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COREBITS EVERYTHING G-I

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GeoPoem: The Mighty Micropile
By Mary C. Nodine
RST Instruments Ltd. offers 2 Wireless Data Collection Systems to quickly get you connected to your data: RSTAR and DT LINK. Both systems offer minimum per channel cost, extra long battery life and long distance data transmission.

**FEATURES**

- **DATA COLLECTION**
  - An RSTAR System uses data loggers (nodes) at the sensor level, deployed in a star topology from an active RSTAR Hub containing an RST flexDAQ Data Logger.
  - Up to 7 years of battery life from 1 lithium ‘C’ or ‘D’ cell.
  - Up to 14 km range from Hub to Node in open country. (depending on antenna type)
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  - Based on 900 MHz and 2.4 GHz spread spectrum band. (country dependent)

**FULLY AUTOMATED COLLECTION (REMTELY)**

- The RSTAR Hub shown left contains a flexDAQ Data Logger System with an antenna and battery. Collected data is saved to the flexDAQ memory where users can access it remotely, either on-site or off-site.

**SEMI-AUTOMATED COLLECTION (ON-SITE)**

- DT LINK is an on-site wireless connection to RST data loggers for quick data collection. Ideal for hard to access areas where the data logger is within line of sight.

**FEATURES**

- **DATA COLLECTION**
  - DT LINK is an on-site wireless connection to RST data loggers for quick data collection. Ideal for hard to access areas where the data logger is within line of sight.
  - Safely & easily collect data from data loggers that are in areas with poor access, trespass issues and hazardous obstacles.
  - Years of battery life from 1 lithium ‘C’ or ‘D’ cell.
  - Range up to 800 m (900 MHz) and up to 500 m (2.4 GHz).
  - Collect data in seconds with a laptop connected to DT LINK HUB.

*Watch the video for both systems at: www.rstinstruments.com/Wireless-Data-Collection.html*
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- Introduction to laboratory management reports
- Top tips for Geological modelling with AutoCAD Civil 3D
- Data mining with HoleBASE SI
- Exploiting XYZ points and surfaces in AutoCAD Civil 3D
- Mastering electronic scheduling

Our team have been watching your webinars on our 84” touch screen and we’ll use this approach for future webinars as it was really good to see everything together. We’ve seen lots of extra features we had not used before! These webinars have really helped in getting our team understanding the benefits of using your software and it’s going to change the way we work.

Scott White, BIM Manager
CEMENTATION SKANSAK LTD

So far they have touched on points that will help speed up our day to day use of Keynetix products. The webinar on Table Learning was extremely useful, as this is something we have been trying to achieve for a while now.

Michelle Hetherington, Engineering Geologist
MOTT MACDONALD

keynetix.com/webinars
Remember what it was like when we were kids, catapulting down the freeway on the way to our unknown destination? The never-ending pavement markers flickering by — click click click — the landscape changing almost imperceptibly; the sound of the highway — kathump kathump kathump. The folks in the front seat told us we were going someplace exciting, but at the time, we just couldn’t grasp what we would experience at the end of our journey. The folks in the front seat would turn occasionally and say, “We’re almost there.” Our destination floated up to us slowly on the horizon like a cloud seeping across the plain. And when our destination finally arrived, it was... well... golden. We stepped out of the station wagon to discover a new and exciting landscape previously unfamiliar to us.

And so it is with our professional lives. We live in the streamed world of opportunity and delivery coursing by, each day almost indistinguishable from the next. Only when we break from our daily routine and take two steps back can we see the ground we have covered, the accomplishments we have achieved. Sometimes we look up in the midst of our professional road trip to wonder what we will find at our next destination. Like those folks in the front seat, I want to turn and say to you, “We’re almost there.” A new and exciting destination is just over the horizon in our geo-future. Consider if you will...

We are in the midst of a geo-information technology explosion; we just don’t quite know it yet. There are those among us that already create cloud-based geo-data rooms full of digitized historical maps and GIS-located investigation data. And — get this — they are using these tools to predict what the subsurface conditions may look like with an assigned degree of confidence before even mobilizing the drill rig to the job site. We are increasingly using remote sensing tools to understand 3D construction movements in real time — enabling rapid response to construction, which fully leverages the benefits...
of the observational approach. Our university researchers are coupling small-strain bender elements with large-strain compression tests to enable the coupling of small- and large-strain design methods. And some researchers who have embraced unsaturated soil mechanics (we will all be doing this soon, ...really) are using remote sensing methods to measure soil water vapor to create maps of surficial soil conditions — a leap frog in our ability to understand subsurface conditions.

