Introduction by John Dunnicliff, Editor

This is the 80th episode of GIN. Two articles this time.

Wireless monitoring

The first article, by Simon Maddison, is titled "The Fundaments of Wireless Monitoring – Things to Consider". The idea for this title came from David Cook's excellent article in the December 2010 episode of GIN, "Fundamentals of Instrumentation Geotechnical Database Management – Things to Consider". It seems to me that this format creates a very user-friendly guideline for the practitioner who is faced with the task of deciding what to do. Three of the sessions at the second International Course on Geotechnical and Structural Monitoring in Italy (see below) will have this format:

- Vibration monitoring
- Wireless monitoring
- Automatic data acquisition systems

If you'd like to have a Word file of Simon Maddison's article so that you can create a checklist of things to consider, by copying and pasting, please let me know. The same applies to David Cook's article.

Widespread misconceptions involving …

How's that for an eye-catching title? The second article (another by Glenn Tofani—his earlier one was in the previous episode of GIN, titled "Resolving unexpected monitoring results") provides yet more support for using the fully-grouted method for installation of piezometers. It also guides us in avoiding widespread misconceptions involving soil gas sampling probes installed above a sub-slab vapor barrier.

Interest in the fully-grouted method for installing piezometers

In their Summer 2014 Quarterly Newsletter GKM Consultants, Quebec, Canada (www.gkmconsultants.com) wrote the following, under a heading "Did You Know?":

> *The fully–grouted borehole method simplifies the installation of piezometers (vibrating wire and other diaphragm transducers), provides quick and reliable response readings, lends itself to nested installation and can reduce the costs by up to 75% compared to the conventional method (sand pack filter and bentonite plug). Although some of our clients still question this method, it is interesting to know that it is gaining in popularity. Supporting documentation on this subject can be found in the June 2012 edition of Geotechnical News [Contreras et al]. Other very interesting articles are available online at www.geotechnicalnews.com/instrumentation_news.php.*

GKM Consultants can receive from their mailing portal the number of clicks (opens) for the Contreras et al article. The latest count is more than 3000 clicks!

To clarify: in my view the fully-grouted method is suitable for vibrating wire, diaphragm piezometers with electrical transducers and fiber-optic piezometers, but not for pneumatic piezometers. But see my editor's note in Glenn Tofani's article, with "**Does anybody have anything to contribute to this**" – the question as to whether the fully-grouted method is suitable for pneumatic piezometers.

Second International Course on Geotechnical and Structural Monitoring in Italy, June 4-6, 2015

Planning for the second course in Tuscany, Italy is well underway, and registration is open. Visit www.geotechnicalmonitoring.com. The list of 14 speakers includes **John Burland** of Imperial College London, **Michele Jamiolkowski** of Technical University of Turin (both of whom were leaders on the International Committee for the Safeguard of the Leaning Tower of Pisa), and **Elmo DiBiagio** of Norwegian Geotechnical Institute.

More information is on page 34.

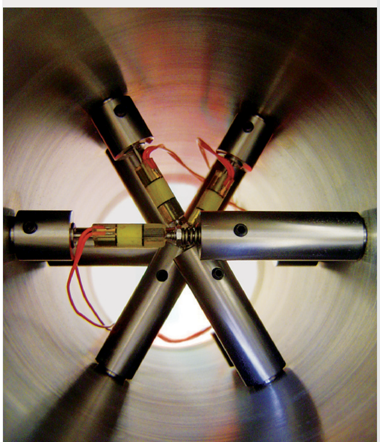
Substantial coverage will again be provided on remote methods for monitoring deformation—it seems to me that these methods are more widely accepted in Europe than in North America, so my North American colleagues may want to join us to get up to speed. As John Gadsby wrote in the previous issue of this magazine, "Travelling to Tuscany just for a three-day engineering course may seem onerous, but you can always extend your visit by adding a vacation and joining one of the nearby world famous cooking schools or wine schools".

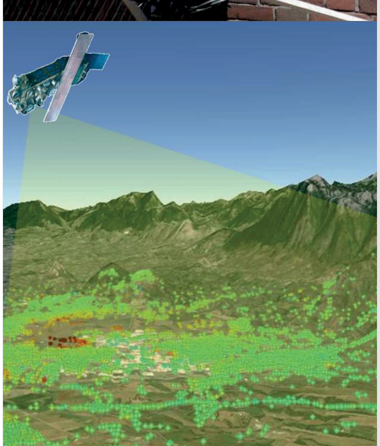
The first course, in June this year, was a great success—it was sold out two months before the beginning of the course, with 100 participants from 27 countries.

Closure

Please send an abstract of an article for GIN to *john@dunnicliff.eclipse.co.uk* —see the guidelines on *www.geotechnicalnews.com/instrumentation_news.php*

Kassutta: "Let our glasses meet"! (Greenland).





