last 5 years pushing forward the development of the data

collection system, Keith was understandably delighted with his brain-child receiving the highest of accolades:

"I am thoroughly delighted, we all are. For KeyLogbook to be identified as the best new product to be introduced to the industry is a massive achievement."

"I am thoroughly delighted, we all are. For KeyLogbook to be identified as the best new product to be introduced to the industry is a massive achievement. It is testament to all of the hard work that Keynetix have put into developing the engine behind KeyLogbook, as well as the loyalty and persistence of Soil Engineering in aiding the development of the product over the last few years."

Keith was especially quick to heap further praise on Soil Engineering Geoservices for their role as Development Partner for KeyLogbook:

"Without Soil Engineering on board and driving forward the development with constant on-site feedback, this could never have been achieved."

Soil Engineering have led the industry in introducing KeyLogbook into its ground investigation business and are progressively moving the reporting of all site investigation drilling to this technology instead of traditional paper-based systems. Digby Harman,



Innovation Manager at Soil Engineering said of their use of KeyLogbook:

"Soil Engineering enjoys multiple benefits from KeyLogbook. At the push of a button all data from each rig comprising the 'Drillers Daily Sheet', associated installation drawings, in situ permeability results and AGS v4 data, is transmitted to the office for automated filing. KeyLogbook eliminates the driller hand writing daily sheets and numerous sample labels, allowing more time for productive activities."

Although Keith was delighted to receive the award alongside Digby, he was keen to look to the future for the fledgling

innovation:

"What we cannot do now is rest on our laurels. Even despite this recognition, there is still a long way to go for KeyLogbook."

"What we cannot do now is rest on our laurels. Even despite this recognition, there is still a long way to go for KeyLogbook. Over the coming months we will be looking to roll out the system to even more companies across the sector, with improved functionality and input options, the aim is to have a KeyLogbook on every geotechnical and drilling site

across the UK within the next 10 years. Recent developments for KeyLogbook have included complete instant import compatibility of AGS data with Keynetix' new HoleBASE SI system, revolutionising the instant data transfer process. These developments will continue to ensure that AGS data is used to create an even wider spectrum of information available instantly to engineers and clients alike." ■

For more information on KeyLogbook, or any Equipe service, please contact the Equipe Group on 01925 670990, info@equipegroup.com, or visit www.equipegroup.com

CONTAMINANT OF THE MONTH: SELENIUM

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 selenium.

Selenium (Se) is in group VIA of the Periodic Table and is considered as a non-metal element. It has an atomic number 34 and an atomic mass of 78.96. Selenium has multiple oxidation states including -2, 0, +4 and +6 and forms chemical compounds similar to those of sulphur.

Volatile selenium compounds that partition into the atmosphere include the inorganic compounds, selenium dioxide and hydrogen selenide, and the organic compounds dimethyl selenide

“The main forms of selenium in soil are selenate (Se6+), selenite (Se4+) and selenide (Se2-), with the proportions in soil solution governed by various physical-chemical properties including pH and oxidation potential and also biological processes.”

and dimethyl diselenide. The

main forms of selenium in soil are selenate (Se6+), selenite (Se4+) and selenide (Se2-), with the proportions in soil solution governed by various physical-chemical properties including pH and oxidation potential and also biological processes (Environment Agency 2009).

Because of their high solubility and low adsorption tendency, selenates are very mobile (ATSDR 2003). Although selenites are usually soluble in water, in acid soils selenium is usually found as selenite bound to iron and aluminium oxides in compounds with low solubility. Elemental selenium and inorganic selenium compounds such as sodium selenite can be methylated by micro-organisms in soil, with subsequent volatilisation to the atmosphere. The transformation depends strongly on temperature and on the concentration and chemical form of the selenium



(Environment Agency 2009). The prevalence of selenium in the form of sulphides is expected to low.

Properties and Uses

Selenium is widely used in the glass industry to counter colouration that results from iron impurities. Sodium selenate (SeO42-) and sodium and ammonium selenite (SeO32-) are used in the manufacture of red and black glasses. In the photocopying and electronics industries selenium is used because of its photoelectric and semiconductor properties, either as elemental selenium or as cadmium selenide (CdSe). It appears in rectifiers, photoelectric cells and the coating on the metals cylinders

“One of the main anthropogenic sources of selenium in soils comes from the atmospheric deposition of emissions from the combustion of coal and oil and from the mining and refining of copper and other metals.”

that transfer the image in photocopiers. Selenium is contained in pigments that are used in plastics, paints, enamels and rubber.

