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18th June 2013,
27th September 2013

GEOTECHNICAL COURSE DATES:

Geotechnical Foundation Design - 26th April 2013

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31st May 2013,
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- The UK Specification for Ground Investigation Second Edition - Part 2
- Contaminant of the Month: Cadmium
- Geotechnical Laboratory's Guide to AGS Data - Part 1

Issue No.
20
April 2013

Contents

Welcome

Welcome to the 20th Edition of **theGeotechnica** - the UK's fastest growing online geotechnically focussed e-magazine.

This month in **theGeotechnica** we have the second of a two-part series focussing on the Self-Boring Pressuremeter. The article is an insightful overview of the presentation given by Cambridge Insitu's Robert Whittle on the methods behind and the values of the self-

"This month's article focuses on the Advantages and Limitations of the self-boring pressuremeter..."

boring pressuremeter at a recent seminar. This month's article focuses on the Advantages and Limitations of the self-boring pressuremeter as well as what parameters can be obtained from the test. Next month we will feature an article on Marchetti DMT's dilatometer which was also examined during the course of the seminar delivered at Equipe's offices in late February.

The second article featured in this issue is also featured on this month's front cover. Recently Equipe Training undertook and delivered a day's training for the Pagani TG63 150 Penetrometer Rig on behalf of Pagani Geotechnical Equipment and their UK trading partner, Rockbit uk Ltd. The article in this month's magazine outlines what the training involved, as well as information about the Pagani rig itself as it begins to infiltrate the UK market, having previously established a successful user-base across Europe and the Middle East.

Article three of this issue is the second in our series from Julian Lovell, Managing Director of the Equipe Group regarding the recent revision of the UK Specification for Ground Investigation:

" This month sees Julian continue to explain what the second edition of the 'Yellow Book' means for the rest of the ground investigation community, with this month's focus on the legislation surrounding competence and training."

Second Edition. This month sees Julian continue to explain what the second edition of the 'Yellow Book' means for the rest of the ground investigation community, with this month's focus on the legislation surrounding competence and training.

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

"... this month Geraint examines Cadmium – its properties, uses, toxicity, as well as a thorough analysis of the element."

contaminant, this month Geraint examines Cadmium – 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 Keynetix. This month's contribution from Roger is the first 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, 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

THE SELF-BORING PRESSUREMETER: PART 2

The following is Part Two of the overview of the presentations given by Clive Dalton and Robert Whittle of Cambridge Insitu on the Self-Boring Pressuremeter, delivered on an Equipe Training Technical Seminar in February 2013.

Advantages And Limitations Of The Pressuremeter Test:

Advantages

- A large number of fundamental soil properties are obtained from a single test.
- To derive these properties, no empirical correcting factors whatever are needed
- Measurements are made insitu at the appropriate confining stress
- A large volume of material is tested - a typical test loads a column of material 0.5 metres high and extending to more than 10 times the expanded cavity radius. This is the equivalent of at least 1000 triaxial tests on 38mm samples.
- Representative loads are applied – in the example shown in fig.2 about 12 tonnes is being applied to the cavity wall.
- Results can be obtained quickly as all the data logging and most of the analysis is carried out by automated systems.
- Commercial operation has shown that the instruments, though more complex than conventional site investigation equipment, are reliable.
- There are many materials whose properties can only be realistically determined by insitu measurement.
- The pressuremeter test is particularly appropriate for predicting the performance of laterally loaded piles.
- Pressuremeter tests are routinely used to calibrate finite element models of complex geotechnical problems.

"Commercial operation has shown that the instruments, though more complex than conventional site investigation equipment, are reliable."

Limitations

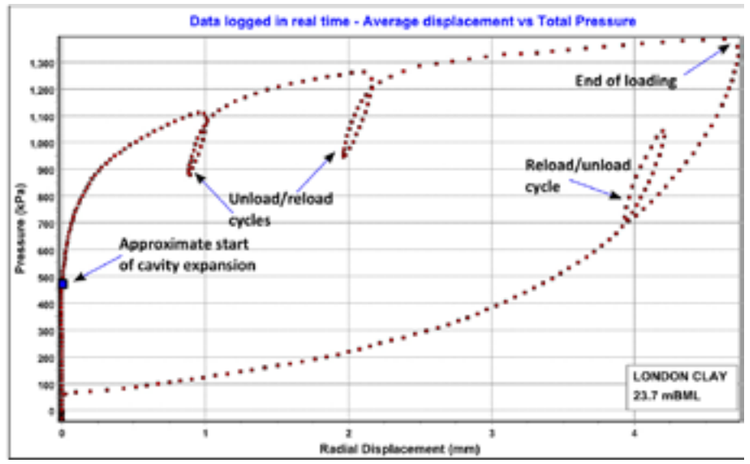
- The instrument will not penetrate gravel, claystone or the like, so generally pressuremeter testing requires support from conventional drilling techniques.
- Failure planes and deformation modes are not always appropriate to those occurring in the final design. An estimate of the anisotropy of the material will be required in order to derive vertical parameters from lateral values.
- Many familiar design rules and empirical factors are based on parameters obtained from traditional techniques. It is not always possible to use them with pressuremeter derived values, even if the insitu parameters more accurately represent the true state of the ground.
- Only two stress paths can in practice be followed, undrained and fully drained

"The instruments and their associated equipment are complex by conventional site investigation standards and can only be operated by trained personnel."

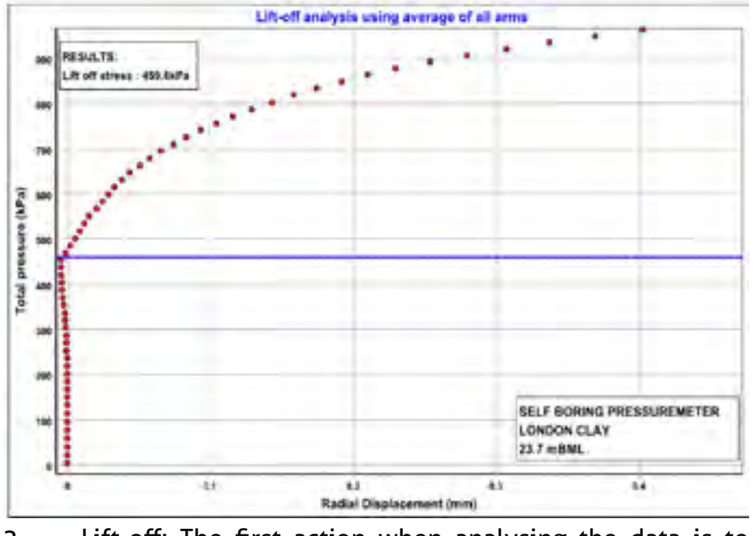
- The instruments and their associated equipment are complex by conventional site investigation standards and can only be operated by trained personnel.
- Use of an inappropriate analysis to interpret a pressuremeter test can result in seriously misleading parameters.