The fundaments of wireless monitoring – Things to consider

Simon Maddison

Introduction

Although wireless sensors have been around for some time, the take up in the geotechnical world has been very low to date. It is technically challenging to develop a truly robust solution with precise and stable sensing, long battery life and seamless mains-power free data transmission to the user. There are many companies and solutions in the market claiming they can achieve the above, but in reality many market offerings are still immature. Nonetheless wireless is now being recognised as a practical and robust option for geotechnical monitoring. There are many factors to consider with the design of any geotechnical monitoring system, and this article is a guide for users that specifically applies to the use of wireless sensors and enabling robust communication links. As a background, and without getting unduly technical, it includes a general guide to the different architectures of wireless systems with the aim of helping the industry pose the right kinds of questions.

Proven and robust wireless solutions offer important advantages in many situations, by reducing costs, dramatically cutting installation manpower and eliminating reliability and other issues associated with cabling. Furthermore proven wireless is now beginning to be recognised for opening up monitoring opportunities which would otherwise either be very difficult if not impossible to achieve. This article rounds off with some discussion as to these possibilities, to show that wireless can be much more than an efficient and cost saving alternative to wired systems.

Generic wireless architecture

First let's explore the principal elements of a generic wireless sensor network. This is shown in Figure 1. A sensor is connected to (or integrated within) a wireless sensor node. One or more of these communicate via radio to a data collection unit, in order to send back the measurement data.

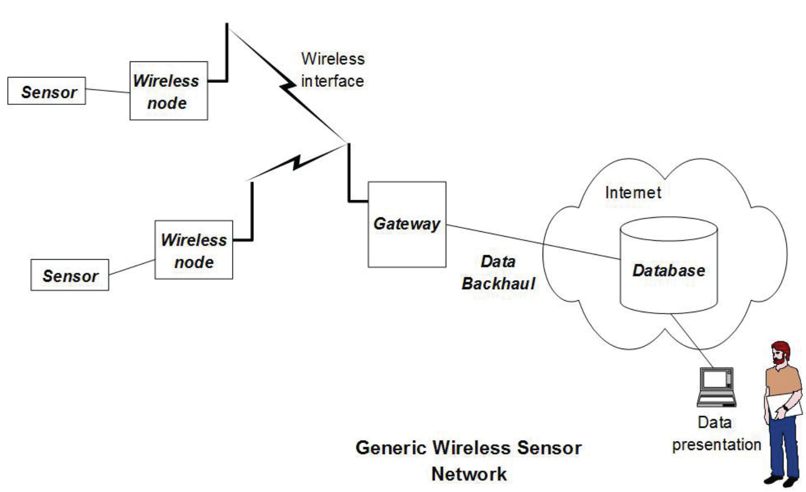


Figure 1. Generic wireless sensor architecture.

This could be simply a data logger, where the data is stored and manually collected, or it could be automatically passed back to a remote data storage location, in which case it is commonly described as a ***gateway***. The data link back to the remote storage is commonly described as ***data backhaul***. Data backhaul can be effected using one of many different mechanisms, for example: dial up modem; ADSL; GSM/GPRS/3G or via a satellite link. The solution chosen will very much depend on the resources available in the environment where it is installed, which will be discussed below. Data are then stored in some form of data base (which could be a data warehouse in the 'Cloud' or simply on a PC). It can then be accessed by the user, either for semi manual processing (e.g. in a spreadsheet application such as Microsoft Excel) or rendered graphically and dynamically by a dedicated software package.

Other than to note that there are some well-established commercially available data visualisation and management packages, and that there continues to be rapid evolution in graphical power and flexibility, it is beyond the scope of this article to go further into data rendering; the focus will be on the wireless elements. Additionally, although as indicated above there may be situations where a wireless node is simply connected to a data logger, for the purposes of this article a full end to end arrangement as in Figure 1 will be assumed.

Wireless architectures for geotechnical sensing

There are three principal wireless architectures for sensing networks, and these are shown in Figure 2. This is not intended to be exhaustive, but to