Despite the nauseating hand wringing by our political leads, our nation’s civil engineers have a great opportunity to respond to our enormous infrastructure needs. The digital visualizations of all of these developments are stunning — they change how we comprehend the unknown. Our U.S. demographics are nothing short of terrific, as we continue to gain a growing population base of home-born and foreign-born citizens who drive our endless innovation and keep us all fresh. Our growing population needs housing, transportation, power, water, and a clean environment, all of which require extensive infrastructure investment to sustain. The time is almost upon us that we have no choice but to build... what will change, however, is that we will not use yesterday’s methods to get there. The magnitude and scope of these developments will be enormous.

Our contracting norms are disappearing as our increasingly sophisticated owners seek valued engineered solutions. It used to be good enough to provide the lowest, first-cost solution. Those on the inside know that these simple days are fading. We are increasingly being asked to provide sustainable and resilient solutions that meet the needs of multiple stakeholders. This means that we are now exposed to human-oriented needs; those of us that understand these needs well and can effectively communicate to a wide spectrum of stakeholders will be the most successful. Our archaic contracting methods are changing rapidly from design-bid-build to investment-funded PPP and design-build ventures; these business models are rewarding innovation and propelling our best engineering minds to create new and amazing developments. Specialized design-build solutions are becoming the norm, with our consultants increasingly taking a higher-level view of the playing field. It means that we have opportunities to learn new mechanics and to challenge ourselves to ask, “What could go wrong as we embrace a method that is not so familiar?” And it means that our consultants have an opportunity to think bigger. No longer encumbered by providing detailed design submittals, we will, if we are smart, take this opportunity to advise our clients about the multitude of as-yet unknown contractor-led options that are emerging into the marketplace. We will see an explosion of options to choose from.

As we carry on in our everyday lives as geotechnical engineers, the days clicking by — click click click — the changes above are all happening RIGHT NOW. The landscape is changing. This new and exciting destination means that we get to deliver our great geo-solutions in new ways, to new people, with new methods. I can see the future destination now, and so can you. And it looks spectacular.

Kord Wissmann, PhD, PE, D.GE, M.ASCE
Geo-Institute President
kwissmann@geopier.com
Hardly a day goes by that we don’t hear something about the state of America’s infrastructure. It’s a hot topic on ASCE’s annual report cards, in trade publications and other non-technical media, in print, on television, and online.

Recently, less than a block from my office, an 1870s-era brick sewer degraded enough to erode the soil cover. It finally worked up to street level, where a fairly large sinkhole developed as the pavement section collapsed. An unlucky SUV happened to be passing by at just the wrong time and... bam!... it wound up with a front wheel in the void and a rear wheel up in the air. Fortunately, the occupants were uninjured, and the damage was minimal. I consider that lucky; other than disruption to traffic (no small matter in rush hour, gridlocked, downtown San Francisco), the sewer was repaired after a few days, and the street returned to normal. However, when the I-35 bridge in Minneapolis collapsed over the Mississippi River in 2007, many drivers and passengers were not so lucky: 13 people died and 145 were injured. Incidents like these are not as rare as they used to be.

We know the estimated cost for maintenance, repair, replacement, and upgrading of America’s infrastructure is in the trillions of dollars. But for myriad reasons, the money needed to tackle this gargantuan task simply has not been available in recent years. Yet we have to keep moving forward despite dwindling finances, and that calls for doing more with less. Project delivery, our theme for this issue, is a key aspect of how to tackle that need. From the traditional design-bid-build (DBB), to design-build (DB), to public-private-partnerships (P3), to construction manager at risk (CMAR), this issue of GEOSTRATA covers it all!

What’s Inside?
We begin this issue with two guest editorials. “Alternative Project Delivery: iPod or New Coke?” by Zachary Jones compares some of the issues that have surfaced in alternative project delivery applications to the introduction of two, well-known commercial products, one wildly successful, the other just the opposite. Then Gary Brierley’s “You Get What You Pay For!” discusses how geotechnical baseline reports, commonly used in underground construction, can work well — but they also have to be executed well... and they can’t be procured on the cheap.

Articles begin with “Answering the $64,000 Question,” by Douglas Gransberg, Kevin McLain, and Michael Loulakis. The authors point out that managing geotechnical risk can be difficult in conventional DBB projects, but the stakes increase even more when using design-build (DB). A key question is how much geotechnical investigation should the owner provide before advertising the DB contract? During the proposal stage, is there time for the DB teams to do additional investigation, or are they expected to price the project — including further geotechnical studies — on what are often insufficient preliminary studies?

In “Geotechnical Delivery on Mega Transportation Projects,” K.N. “Guna” Gunalan explains how, in the early days of alternative project delivery, reasonable amounts of time were provided through the procurement phase for geotechnical investigation, analysis, and design. Now, because “time is money,” delivery schedules
are being accelerated, pursuit times are getting shorter, and that can limit the amount of geotechnical information available to bidders. Thus, risk identification and risk sharing have become much more important to help ensure project success.

