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inside this edition...

Geotechnica 2011

the review of this year's show...

also included...

- an insight into corporate manslaughter
- an update on Eurocode and SPT calibrations
- guidance on climbing cable percussion rigs

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issue no. 3
august 2011

an introduction

Welcome to the August edition of **theGeotechnica.** This is our third issue and as in previous issues it is packed with important, relevant and interesting articles giving practical advice and guidance for geotechnical and drilling practitioners.

July was a busy month for the Equipe Group, with our geotechnical trade show and exhibition, Geotechnica, taking place. This year's show was very well received with some great reviews from attendees and exhibitors alike. A great big thank you to everyone who supported the event to make it the success it was., especially our sponsors: Geotechnical Engineering, Geotechnical Observations, Drillwell, Muovitech, DuraDeck, Rockbit UK and Atlas Copco.

The speaker programme was particularly pleasing, this year, both in terms of technical excellence and thought provoking content. Over the coming months, **theGeotechnica** will be featuring articles inspired by the speaker's outstanding presentations.

The first of the series to be featured comes from Neil Smith, and can be found in this month's Training section. The article includes a recount of a sobering incident which whilst being horrific could have been much worse. Neil goes on to provide some philosophical guidance and highlights the need for continued professional development so that individuals are sufficiently informed to make the right decisions.

This month's Geotechnical section features a sobering article from solicitor Natalie Puce. Natalie's contribution, providing a legal perspective on Corporate Manslaughter, is as a result of a tragic incident and goes to remind us all of our responsibilities.

Also in this months issue there is an article from Hazel Davidson of ALcontrol tackling the subject of deviating or nonconforming samples taken for chemical testing. Hazel provides some practical advice on how to deal with such issues.

In the Drilling section we have an article looking at climbing the mast of rigs and the implications of working from height. In the Eurocode section we have an article on the measurement of the energy ratio of SPT hammers in accordance with BS EN ISO 22476-3:2005.

If you want to make a contribution of an article to **theGeotechnica** just send it to magazine@geotechnica.co.uk and provided it's content is applicable and not defamatory or blatant advertising we will publish your article.

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geotechnical

contents

The following is an article from Natalie Puce, a solicitor at Berrymans Lace Mawer, providing a lawyers take on corporate manslaughter. Although the Corporate Manslaughter and Corporate Homicide Act 2007 came into force in 2008, it can be said that the industry is still failing to take proper and thorough precautions to prevent a repeat occurrence in 2011. Appropriate and relevant training is still being passed up in favour of 'experience' – something which does not stand up in a court of law.

Here, Natalie Puce outlines the seriousness of the issue for the readers of **theGeotechnica.**

Cotswold Geotechnical Holdings convicted of first corporate manslaughter charge

The Corporate Manslaughter and Corporate Homicide Act 2007 came into force in April 2008 and just under three years later, Cotswold Geotechnical Holdings (CGH) is the first company to be convicted of the offence.

The case follows the death of a 27-year-old geologist, Alex Wright, who was an employee of the company. On 5 September 2008 he was working alone investigating soil conditions in a 3.5 metre deep trench when it collapsed and killed him. The company's director, Peter Eaton, had been on site during the day but had left shortly before the incident.

"The industry codes of practice prohibit entry into an excavation of more than 1.2 metres deep because of the risk of the pit collapsing."

The industry codes of practice prohibit entry into an excavation of more than 1.2 metres deep because of the risk of the pit collapsing. CGH's own health and safety document adopted this guidance.

At the trial, the prosecution alleged that the substantial cause of death was the failure of the company to manage its affairs so as to comply with its legal duty to ensure that Alex Wright's health was not put at risk. However, it is reported that Mr Eaton said geologists use their judgment to determine whether it is safe to enter a pit.

Under the Corporate Manslaughter and Corporate Homicide Act 2007 an organisation is guilty of corporate manslaughter if the way in which its activities are managed or organised causes a death, and amounts to a gross breach of a duty of care to the person who died. A substantial part of the breach must have been in the way activities were organised by senior management.

"The jury found the company guilty of the offence and the judge imposed a fine of £385,000."

The jury found the company guilty of the offence and the judge imposed a fine of £385,000. Mr Justice Field acknowledged that the level of fine may put the company into liquidation but stated that whilst such an outcome would be unfortunate it is unavoidable and a consequence of such a serious breach.

An appeal was lodged over the conviction and the level of fine which represented 250% of the company's turnover. Both the conviction and fine were upheld.

The purpose of the Act was to ensure that large and medium-sized companies could not escape prosecution due to the inability to identify a 'directing mind' of the company (ie, a senior individual who could be said to embody the company in his actions and decisions) who was also guilty of the offence.

However, CGH was a small company with only eight employees at the time of the incident and Mr Eaton was in overall control of the way that the company managed its affairs. As such, Mr Eaton was an easily identifiable 'directing mind' and the case does not provide any guidance as to how the Act will apply to large and medium-sized companies with a more complex management chain, who were the impetus for it in the first place.

What is perhaps more interesting in this particular case is the level of fine which was imposed. Although less than the sentencing council's guidelines which were issued in 2010, and which stated that fines would start at around £500,000, the fine imposed has the potential to put CGH out of business. In the past, courts have taken on board a company's ability to pay a fine when considering the appropriate penalty. However, now it seems

"...where there has been a serious breach, a company may have to face the possibility of a fine so large as to put it out of business."

that where there has been a serious breach, a company may have to face the possibility of a fine so large as to put it out of business.

Natalie Puce
Solicitor
Berrymans Lace Mawer, Manchester

Editorial Note:

Not withstanding the potential financial penalty, this case is a sobering reminder to us all of our responsibilities for tasks which many of us take as every day. It has always been the case that geologists and engineers have carried out trial pitting exercises alone, with just an excavator driver on site remote from the office. The driver probably has never dug pits to obtain samples and is often unaware of the dangers which may result from the exercise.

"Often familiarity results in complacency..."

Often familiarity results in complacency - the engineer forgets that a cubic metre of soil weighs 2 tonnes, a pit 3m long,1m wide and 3m depth will produce spoil which weighs 18 tonnes, which is often stockpiled adjacent to the pit along one of the sides which are most prone to collapse. The spoil becomes a surcharge to an unsupported face.

Many will argue that they produce risk assessments which will highlight the hazards associated with the digging of trial pits, however, how many of these risk assessments are generic, brought out whenever the specification indicates that pits need to be dug. This approach can nurture complacency. It is important that lessons are learnt and we take our responsibilities seriously and do not assign commonplace activities to the insignificant.

How many risk assessments for trial pitting are site specific? Do your risk assessments consider the risk of:

- Sloping ground?
- Relic landslips?
- Soil type?
- Potential ground water level?
- Weather conditions – in particular heavy rainfall either prior to or during pitting
- Working alone?
- Inexperienced machine driver?

Do you consider a working method to decide where spoil is placed? A set of hand signals so the driver can understand what the engineer requires and how and where the engineer should be positioned during the

Potential danger: Trial Pit.

pitting operations? It is hoped that every risk assessment will give due cognisance to the location of services and other underground obstructions.

All of these risks, and more, should be considered and discussed with the site engineer. It is essential that any uncertainty or lack of understanding is indentified

"Do not assume that because the engineer has been working for several years that he or she will know what to do."

prior to commencement of the work. Do not assume that because the engineer has been working for several years that he or she will know what to do. Certainly they are more likely to have greater experience to one who has fewer years in the geotechnical industry, but length of service is not an indicator of experience - often it may just lead to complacency. It is the employer's responsibility to ensure that the workforce is properly trained and aware of the situation in which they will be expected to work. That situation must be safe.

"It is the employer's responsibility to ensure that the workforce is properly trained..."

Trial pitting is just one exercise undertaken by engineers and drillers in the field, the same level of scrutiny should be carried out for each activity undertaken. None of us want to be in the position described by Natalie Puce. We as an industry must learn from the mistakes of others and it is important that we talk about our errors and enable others to learn from them, because none of us would wish tragedy upon our friends, colleagues and competitors. Let us hope that this case will give impetus to development in our attitude towards risk. ■

eurocode

In July 2007 the European Standard covering the standard penetration test (SPT) BS EN ISO 22476-3 : 2005 was fully implemented into UK practice and for the first time required energy measurements to be carried out. Julian Lovell and Peter Reading from Equipe and Dr John Powell from Geolabs discuss the preliminary findings of the energy measurement testing and how the tests can help to improve the quality of the data.

The new standard is very similar in general terms to the old BS1377 Part 9 : 1990 but requires that the energy ratio (Er value) be measured for the hammer when the measured penetration resistance (N value) is going to be used for the quantitative evaluation of foundations or for the comparison of results. The Standard requires that a certificate of calibration of the Er value be available and provides a recommended method for determining the energy ratio and reporting the results. In addition to the requirements for determining the energy ratio, the standard also provides details of the SPT equipment, test procedure, test results and reporting. The majority of these have been previously discussed by Hepton and Gosling (2008) and this paper focuses on the measurement of the energy ratio, the results and additional criteria which can be further used to determine best practice and quality assurance for the SPT test. Although, this paper focuses on BS EN ISO 22476-3, it should be noted that the British Standard covering Dynamic Sampling, BS EN ISO 22476-2 : 2005 was implemented at the same time and also requires energy ratios for that equipment to be determined.