What parameters can be obtained from the tests?

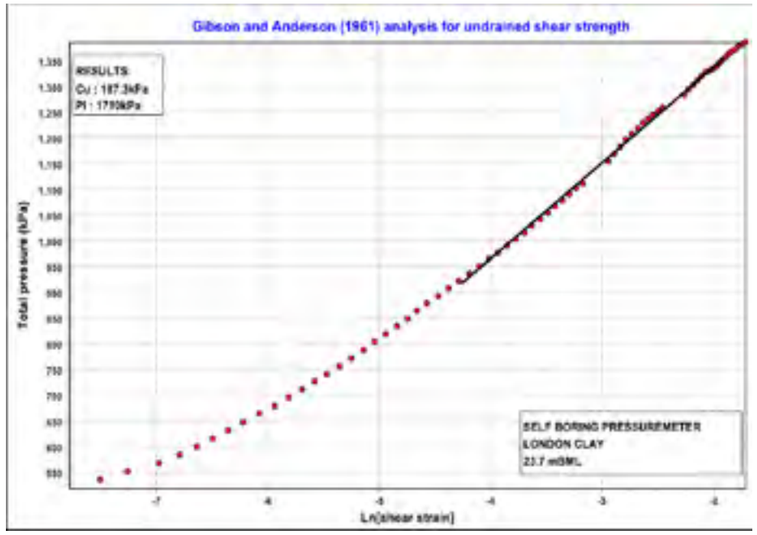
The most straightforward test to analyse is an undrained cavity expansion and contraction in clay, where a self boring pressuremeter has been used. The insertion disturbance is likely to be small and the undrained path means it is easy to calculate radial and circumferential stresses and strains directly from the displacement and pressure measurements made by the instrument. There are a number of analyses that can be applied; what is described here is one approach. The test itself was over water so depth is referred to bed level.



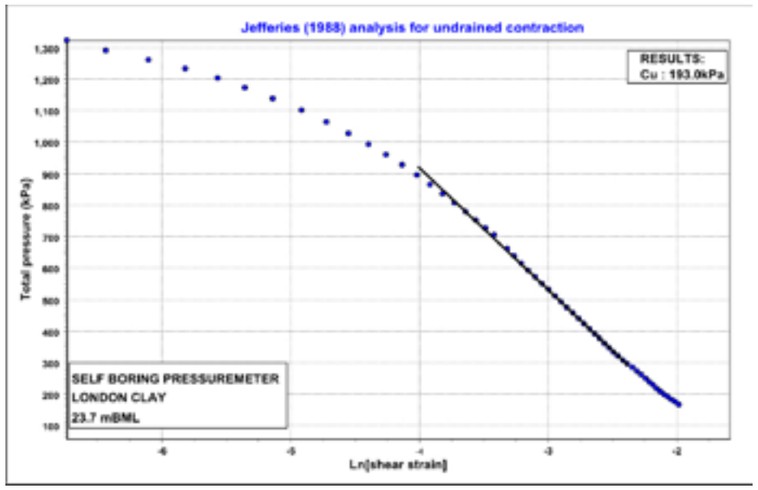
1. Field curve: The test is logged as a set of readings of pressure and displacement. At intervals the loading is interrupted to make a small unload/reload cycle. These cycles can also be taken on the final contraction



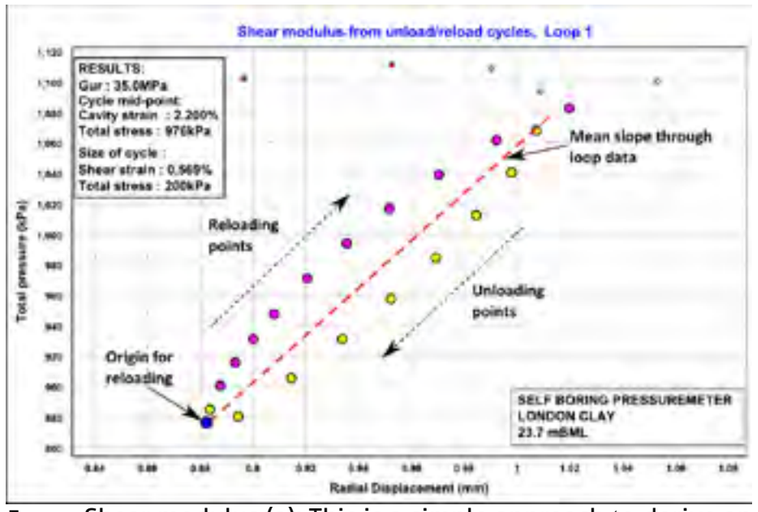
2. Lift-off: The first action when analysing the data is to select a plausible co-ordinate of stress and displacement that represents the origin for the cavity expansion. The stress value is the point where some movement is apparent. The displacement ordinate is close to zero, a feature of self boring.



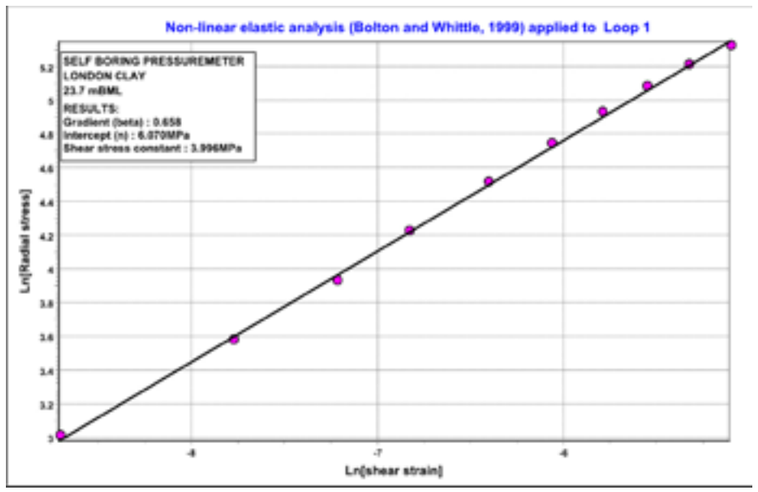
3. Shear strength (a): Having selected an origin, displacement can be converted to strain and the data analysed. This figure shows the result of plotting the loading data on semi-log scales and identifying the ultimate slope and intercept. These give shear strength and limit pressure.