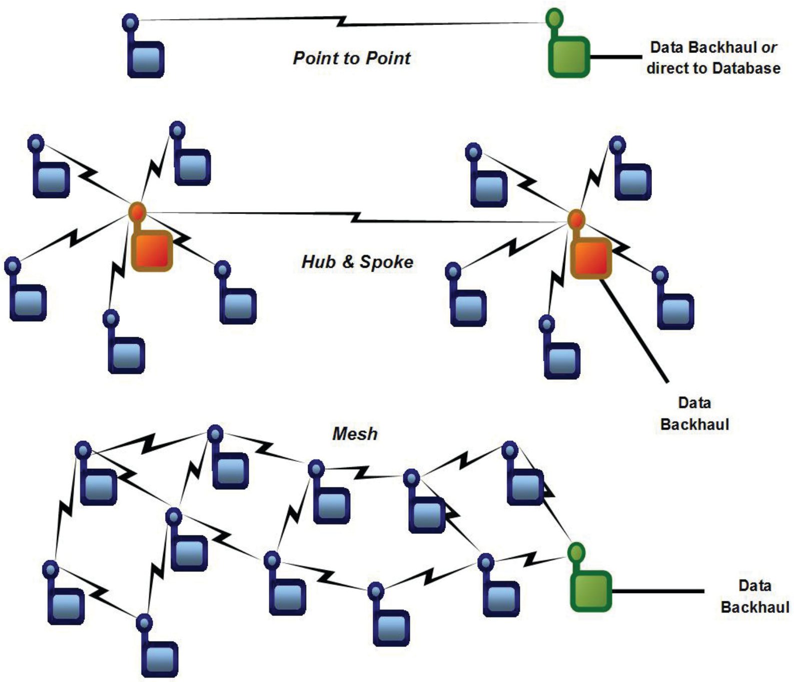


Figure 2. Wireless architectures for sensing.

identify the main types. These will be discussed in turn.

Point to point

Point to point is the simplest wireless architecture. This comprises a remote sensor node that communicates via radio directly with a gateway. The gateway provides the data backhaul to the database, but it could be collocated with the main data storage system. This architecture is suitable for single or widely dispersed monitoring points, and might typically use GSM/GPRS as the wireless link, or satellite for very remote locations.

Hub & spoke

In a hub and spoke system wireless sensor nodes communicate directly with a 'relay' or 'controller' node. Each sensor node needs to be within range of such a node. The relay nodes then in turn communicate (directly or indirectly) with a primary controller node, which acts as a gateway. This then forwards the data to the data storage system via a data backhaul. This is often characterized as a hierarchical network, as the nodes act as 'slaves' to the controller or relay nodes. Typically these systems use low power, short range wireless for sensor node communications and are suitable where clusters of sensors are required. However the relay and controller nodes have significant additional power requirements associated with their need to relay messages; in practice these must be provided with an external power source.

Mesh

In a mesh network, each node communicates with one or more of its neighbours. All the nodes in the network are equal in status, and this is often characterized as a non-hierarchical network architecture. The nodes forward data via their neighbours, using the most efficient route in the direction of the gateway. The gateway then collects the data and sends it on to the user via the data backhaul. This architecture allows for the network to be self-configuring, which makes it self-healing and robust, as well as easy to extend and amend.

Project considerations

As with any monitoring project, a number of questions need to be answered, explicitly or implicitly. This will influence the choice as to whether to use wireless or not, and the type of wireless system to be used if this option is selected.

What to measure and how often?

How many monitoring points are required? Are they close together or widely spaced? How often are readings required? I mean REALLY how often are data points required? Wireless is not generally suited to continuous or very frequent data readings as this places heavy demands on the battery power of the sensor node. As an example, in many long term structural applications, one reading an hour is more than sufficient.

It may be required to adjust the reporting rate of the sensors, for example when intense construction activity takes place or significant movements are observed. Some systems can support this. If so is it simple or does it require local intervention? Can it be done remotely via the backhaul?

Location & access

Where are the sensors to be deployed? Are they clustered in a limited space, or are they widely scattered? Is it in open outdoor space or a restricted space or even confined underground, such as a tunnel or basement? What facilities are available for power? What communications facilities are available to get the data out of the location? Is GSM or satellite possible? If not, then is there access to the telephone network, a data communications network, and/or the internet?

Is the location difficult to reach, and/or hazardous to access? What time restrictions and permissions apply to accessing the location? Are there maintenance liabilities with running cables to sensors, or are they prone to damage by engineering crews or rodents? Is flexibility required in the deployment of sensors? Is it required to extend, adapt, move or redeploy them during the monitoring period?

Network topology

If you only need one, two or a very small number of sensor points, and they are not clustered, then a simple point to point system may be quite sufficient. However these days with even a relatively few sensors, a network based solution will be equally cost effective in comparison. Networks are invariably more flexible and allow for adaptation and extension through the life of the monitoring project.

Both hub & spoke and mesh architectures provide solutions that readily support multiple sensors; however there are significant differences in configuration, flexibility, robustness and power requirements across the installation, depending on the architecture and the specific product selected.

Important considerations in the choice of architecture and supplier do require careful teasing out, as parts of the industry are still very immature. How easy is it to configure the network? Is configuration required on a sensor by sensor basis? This can particularly be an issue with hub and spoke type networks where the controller and relay nodes may require configuring as nodes are added/removed.

In a multi-hop network, such as a mesh network, how many 'hops' can be supported? If this is small, then this could considerably limit the area over which the sensors can be installed.