"...the standard also provides details of the SPT equipment, test procedure, test results and reporting."

It has only been since late 2008 that an instrument to measure the energy ratio which fully complies with the requirements in the British Standards has been available in the UK. This development has enabled an extensive number of energy ratio tests to be carried out on SPT hammers, automatic hammers and dynamic sampling drop weights typically used in the UK. Whilst these tests are conducted, additional measurements have been made of drop height, drop weight and observations of the general condition of each test hammer and test equipment. This is the first time that such a comprehensive study of the UK SPT test equipment has been made. The results of these observations are maintained in The Drilling Academy™ database which provides a unique and invaluable set of data and has been used in this paper to examine the energy ratio measurements, their implications and other variables which can influence energy loss and variations in the energy ratio.

The majority of design calculations have previously used N values direct from the field and then compared these un-normalised results with similar uncorrected published results and correlations available in the technical literature. As several different types of SPT test equipment are used to conduct the tests their varying efficiencies influence the penetration resistance, N value. Researchers and practitioners have therefore recommended that the measured energy transferred to the rod should be normalised to 60% of the theoretical potential energy, N60.

Furthermore, Eurocode design procedures now require partial factors of safety to be used which in turn requires better understanding and reliance of the original data. The Standard also provides examples of some possible methods for calculating normalised N values using correction factors and although these formulae are only provided for tests within sands the significant point is the use of N60.

General Construction of the SPT Equipment

Amongst the hammers tested, there is a significant range in terms of types of hammer and their construction. Clayton et al (1982) stated that "since the SPT is an empirical test it is important to follow the original method closely". Indeed, not only should the method be examined but also the design of the equipment.

The early test methods described a standardised weight of 140lbs falling through 30ins which subsequently became today's standard weight of 63.5kg falling through 760mm. It is apparent that the current SPT and the equipment design have advanced little. Most hammers are manufactured to this standard specification which in general complies with the requirements of the British Standard relevant at the time of manufacture.

"It is apparent that the current SPT and the equipment design have advanced little."

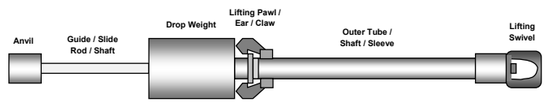


Figure 1. Typical SPT hammer construction.

Three types of SPT hammer have been investigated in this study. The first and most common of those studied, uses the winch rope on the rig and a two claw/pawl latching mechanism, to lift the weight (Figure 1) (hammers with three claws have also been tested). The SPT hammer drop weight is automatically tripped when the pawls reach a raised section on the guide rod which moves the pawls outwards thus releasing the weight. The distance from the anvil to the raised section is the drop height (760mm ± 10mm in the Standard).

The second main type of SPT equipment tested comprised chain driven drop weights. This is the standard mechanism used on dynamic sampling rigs where the drop weight is lifted by means of a moving chain with an integral latch that allows the weight to be picked up. The weight is lifted up one or two guide rods and when the weight reaches the top of its travel it is released from the latch. As the test is carried out the sliding carriage carrying the drop weight follows the weight down. The third type of SPT equipment is a new type of hammer, developed by Geotechnical Engineering Limited, which is also chain driven but after each blow the carriage is automatically lifted from the drop weight ensuring that only the weight of the hammer performs the test. For the purposes of this paper this type of SPT hammer has been called an Automatic Hammer.

"The construction and engineering of the rods, sleeve, claws etc can be completed using standard measurements..."

The construction and engineering of the rods, sleeve, claws etc can be completed using standard measurements, however, the construction of a pre-determined weight from a cylindrical steel mass is less straight forward. The majority of test equipment manufacturers were consulted to determine how the drop weight was engineered and checked prior to use and in most cases, as the material density is known and rarely changes, the weights are engineered using pre-determined dimensions (diameter and length). Although, the dimensions are checked whilst machining, it is not typical for these weights to be physically weighed before the SPT hammer is assembled and despatched to the user, this would appear somewhat surprising particularly when the weight has been a prerequisite in both the old and new standards.

Test Equipment Checks

The Standard, as with previous British Standards, requires checks of the test equipment to be carried out including the hammer condition. The Standard is a little unclear on frequency but does suggest that visual equipment inspections are carried out after every 20 tests. These checks are to include the straightness of the shaft and the proper functioning of the hammer and trip mechanism.

Checks of the test equipment and hammer condition should also comprise measuring the drive weight as-

sembly to ensure compliance. Hepton and Gosling : 2008 : provide a table comparing test equipment specifications required in BS EN ISO 22476-3 : 2005 and BS 1377 - Part 9 : 1990. The specification for the drive weight assembly is tabulated below. Of particular note is the stricter tolerance for the drop height in the new Standard, this will result in some hammers that were previously within the old tolerences now being non-compliant.

Drive Weight Assembly	*BS EN ISO 22476-3 : 2005*	*BS 1377 – Part 9 : 1990*
Overall Mass	*≤115 kg*	*≤115 kg*
Hammer Mass	*63.5 ± 0.5 kg*	*63.5 ± 0.5 kg*
Drop Height	*760 ± 10 mm*	*760 ± 20 mm*
Drive Head (Anvil Mass)	*Unspecified*	*15 to 20 kg*

Table 1. Comparison of the specification requirements of the drive weight assembly.

The results presented here from The Drilling Academy™ database suggest that up to 47% of SPT hammers were non-compliant on drop weight and 19% were non-compliant on drop height. It should be noted that with respect to drop height, less than 1% of these hammers would have been non-compliant to the old British Standard. The drop weight was measured using a spring balance but it is recognised that this method may introduce errors due to the shape and nature of the weights and assembly. A more accurate method would be to strip the equipment apart and to weigh it on scales but this method was not practical at the time of this work. Even taking into account the method of measurement of the mass of the drop weight, it is suggested that a number of SPT hammers will still be non-compliant due to the method of manufacture.

The fact that the test equipment has been subjected to scrutiny during the energy ratio measurement process has resulted in the cleaning and replacement of defective parts such as the pawls on the trip mechanism. It is imperative that this should be part of a normal routine maintenance schedule, however, unless such operations are policed there is a tendency to ig-

"It is the responsibility of the qualified operator to ensure that the SPT equipment is in good condition..."

nore these requirements. It is the responsibility of the qualified operator (the Lead Driller or Supervisor) to ensure that the SPT equipment is in good condition, can be operated correctly and is in accordance with the Standard. Prior to testing simple checks along with improved maintenance regimes will ensure only compliant hammers are used. The ethos of Eurocode also requires that the Responsible Expert and the Enterprise have responsibilities to ensure that the equipment used is compliant and operated by a competent person.
(The role of the qualified operator is defined in CEN ISO/TS 22475-2).

Measurement of Energy Method

The test as described in BS EN ISO 22476-3 : 2005 Annex B describes how the actual energy should be measured and the energy ratio calculated. This requires measurement of the acceleration and strain imparted to the rod immediately below the hammer anvil from single blows of the hammer weight. The Annex also gives details of the measuring criteria necessary and critically it prescribes that the precision of the accelerometers and strain gauges should be better than 2% of the measured value.

The force transmitted to the rods is given by:

$$F(t) = A_a \times E_a \times \varepsilon_m(t)$$

Where:

ε_m is the measured axial strain of the instrumented rod at time t
A_a is the cross-sectional area of the instrumented rod
E_a is the Young's modulus of the instrumented rod
The particle velocity of the measurement section is calculated by the integration of the acceleration (a(t)) with respect to time t.

The energy passing into the drive rod is obtained from integration of the Force and velocity with time and so in the interval of time from 0 to t' the energy, $E(t')$ is given by:

$$E(t') = \int_0^{t'} F(t)v(t)dt$$

The hammer energy is then expressed as:

$$E_{meas} = \frac{1}{n} \sum_1^n E$$

Where n is the number of blows used to provide the mean value.

Energy Ratio (E_r) Measurements

The energy ratio is the actual energy measured (E_{meas}) upon initial impact of the hammer compared to the theoretical energy (E_{theor}) and is expressed as a percentage.

$$E_r = \frac{E_{meas}}{E_{theor}} < 100\%$$

For a totally compliant SPT hammer the theoretical energy would be:

$$E_{theor} = m \times g \times h = 63.5\,kg \times 9.8\,m/s/s \times 0.760\,m = 473\,J$$

where: m = the mass of the hammer,
g = acceleration due to gravity
h = drop height

A totally compliant free falling frictionless hammer would have an energy ratio of 100%, however, Clayton (1995) and the new British Standard discuss many variables which can lead to energy loss.

Figure 2 presents results of all energy ratios determined for hammers available in The Drilling Academy™ database and includes both old and new equipment and both compliant and non-compliant equipment. The energy ratios represent the averaged values determined from a minimum of ten determinations for each of the tested hammers plotted against Fmax (Fmax is a function of the work done). Due to the variety of equipment tested and the variables which influence the energy ratio, which are discussed below, it is not surprising the results show a wide scatter. However, the results do indicate that dynamic sampling drop weights and SPT hammers provide similar ranges in energy ratios indicating that both types of equipment should provide comparable SPT N values.