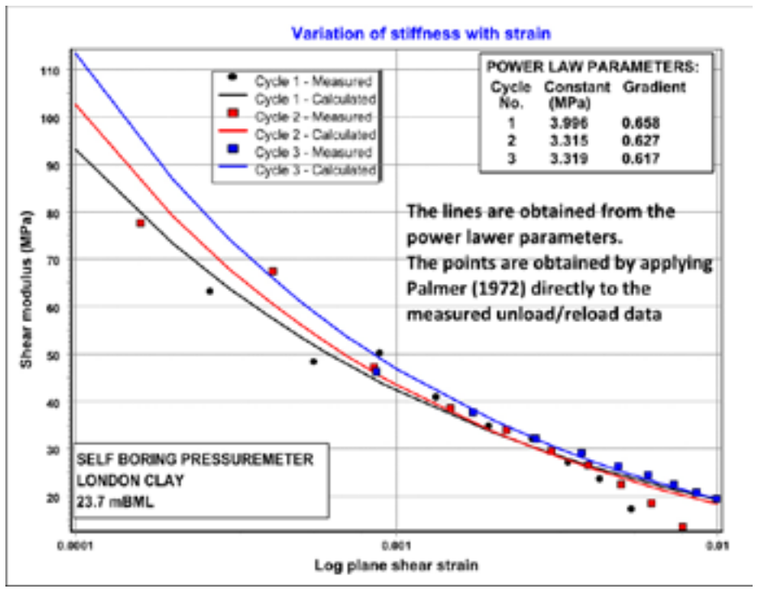
4. Shear strength (b): This is a similar procedure but applied to the final contraction data. It is of special interest because the origin at the start of unloading is an observable point – the origin used for the initial loading is always uncertain due to disturbance.



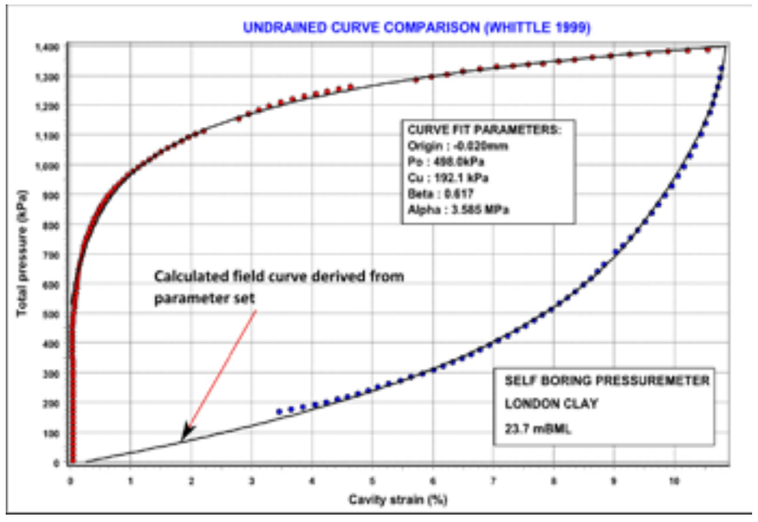
5. Shear modulus (a): This is a simple approach to derive an estimate of the shear modulus, by taking the slope of the chord bisecting a cycle of unloading and reloading. In a linear elastic material the unloading and reloading data would coincide. Here the cycle appears hysteretic, indicating that modulus varies with strain.



6. Shear modulus (b): This non-linear stiffness behaviour can be represented by a power law. Here the reloading data from the previous plot are redrawn on log-log scales and the slope and intercept identified. These two parameters allow the current shear stress to be predicted at any strain.



7. Stiffness/strain: The trend of declining stiffness with strain is drawn here for each cycle. Because the test is virtually undrained the three cycles give almost exactly the same result. The lines come from the power law results, the data points from applying Palmer (1972) directly to the data.



8. Curve comparison: The parameters produced so far are used to calculate a pressure/strain curve for comparison with the measured data. The non-linear stiffness parameters are assumed correct. A tiny alteration to the origin reconciles loading and unloading shear strength. Finally, the initial reference stress is chosen for best fit.

"At this stage of the process the analyst has a set of parameters describing the strength and stiffness of the material, and the insitu stress state."

At this stage of the process the analyst has a set of parameters describing the strength and stiffness of the material, and the insitu stress state. There are differing levels of uncertainty in these values. One method for resolving this uncertainty is to see if the parameter set can reproduce the measured field curve. Every measured data point could be calculated if the underlying stress:strain

"The soil model used here assumes a non-linear elastic/perfectly plastic stress:strain curve for which there is a closed-form solution."

curve was known. The soil model used here assumes a non-linear elastic/perfectly plastic stress:strain curve for which there is a closed-form solution. The essence of such solutions is to define the stress and strain required to make the material yield, then integrate this condition between

"In the implementation shown here only the insitu horizontal stress is treated as a free variable."

known boundaries. In the implementation shown here only the insitu horizontal stress is treated as a free variable.