Power

What power is required, and how is this different for different parts of the system? Typically sensor nodes should be battery powered and give a long operational life of 5-15 years. The life however will depend on the type and make of sensor, the frequency with which readings are taken, the size of the battery cell, but it can also be influenced by where the node sits in a network. In some mesh networks for example, where there are many nodes, those nearer the gateway may use up their batteries slightly faster.

In hub & spoke systems the relay and control nodes will need external power, as they need to be on all the time. In a mesh network, typically the only item to require power will be the gateway. Is it possible to use energy harvesting to provide power where needed, for example with a solar panel? This will depend on the system supplier, and the type of backhaul used. In some implementations the power requirement for the gateway and backhaul is such that solar power is not practicable. If not, is a suitable source of mains power available in the locations required?

Data robustness

How reliable is the data transmission? Does the system retransmit 'lost' data readings? Are data readings buffered on the nodes? If so, how many readings can be stored? If a communication link is lost temporarily, does the system retransmit them when communication link is re-established? This applies to individual sensor nodes, but also to relay/controller/ gateway nodes.

Sensor stability

It may seem self evident, but of course the quality of the data is paramount, and needs to be fit for purpose. This applies particular to systems with integrated sensors, as well as those connected to external sensors. Is the resolution of the data sufficient for purpose? How stable is the data over time and temperature? Is the data liable to noise, spikes or anomalous readings?

Installation

How easy is it to install the system? Is a lot of configuration required, either before, during or after the installation? Is an intervention required on the nodes themselves? Is it possible to determine network wireless performance at the time of installation, so that the installer can be confident of system operation before leaving site? Can a contractor, surveyor or any reasonably trained individual install without significant help or support?

Wireless range

Range capability can vary considerably not just with type of system but placement and height of the wireless nodes. Key factors depend on the site, where the gateway can be located, how far the sensor deployment needs to extend and what obstructions may exist.

What is the range of each wireless node? How is this affected by local environmental factors, such as height, obstructions and vegetation? Does the system need repeaters to get around obstructions and do those repeaters need to be powered on all the time? What sort of obstructions can the wireless signal pass through? Note that generally speaking the higher the position of the antenna, the better the wireless range that can be achieved.

Frequency bands

Generally speaking wireless sensor systems (not the backhaul) operate on the internationally agreed Industrial, Scientific and Medical (ISM) radio bands, typically in the 2.4GHz or 900MHz bands. These should be license exempt, but it is important to check this against the individual country where they are to be installed, and what local restrictions there may be on wireless power or indeed the sort of application to be used.

Data backhaul

Data backhaul will depend very much upon the facilities available where the system is to be installed. In most parts of Western Europe, GSM is of good quality and available, although it should be checked in more remote locations. At its simplest, data can be stored at the gateway and collected manually, but this is clearly less desirable. For very remote locations where GSM is not available then Satellite may be a good alternative.

For confined and underground locations, then the only viable solution may be to use a wired communication link. Again the actual option will depend on the location, and a wired 'hop' to a GSM modem could be possible, a DSL link via a phone line, or an Ethernet connection, but this will very much depend on local circumstances.

The potential of wireless

The common drivers for the use of wireless for geotechnical monitoring have been cost, low maintenance and the ease of installation. Wireless sensors should typically always be cheaper to install than wired systems, as they don't need wires and should be much quicker to deploy. That has collateral benefits in terms of hazardous locations where access is time restricted, and may incur access and additional personnel costs. The elimination of wires itself may incur savings through reduction in support and maintenance during the life of the deployment.

However there are further potential benefits to using wireless. Using wireless for backhaul gives remote access to data. But the use of wireless mesh sensors allows for much more flexibility in terms of system deployment. It should be possible to add sensors to a system, irrespective of sensor type, to extend the specific application as well as reconfiguring the system as needs dictate, with a minimum of effort and without the need for specialised skills.

Wireless also offers the possibility of monitoring where wired or other systems, such as optical based (robotic total station) systems are not feasible, because of space and other constraints. Wireless also lends itself to tactical deployment where sensing is required in a dynamic environment, as engineering and construction works move over an asset. Again this should be possible without specialised skills.

Finally, the evolution of electronics is going to continue to drive evolution of wireless sensing, with units becoming ever more energy efficient, smaller so they are simpler and less obtrusive to deploy, and falling in cost so that it will be ever more economically viable to deploy sensors comprehensively on assets where it has not be considered possible in the past.