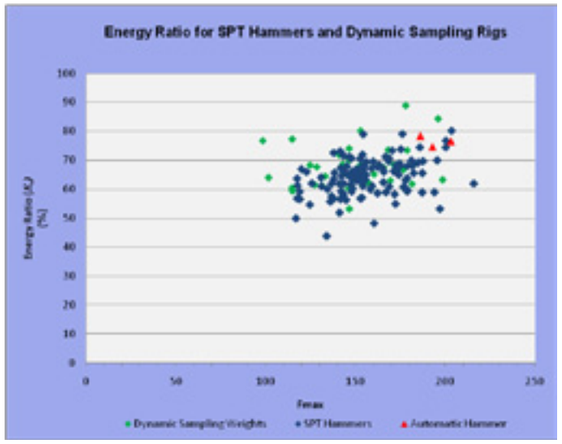


Figure 2. Energy Ratio for SPT Hammers and Dynamic Sampling Drop Weights.

Clayton (1995) reported a measured energy ratio for a UK SPT hammer of 73%. The Drilling Academy™ database reports measured energy ratios ranging from 43% to 81% for SPT hammers and from 53% to 89% for dynamic sampling rigs. The Standard does not specify what an acceptable energy ratio is but only requires that it has to be measured and reported on a calibration certificate. The result should then be applied to normalise all the penetration resistance values along with other corrections used to obtain penetration resistance values for use in design.

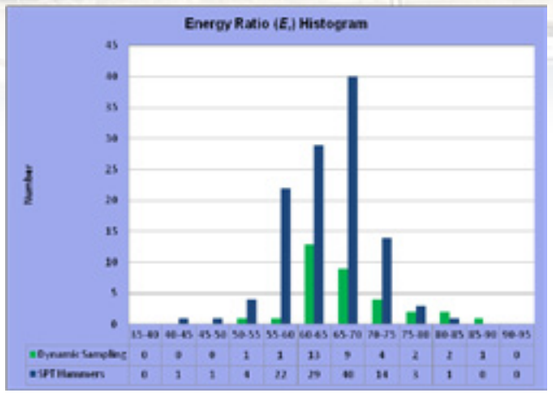


Figure 3. Energy Ratio Histogram.

Figure 3 indicates that the majority of dynamic sampling drop weights have energy ratios between 60 and 70% whereas SPT hammers have energy ratios between 55 and 75%. Therefore, it is more likely for SPT hammers to achieve higher energy ratios but the results are likely to be less consistent than those achieved for dynamic sampling test equipment. A simplistic reason for this could be that SPTs carried out using dynamic sampling equipment are more automated and therefore less influenced by the operator.

In addition, many SPT hammers are relatively old, some over 30 years old, and have undergone repair often by the operator rather than being reconditioned by the original manufacture and this is likely to introduce additional variables to the test equipment which affects potential energy loss.

Energy Losses

The variables in energy losses have been discussed by Clayton (1995) and are also mentioned in BS EN ISO 22476-3: 2005 and are assigned to frictional and other 'parasitic' effects. The potential losses of energy are listed as those originated by the impact on the anvil, depending upon its mass and other characteristics, the type of machine and skill of the operator.

Analysis of the initial results obtained by The Drilling Academy™, have indicated that more specifically the following variables can adversely affect the measured energy ratio; drop height, drop weight, bent slide rod or sleeve, verticality of the test (wobbling rods/uneven drop of the weight), poor condition of the trip mechanism, grease/dirt/rust on the slide rod or within the sleeve, poor contact at joints (worn threads/belled shoulders/incompatible thread types), type, quality, number and size of rod subs, worn or broken release pawls/ears, poor winch control and speed of testing.

The latter issue of the speed at which the test is carried out relates to the approach of the operator towards the test and often reflects that on most contracts the test is paid for on a number basis and not time related. It is also suggested that often the operator is unaware of the significance of the result and its ultimate use. The speed of testing in relation to dynamic sampling rigs also means the speed of the rig engine as this will determine the speed of the lifting mechanism which has been proven to influence the actual drop height of the weight. High engine speeds will typically increase drop heights and, therefore, care should be taken to adjust the engine speed for a test to achieve a compliant drop height.

From the tests carried out thus far it is clear that the energy ratio value is of little use if the test is not performed in a controlled manner. Furthermore, the actual energy ratio should not be viewed in isolation as other plots, in particular the plot of energy ratio per blow, can provide significant information about the hammer condition and/or quality of the test.

The plot of energy ratio for an energy ratio test carried out for a newly manufactured SPT hammer is presented in Figure 4.1 and shows a tight cluster of results. This should be compared to Figure 4.2 which shows a much wider scatter provided from an older under used SPT hammer which was described by the energy ratio test operator as being rusty. These plots provide valuable information directly relating to the reliability of the data and it should be expected that an N value obtained from the new hammer should be more repeatable than those obtained from the 'rusty' hammer. It should also be noted that as the Standard requires the energy ratio to be calculated as an average of a number of blows, these hammers could provide similar energy ratios. Only from directly supervising the test or from comparing these plots, which are not required by the Standard, can a Designer determine reliability of the data which suggests a weakness in the Standard.

Plots which also show a wide scatter of data can often be attributed to the energy loss factors described above and a qualified energy ratio test operator can differentiate them. Plots which show tight clusters of results are typically obtained from dynamic sampling rigs but have also been obtained from the Automatic Hammer (Figure 4.3).

Figure 4.4 shows the influence of a test which includes a blow where the weight is released early due to a poor trip mechanism. This result shows a single result (blow 6) which is 10% below the main cluster of results. In other tests the energy ratio for a partially dropped blow can provide energy ratio values as low as 12%. The significance to the average energy ratio, of these low and spurious values depends upon the operator and if they are used in the calculation or ignored. The significance of single spurious blows relating to the N value is unknown but it is likely to be low. However, it does highlight that maintenance is required on the test equipment prior to commencing the next test.

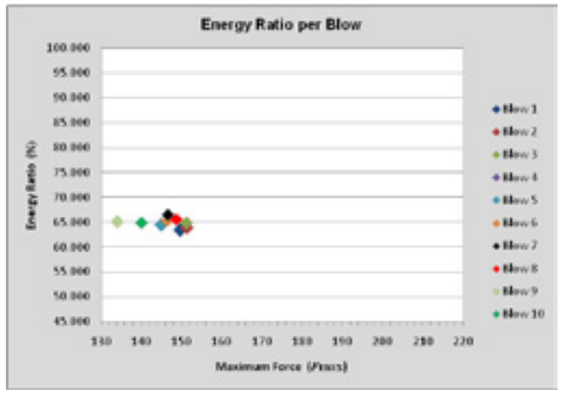


Figure 4.1 Energy ratio values for a new SPT hammer

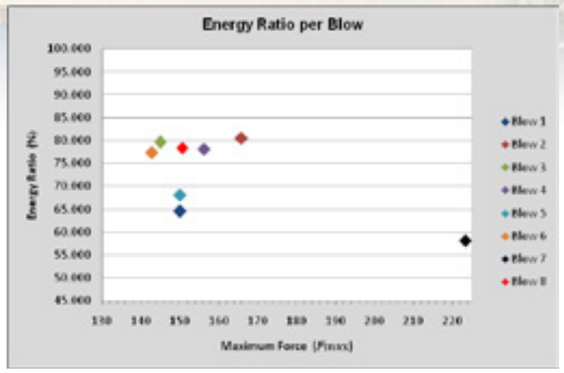


Figure 4.2 Energy ratio values for an under used rusty SPT hammer

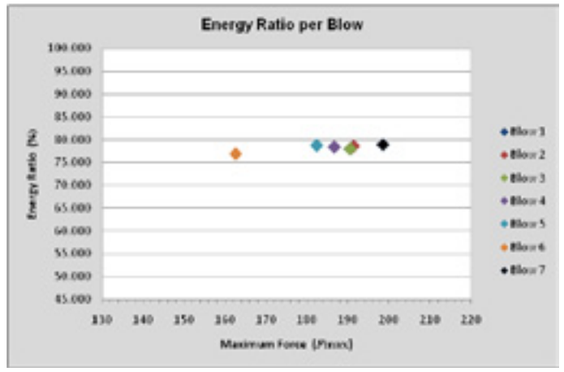


Figure 4.3 Energy ratio plot for the Automatic Hammer.

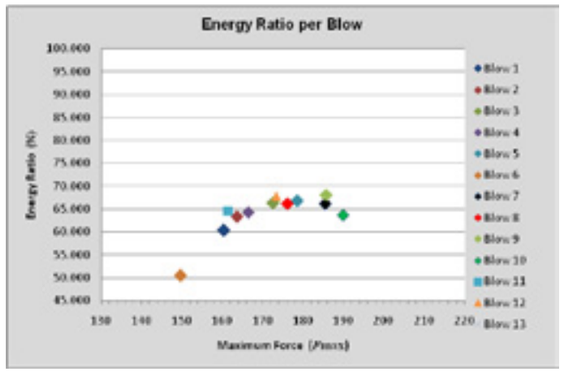


Figure 4.4 Plot showing the influence of a partial drop (Blow 6).