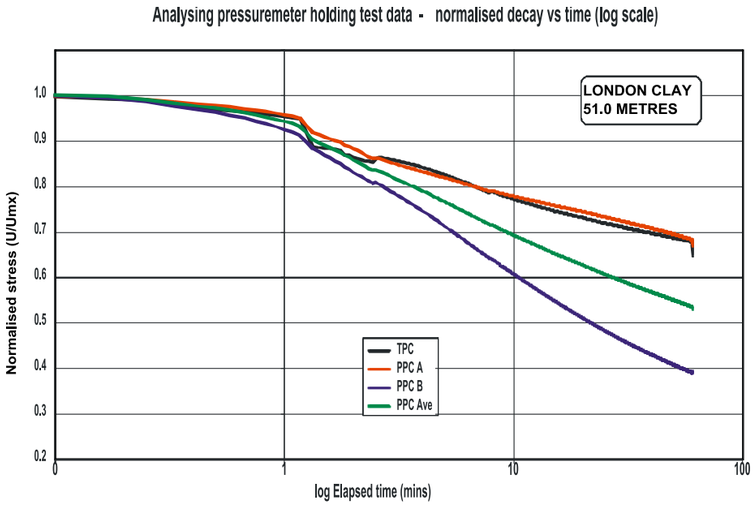


Figure 1 – Consolidation testing in London Clay

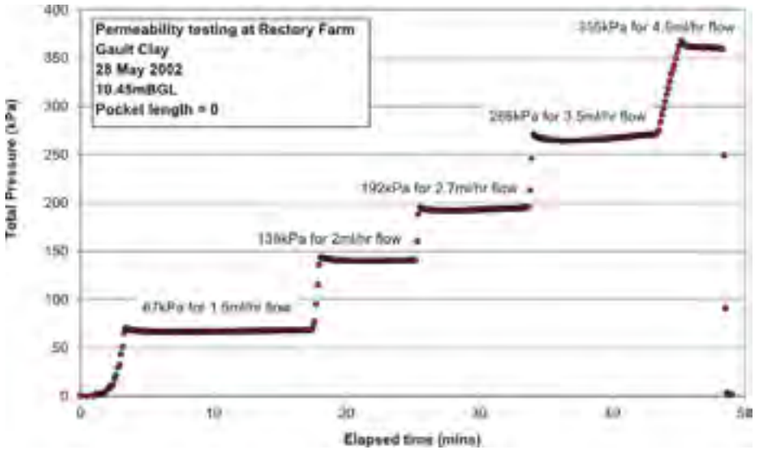


Figure 2 – Permeability testing, raw data

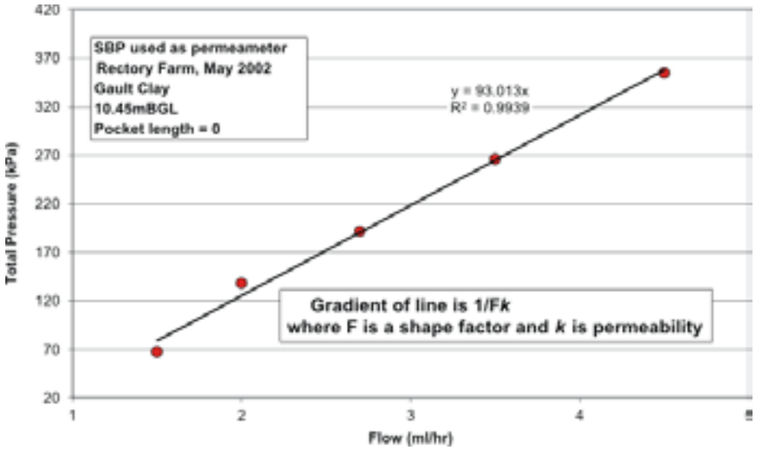


Figure 3 – Permeability testing, result

Consolidation Tests

The SBP can carry out a holding test to obtain consolidation parameters. It is a modification of a normal undrained

"Near the point where the cavity would be unloaded it is instead held at that expansion and the excess pore water pressure (pwp) that has been generated is allowed to dissipate."

expansion test. Near the point where the cavity would be unloaded it is instead held at that expansion and the excess pore water pressure (pwp) that has been generated is allowed to dissipate. As it does so the effective stress at the cavity wall starts to rise and the cavity wants to expand.

This triggers an automatic control system to reduce the total pressure at the cavity wall

"The net result is that the cavity remains at a constant diameter for as long as the test is conducted."

to compensate. The net result is that the cavity remains at a constant diameter for as long as the test is conducted. There is a closed form solution for this situation that uses the parameters derived from the expansion phase of the test and the time taken for 50% of the generated excess to dissipate. Here the dissipation data from two pwp cells, their mean and the total pressure response are plotted in a normalised form. Any of the profiles can give a value for the horizontal consolidation, but it is normal to use the mean of the two pwp sensors.

Permeability Testing

The two figures above show the result of a permeability test carried out with a self boring pressuremeter. The procedure exploits the ability of the pressuremeter to bore a pocket in the ground that it exactly fits. The stress conditions are, more or less, representative of the insitu state and are acting on the body of the probe,

"As a consequence the drill string now provides a pipe from the surface down to the bottom of the probe allowing access to the formation."

giving an excellent seal. As a consequence the drill string now provides a pipe from the surface down to the bottom of the probe allowing access to the formation. For low permeability material the pipe work is filled with water, is sealed off and is connected to the output of a small constant flow pump. This then pressurises the water column. Figure 2 shows steps of pressure, and the flow rates required to establish each

"Figure 3 plots the flow rates against pressure, and gives a linear trend."

step. Figure 3 plots the flow rates against pressure, and gives a linear trend. The slope of this trend is a function of the permeability and a shape factor.

This is one result at this location, for one geometry – the tested pocket is zero length and the permeability is the mean of the horizontal and vertical

"If time allows, then the probe can be pulled back to give a pocket of some length and the test repeated."

characteristics. If time allows, then the probe can be pulled back to give a pocket of some length and the test repeated. This gives a second permeability value where the horizontal characteristic is having a greater influence. Further pulling back allows additional values to be obtained. By a best fit process it is possible to identify the anisotropy factor for the horizontal and vertical conditions. In practice reconciling the data is more complex than this implies because as more and more of the material is exposed to the test then a scale effect related to the variability of the fabric becomes apparent.

"The permeability testing is an addition to the conventional expansion test..."

The permeability testing is an addition to the conventional expansion test, and is a way of obtaining more data from one self boring episode. If k is higher than 10^{-7} m/sec then the same concept can be used, but constant flow is not required and a falling head test can be carried out, measuring the height of the water column in the SBP drill rods. ■

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THE FIRST OF MANY

FIRST PAGANI PENETROMETER TRAINING COURSE DELIVERED

Tuesday the 12th March 2013 saw Equipe Training deliver its first round of training for the Pagani TG63 150 Penetrometer rig. The rig has only recently been introduced to the UK geotechnical industry by Pagani's UK supplier Rockbit uk Ltd. This introduction comes after establishing a broad and thoroughly successful user-base in Pagani's native Italy, as well as all across Europe and the Middle East. Last month's training is lining up to be the first of many Pagani-orientated training days delivered by Equipe, as demand and interest in the Pagani fleet of rigs begins to grow.

"This introduction comes after establishing a broad and thoroughly successful user-base in Pagani's native Italy, as well as all across Europe and the Middle East."

The rig itself is a cost effective method of carrying out in situ testing, with the rig able to carry out both dynamic and static cone (CPT) tests. Small and versatile, the TG63 150 boasts a self-anchoring system that solves many of the issues regarding CPT tests, whilst also incorporating a fully compliant SPT and dynamic super heavy probing capability. The anchoring helicoids allow for 15 tonnes of resistance that can be applied to the cones, all from the incredibly small 2m x 1m rig footprint. Other additional enhancements include the ability to rotary auger difficult ground, insert casings and an ability to discreet sample more difficult, soft or contaminated ground accurately. All of these features add up to a rig that is very quickly gaining interest across the UK market.

Training for the Pagani rig only requires one to two days training in order to be proficient in safely carrying out CPT and CPTu tests using the rig itself, as well as the built-in touchscreen digital acquisition system – the TGA07. Undertaking the training were representatives from UK based contractors who are seriously considering adding a Pagani to their fleet.

"Undertaking the training were representatives from UK based contractors who are seriously considering adding a Pagani to their fleet."