Simon Maddison
Chief Operating Officer,
Senceive Ltd.
Hurlingham Studios, Ranelagh Gardens, London SW6 3PA, England
Tel: +44 7679 5720
email: smaddison@senceive.com

Widespread misconceptions involving liquid or vapor flow in geotechnical monitoring applications

Glenn Tofani

This article presents examples of two geotechnical monitoring scenarios where liquids or gases are transmitted across what are commonly perceived to be relatively impermeable barriers. The first case involves the transmission of groundwater hydrostatic pressure to a pressure transducer embedded within a column of cement/bentonite grout. The second case involves the transmission of vapors (Volatile Organic Compounds or VOCs) across an engineered barrier placed below a floor slab that is intended to block their transmission. In both cases, there have been widespread misconceptions within the engineering and regulatory communities regarding the degree to which transmission occurs.

Fully-grouted piezometers

The first case involves the development of fully-grouted installation procedures for pneumatic or vibrating wire piezometers during the 1980s and 1990s. During the early 1980s, piezometer installations in southern California typically consisted of open standpipes or, less frequently, pneumatic or vibrating wire transducers embedded in sand backfill. It was generally recognized that open standpipes could give misleading results at stratified sites where multiple zones of groundwater occur, or where significant vertical flow gradients are present. The use of transducers to measure piezometric levels at discrete points or within relatively isolated zones was found to produce more reliable and useful data. However, the construction of multi-stage installations with transducers embedded within sand intervals isolated by bentonite seals was difficult, time consuming, and often resulted in damage to the transducers, bridging of the borehole during backfilling, or other installation problems.

Fully-grouted installations were considered as a means of eliminating these installation problems. However, many clients, consultants, and regulatory agencies were reluctant to utilize

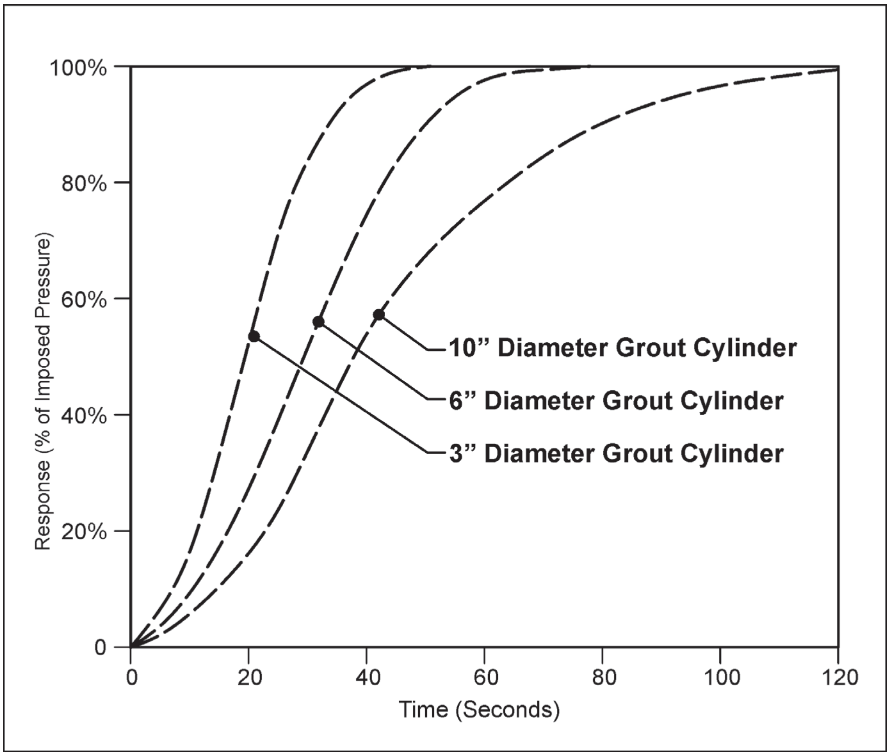


Figure 1. Response time lag for pressure transducers cast in grout cylinders.