Test Methodology

Although, the Standard provides details on test execution it gives little guidance relating to the physical parameters and set up of the test. Based on the au-

"... it is recommended here that the qualified test operator (Lead Driller) should replace any broken, bent or worn parts of the equipment..."

thors' observations it is recommended here that the qualified test operator (Lead Driller) should replace any broken, bent or worn parts of the equipment, use centralisers or rod guides to ensure verticality, ensure that the latching mechanisms are fully functional and lifting vertically as well as releasing from the correct drop height, ensure that the equipment is clean and free from rust, dirt or grease, tighten up all of the joints and avoid the use of subs below the anvil. It is also imperative that the qualified test operator is trained and conversant with the test method and variables that can result in energy losses. The qualified operator must then ensure that the test is carried out carefully and in a controlled manner using well maintained equipment.

Comparisons of Results

The range in energy ratios will have a significant effect on the resulting corrected N value when correction factors are applied. As discussed previously, the Standard indicates that for general design and comparison purposes in sands, the N value should be adjusted to a reference energy ratio of 60%, by the following equation:

$$N_{60} = {}^{E_r}/_{60}\, N$$

where N is the blow count and E_r is the energy ratio of the specific test equipment.


Mid-flow: An SPT Calibration.

Therefore, to provide some perspective, consider two SPT hammers; Hammer 1 has an energy ratio of 43% and Hammer 2 an energy ratio of 80%. In the same strata, Hammer 1 would give an uncorrected penetration resistance of 34 whilst Hammer 2 would give an uncorrected penetration resistance of 18. Applying a correction to these values based on their measured energy ratio would give a penetration resistance of 25 for both tests.

BS EN ISO 22476 Part 3 : 2005 edicts that calibrations, which include the determination of the energy ratio for SPT trip hammers and drop weights, should be carried every 6 months. It also clearly states that a retest is required should the hammer be damaged or parts replaced. Although the Standard discusses a certificate of calibration, the test result, unlike typical calibrations, is an average value from a series of blows (minimum 5) which should be repeatable. The repeatability of the result will, however, be significantly influenced by the variables discussed above and how they are controlled or reduced.

"The scatter of energy ratio results per blow, seen for SPT hammers, is due mainly to friction effects and parasitic effects."

The scatter of energy ratio results per blow, seen for SPT hammers, is due mainly to friction effects and parasitic effects. Both effects can be minimised with better control and maintenance of the test equipment


On site: SPT Calibration.

and a more rigorous test procedure.

The Standard suggests that where several rigs are to work on a project it is of significant value to the Designer to have the energy ratio assessed for each hammer and the equipment checks carried out at the start of the works. In this way variations between SPT results can be taken into account using the calculation provided in the standard to normalise results.

It should be borne in mind that to obtain a meaningful result the test still needs to be carried out in accordance with the method prescribed in the standard by a properly trained and competent Lead Driller or the Qualified Operator (CEN ISO/TS 22475-2:2006). It is essential that the driller understands the test equipment and the importance of ensuring verticality when performing the test.

Conclusion

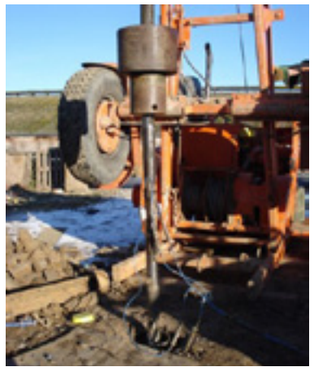
"This current study has shown that the standard penetration test is far from standard."

This current study has shown that the standard penetration test is far from standard. The work has highlighted the variability induced by the test equipment; this can be accentuated by poor operation and poor maintenance. These effects can now be assessed by the regular measurement of the energy ratio.

In order to remove or at least reduce the effect of both frictional and parasitic effects the test needs to be performed in a careful and controlled manner, verticality needs to be assured and connections between the rods and the hammer must be clean and tight to ensure the energy passes cleanly from one rod to another and to the test tool at the base of the borehole. Friction losses and effects of rod type and condition are not considered by this paper but clearly these also need to be considered if a meaningful understanding of the test is to be obtained or additional correction factors applied.

The Drilling Academy™ database can now be used to improve awareness of the potential variability of test results which should lead to an improvement of test techniques, methodology and test equipment. This may then also lead to more efficient test equipment, such as the Automatic Hammer, being designed but should lead to better confidence in the results which is an implicit requirement of Eurocode where reliance on results used for design is imperative to allow factors of safety to be reduced.

If we are to continue to rely on the standard penetration test in design, then the measurement of drive weight assembly (the drop height, hammer weight and overall mass) should be carried out as a matter of course and at regular intervals as should the determination of the energy ratio. Identification marks should be clearly marked on each significant part of the drop weight assembly and all new hammers should be accompanied by drop weight assembly measurements and dimensions as well as a valid certificate of calibration produced


Cable Tool SPT Calibration.

at the time of despatch from the manufacturer.

The database has identified that some SPT equipment produces wide scatters of energy ratio values which should raise concerns regarding the compliance of the equipment, the quality of the data and, therefore, the repeatability and confidence in the final reported energy ratio value and N values. It is recommended that a measure of compliance is applied to the energy ratio values obtained and to this end it is suggested that energy ratio values for tests should be between ± 5% of the reported final energy ratio. Consideration should also be made of the nature of the scatter and these should be analysed by a competent energy ratio test operator. Currently, the standard suggests that SPT equipment can only be designated non-compliant if the dimensions of the equipment fall outside the specification, however, from energy ratio testing there is now empirical data which should provide a further method for measuring compliance and assuring quality of the data being obtained.

Eurocode (CEN ISO/TS 22475 – Parts 3 and 4) dictates that only qualified operators shall carry out field tests and these operators shall be competent, trained and certified. This is equally applicable to the energy ratio testing operatives as well as the Lead Drillers. Designers should also carefully consider that calibrations and equipment checks are being carried out by operatives who have an in depth knowledge of the results obtained and the equipment being used. Adherence to these requirements is considered to be a significant step forward to improving the quality of the SPT and dynamic probing results used for design in the UK.

ACKNOWLEDGEMENTS

The authors would like to thank Equipe Training Limited and The Drilling Academy™ for allowing use of their database, Drillwell Limited for providing new hammers for calibration, Geotechnical Engineering Limited for allowing testing of their Automatic Hammer.

deviating (or non-conforming) samples

environmental

contents

Writing for **theGeotechnica** *for the first time, Hazel Davidson, Technical Marketing Manager of* ALcontrol Laboratories. *Here, Hazel talks about policy changes by UKAS concerning deviating samples.*

A recent policy change by UKAS (the United Kingdom Accreditation Service) will have significant consequences to site sampling staff, with respect to the protocols they need to follow when taking soil or water samples.

UKAS are the accreditation body responsible for auditing laboratories to both ISO 17025 and MCERTS (the Environment Agency's Monitoring Certification Scheme) in the UK, and they participate in the European Accreditation (EA) system concerned with the harmonisation of standards across Europe. A recent policy document, relating to deviating samples, issued by this organisation can be found at:

http://www.european-accreditation.org/content/ea/europNetwork.htm

This document has now caused UKAS to raise a mandatory action for all laboratories to implement this policy with respect to deviating samples. UKAS have now issued their own statement regarding this action:

http://www.ukas.com/media-centre/news/news-archive/2010/Guidance_on_Deviating_Samples.asp

During the last year, UKAS have highlighted this issue to all the laboratories during the annual surveillance audits. In addition to the analytical testing, ISO 17025 covers contract review and communication with the client, and also places significant emphasis on continuous improvement within a laboratory's quality system.

Deviating (or non-conforming) samples are defined as those which may have been compromised in some way during sampling, transportation, storage or analysis, and which may cause the integrity of the data to be questioned. Examples of deviating samples include:

- No separate volatile container supplied.
- Headspace present in volatile or BOD con tainer.
- No preserved bottles supplied .
- Holding time exceeded.
- Temperature exceeded.
- No sampling date supplied (mandatory for MCERTS).
- AQC failed during run and sample cannot be repeated.
- Deviation from method, e.g. limited sample size or matrix issues.

Therefore, in order to comply with UKAS requirements, laboratories will need to include a page in any report where deviating (or non-conforming) samples are included, or to flag these samples in some other way, and also to provide a list of non-conforming samples, including the reason.

"...laboratories will need to include a page in any report where deviating (or non-conforming) samples are included..."

In addition, a small symbol should be added to the actual result box, in the same way the symbols for accreditation are often included. This is to ensure non-conformance is clearly flagged, and cannot be omitted from the final report by simply removing the summary page. The inclusion of this symbol may allow for accreditation to be retained, despite non-conformance of the sample, as the method is accredited, despite the possible compromise to the quality of the sample itself.

When samples are received, an email should be sent to confirm receipt and the scheduled tests, and will also contain details of any non-conforming samples. This will then provide the option for clients to notify the laboratory if they do not want the testing to proceed. If the client still wishes to proceed, then the reports will include the information on non-conformance, as specified above.

FAQs

Will my samples lose accreditation if they exceed temperature?

The MCERTS standard for waters states that 'the sample storage environment shall maintain a temperature of 5 +/- 3oC', and although samples exceeding these limits will be reported as non-conforming, they will not lose their accreditation. Initially, this will only apply to waters requiring MCERTS, as the soils standard does not actually specify a storage temperature.

Which holding times will be used?