The training was to ensure that all participants were proficient operators of the rig and it was principally delivered through hands on operations with the rig. The training was led by Equipe Operations Director, Mr Keith Spires, who is Pagani's trainer in the UK. The course content included; the importance of the positioning and anchoring of the penetrometer rig; correct anchoring; rig operations, tracking, test set up and validation of the results. Following the explanation of the controls and operations of the rig, the participants were given the opportunity to operate the rig under supervised conditions and commence testing.

"The training was led by Equipe Operations Director, Mr Keith Spires, who is Pagani's trainer in the UK."

The training day was held at Equipe's facility near Banbury and was extremely well received by the attendants and supported by Rockbit uk. Equipe's Managing Director, Mr Julian Lovell, explained "Equipe originally established itself to provide training on all aspects of geotechnical and drilling work which is why the training for Pagani and Rockbit fits in so well with our portfolio. We would welcome other suppliers and manufacturers to use our unique facility to provide theory and hands on training for their plant and equipment. Let us hope that this is the first of many such events." ■

"The training day was held at Equipe's facility near Banbury and was extremely well received by the attendants..."

ROTARY DRILLING AWARENESS FOR ENGINEERS

7th May 2013
£150 + VAT

The course is a unique opportunity to learn about drilling techniques as well as assessing and observing rigs in operation. The content will include drilling techniques and equipment, advantages and limitations and new technologies as well as the legislative requirements which impact on rotary drilling. The course will comprise some theory in the classroom but will also be based outside with rotary drill rigs in action.

- Rotary Drilling Techniques
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  - Coring – conventional and wireline
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- Advantages and Limitations
- Environmental Issues
- Health and Safety – PUWER & LOLER inc. Rig Guarding
- **Health and Safety Audit on Drill Rigs***

*N.B. Those aspects shown in bold will be practical activities outside.

For more information, or to book your place on a course, please contact Equipe Training on:

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01295 678232

Who should attend?

This course is essential training for Engineers, Geologists and Ground Specialists specifying or supervising rotary drilling works or those who just want to improve their knowledge.

ROTARY DRILLING TRAINING

8th - 10th May 2013

Equipe Training are offering comprehensive Rotary Drilling Training that will take place over the course of three days. Each day will focus on a specific aspect of rotary drilling with the aim to give all attendees a high level of understanding of the skills, techniques and knowledge required to safely and effectively operate rotary drilling rigs.

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Day One is a must for those specifying, managing, supervising and carrying out rotary drilling operations so that they can understand the drilling activity and interact more professionally with the drill crew.

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- Ancillary Plant
- Flushing Media
- LOLER Requirements & Inspections
- Equipment
- Health, Safety and Environmental Aspects
- Techniques

DAY TWO - DRILLING APPLICATIONS

Day Two is a must for those drillers and drilling engineers serious about drilling properly, efficiently and knowledgably. The day will incorporate hands on practicals where attendees will obtain a better understanding about how geology and hydrogeology may affect the drilling process, coring and core barrels and the drills themselves including demonstrations.

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PART TWO: THE UK SPECIFICATION FOR GROUND INVESTIGATION SECOND EDITION EXPLAINED

COMPETENCE AND TRAINING

*Writing for **theGeotechnica** once again are the experts at the Equipe Group - notably Managing Director Julian Lovell This month is the second in a series of articles that will look at the background to and principle changes made within the revision and final publication of the UK Specification for Ground Investigation – Second Edition. This month focuses on the revision of the sections covering competence and training.*

Part 2 of our series of articles entitled 'The UK Specification for Ground Investigation – Second Edition Explained' will discuss the elements of competence and training. The issue of definitions of competency and specialists will be examined in the context of current industry practice and the Second Edition approach.

The use of the word 'competence' and 'competent' has become commonplace throughout legal, contractual and other documents yet clear and concise definitions are very difficult to find. The Oxford English dictionary defines competence as 'The condition of being capable; ability' or 'A state of being legally competent or qualified' and being competent is defined as 'having sufficient skill, knowledge,

"Competence is clearly not just a qualification and therefore skills, ability and knowledge must form part of the overall ideal of competence..."

etc; capable'. Competence is clearly not just a qualification and therefore skills, ability and knowledge must form part of the overall ideal of competence not forgetting to factor in sufficiency of experience. The Second Edition has tried to follow this ideal whilst assessing the individuals required to manage, supervise and carry out a ground investigation efficiently, safely and to the required technical and quality standard.

"Therefore, it could be argued that it is somewhat surprising the Second Edition appears to not be explicit regarding competence of the individual who is specifying the work."

Therefore, it could be argued that it is somewhat surprising the Second Edition appears to not be explicit regarding competence of the individual who is specifying the work. As this is the 'UK Specification' then this is possibly a major failing. The fact is that the AGS Working Party very carefully considered this element and decided that this is a professional industry providing professional and specialist services and therefore it should be a given that a competent person will specify the work. The reality is that when an inexperienced geologist/ engineer is used to produce the specification or when an environmental practitioner produces a specification for a geotechnical investigation is this incompetence, an indication of a lackadaisical approach or is it the harsh reality of commercial pressures?

Ground Specialists

The titles and terminology for 'ground specialists' and of the term 'geotechnical specialist' itself have become poorly defined and sometimes confusing. The Second Edition therefore, refers generically to those involved with the ground as 'ground practitioners' and these include, but are not necessarily limited to, geotechnical engineers, geologists, engineering geologists, geoenvironmental engineers, environmental scientists, geochemists and geophysicists. However, it then further splits levels of competency for the ground

"The lower levels of competence are simply measured with relevant qualifications and experience whereas the definition for the 'experienced' ground engineers follows published definitions."

practitioners into six categories from Technician to Registered GroundEngineeringAdvisor.The lower levels of competence are simply measured with relevant qualifications and experience whereas the definition for the 'experienced' ground engineers follows published definitions. The definition of an 'Experienced Ground Engineer' uses the original definition of a 'Responsible Expert' from BS EN ISO 22475: Part 2 and for the higher level experienced ground engineers, adopts the UK Register of Ground Engineering Professionals (RoGEP) definitions as set out by the Institution of Civil

"It should be noted that the Second Edition does not recognise a level of professionalism for a Chartered professional without registration to RoGEP and therefore fully supports RoGEP."

Engineers (ICE3009, 2010). It should be noted that the Second Edition does not recognise a level of professionalism for a Chartered professional without registration to RoGEP and therefore fully supports RoGEP.

Investigation Supervisor

The AGS Working Party were extremely keen to create a

document which would help the creation of clear and relevant specifications and help to improve the quality of ground investigations. After much consideration it was clear that the element of supervision was key to assisting this goal. Therefore, the Investigation Supervisor started to evolve and became a very passionate discussion point at many meetings and during industry and peer reviews.