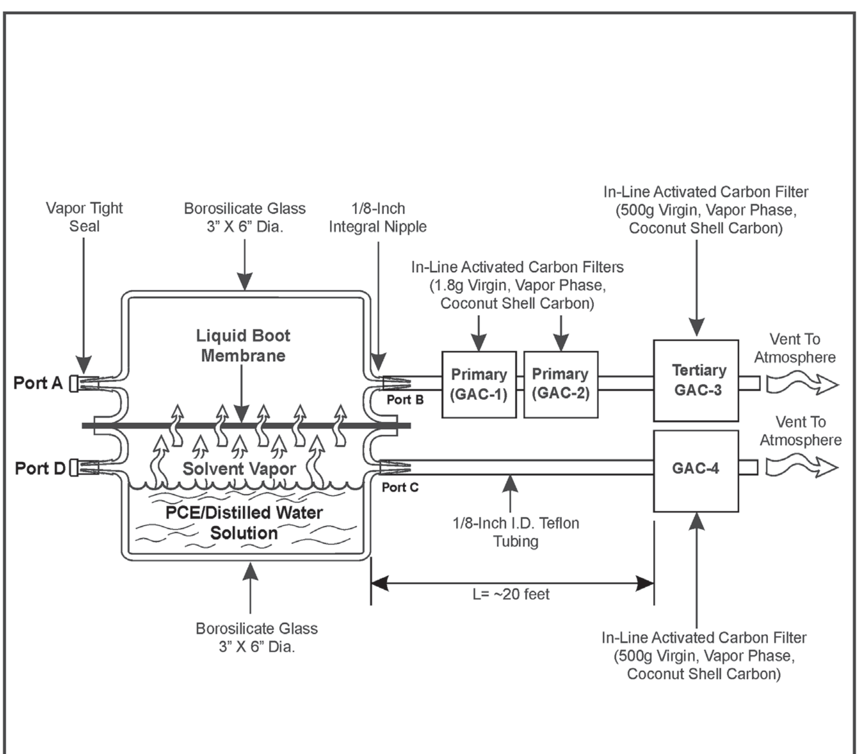


Figure 2. Vapor barrier diffusion test configuration.

fully-grouted installations. There was often a strong perception that the groundwater pressure outside of the grout column would not be fully transmitted through the grout to the embedded sensors. The low permeability of a typical grout mixture (about 1 x 10^{-6} cm/sec) contributed to this perception. Simple one-dimensional calculations suggested that an extended period of time (i.e. hours to days) could be required for a transducer embedded in low permeability grout to respond to pressure changes outside of the grout column. These calculations contributed to the skepticism.

In order to evaluate the transducer response and associated time lag, several pneumatic and vibrating wire transducers were cast in grout cylinders ranging from 3" to 10" in diameter. Each of the transducers was fitted with a 0.4" diameter by 1" long porous polypropylene filter tip. The length of each test cylinder was twice its diameter. After curing for at least 24 hours, the test cylinders were lowered into a 1 foot diameter by 8 foot long standpipe that was filled with water. The test cylinders were typically lowered two feet at a time and monitored continuously until steady state pressures were recorded. The results of a typical test series with pneumatic piezometer transducers are shown in Figure 1. As indicated, the transducers were found to respond rapidly to the pressure changes. In each case, steady state readings were obtained within 60 seconds, or less, of moving a test cylinder to a deeper or shallower depth. The stabilization time was found to be more or less linearly proportional to the diameter of the test cylinder. For all tests, the steady state readings were found to correspond to the depth of the tip of the sensor within the accuracy of the measurement (±0.5"). These testing results, and real time demonstrations, were used to convince clients, consultants, and regulators that the fully-grouted installation procedure

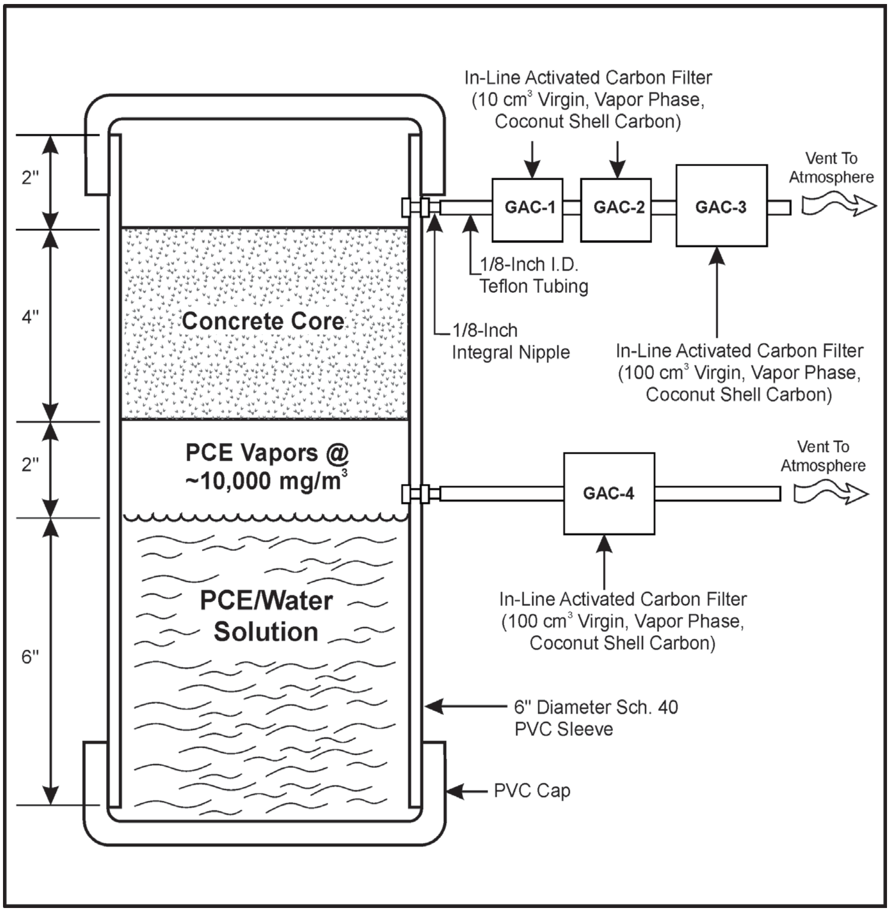


Figure 3. Concrete slab diffusion test configuration.

was a viable, and typically superior, alternative.