For many years, the USEPA holding times were used, but there are now two ISO standards covering soils (BS EN ISO 18512) and waters (BS EN ISO 5667-3), and some parameters have more stringent requirements in these standards. In addition, laboratories may perform stability trials on these parameters, and holding times derived from these trials may be used as an alternative, as long as the data is reviewed and approved by UKAS. This particularly applies to holding times of 24 hours, which are not usually possible, as it generally takes 24 hours for samples to arrive at the laboratory. The holding times used by ALcontrol can be obtained by contacting Customer Services or your Account Manager (see details below).

"... laboratories may perform stability trials on these parameters, and holding times derived from these trials may be used as an alternative..."

When does the holding time start from?

In the two ISO standards, the holding time should commence from the date sampled, but in the laboratory, the holding time is often measured from the date received, as the labs are not always informed of the date sampled.

If my volatile samples are not taken in separate vials/jars will the data lose accreditation?

They will be reported as non-conforming, and may lose accreditation, depending on the circumstances.

Which bottles should I use?

Contact your laboratory for information - ALcontrol supply an illustrated flyer listing the appropriate bottles, or similar information can be obtained from other accredited laboratories. Examples of suitable bottles are included below.

Left:
Organics in waters.

Right:
Inorganics in waters – may include preservatives

Left:
VOCs in waters.

Right:
VOCs in soils.

Should I filter water samples?

Yes, MCERTS for waters states that samples should be filtered at 'point of sampling'.

For further details on deviating samples, contact one of the following:

customerservices@alcontrol.com

Hawarden.sales@alcontrol.com

Tel: *+44 (0) 1244 528700 (ALcontrol Hawarden)*

Geotechnica 2011

The UK's Largest Geotechnical Trade Show and Exhibition

equip[e]

geotechnica 2011

contents

Geotechnica 2011 – "Not quite Glastonbury – but it could be..."

On the 6th and 7th of July, the Equipe Group presented Geotechnica, the marquee event of the drilling and geotechnical industries. Since its inception in 2009, the Trade Show and Exhibition has continued to grow, year on year. This occasion was no exception. With over 70 exhibitors and multiple speakers, the event attracted over 600 visitors, with some coming from as far afield as Italy, Qatar and even the Philippines.

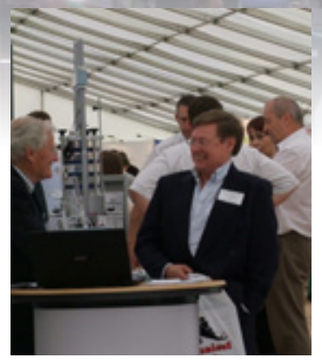
Geotechnica has become a staple event in many leading companies and organisation's diaries over recent years, with exhibitor and visitor numbers continuing to increase with every passing year.

"...feedback from the event has been overwhelmingly positive, not only from exhibitors perspective, but also from the event's visitors and speakers..."

The response and feedback from the event has been overwhelmingly positive, not only from exhibitors perspective, but also from the event's visitors and speakers. During the show, **theGeotechnica** spoke to a multitude of exhibitors such as JKS Boyles, Keynetix, Soil Engineering, as well as event sponsors Drillwell and Geotechnical Engineering.

It became abundantly clear to **theGeotechnica**, that is was the positive, friendly atmosphere created at Geotechnica 2011 that was most pleasing to nearly every single attendee.

Done deal: Successful business at Geotechnica.


Relaxed and friendly.

Keynetix, the UK's leading supplier of geotechnical data management and mapping solutions, have been a regular exhibitor at Geotechnica, starting from the show's inception in 2009. Since then, they have returned every year. Fionn Wardrop, Business Development Manager at Keynetix, was delighted with this year's exhibition, calling it the "ideal industry event ... anyone who is involved in any aspect of site investigation and the geotechnical world should be here...".

Wardrop was keen to point out that the calibre of visitors to his stand were very high, with a "large number of very good leads" coming out of Keynetix's attendance. Gary Morin, Technical Director of the company, fully supported Fionn's sentiments, adding: "... if you're involved in geotechnics and site investigation, and you're not here, then where are you?"

"... if you're involved in geotechnics and site investigation, and you're not here, then where are you?"

In agreement with Fionn and Gary, was Greg Adamson of Geotechnical Engineering, who commented on the "good quality of attendee" at this year's event. For Greg, Geotechnica was an opportunity for Geotechnical Engineering to "consolidate their message", as well as "make some business and grow our company". As event sponsors, Geotechnical are large backers of the event, however, this is only due to the fact that the event provides a valuable opportunity to network and liaise with other companies, building up contacts, as well as creating interest in business. "I walk 5 steps and there's somebody else that wants to talk to me, we've had some good discussions and business has been done."

"On this evidence, it cannot be denied that Geotechnica provides a rare opportunity to create interest and leads to sales that cannot be found elsewhere."

On this evidence, it cannot be denied that Geotechnica provides a rare opportunity to create interest and leads to sales that cannot be found elsewhere. Greg added: "The show is so specific [to the industry] that it is beneficial to a company like us."


Well attended: Geotechnical Symposia.

It was not just the exhibitors that were thoroughly pleased with their experience. Both speakers and audience members alike expressed enjoyment and satisfaction regarding Equipe's two-day-symposium titled 'Engineering Efficiencies for Sustainable Growth'. The symposium focussed on innovation, as well as the increasingly important Eurocodes that are continuing to be implemented throughout the sector. All of the talks were well attended, with a high number of audience members coming to the exhibition purely for the symposium. Professor Quentin Leiper, Group Chief Engineer at Carillion plc as well as a symposium speaker, expressed his enjoyment by revealing that the event presented a "great opportunity to meet with friends, old and new, in geotechnical engineering... and to meet and discuss techniques and ideas."

When asked to describe Geotechnica in as few words as possible, there were a number of immensely positive suggestions: 'unique', 'relevant', 'enjoyable', 'ideal', 'quality', 'beneficial' and 'well worth attending' but to name a few. However, possibly the best quote came from Dr Andrew Ridley, Managing Director of Geotechnical Observations: "Geotechnica: Not quite Glastonbury – but it could be!"

Plans are already in place for next year's Geotechnica, to be held on the 4th and 5th of July, at the Upton Estate Showground once more. Next year promises to build on this year's success, with plans for a more prominent Evening Event to be held on the Wednesday, as well as increased numbers in both exhibitors and visitors.

"... ensure your companies attendance early by signing up today and guarantee your place at Geotechnica 2012, but at 2011's rates..."

Next year's show is beginning to take shape already, with a number of companies already signed up in order to ensure prime position and guaranteed space. With that in mind, ensure your companies attendance early by signing up today and guarantee your place at Geotechnica 2012, but at 2011's rates – for a limited time only.

If you have further feedback on this year's event, please email us with your thoughts, opinions and recommendations for development for the future of Geotechnica at magazine@geotechnica.co.uk. ■


Busy: Over 600 visitors.

drilling

contents

Julian Lovell, AGS Safety Working Group Chairman and Keith Spires of Equipe, a veteran of the drilling industry have reviewed a new document soon to be published by the AGS about the safe climbing of cable percussion rigs. The AGS guidance is currently being finalised and therefore this article represents the views of the authors and not AGS.

The Climbing of Cable Percussion Drilling Rigs

"The dangers of working at height are equally as important when either erecting or dismantling the rig..."

The climbing of cable percussion rigs has been a growing concern for clients for a number of years. The dangers of working at height are equally as important when either erecting or dismantling the rig, freeing a jammed winch rope, feeding a rope over a pulley or to attach a secondary pulley (blocking). There are a number of things that can help to eliminate or reduce the risk of fall injuries and clients and contractors alike should consider implementing the improvements, identified by the industry over the past few years, on all their contracts.

The hierarchy for controlling the risk would ask that we initially consider if we can eliminate the risk and therefore consider removing the need to climb the rig completely. The hierarchy would then suggest that if the latter is not possible then we *reduce* the need to climb the rig, improve the ease of access (should the need arise) and finally provide suitable PPE to prevent the driller from falling should he climb. This article provides some solutions to the problem and also introduces rig modifications which have been made to provide some solutions to reduce the risk.

Can we eliminate the risk?

The fitting of a secondary winch for raising and lowering the rig removes the need for the crew to climb the rig during erection and dismantling of the cable percussive rig. This is supplied to all new Dando rigs but can also be retro-fitted to all cable percussive rigs that have an electrical system fitted, as 12 volt power is needed to operate the winch.

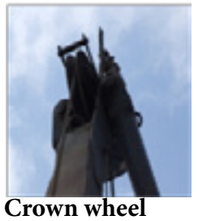
Electric winch raising.

Some high profile contracts are already insisting that a powered access platform is provided in the form of cherry pickers or MEWPs to remove the need to climb at all.

Can we reduce the need to climb?

One of the biggest reasons for climbing the mast was to replace the wire rope on the crown wheel, but there has been some very successful trials of simple additions to the rig to reduce and virtually eliminate this from the drilling operation. The first of these is a simple hoop fitted near to the top of the A frame. The hoop is effective at taking the whip out of the winch rope and keeps the rope aligned with the centre of the pulley wheel. This prevents the rope becoming dislodged and jammed. Care should be taken to ensure the hoop is as small as possible in order to ensure that, should the mast need to be climbed, it does not provided an obstacle when climbing.

Whip prevention loop.



Crown wheel restraints.

The positioning of the additional crown wheel bar restraints at the front of the crown wheel further reduce the opportunity of the wire rope becoming disengaged from the crown wheel recess.