Selenium and selenium dioxide (SeO2) are used as a catalyst in the preparation of pharmaceuticals. Selenium sulphide (SeS) and disulphide (SeS2) are used as anti-dandruff ingredients in shampoo. Selenium compounds are used in fungicides and pesticides. Selenium is also used in dietary supplements and as a feed additive for livestock.

One of the main anthropogenic sources of selenium in soils comes from the atmospheric deposition of emissions from the combustion of coal and oil and from the mining and refining of copper and other metals.

Toxicity, Essentiality and

“Adverse effects on human health occur from both too much and from too little exposure to selenium.”

Deficiency

Adverse effects on human health occur from both too much and from too little exposure to selenium. Selenium has been extensively investigated with regard to both toxicity and deficiency.

Selenium is an essential trace element. Selenium is a component of glutathione peroxidase (GSHPx) and interacts with vitamin E in protecting against oxidative damage. Other selenoenzymes, the iodothyronine deiodinases, are necessary for the conversion of thyroxine (T4) to the active thyronine (T3) form, and hence are important in the control of thyroid hormone metabolism. These and other selenoproteins incorporate selenocysteine in their structure. Selenium deficiency has been strongly associated with two widely endemic diseases in China, Keshan disease and Kashin-Beck disease which are characterised by cardiomyopathy and by chronic degenerative osteoarthritis respectively (SACN 2011).

Long-term repeated ingestion of selenium in food has resulted in a range of adverse effects in humans. Selenosis is characterised by changes to the hair and nails, skin lesions and clinical neurological effects (e.g. peripheral hypoesthesia, acroparasthesia, pain, hyperreflexia and

numbness). Convulsions and paralysis may develop. Only limited carcinogenicity studies have been reported on selenium compounds. With the exception of selenium sulphides, these have not given convincing evidence of carcinogenicity.

“The UK Expert Group on Vitamins and Minerals (EVM) has estimated that a daily oral dose of 450 µg of selenium would not pose a significant risk to the health of an adult.”

The UK Expert Group on Vitamins and Minerals (EVM) has estimated that a daily oral dose of 450 µg of selenium would not pose a significant risk to the health of an adult. Based on the default adult bodyweight of 70kg, this is equivalent to 6.4 µg kg⁻¹ bw day⁻¹, which is recommended by Defra and the Environment Agency as the oral tolerable

“The milder signs of selenosis (involving changes to nails and hair) might be expected to develop at exposures as low as twice this...”

daily intake (TDI_{oral}). The milder signs of selenosis (involving changes to nails and hair) might be expected to develop at exposures as low as twice this, i.e. at around 13 µg kg⁻¹ bw day⁻¹ (Environment

Agency 2009).

The adult oral mean daily intake (MDI_{oral}) for selenium from food (34 µg day⁻¹) and water (1 µg day⁻¹) combined is estimated to be 35 µg day⁻¹. This is equivalent to 0.5 µg kg⁻¹ bw day⁻¹ for a 70 kg adult. For a 20 kg child (aged six) who ingests 74% of the adult dietary intake, the estimated daily oral intake would be 1.3 µg kg⁻¹ bw day⁻¹. Background oral exposures therefore amount to less than half of the oral TDI (Environment Agency 2009).

There are no expert group evaluations of inhalation or dermal exposure to selenium and data for these routes appear very limited. In view of the uncertainties around inhalation toxicity and since oral exposure dominates risk assessment of selenium in soil, no inhalation TDI has been proposed (Environment Agency 2009).

Soil Guideline Values

SGVs for elemental selenium and its inorganic compounds are presented below according to generic SR3 land uses in the Environment Agency Report SC050021/Selenium SGV.

Land Use	Soil Guideline Value (mg/kg dry weight) ^{1,2,3}
	Selenium
Residential	350
Allotment	120
Commercial	13000

¹ Figures are rounded to one or two significant figures

² Based on a sandy loam soil with 6% soil organic matter

³ Based on oral, dermal and inhalation exposure pathways.