As stated in the Second Edition *'The term 'Investigation Supervisor' means the named individual having responsibility to see that the technical objectives and quality of the investigation are met within the programme and cost constraints. The Investigation Supervisor shall act in a professional and independent manner in order to achieve the technical objectives. The Investigation Supervisor shall be appointed or agreed by the Employer and shall have a level of competency and experience appropriate to the size, nature and complexity of the investigation'.*

So who is or should be the Investigation Supervisor?
It should be quite simple

that he/she is the individual who is competent to do so!

"... if the project is a small trial pitting project for a domestic housing client then a competent Experienced Ground Engineer could be the Investigation Supervisor."

Therefore, if the project is a small trial pitting project for a domestic housing client then a competent Experienced Ground Engineer could be the Investigation Supervisor. The clarification of competence would be that he/she had sufficient relevant skill, knowledge and experience of similar ground investigations, is able to understand the aims of the investigation programme and supervise the project. He/she shall also have proven knowledge of the:

- Health and safety regulations, technical rules, and standards
- Purpose of ground investigation, geological, soil and rock mechanical and hydrogeological principles.
- Sampling procedures
- Reporting results of sampling
- The identification and description of soil and rock
- The quality assurance system

If the project is a large sophisticated ground investigation for a nuclear facility, highway, railway etc then the competence of the Investigation Supervisor should include all of the above as well as sufficient skill, knowledge and experience of the additional elements specified in this more complex project. These elements should be clear within the schedules of the specification but would likely include obtaining Class 1 samples, sophisticated in situ testing techniques, advanced drilling techniques and advanced laboratory testing. It is therefore unlikely that the Investigation Supervisor for such a project would be at the level of 'Experience Ground Engineer'.

"It is therefore unlikely that the Investigation Supervisor for such a project would be at the level of 'Experience Ground Engineer'."

Site Operatives

The Second Edition intends that all site works are carried out by appropriately trained and qualified personnel from throughout the process. The site operatives such as the drillers, window samplers, technicians, CPT operators etc other than professionally qualified individuals should all hold:

- A valid and current NVQ applicable to the work
- A CSCS blue card or CPCS for plant operatives
- A valid and current audit card

"NVQs are not a training scheme but a competence based assessment process against a set of criteria agreed and approved by the industry sector."

NVQs are not a training scheme but a competence based assessment process against a set of criteria agreed and approved by the industry sector.

The NVQs for drillers wholly replaced BDA accreditation around 2005 and now drillers/lead drillers/foreman drillers should all have a Level 2 NVQ as a 'Land Driller'. All competent second men/assistant drillers should hold a Level 2 NVQ as a 'Driller' or 'Drilling Support Operative'. Aligned with the NVQ is the Blue Skilled Worker card which is provided to each individual who has obtained their NVQ and these details are printed on the back of the card. For drillers it will also state which type of drilling plant they are competent to operate i.e. rotary, cable percussion, dynamic sampling.

"Aligned with the NVQ is the Blue Skilled Worker card which is provided to each individual who has obtained their NVQ..."

WARNING: If an NVQ states 'Driller' this is a second man's NVQ and NOT a drillers!

It should also be noted that on many construction sites the Principal Contractor will expect all Supervisors to have completed a supervisor's NVQ and hold a gold supervisor CSCS card.

The Second Edition does not ban the use of trainees or requirement for individuals to learn their trade but this is an area which should be clarified within the schedules and will undoubtedly depend upon the nature of the project.

Training

The Second Edition is not explicit about how training should be delivered, by whom or over what period. However, it is integral within the proof of competence and often required to maintain professional qualifications and support continuous professional development (CPD).

Training can be provided in many different ways including formal training (tested or untested), experience based, mentoring and self-directed study. The most important aspect of training whichever way it is provided is for both the individual and their employer to ensure the relevancy of such and also its effectiveness in providing CPD. Training and CPD must not also be confined to the professionally qualified individuals but include site operatives and all within the process of providing the success of the ground investigation.

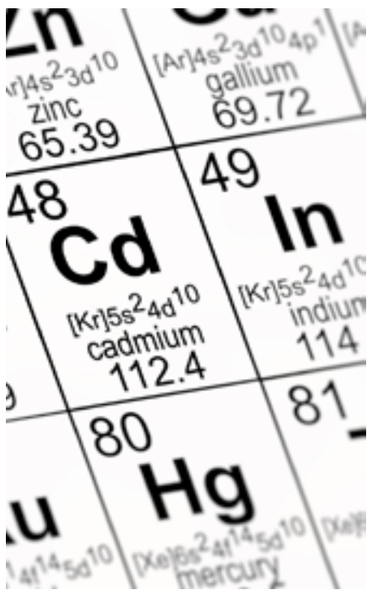
"Training and CPD must not also be confined to the professionally qualified individuals but include site operatives..."

CONTAMINANT OF THE MONTH:
CADMIUM
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 cadmium*

Cadmium (CAS No. 7440-43-9) has a relatively low abundance in the Earth's crust and is found in association with sulphide ores of zinc, lead and copper. Cadmium is in Group IIB of the Periodic Table. It has an atomic number of 48 and an atomic mass of 112.

"It usually combines with other elements such as oxygen, chlorine or sulphur to form cadmium oxide, cadmium chloride or cadmium sulphate."



It usually combines with other elements such as oxygen, chlorine or sulphur to form cadmium oxide, cadmium chloride or cadmium sulphate. Cadmium oxide is most commonly found in the air whereas cadmium chloride and cadmium sulphate dissolve in the water. The type of cadmium is important when assessing the risk of adverse health effects (HPA, 2008).

The behaviour of cadmium in soil is dependant on a wide range of soil properties, such as soil organic matter (SOM) and pH. Cadmium has negligible vapour pressure and forms few known volatile compounds. Although it has possible valencies of 0, +1 and +2, it forms almost all of its compounds in the +2 oxidation state. Adsorption of cadmium by soil depends on pH, with its mobility decreasing with increasing alkalinity. Cadmium can be adsorbed onto clay and other mineral surfaces although the extent will depend on the soil chemistry. Absorption is also affected by the relative concentrations of other metals and through the formation of stable soluble complexes, such as with chloride.

"Adsorption of cadmium by soil depends on pH, with its mobility decreasing with increasing alkalinity."

Properties and Uses

Cadmium metals, its alloys and compounds have been used in a variety of applications. Cadmium (as cadmium oxide) is obtained mainly as a byproduct during the processing of zinc-bearing ores and also from the refining of lead and copper from sulphide ores. Its main uses are for galvanising and electroplating, in stablisers for plastics including PVC, in pigments for enamels and glazes and in nickel-cadmium batteries.

"Point source contamination of soil with cadmium has occurred historically from mining and waste disposal activities."