Pre-threaded snatch block.

It is commonly fitted by the manufacturer as standard but is sometimes removed by the driller.

Another reason for climbing the drilling rig, when required to 'block' the casing, can also be removed by some forethought. By attaching a snatch block to the top of the rig prior to erection and pre-threaded with its own 16mm tested slave rope (thimbles both ends) and tied out of the way, you remove the need to climb the erected rig should the need for extra pull be required to extract casing etc. This slave rope and pulley block should be fitted on to structural parts of the rig by the addition of certified eye bolts or anchor points which can be suitably examined and or tested.

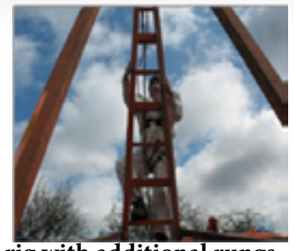
Can we improve the ease of climbing?

Extra 40mm x 40mm square section box section rungs can be welded to the "A" frame to improve the "ladder" effect of the rear. These 'ladder rungs' should have anti-slip surfaces and be a suitable distance apart. Any welding of the ladder sections should be carried out by a competent person, ensuring that the structure of the rig is not damaged. These modifications, if implemented sensibly, can provide a safer climbing arrangement, giving better grip and a smaller and more comfortable spacing of the rungs to ease climbing.

What PPE can be provided?

A three or four point safety harness with twin tail lanyards and scaffolder's hooks can be provided to the drill crew together with training in its use by a competent person. The twin tail lanyard should be as short as possible to enable the climber to be secured by at least one lanyard at all times during the climbing process. When the climber reaches the point where he will need to secure himself to carry out his work i.e. re-thread the rope or attach a snatch block, then he should be held as close to the ladder as possible and be securely held in place by both lanyards. All fastenings on to the rig should be to structural parts, or alternatively, by the addition of certified eye bolts or anchor points which can be suitably examined or tested. If there is any likelihood that he may fall away from the ladder there should be a suitable rescue plan in place to recover him.

A lanyard.



A rig with additional rungs.

3-point harness.

Conclusion

The activity of climbing cable percussion rigs is still all too common on many sites. Whereas, some blue chip clients and main contractors are already insisting that the use of mobile platforms is a reasonably practicable solution, many contractors, especially small subcontractors, cannot afford to bear this cost and also would find it difficult to source suitable plant. Notwithstanding the latter, there will be sites where access platforms are not suitable or practical. The rig modifications discussed above provide improvements to most common types of cable percussion rig and all of the improvements are simple to do and the costs are minimal. As both contractors and clients must consider all significant risks, sufficient consideration should be taken to the hierarchy for controlling that risk when developing their robust risk assessment. Control measures are available where the risk of falling from height can in some instances be eliminated or sufficiently reduced to meet legislative requirements. ■

"... all of the improvements are simple to do and the costs are minimal."

safety issues

contents

Writing for **theGeotechnica** *for the third time,* Tom Phillips*, an independant chartered occupational safety professional from* RPA Safety Services*, provides a brief guide to the Construction, Design and Management Regulations 2007.*

Construction, Design and Management Regulations 2007 – a brief guide.

Compliance with Construction, Design and Management Regulations 2007 (CDM) should be a key objective and competitive advantage for any geotechnical company. Those that get it right will reduce their costs and importantly, protect their client but it comes as a surprise to many that not only does the work fall under the scope of CDM, but most sites are probably notifiable.

Construction is any building or civil engineering project, where the ground is broken. Although ground investigation (GI) generally only forms a small aspect of the total construction phase, it is quite categorically construction in the eyes of the Health and Safety Executive.

Projects falling under the scope of CDM are separated into notifiable (projects that last more than 30 days or involve 500 person days of construction work) or non-notifiable. It isn't individual packages of work which are counted, but the TOTAL phase of works, from initial design to the hand-over of the keys, thus making the majority of GI work notifiable.

Understanding: Instructions for the job.

"It is therefore vital that all parties involved must understand their roles or they may unwittingly take on responsibilities for which they are ill prepared."

It is therefore vital that all parties involved must understand their roles or they may unwittingly take on responsibilities for which they are ill prepared. CDM is covered in some depth during the IOSH accredited Safe Supervision of Geotechnical Sites course run in conjunction with Equipe, thus ensuring all your key staff understand the role they need to play and the critical questions they need to ask before work starts.

In this article I will look at duty holders as outlined in CDM, covering issues which often arise as points for discussion during the training sessions.

Clients (all sites) - A 'client' is anyone having construction or building work carried out as part of their business. This could be an individual, partnership or company and includes property developers or management companies for domestic properties. It may not be your client, but ultimately they set the tone of the project and should ensure it is managed correctly.

CDM co-ordinators (notifiable sites only) - A 'CDM co-ordinator' (CDMC) has to be appointed to advise the client on health and safety issues during the design and planning phases of construction work. Done correctly, they should ensure any potential risks involved with the construction phases are discussed and where possible, eliminated or reduced. They are also responsible for notifying the project and should be appointed at project start.

Designers (all sites) - The term 'designer' has a broad meaning and relates to the function performed, rather than the profession or job title. Designers are those who, as part of their work, prepare design drawings, specifications, bills of quantities and the specification of articles and substances. This could include architects, engineers and quantity surveyors. It is unlikely to apply to geotechnical contractors or consultancies, as design relates to finished structures and not the carrying out of preconstruction studies despite the fact this is often described as 'design'.

Principal contractors (notifiable sites only) - The principal contractor's role is to plan, manage and co-ordinate health and safety while construction work is being undertaken. The principal contractor is usually the main or managing contractor for the work and is responsible for welfare, site security and the conduct of all other contractors on site. They are also responsible for the development and maintenance of the construction phase plan so if you are the main or only contractor on site, this is probably you.

Contractors (all sites) - A 'contractor' is a business who is involved in construction, alteration, maintenance or demolition work. This could involve building, civil engineering, mechanical, electrical, demolition and maintenance companies, partnerships and the self-employed. It would also involve drilling contractors, excavation activities and in-situ testing.

Workers (all sites) - A 'worker' is anyone who carries out work during the construction, alteration, maintenance or demolition of a building or structure. A worker could be, for example, a plumber, electrician, scaffolder, painter, decorator, steel erector, as well as those supervising the work, such as foreman and chargehands.

So who is who on a Ground Investigation project?

Consultancies, partnerships, surveyors and similar - Although these parties may view themselves as the 'Client', in as much as they employ contractors to do the work, they are unlikely to be the 'Client' in terms of CDM where there is a strict definition. The Client under CDM is the person who will ultimately benefit from the project, so housing developers, local authorities, project originators on PFI contracts are all clients. Domestic clients carry no obligations under CDM.

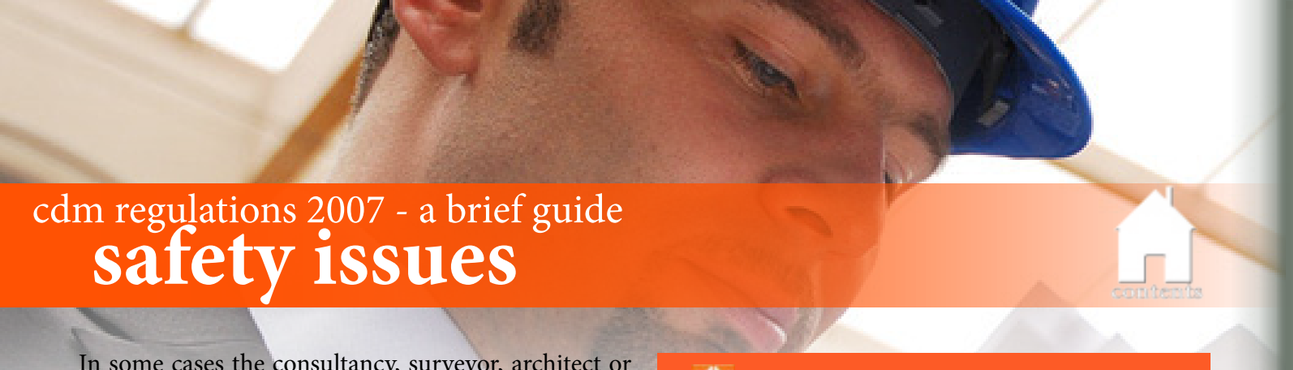
Health and Safety training.

Consultancies may take on design responsibilities where work involves the development of parts of the structure but the term 'Designer' is a responsibility rather than a role under CDM. Design activities would include foundation design, remediation barriers, grouting, pinning etc. Where design activity is carried out, considerable effort must be made to eliminate risk not just to the people who will use or occupy the structure, but also to those who must build it.

"Where asked to act as Principal Contractor, care should be taken to consider competency in understanding and managing..."

Where asked to act as Principal Contractor, care should be taken to consider competency in understanding and managing the risks involved with the GI phase of the construction project. Specific duties are imposed on Principal Contractors including the development of safety plans, site security, safety inductions and the coordination of all other contractors on site and must therefore be approached with care.