Selenium sulphides are not included because of their markedly different toxicity. The default assumptions for residential and allotment land uses are based on estimates representative of exposure of young children. The SGV document describes in full the proportion of exposure attributable to each individual pathway. In summary:

““The ingestion of soil and indoor dust is the most significant pathway for residential and commercial land use. The consumption of homegrown produce is the most significant pathway for the allotment land use.”

- the ingestion of soil and indoor dust is the most significant pathway for residential and commercial land use;
- the consumption of homegrown produce is the most significant exposure pathway for the allotment land use;
- for all standard land uses

the contribution from dermal contact, vapour inhalation and outdoor dust inhalation is negligible; and

- for residential and commercial land uses percentage exposure contribution from inhalation of indoor dust is negligible.

“The availability of selenium and its inorganic compounds to garden fruit and vegetables depends on a number of complex factors. The soil-to-plant concentration factors used in the derivation of the SGV are based on a geometric mean value.”

The availability of selenium and its inorganic compounds to garden fruit and vegetables depends on a number of complex factors. The soil-to-

plant concentration factors used in the derivation of the SGV are based on a geometric mean value. Selenium will be generally more available for plant uptake in alkaline soils. Under typical soil conditions, selenate forms will also be more available than selenite forms. In the presence of iron minerals, the selenium may be more strongly adsorbed and will therefore be less available for plant uptake (Environment Agency 2009).

Analysis

Selenium is generally analysed by ICP (Inductively Coupled Plasma Emission) as part of a suite of toxic metals. Waters are filtered, acidified and analysed by ICP-MS (Mass Spectroscopy) to achieve lower detection limits, whereas soils are digested in a concentrated hydrochloric acid and nitric acid (aqua regia) mixture, filtered and then analysed by ICP-OES (Optical Emission Spectroscopy). Typical detection limits for waters are 0.39 µg/l and 1 mg/kg for soils. ■

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GEOTECHNICAL LABORATORY'S GUIDE TO AGS DATA – PART II

Dr Roger Chandler, Managing Director of [Keynetix](http://Keynetix.com) and member of the AGS Data Management committee talks to *theGeotechnica* once again. This month, Roger continues his guide to AGS Data for geotechnical laboratories.

The speed with which consultants are able to analyse and plot laboratory data is the main reason why AGS data is being requested more frequently in laboratories working on medium to large construction projects. For a significant number of laboratories the production of AGS data is causing a number of problems but these can be easily avoided..."

"For a significant number of laboratories the production of AGS data is causing a number of problems but these can be easily avoided if the requirements are clearly thought out at the start of a project.

"The sample data is generally passed to the laboratory from the customer and consists of location data and sample parameters."

The sample data is generally passed to the laboratory from the customer and consists of location data and sample parameters.

The sample data is generally passed to the laboratory from the customer and consists of location data and sample parameters. This data is traditionally supplied to the laboratory either via an Excel schedule sheet or simply via a paper hard copy. How to best handle this type of data was covered in Part I of this article. The test data are the results that the laboratory has produced from the tests carried out. What is included in this data and how to create it is covered in this article.

"The data contained within an AGS file is classified as engineering data..."

Data Requirements
The data contained within an AGS file is classified as engineering data and so a laboratory is only required to include the results and any supporting data required by the appropriate testing standard. Raw lab data, such as tin weights, or consolidation curves are not required. A full list of data for each tests is included in the AGS Data transfer publication that can be downloaded from www.ags.org.uk

Tests Groups
Each test type has one or multiple groups in an AGS file. Simple tests, such as Moisture content or Density tests have a single group that records the "Multistage testing such as Triaxial or Consolidation tests have two groups, often referred to as a paired table."

results and relevant testing parameters. Multistage testing such as Triaxial or Consolidation tests have two groups, often referred to as a paired table. The first group contains the results for the tests and the second table contains results for each stage within the test.

"Where multiple testing has been carried out on a sample then the AGS data requires a specimen reference number and specimen depth..."

Where multiple testing has been carried out on a sample then the AGS data requires a specimen reference number and specimen depth to ensure that the data is correctly identified to the location on the

sample and so every laboratory testing table in AGS has SPEC_REF and SPEC_DPTH headings.

Creating AGS data
The easiest way to create Laboratory AGS data is to use an AGS compatible Laboratory Information Management

"... at time of writing, KeyLAB from Keynetix is the only LIMS that is listed on the AGS website as AGS compatible..."