[I'm concerned about this apparent green light for installation of pneumatic piezometers by the fully-grouted method. There are several types of pneumatic transduces, including those that are read as gas is flowing past the diaphragm and, very preferably, those that are read under a condition of no gas flow immediately after the flow is stopped. In the latter case a volume change occurs in the pore space at the instant of reading (red book Section 8.3). I've always contended that this feature negates the use of the fully-grouted installation method for installation of pneumatic piezometers. I made this point to the author of this article, who replied: "With respect to the diaphragm displacement issue with the pneumatic transducers, we can create a situation where the pressure response oscillates as the diaphragm opens and closes (but gradually converges on a stable reading) if we cast the transducer without a filter tip. With a filter tip, we have never experienced that type of oscillation – out of several hundred installations. We have read the grouted-in-place pneumatic transducers both ways – with a slow constant air flow through a needle valve and by over-pressurizing the tip and allowing the pressure to drop and stabilize – both yield the same results within about an inch of water column". Despite this reply, I'm reluctant to change my contention and support the green light. **Does anybody have anything to contribute to this?** *J.D.]*

Sub-slab vapor barriers

The second case involves the monitoring of soil gas sampling probes installed above a sub-slab vapor barrier. Engineered vapor barriers are frequently installed beneath buildings that are constructed at sites where Volatile Organic Compounds (VOCs) such as solvents, gasoline, or other hydrocarbons are present in the subsurface. The barriers are intended to reduce the rate at which VOCs would otherwise migrate to the interior air spaces of buildings. Post-installation monitoring and evaluation of the performance of sub-slab vapor barriers is becoming an increasingly common requirement at contaminated properties. Soil gas sampling probes are often installed above and below a vapor barrier to confirm that it is functioning as expected. There is a common perception that vapor concentrations above a barrier should be very low - if not below detectible levels. The presence of elevated vapor levels in the space above a vapor barrier and below a floor slab is frequently taken as an indication that the barrier is not functioning properly. This interpretation is not necessarily correct. All vapor barriers will transmit VOCs to some extent. The purpose of the barrier is to limit the rate of VOC transmission to the interior of a building such that acceptable risk thresholds are not exceeded. High quality, intact concrete also provides considerable resistance to the transmission of many organic vapors. Although a concrete floor slab can typically not be relied upon to function as a vapor barrier for a number of reasons, the characteristics of the floor slab need to be considered when data from sub-slab vapor probes is to be used to evaluate the performance of an underlying barrier.

The diffusion coefficients for a number of vapor barrier materials have been measured for various VOCs using the test configuration illustrated in Figure 2. Similar tests have been performed to measure the vapor diffusion coefficients for concrete (Figure 3). As shown, for both the membrane and concrete tests, a water reservoir is maintained in the lower test chamber. VOCs are dissolved in the water to provide and maintain a specified VOC vapor concentration in the lower test chamber in accordance with Henry's Law. A granular activated carbon (GAC) filter is attached to the upper test chamber to absorb VOCs that diffuse across the membrane or concrete core. Both the upper and lower chambers are vented to the atmosphere to prevent the development of a pressure differential between the upper and lower chamber. Typical results obtained for one solvent (tetrachloroethylene or PCE) are shown in Table 1.

Table 1		
Material	PCE Vapor Concentration	Diffusion Coefficient
Concrete (2,500 psi)	10,000 mg/m^3	1.4 x 10^{-8} m^2/day
Concrete (5,000 psi)	10,000 mg/m^3	3.0 x 10^{-9} m^2/day
60-mil HDPE	6,000 mg/m^3	1.1 x 10^{-9} m^2/day
60-mil Spray-Applied Membrane	6,000 mg/m^3	2.4 x 10^{-9} m^2/day

Table 2	
Material	Relative Impedance
Concrete (2,500 psi)	5.2
Concrete (5,000 psi)	24
60-mil HDPE	1.0
60-mil Spray-Applied Membrane	0.6

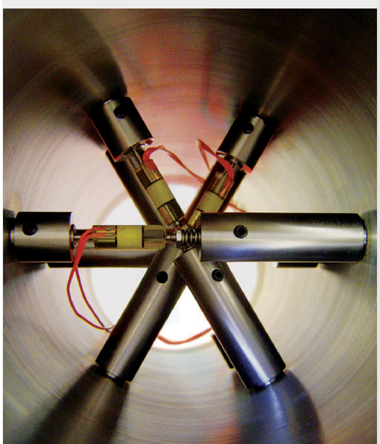
Although the diffusion coefficients measured for the concrete core samples are higher than those of the membrane samples (i.e. the VOCs can diffuse more readily through the concrete), the intact concrete would actually provide a higher overall level of resistance to diffusion of the VOCs due to its greater thickness. The resistance to diffusive transmission, or impedance, is represented by the thickness of the barrier divided by its diffusion coefficient for the compound in question. Based upon a typical 4-inch floor slab thickness, the relative impedance of the materials outlined previously (normalized to 60-mil HDPE) would be as shown in Table 2.