While on site all site activities such as site visits, supervision of bore-hole locations etc. must be done with reference to the Principal Contractor. On site, the Principal Contractor is in charge and carries overall responsibility for site safety.



cdm regulations 2007 - a brief guide

safety issues

In some cases the consultancy, surveyor, architect or similar may be appointed as the CDMC, responsible for the liaison and communication between parties. Safety of the project remains the responsibility of the Principal Contractor although the CDMC has a duty

"The CDMC is not responsible for telling the Principal Contractor or Contractor how to do the work..."

to advise the Client about any concerns involving other parties. The CDMC is not responsible for telling the Principal Contractor or Contractor how to do the work but for ensuring everyone carries out their obligations under CDM and all information is passed to the relevant parties.

It is suggested the same company or person remains responsible for the role of CDMC throughout the life of the project. For projects notified solely due to the length of the geotechnical phase, where there is no further anticipated construction work, the consultancy or similar may be competent to act as the CDMC. Competency must be reassessed throughout the project, where it progresses beyond GI.

Contractors - Those on site carrying out the work are classed as contractors. Where there is only one contractor on site, such as a drilling contractor, these are classed as the main contractor or on notifiable sites, the Principal Contractor.

On larger GI projects, where multiple contractors are on site at one time and the project becomes notifiable, one contractor must be the Principal Contractor. This should be stated on the paperwork submitted to the Health and Safety Executive and they must agree to carry out the duties under CDM.

"Contractors must be competent to carry out their work..."

Contractors must be competent to carry out their work and where they are appointed Principal Contractor they must ensure they are competent to discharge these additional duties. In most cases a GI project will be notifiable from the start and the drilling contractor or ground investigation crews may find themselves acting as Principal Contractors by virtue of being the only ones on site. This imposes little additional responsibility from those under their statutory obligations and most should find little difficulty in discharging these duties but being given this explicit role under CDM can be intimidating.

HSC — Health and Safety Commission

Managing health and safety in construction

Construction (Design and Management) Regulations 2007

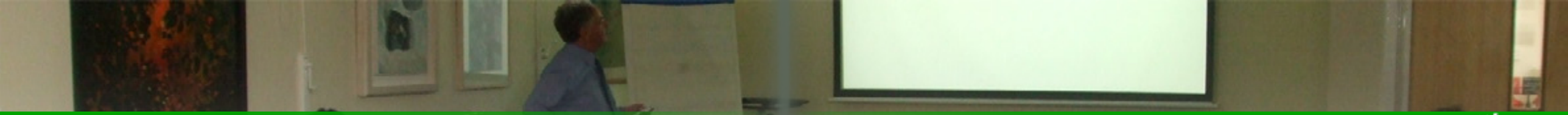
HSC CDM Regulations 2007.

In some cases, again where the project becomes notified solely due to the length of the geotechnical phase,

"...there is little to stop a contractor acting as CDMC but the role must be clearly understood."

there is little to stop a contractor acting as CDMC but the role must be clearly understood.

Where a contractor is responsible for designing or developing parts of a structure, they may carry responsibilities as a designer. For GI projects, this is unlikely unless something is to be left as part of a structure such as a pile or a remediation barrier. Although as a contractor there is a duty to eliminate, as far as is reasonably practicable, the risk to those involved in the work, this is not design as interpreted by CDM. As a result a contractor planning the location of boreholes is not a designer, but a piling contractor is. ■



contents

In the first of a series of articles featuring content from talks held at Geotechnica 2011 - Neil Smith of Applied Geotechnical Enginerring writes for **theGeoetchnica** *to discuss the need to learn from previous failures when moving forward.*

Some thoughts on failures past and future

A study of failures can be a very effective way of advancing knowledge in any field; in ground engineering especially, the process of back analysis has led to much greater understanding of mechanisms and validation of design processes – after all, we can only really know the factor of safety of a structure when it drops to unity and a failure of some kind takes place.

Past failures - Causes and reasons

Failures are often studied to determine the cause of the event. However, this is not enough for a full understanding – we need to know the reasons for the fail-

"Chains of causation can be difficult to determine in major failures where many factors are involved."

ures. Chains of causation can be difficult to determine in major failures where many factors are involved. A quite straightforward example may serve as an illustration. It was by good fortune that no-one was killed.

A site investigation project for a new road was to be done around a roundabout under which was a rail tunnel. The position of the rail tunnel was accurately known. The first relevant event was a decision by the project design team to set up a site grid for the project. This is often a convenient way of making setting out simple. However, in this instance, the origin of the chosen site grid was only 15m from the origin of the National Grid; on some drawings both grids were shown with the same numbers on gridlines only a short distance apart. This is illustrated in Figure 1.

In view of the risks associated with the tunnel the

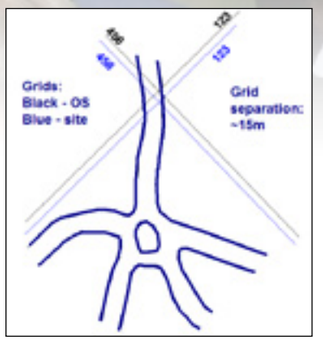


Figure 1.

Engineer took on the responsibility of setting out the borehole positions. However, the surveyor was sent to site with a reference point to one set of coordinates and the borehole locations to another. When locating the pegs, it was obvious that some of the positions were wrong – they were in the middle of carriageways, when his site layout drawing showed they were, for example, within the roundabout (which was quite large). He adjusted the positions of these boreholes to fit the drawing. Some of the five 'fingers' of land between the approach roads to the roundabout were built up, but others were open ground with no real landmarks. Pegs remote from obvious surface features went into the ground according to the coordinates. When he returned to the office, the surveyor did not mention the problems with setting out, or, at least, no message about the problems was received by

"...one of the boreholes was incorrectly positioned and penetrated the tunnel."

the design team leaders. The result was that one of the boreholes was incorrectly positioned and penetrated the tunnel. There was a live electrical rail in the tunnel but, fortunately for the driller, his drilling tool did not drop onto the rail. Instead, it penetrated the cab of a train which happened to be passing at that instant. Again, by good fortune, the drilling tool landed in the empty passenger seat. Though not physically hurt, it is not surprising that the driver of the train was severely shocked and was off work for a long time.

Clearly, there was a failure of a sort here. The cause of the damage to the tunnel and the train was obviously the borehole being drilled in the wrong place. The reason for this failure was a sequence of bad judgements, none of which would have caused the failure on its own.

"The reason for this failure was a sequence of bad judgements, none of which would have caused the failure on its own."

On a much larger scale, in 1976, the Teton Dam in the USA failed during its first filling and seven people were killed with a great deal of additional damage. Many studies were carried out into this failure, but I want to refer to an analysis by George Sowers, published in 19931. Sowers looked for the reasons for the cause(s) of the failure. He identified three groups of problems which contributed to the failure and 11 more specific aspects. He considered whether there had been technology available to eliminate the specific problem and, if so, whether the technology had been rejected or ignored. His conclusions can be summarised:

Problem Group	*Originating In*	*Relevant Technology*
Piping Initiation (6 specific aspects)	*Planning Design Construction*	*6*Rejected Ignored Absent*
Seepage blocking (3 specific aspects)	*Design Construction*	*3*Rejected Ignored*
Seepage erosion control (2 specific aspects)	*Design Construction*	*2*Rejected*

Table 1 Sowers' assessment of the Teton Dam failure.

It can be seen that Sowers concluded that, in 13 out of 14 instances, available technology was either rejected or ignored. In only one case was available technology lacking. The Teton Dam example was the largest cited in Sowers' study, that looked at 480 projects which had suffered problems in the ground. Overall, he found that technology was overwhelming either rejected or

***Absence** of Current Technology*	*12%*
Ignorance *of Current Technology*	*33%*
Rejection *of Current Technology*	*55%*

Table 2 Sowers determination of sources of problems in 480 projectsignored:

My own experience of problem projects is, thankfully, substantially less than Sowers was able to access, but personal experience tells me that a similar picture

"Excavation below the groundwater table often seems to bring unwelcome surprises..."

persists to this day. Excavation below the groundwater table often seems to bring unwelcome surprises, as does the removal of material from the toes of slopes. I sometimes wonder how many times mankind had to invent the wheel before the idea finally stuck.

In 2002, Donald Rumsfeld, then the US Secretary of State for Defence, gave us his definition of classes of knowledge:
"there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know."

As others have pointed out, Rumsfeld missed one category – there are knowns that we don't know that we know. These are the unknown knowns. It seems clear to me that one of the biggest reasons for ground-related failures are the unknown knowns. There is information in the public domain that the critical project staff either do not know or do not understand. We need to be much more concerned about the state of application of the art and science of ground engineering.

Future failures – specialisation and communication

All this analysis of long-ago failures is of no use if it does not help to reduce the risk of future failures.


Unwelcome: Water below table.

Considering the way in which past failures have come about indicates where we may meet challenges in the future.

When I graduated with my MSc in Foundation Engineering, rather more than 40 years ago, I was considered to have specialised. I have not significantly increased the scope of my interests since then, but Rab Fernie, the current BGA Chairman, recently described me as a generalist, adding that there are not many of those around now. Over the period I have practised (with emphasis on the word 'practise') ground engineering, it has changed from an emerging to a mature science and it has broadened hugely. It is a prime example of a field of knowledge in which people have rapidly come to know more and more about less and less.