System (LIMS), however, at time of writing, KeyLAB from Keynetix is the only LIMS that is listed on the AGS website as AGS compatible, so there is a strong chance that if you are reading this article you do not yet have the option to simply select AGS export from your existing LIMS systems.

Excel to the rescue
There is a cheap application available called KeyAGS that allows you to create AGS data from spreadsheets and this can be used for laboratories that use Excel spreadsheets to report their data or can export data from their LIMS system into spreadsheet format. However how you prepare your worksheets is important.

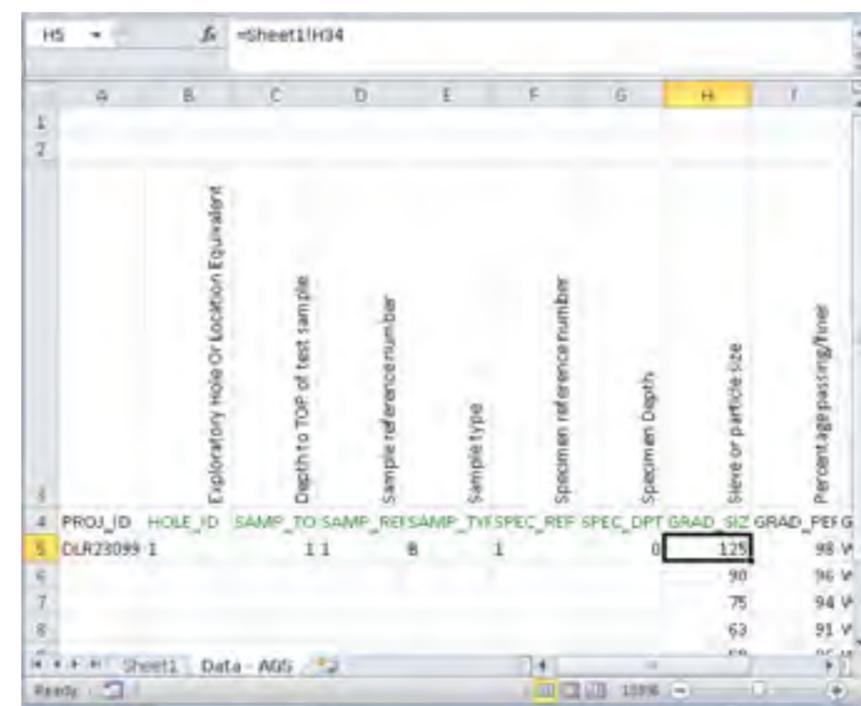
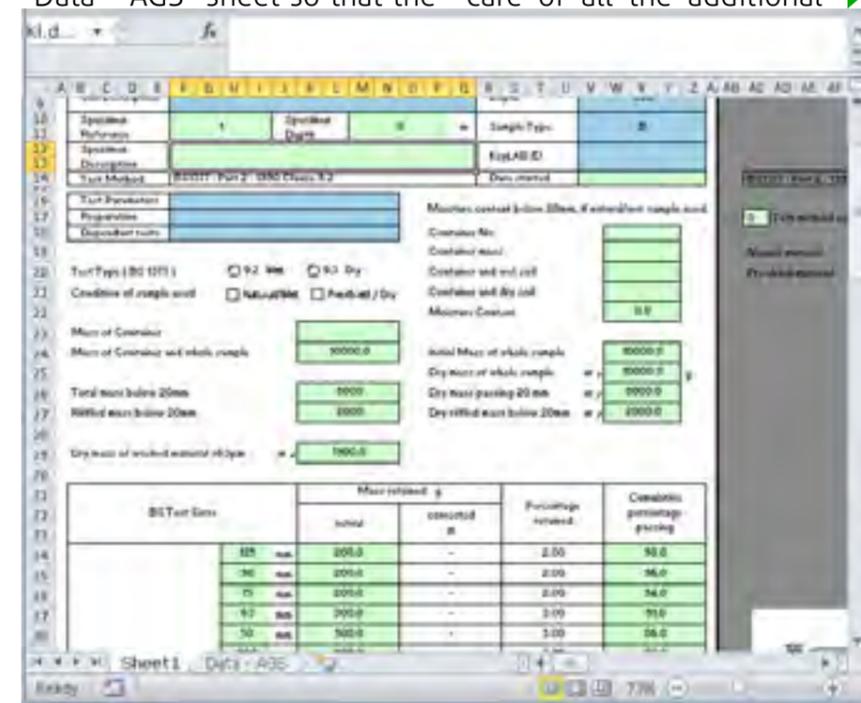
Customers who choose this route should create an additional tab on their spreadsheets and set up this worksheet to pull data from the laboratory worksheet and put in a simple AGS style grid on the spreadsheet using simple Excel equations. This then allows changes to be made to

