

# Guidance for drillers on geophysical surveys

Valuable subsurface information can be provided by geophysics – Zetica gives some pointers to effective usage of the technology

**P**ROSPECTIVE users of geophysics frequently include those in drilling-related activities, but some possible users of this technology are put off by the perceived lack of guidance available to them on how to procure geophysical surveys. Rather than get involved with something new they simply rely on tried and tested tools.

A good reference document for engineers requiring a geophysical survey is the UK's Geological Society Engineering Geology Special Publication 19, "Geophysics in Engineering Investigations" published in 2002. This is the result of collaboration between CIRIA, a Working Party of the Engineering Group of the Geological Society, the BGS and BRE, which discusses procurement of geophysical services including the role of a Geophysical Adviser.

It is also relatively easy to stay abreast of applications of engineering geophysical methods by building a relationship with a trusted service provider with a solid reputation for delivery and a track record for innovation.

At a project design stage geophysics can play an important role in the initial ground investigation. Typical applications might be the determination of bedrock depth, *in-situ* determination of engineering properties of the bedrock strata (such as small strain shear strength) and the location of potential hazards such as voids, faults and even unexploded ordnance (UXO).

During the various stages of construction, non-destructive testing methods including time-domain reflectometry (TDR), sonic logging and seismic testing can be used to monitor work such as piling and consolidation grouting. Working closely with the engineer, a geophysical adviser can provide clarity on the likely value to be obtained using geophysics.

## SUCCESS FACTORS

The success of all geophysical methods relies on there being a measurable contrast between the physical properties of the target and the surrounding medium. The design of a survey can be aided by the use of powerful 2D and 3D forward modelling geophysical software. With information on the expected target size, depth and composition, a

geophysicist can evaluate the feasibility of a particular method including likely error bars on modelled size or depth and can determine optimum survey design parameters.

UK-based company Zetica offers free geophysical advice to its customers, and also gives a popular Geological Society registered seminar on the uses and abuses of geophysics. Engineers are brought up-to-date on the latest geophysical methods available in the market place and interesting areas of Research & Development. The presentation normally lasts 30-40 minutes and is case history-based with a 15 minute discussion session following on.

Geophysics is, however, said to have a chequered history when it comes to locating long-disused mine shafts including tunnels and adits, of which there are many in the UK. The answer lies to some extent in the fact that geophysical techniques are all too often indiscriminately applied. A geophysicist must design a suitable survey based on knowledge of the target and its surroundings (both above and below ground). Knowledge of the material properties likely to be associated with a mineshaft or adit target is therefore essential to choosing the correct method(s) and interpreting the results obtained. If a geophysicist isn't asking all of the following questions, be sceptical about the advice provided:

1. What are the expected construction parameters of the mine shaft (material used, diameter, capping, depth)?
2. What is the expected burial depth?
3. What materials are believed to overlie the mine shaft?
4. Are the mine shafts suspected of being backfilled with spoil materials, are they water filled or with air voids?

Depending on the answers to these questions the geophysical solution may range from a £1,000/ha gradient magnetic survey to detect a shallow reinforced concrete capped shaft to a £20,000/ha detailed microgravity survey to detect 5 m deep water filled, uncapped and concrete-lined shafts. Zetica has in the past year won several large-scale mine shaft detection contracts ranging from £30,000 to £250,000 in value.

Regarding UXO risk assessment, strangely,

there are no recognised standards governing the advice provided or services offered to mitigate ordnance risk. Anybody can set himself or herself up as an "expert" in UXO issues and many have. To assist in demystifying some of the grey areas that have arisen, Zetica has published a 'Frequently Asked Questions' flyer in collaboration with UXB International Inc. This document provides a realistic view of the potential UXO risks that can apply to construction and engineering projects in the UK.

Zetica has also recently won a prestigious contract to detect intrusive dykes and map depth to rock head using shear wave reflection seismics as part of the ground investigation for a tunnelling scheme in Northern Ireland. The firm researched the available vibratory shear wave sources across Europe and the US and finally settled on Bay Geophysical's proprietary micro vibrator (MicroVib).

The shear wave reflection technique was selected in collaboration with John Arthur of Top Hole Site Studies Ltd and was chosen in preference to a more conventional P-wave survey due to the shorter signal wavelengths and commensurate increase in survey resolution offered by shear waves. The MicroVib source offers additional benefits including a higher immunity to traffic noise.

Challenges include running profiles over a mixture of hard surfaces (asphalt, concrete, brick) and grass with some lines crossing road junctions. A trial survey will be undertaken first to ensure that the method is suitable under the given site conditions and to optimise survey parameters such as source and receiver spacing.

Zetica recently attained ISO 9001:2000 certification for all services allied to engineering geophysics and ordnance risk mitigation. "Achieving ISO 9001:2000 certification provides both external and internal benefits to Zetica," said Mike Sainsbury, director.

## FURTHER DETAILS

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