Michael Loulakis, Nancy Smith, and Douglas Gransberg have authored, “What Does the Case Law Say?” This article discusses the age-old question of who should bear the risk of unforeseen conditions. A number of recent cases are highlighted, including one dealing with the enforceability of owner disclaimer of liability provisions of the geotechnical information provided in project RFPs. The authors also cover cases dealing with alleged differing site conditions claims by the DB team and conflicts that arise during the design development process for foundations and other geotechnical project aspects.

In our fourth article, “Improving Cost and Schedule Performance on Municipal Pipeline Projects” by Mounir El Asmar, Samuel Ariaratnam, and Tober Francom, the authors discuss the limitations of DBB projects traditionally used for water and wastewater pipeline infrastructure projects. Construction Manager at Risk (CMAR) is an alternative project delivery method that can be used successfully on pipeline projects and was studied by the authors during a two-year-long study comparing CMAR and DBB. Among the topics they highlight from this study are contractual relationships between project stakeholders, contractor selection processes, pipeline industry perceptions of alternative project delivery methods, and measuring the performance of CMAR pipeline projects.

In this issue’s installment of “Lessons Learned from GeoLegends,” University of Michigan students Athena Gkrizi and Xunchang Fei present their interview of Michigan professor Richard Woods, an international authority on soil dynamics and, in particular, vibration of foundations. Professor Woods

CORRECTION: Figures were not identified correctly in the article “Optimized Drilled Shaft Design through Post-Grouting,” by Antonio Marinucci and Silas Nichols (May/June 2016 GEOSTRATA, p. 38-42). Where the text refers to Figures 1, 2, and 3, it should have referred to Figures 2, 3, and 4, respectively. The graphic labeled Figure 1 was inadvertently not cited in the text.

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Board of Governors Update

The key tool the Board uses these days to keep our organization moving forward is our Annual Operating Plan (AOP). One of the main areas of focus within the AOP is building and fostering relationships with allied organizations. As Dr. Wissmann pointed out in his first President’s Message last fall, we are working closer than ever with allies in the geoindustry, including GBA, DFI, SME and UCI, ADSC, and others. This allows us to not only enhance the profession on a national level, but also locally – bringing great content to our Chapters and Graduate Student Organizations (GSOs), another focus of our AOP.

You may have been hearing a lot about G-I’s efforts with GBA. The two organizations signed an MOU in 2015, which has enabled us to begin bringing business-related content to chapter and regional events. In the last few months, GBA representatives have visited our Seattle and San Antonio Chapters to share some great Ethics presentations. We would like to thank Phil King and Rick Smith for these visits and the offers to continue to work with our Local Involvement Committee (LIC) to bring more great content to our members. On a national level, for the first time ever, GBA opened up its Crystal Ball Workshop to the G-I, enabling us to provide a representative to share in the important discussions about emerging business trends and the future of our industry. When completed, we will be sharing the summary report from the Workshop in GEOSTRATA.

One of our newest MOUs is with the Underground Construction Association of the Society for Mining Metallurgy and Exploration (SME). A long name, but a close relationship with our own Underground Engineering and Construction Technical Committee. Together, these groups are planning traveling speaker programs and site visits of underground construction projects. What great synergy Paul Schmall (SME) and Liz Dwyer (G-I) have put together for student and local chapter events.

We will also again partner with ADSC, DFI, and PDCA to bring another IFCEE to the G-I calendar in 2018. The cooperative effort was such a success in 2015 in San Antonio, that we will bring it to you again in Orlando, FL. Planning is getting underway — be on the lookout for opportunities to participate.

G-I Board of Governors

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The Earth Retaining Structures Committee, chaired by Dimitrios Konstantakos, PE, M.ASCE, and the Geosynthetics Committee, chaired by Jorge G. Zornberg, PhD, PE, M.ASCE, conducted a technical review of the draft Protocol for Technical Evaluation of Earth Retention Systems for FHWA’s new Highway Innovations, Developments, Enhancements, and Advancements (IDEA) program. The IDEA program will be replacing FHWA’s current Highway Innovative Technology Evaluation Center (HITEC) program. The goal of the IDEA program is to foster further innovation with proven Earth Retaining System (ERS) technology, encourage the development of new technologies, and improve the methods by which the technologies are delivered to projects on the ground.