the report sheet or worksheet without affecting the AGS output sheets

The example below shows this arrangement for a sieve sheet. No data entry is needed on the "Data – AGS" sheet as all the information required by this sheet is pulled from the "sheet1" sheet using equations. Laboratories that adopt this method will often hide the "Data – AGS" sheet so that the

users of the workbook see no difference between their old sheet and one that has been enabled for AGS export.

The KeyAGS application allows you to export and merge data from more than one workbook at once so creating AGS data can be completed by simply opening all your test workbooks and selecting the export all option. This process takes care of all the additional



reference tables required by AGS as well as the test data. An example file created from the above workbook is shown below.

Early adoption = Significant cost saving

If you have data entered into a worksheet that has not been set up for KeyAGS then it is easy to add the sheet and equations as shown below, however if you have a large number of these sheets then this process becomes too time-consuming

to be practical. In these cases it is common to create a script file that adds the sheet and mapping to each sheet one at a time and automates the production of AGS data but this is something that is outside of this article's scope.

Conclusion

Creating AGS data from laboratory test data does not need to be difficult or expensive to do. If the volume of AGS data produced by the laboratory is small then Excel spreadsheets

can be used to create the data but careful preparation of the templates is important before the data is added to any sheets.

Dr Roger Chandler is the Managing Director of Keynetix and has served on the AGS data management committee for 15 years. Keynetix produce a wide range of AGS compatible software such as KeyLAB, KeyAGS and HoleBASE SI. For more information please visit www.keynetix.com ■

```

AGS Editor
File Edit Help
1  **PROJ**
2  **PROJ_ID**,**PROJ_AGS**
3  <UNITS>,**
4  "DLR23099", "3.1"
5
6  **ABBR**
7  **ABBR_HDNG**,**ABBR_CODE**,**ABBR_DESC**
8  "SAMP_TYPE","B","Bulk disturbed sample"
9  "GRAD_TYPE","WS","Wet sieve"
10
11  **HOLE**
12  **HOLE_ID**
13  <UNITS>
14  "1"
15
16  **UNIT**
17  **UNIT_UNIT**,**UNIT_DESC**
18  "m","metre"
19  "mm","millimetre"
20  "%","percentage"
21
22  **SAMP**
23  **HOLE_ID**,**SAMP_TOP**,**SAMP_REF**,**SAMP_TYPE**
24  <UNITS>,"m",**
25  "1","1","1","B"
26
27  **GRAD**
28  **HOLE_ID**,**SAMP_TOP**,**SAMP_REF**,**SAMP_TYPE**,**SPEC_REF**,**SPEC_DPTH**,**GRAD_SIZE**,**GRAD_PER**
29  <UNITS>,"m",**,"m",**,"mm",**,"%",**
30  "1","1","1","B","1","0","125","98","WS"
31  "1","1","1","B","1","0","90","96","WS"
32  "1","1","1","B","1","0","75","94","WS"
33  "1","1","1","B","1","0","63","91","WS"
34  "1","1","1","B","1","0","50","86","WS"
35  "1","1","1","B","1","0","37.5","83","WS"
36  "1","1","1","B","1","0","28","81","WS"
37  "1","1","1","B","1","0","20","80","WS"
38  "1","1","1","B","1","0","14","76","WS"
39  "1","1","1","B","1","0","10","72","WS"
40  "1","1","1","B","1","0","6.3","68","WS"
41  "1","1","1","B","1","0","5","61.6","WS"
42  "1","1","1","B","1","0","3.35","55.2","WS"
43  "1","1","1","B","1","0","2","48.8","WS"
44  "1","1","1","B","1","0","1.18","42.4","WS"
45  "1","1","1","B","1","0","0.6","36","WS"
46  "1","1","1","B","1","0","0.425","29.6","WS"
47  "1","1","1","B","1","0","0.3","23.2","WS"
48  "1","1","1","B","1","0","0.212","16.8","WS"
49
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We believe that further opportunities are now opening up for us in several of our markets, and are intending to recruit additional senior staff to the following roles:

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