The saying "A little learning is a dangerous thing" is well known and may have originated from Alexander Pope in the eighteenth century. Rather more recently, George Bernard Shaw made a perceptive addition to the phrase – "but we must take that risk [the danger of little knowledge] because a little is as much as our biggest heads [brains] can hold". There are two factors involved here:

- As our profession learns more and more, so the "little our heads can hold" is a decreasing proportion of the knowledge required to bring a project to fruition.
- As we push back the frontiers of engineering and construction and as the population grows, so the projects engineers will be asked to deliver will become more complex and the knowledge required to bring a project to fruition will increase.

The less we know as a proportion of the whole project knowledge requirement, the better we must communicate with the other specialists working on the project.

Communication is not easy. In the early 1990's, I was given a site investigation report written by an established site investigation contractor, that averred that the work had been done in accordance with CP2001. This had been superseded in 1981. Recently I became aware of a retaining wall design done in 2007 "in accordance with CP2" which had been superseded in 1994, 13 years earlier. I believe these examples illustrate the difficulty in communicating information widely amongst construction industry professionals. I am pessimistic about the real, widespread application of Eurocodes happening in anything like the near future. (I hope I might be proved wrong on this – I know many good people are working hard to spread the word.)

"The single biggest problem in communication is the illusion that it has taken place..."

George Bernard Shaw (yes, him again!) also said "The single biggest problem in communication is the illusion that it has taken place". I would add that communication is not communication if it does not both reach and be understood by its target. Does the ability to transfer information from one place to another by email help or hinder communication? Sending multiple megabites of data to everyone involved in a project is no way to ensure that the required information is properly communicated to the right person(s). Excessive distribution of information should be discouraged at the very least, if not made an offence subject to discplinary procedures. This was recognised in the HSE report of 20072 and in Carpenter et al 20083, who wrote "Key messages must not be buried beneath a swathe of secondary or even irrelevant data."
So what next?

This last section is deliberately not called 'conclusions', because I don't really know what to conclude. I want to set readers thinking and contributing to a debate. I have had one or two ideas which I think may be helpful, but I can't change very much by myself. All the analysis of past failures is of no use if we cannot reduce the risk of future failures. What steps might we take, then, to reduce the risks associated with future projects?

"... we need to find ways of providing crucial information in a way that our 'reasonably conservative' average heads can absorb."

Given that a small proportion of project knowledge is all that our heads can hold, we need to find ways of providing crucial information in a way that our 'reasonably conservative' average heads can absorb. I think it would be very useful to provide a distillation of the causes of and reasons for (and costs of) construction problems which have been brought to the attention of insurers. Given a straightforward reporting procedure, the insurance and construction industries could cooperate to establish a database of problems, summarised in a similar way to that used by Sowers. Annual statistics showing where problems have arisen would be a way of focussing the attention of construction professionals on the most risky aspects of their activities.

Major failures such as the Teton and Carsington Dams, Heathrow Express and the Singapore Nicol Highway are analysed in great detail. The results of these studies are published in journals and in conference proceedings, but is the detail presented too much for our average heads to absorb? It could be of great help to a large number of construction professionals to if summarised analyses could be produced almost as bullet points of 'do's and don't's'.

The general public would feel great concern if they felt that medical professionals did not keep up to date with the development of their own particular discipline. This is because the risk of medical mistakes are, more often than not, the action of one individual on another with consequences that follow quickly on the

"The public is at risk if construction professionals make mistakes..."

deed. The public is at risk if construction professionals make mistakes, but the differences from the medical professionals are (a) that we work in teams, (b) there is normally a significant period between the originating mistake and the event that causes a problem and (c) that many members of the public may be harmed. Continuing Professional Development is, therefore, essential, but it needs to be backed up by revalidation of professional capability. This isn't a new idea – Shaw, yet again! – "We should all be obliged to appear before a board every five years and justify our existence... on pain of liquidation." Five year revalidation is required of those who wish to be Registered Ground Engineering Professionals.

1. Sowers, G. F. (1993). "Human Factors in Civil and Geotechnical Engineering Failures". Journal of Geotechnical Engineering, ASCE, 119(2): 238-256.
2. Managing Health and Safety in Construction. Approved Code of Practice. HSE Books, London. L144
3. Carpenter, J, Powderham, A and Williams, R. (2008) Systemic failure in civil engineering – its causes and avoidance. Proc Conf on Forensic Engineering: from failure to understanding. Thomas Telford, London. ■


Geotechnica: Audience for Neil Smith.

where have all the pins gone?

contents

Roger Chandler, Director of Keynetix, talks to **theGeotechnica** *about innovative ways of managing data and knowledge. He tells us about how technology has advanced to enable software developers to now provide cost effective solutions.*

A company's previous work experience is a valued knowledge-bank but many companies find it difficult or costly to ensure that their knowledge is not lost. This short article looks at the ways in which companies have approached this problem in the past and what solutions are currently available if you're looking to set up a new system or upgrade your existing system.

The oldest method of knowledge management is word of mouth. If you want to know if your company has worked near a specific location before then you simply find the person who has worked there the longest and ask them. This method is alive and well even in the IT driven world that we now live in. However, with such a mobile workforce at the moment it can be difficult to rely on this method for the medium or long term.

The next level of sophistication is to stick pins on a map on the office wall, or as I have seen in the past red dots on a road atlas. This system works surprisingly well for everyone who can see the map (and not so well for others!) and is still commonly used in small, single office, companies.

There are two common problems with this method that you need to be aware of. What happens when a pin falls out or a dot comes off your atlas? How do you know that the project in question has just left your project archive? The problem gets even bigger when you have just dislodged a pin and the guilt associated with this action means you are compelled to put it back in the map…. probably in the wrong place! Now your archive information is being randomly muddled by guilty, well meaning, colleagues. This usually results in a big sign being placed next to the map warning of the dangers of replacing pins without the necessary training!

Outdated: Pins in a map.

"What happens when a pin falls out or a dot comes off your atlas? How do you know that the project in question has just left your project archive?"

It was these simple problems that drove many companies in the past to look for IT solutions to solve the "where have the pins gone" problems.

Microsoft AutoRoute was first introduced in 1994 and allowed you to import push pins files and display them on your UK Mapping interface. This gave users the opportunity to electronically display their Pins for less than £100 a computer - there are still companies today that hold onto their original AutoRoute program with great sentimental attachment for purely this reason.

"...there are still companies today that hold onto their original AutoRoute program with great sentimental attachment..."

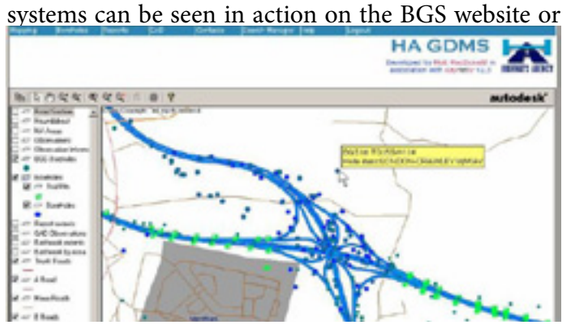
The main driver for these types of programs was that you got the mapping data included in the licence fee. This was amazing value considering that at the time buying the same data from the OS to include in an in house application would have cost around £20K.

Google Earth then raised the bar– allowing you to display your push pins in a map, but this time you were not limited to the UK but could locate your projects anywhere in the world as long as you could work out the Lat and Long coordinates for each project. Some even say that it covers a lot of the known universe as you can look away from the Earth and see the stars – hence covering any extraterrestrial work you may win in coming years!

As long as you know how to create a KML file then the world is your oyster with Google Earth. Google Earth has really opened up Geographic Information Systems (GIS) to the masses as it is fun and free and can just as easily be used for displaying your borehole locations as it can for checking out your next holiday hotel or campsite.

However, there are two main reasons why Google Earth is not the ultimate answer it may first appear. 1) The licence conditions on what you can and cannot do with the data and application are unclear, and this has led to the AGS issuing a loss prevention alert(1) on the subject and many companies banning its use to be on the safe side of the law. And 2) there is no way to add your own mapping layers to the system and therefore no UK geology, mining information or other freely available information.

The final chapter of this story moves to browser based mapping systems. These systems allow you to set up your own server and have an internal or external website which allows you to display background mapping data from the OS and overlay your own data. These systems can be seen in action on the BGS website or via the Highways Agency's Geotechnical Data Management System. However, until recently these types of systems have been very expensive to set up and maintain due to the software licensing fees and mapping licences. All this has changed in the last year or two with many OS and BGS mapping sets now free for use and Autodesk making their mapping server free and open source.



HA GDMS: Previously expensive.

"...until recently these types of systems have been very expensive to set up and maintain due to the software licensing fees and mapping licences."

To get this into perspective, a system that used to cost around £40K to set up and a further £15K in yearly licence fees can now be set up and run for around £5000 (or £2000 a year) with a system like KeySpatial from Keynetix. This has changed the way small to medium sized companies view the use of these systems and brought the ultimate solution into reach of many more organisations.

In use: Keynetix product KeySpatial.

I hope this article has inspired you to take a new look at your company archive. Whether you are now going to put up that notice next to your wall map, dust down your beloved AutoRoute or investigate browser based mapping systems for your company I wish you luck.

In the next issue of ***theGeotechnica****, Roger Chandler will cover which mapping datasets are freely available from the OS, BGS and other sources to help you fill your system with useful data for free.* ■

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