Point source contamination of soils with cadmium has occurred historically from mining and waste disposal activities. In the urban environment, soil contamination arises from the aerial deposition of particulates from smelting activities and the burning of fossil fuels. The presence of cadmium in car tyres and lubricating oil often accounts for the relative accumulation in roadside soils. Enrichment of cadmium on agricultural land may result from the application of phosphate fertilisers or the use of sewage sludge.

"The kidney is considered to be a critical target of repeated exposure of humans to cadmium."

Toxicity

The key aspects of cadmium's toxicity profile in humans are its adverse effects on kidney and bone, arising from either oral or inhalation exposure, and its lung carcinogenicity. The dose-response of the renal effects are better characterised and so risk assessment of threshold toxicity are generally based on this. If accumulated cadmium exceeds a critical concentration in the kidney, the tubule cells become damaged and renal function impaired. Renal cadmium accumulation also affects vitamin D metabolism, which causes disturbances in calcium balance and can decrease the mineral content of bone resulting in osteoporosis and osteomalacia.

Cadmium has been classified by the International Agency for the Research on Cancer (IARC) as a category 1 carcinogen. There is sufficient evidence that inhalation of cadmium increases the risk of lung cancer. There is weaker evidence of an association with other cancers. Cadmium exposure may result in damage to genetic material particularly at the level of the chromosome and this genotoxicity is expected to underlie the tumour formation. Other effects of cadmium, including toxicity to the respiratory tract and neurotoxicity, may be elicited at exposures above those causing renal and bone effects (Environment Agency, 2009).

"Other effects of cadmium, including toxicity to the respiratory tract and neurotoxicity, may be elicited at exposures above those causing renal and bone effects..."

An inhalation Tolerable Daily Intake (TDI_{inh}) of 0.0014 µg/kg^{-1} bodyweight (bw) day^{-1} (1.4 ng kg^{-1} bw day^{-1}) has been derived to protect against kidney toxicity. An adult inhalation Mean Daily Intake (MDI_{inh}) from ambient air is approximately 0.02 µg day^{-1}. Exposure at the TDI_{inh} poses minimal risk of lung cancer. The original inhalation Index Dose (ID_{inh}) recommended in the 2002 TOX report was removed because of the mechanisms of genotoxicity believed to underlie the observed cancers.

An oral Tolerable Daily Intake (TDI_{oral}) of 0.36 µg kg^{-1} bw day^{-1} (360ng kg^{-1} bw day^{-1}) is recommended, also to protect against kidney toxicity. The adult oral Mean Daily Intake (MDI_{oral}) of cadmium from its presence in food and drinking water is estimated at 13.4 µg day^{-1} (Environment Agency, 2009). The effects of dermal exposure to cadmium are not expected to be significant in view of its limited absorption across the skin. A conservative assessment of dermal exposure can

Following an extensive literature review, other widely adopted assessment criteria have, however, applied an Index Dose for inhalation exposure to reflect non-threshold behaviour of cadmium. Accordingly no inhalation MDI has been derived on this basis.

Land Use	Soil Guideline Value (mg/kg dry weight) 1,2,3,4
	Cadmium
Residential	10
Allotment	1.8
Commercial	230

1 Figures are rounded to one or two significant figures
2 Based on a sandy loam soil with 6% SOM
3 Based on lifetime exposure via oral, dermal and inhalation pathways.
4 In applying the rules for non-soil background Average Daily Exposure (ADE) is limited to being no larger than the contribution from the relevant soil ADE.

Soil Guideline Values

Soil Guideline Values (SGVs) for cadmium are presented according to generic SR3 land uses in the Environment Agency Report SC050021/ Cadmium SGV

Lifetime averaging has been assumed by the Environment Agency for the derivation of the SGV for residential and allotment land uses. This is justified on the basis that the critical toxicological effect is based on body burden of cadmium built up over a lifetime (0 to 75 year old).

"Consumption of homegrown produce and attached soil makes the biggest contribution to total exposure for the residential and allotment land use."

The Environment Agency conclude consumption of homegrown produce and attached soil makes the biggest contribution to total exposure for the residential and allotment land use. Soil ingestion makes the greatest contribution to total exposure for the commercial land use scenario and is one of the risk driving pathways. Inhalation of indoor dust makes a negligible contribution to total exposure but is an important risk driver for commercial land use. Background exposure is a significant contributor to total exposure for all land use scenarios (Environment Agency, 2009).

The Environment Agency's Supplementary information report for cadmium summarises available literature on contaminant specific soil to plant concentration factors. It concludes that, although soil pH influences the availability of cadmium in soil and plant uptake, there is insufficient data in the literature to robustly quantify this relationship.

Analysis

Cadmium 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 0.1 µg/1 and 0.02 mg/kg for soils.

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GEOTECHNICAL LABORATORY'S GUIDE TO AGS DATA – PART I

Dr Roger Chandler, Managing Director of Keynetix and member of the AGS Data Management committee talks to theGeotechnica once again. This month, Roger delivers a 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

"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."

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 if the requirements are clearly thought out at the start of a project.

This article highlights the two most common problems and details the best way laboratories can benefit from AGS data.

The data contained within an AGS file generated by a laboratory can be split into two broad categories; sample data and test data.

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.

The test data are the results that the laboratory has produced from the tests carried out. Each set of test parameters is linked back to the source sample, using 4 reference parameters; Location ID, Top Depth, Type and Reference Number. If more than one test has been carried out on a sample then a unique specimen number and/or depth are assigned to each test to make it uniquely identifiable. The two biggest AGS related problems that laboratories have are:

- Maintaining the clients sample reference data
- Developing a system that enables the lab to produce AGS 3 or AGS 4 data from a project without re-keying the test data.

Part I of this article will deal with the first of these problems. A Part II of this article will address the second problem.

Sample References

The biggest single cause for AGS data disputes between consultants and laboratories is that the returned test data references samples that do not

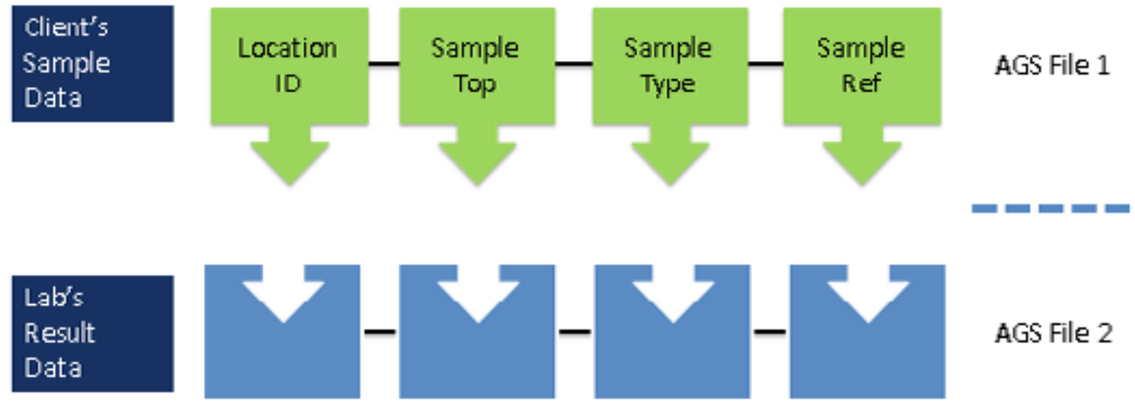
"This is caused either by the laboratory incorrectly entering and storing the client's data or the client changing the reference data after they have supplied it to the laboratory."

exist in the client's data. This is caused either by the laboratory incorrectly entering and storing the client's data or the client changing the reference data after they have supplied it to the laboratory.