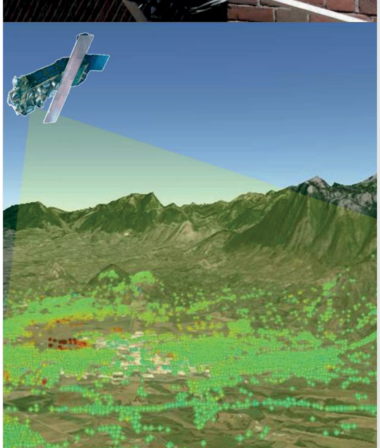
Accordingly, even low strength concrete (when intact) can provide significant resistance to the transmission of VOCs to the interior of a building. While a concrete floor slab can generally not be relied upon to function as a vapor barrier due to the potential for cracks to form within that material, the effects of the concrete floor slab on vapor probe monitoring results must be considered if the slab is in good condition.

One such example involved a former dry cleaning facility in San Diego, California where a 4-inch thick floor slab constructed of 2,500 psi concrete was present above a 60-mil spray-applied vapor barrier. PCE vapors were measured at a concentration of 5,000 ppm in a gas probe installed below the vapor barrier, and at a concentration of 350 ppm in a gas probe above the vapor barrier. The local regulatory agency initially concluded the vapor barrier was not functioning properly due to the elevated VOC levels measured above the barrier. Upon investigating the condition of the floor slab, it was found that it was in good condition with some minor localized cracking. The total area of the open cracks was found to be 0.018% of the area of the floor slab. Based upon that ratio and the testing results described previously, the impedance of the concrete floor slab was calculated to be 8% of that of the vapor barrier. It was shown that the PCE vapor concentration above the barrier, assuming the barrier was intact and functioning as intended, should be 350 ppm under that condition. This was consistent with the measured value and the barrier was approved by the regulatory agency.

Both of the cases involve common engineering monitoring problems where there are (or were) widespread misconceptions regarding the transmission of liquids or vapors across relatively impermeable barriers. In both instances, modeling and simulation of the barrier systems provided a means of understanding and quantifying the behavior and performance of those systems.

Glenn D. Tofani
Principal Engineer
GeoKinetics
77 Bunsen, Irvine, California 92618
Tel: (949) 502-5353
email: glenn@geokinetics.org





SECOND INTERNATIONAL COURSE ON GEOTECHNICAL AND STRUCTURAL MONITORING

June 4-6, 2015, Tuscany (Italy)

Course Director: John Dunnicliff, Consulting Engineer

Organizer: Paolo Mazzanti, NHAZCA S.r.l.

THE COURSE: following the first successful edition, this course in Italy will now be presented annually. Substantial improvements with new topics and new speakers are expected yearly. Attendance at the course is a great opportunity **to establish a valuable network** with colleagues from all over the world, **to meet manufacturers** and **see the most recent and innovative instrumentation**, thanks to a large exhibition area.

COURSE EMPHASIS: is on **why and how to monitor field** performance. The course will include planning monitoring programs, hardware and software, web-based and wireless monitoring, remote methods for monitoring deformation, vibration monitoring and offshore monitoring. Case histories presented by prominent international experts and discussion during the open forum will be an additional source of knowledge.

WHO: engineers, geologists and technicians who are involved with performance monitoring of geotechnical features of civil engineering, mining and oil and gas projects. Project managers and other decision-makers who are concerned with **management of RISK during construction**.

OBJECTIVE: to learn the who, why and how of successful geotechnical and structural monitoring while networking and sharing best practices with others in the geotechnical and structural monitoring community.

INSTRUCTION: **provided by leaders of the geotechnical and structural monitoring community,** representing users, manufacturers, designers and people from academia from all over the world.

LOCATION: the 3-day course will be held in Tuscany (Italy). In addition to providing an opportunity **to increase your own expertise** about geotechnical and structural monitoring, attendance at the course will give you **a beautiful cultural, historical and taste experience** in one of the most attractive places in the world.

As **John Gadsby** (publisher of this magazine) wrote in the September issue, "*The 2014 edition of this course was a great success. Anyone in the monitoring community should add this course to his/her list of 'to dos'*"

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