The laboratory's job is therefore to ensure that it does not change the client's references. Further, if the client changes the references the laboratory can prove without doubt that the problem lies with them and not the data produced.

"The secret to avoiding both of the above scenarios is to get the sample data from your client in an electronic format, preferably in AGS format."

The secret to avoiding both of the above scenarios is to get the sample data from your client in an electronic format, preferably in AGS format.



The majority of customers who ask for AGS as a deliverable will be able to produce their sample and location data in AGS data format when they schedule their testing. I always say to laboratory managers "If they ask for AGS data then you ask for AGS data at the start of the project".

"Once you have the AGS data it is important that you keep a copy of the file to send back to them."

Once you have the AGS data it is important that you keep a copy of the file to send back to them. Let me repeat that- you are going to send the very same file back to them at the end of the project!

The next step is to produce your test data in AGS format, but do not include the location and sample tables in your exported AGS file. If your software does not allow you to exclude this information you can delete the SAMP and HOLE table from the file using a text editor. (Note in AGS 4 format the HOLE data is stored in LOCA table).

You now have two AGS files, one with the sample data in it and one with the test data in it. You then run these files through an AGS checker together as one

"There are a couple of free AGS checkers available and these are listed on the AGS website..."

submission. There are a couple of free AGS checkers available and these are listed on the AGS website, but one that allows you to check multiple files together is KeyAGS.

If the AGS checker finds errors with the sample referencing between the files then the laboratory has entered the data incorrectly and these errors will need to be fixed before you submit the data to your client. If there are no errors with the data then you can send both files to the client and know that if they come back with sample referencing problems in the file then these problems were caused by the client . You will know this for a fact as you sent them their own file back in exactly the same format they sent it to you.

Getting sample data in electronic format.

Not all of the laboratory's clients will be able to provide AGS sample data. However it is still possible for the laboratory to benefit internally by using the AGS format with these clients.

There are tools available, such as KeyAGS Professional, that will create AGS data from a spreadsheet and this allows the laboratory to send out a schedule spreadsheet that is set up to work with KeyAGS and ask the client to complete their scheduling by filling in this spreadsheet. Once complete, this spreadsheet can easily be converted to AGS data once it has been received by the laboratory.

"The data can then be imported into an AGS compatible laboratory management system, such as KeyLAB, without having to rekey the data."

The data can then be imported into an AGS compatible laboratory management system, such as KeyLAB, without having to rekey the data. This saves the laboratory a lot of administration time and reduces the errors from re-keying the client's data.

"Electronic Scheduling has been introduced in AGS 4 and so it is now possible to get the client to do all your scheduling for you using a simple spreadsheet."

Electronic Scheduling has been introduced in AGS 4 and so it is now possible to get the client to do all your scheduling for you using a simple spreadsheet. This allows the laboratory manager to import the samples and the client's testing requirements within a few minutes no matter how large the project. In some laboratories this single improvement in data handling will save them around a man year of time each year.

Benefits for the Laboratory

AGS data is often seen as a hassle and costly request from a client. However if the laboratory focuses on the benefits that AGS data can provide the laboratory at the start of a project then it can save them a large amount of time in setting up projects by getting their client to do the data entry for them.

"If the simple procedure, outlined in this article, is also followed then the laboratory should never be involved with sample referencing disputes with their clients."

If the simple procedure, outlined in this article, is also followed then the laboratory should never be involved with sample referencing disputes with their clients.

All that is left to do is to ensure that test results can easily be converted to AGS data at the end of the testing stage and I will cover this part of the process in my next article.

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

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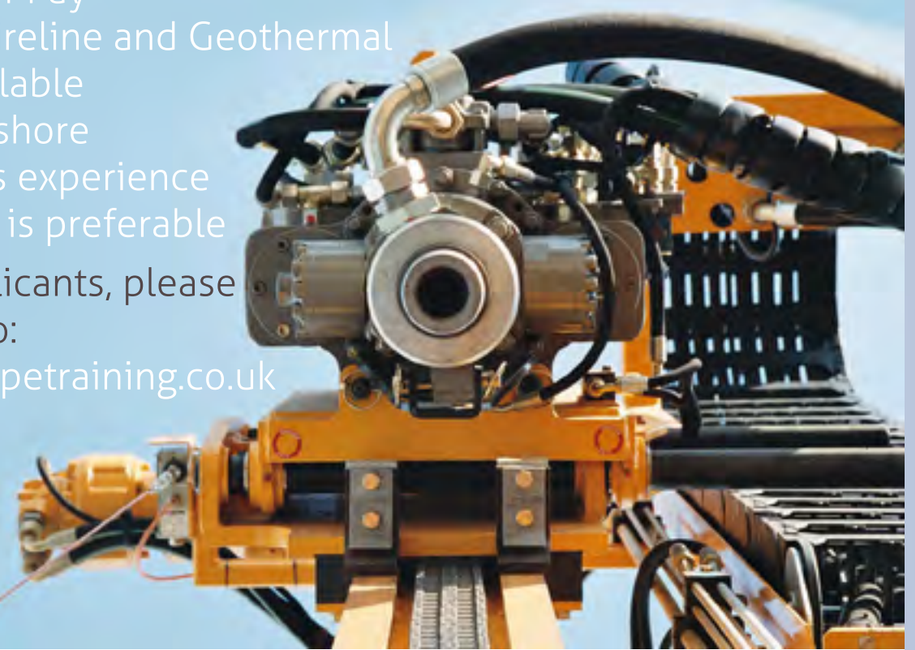

geotechnical

Geotechnical Engineering Ltd is a long-established ground investigation specialist, employing some 125 people from its base in Gloucester. We have our own drilling rigs and drillers, laboratory and field technicians, geotechnical and geo-environmental engineers. We offer a full range of services to a wide variety of Clients throughout the UK.

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