### Technical Committees

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The Grouting Committee, chaired by Paolo Gazzarrini, P.Eng, M.ASCE, provided photographs of ground modification for the draft update of the FHWA Ground Modification reference manual (GEC 13). The committee conducted a high-level technical review of the draft manual and provided cost data, case histories, and references to FHWA for inclusion in the manual. It has also been busy organizing the specialty conference “Grouting 2017: Grouting, Deep Mixing Method, and Diaphragm Walls,” to be held in Honolulu, HI, in July 2017. Additionally, the Grouting Committee has been reviewing the Jet Grouting Guide Specification, prepared by a task force of the committee, as well as the Compaction Grouting Consensus Guide, prepared by the Compaction Grouting Consensus Committee.

The Engineering Geology and Site Characterization Committee, chaired by Xiong (Bill) Yu, PhD, PE, M.ASCE, conducted a high-level technical review of the draft update to the FHWA’s Geotechnical Subsurface Characterization reference manual (GEC 5). The GEC revisions are a significant effort from FHWA to update their technical guidance, reflect the state of the practice in the design and construction of foundations and other geotechnical features, and support geotechnical policy for the agency.

The Geoenvironmental Engineering Committee, chaired by Dimitrios Zekkos, PhD, PE, M.ASCE, is organizing a one-day, U.S.-India bilateral workshop on “Establishing Linkages between Geoenvironmental Practices and Sustainability” in conjunction with Geo-Chicago 2016. The workshop will be held on August 18, 2016. It is a sequel to the first U.S.-India workshop held in New Delhi, India, in November 2010 under the Geo-Institute and the Indian Geotechnical Society Collaborative Agreement. Participants will include academics and practitioners with technical expertise in geotechnical, geosynthetic, environmental, or materials disciplines.

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TIP Reporter shows soil profile and reinforcing cage.
Titus Named Chairman of ASTM International Committee E36

Leo J. Titus, PE, M.ASCE, has been named the chairman of ASTM International’s Committee E36 on Accreditation & Certification. An engineer with more than 18 years of professional consulting engineering experience, Titus is the president of ECS Mid-Atlantic, a G-I Organizational Member, and has been a member of ASTM since 2001. ASTM is a leader in the development of voluntary consensus standards, which are used internationally to help improve product quality, enhance health and safety, and build consumer confidence.

An employee-owned firm whose principal owners are engineers, the parent company of ECS Mid-Atlantic — Engineering Consulting Services (ECS) — specializes in geotechnical engineering, environmental consulting, construction materials testing, and facilities engineering services. ECS has 50 locations in the Mid-Atlantic, South, and Midwest; employs 1,350 personnel; and ranks 86th on Engineering News-Record’s list of top 500 design firms.

Ryan Retires from Geo-Solutions

Chris Ryan, PE, D.GE, M.ASCE, has retired from Geo-Solutions, the specialty geoenvironmental/geotechnical contracting firm he founded and led for 20 years. Ryan’s early career was based with the Pittsburgh contractor Engineered Construction International (ECI), which formed two joint ventures with the French specialty construction companies Soletanche and Menard. Through his work with these two ventures, Ryan was introduced to sophisticated technologies applied to geotechnical work. He worked as a young engineer on sites through the U.S. and Europe and, after seven years, founded the specialty construction company Geo-Con, which grew from a one-man operation into a national specialty contractor with operations overseas as well. Geo-Con provided specialty equipment and experienced supervisors for a project, relying on local contractors to provide labor. This business model enabled Geo-Con to expand rapidly and to work in difficult labor markets.

Under Ryan’s leadership, Geo-Con expanded into the environmental remediation market as it developed in the 1980s, applying some of the technologies that had proved so successful in the geotechnical construction industry. Geo-Con was sold in 1995, and Ryan went on to found another specialty contractor, Geo-Solutions — a G-I Organizational Member — which focused on establishing relationships with owners early in the design process. Geo-Solutions worked throughout the U.S. and on sites throughout the world. A Canadian subsidiary handled its extensive operations throughout Canada.

Moretrench’s Sopko Honored by Michigan State

Joseph A. Sopko, PhD, PE, M.ASCE, the director of ground freezing for Moretrench, has been named a distinguished alumnus by Michigan State University’s (MSU) Department of Civil and Environmental Engineering. He was recognized at a formal presentation on May 7, and then again during MSU’s undergraduate commencement the following day. Sopko received his bachelor’s, master’s, and doctoral degrees from Michigan State, and has dedicated his career to ground freezing technology. He joined Moretrench in 2010, and has been instrumental in expanding the firm’s reach into Canada and South America.

Smith Inducted into Virginia Tech’s Academy of Distinguished Alumni

Elizabeth M. Smith, PE, GE, D.GE, M.ASCE, a senior principal and the national program manager for transportation for Terracon, was selected as one of six 2015 inductees into the Academy of Distinguished Alumni of the Charles Edward Via, Jr., Department of Civil and Environmental Engineering at Virginia Polytechnic Institute and State University. Smith earned both her bachelor’s and master’s degrees in civil engineering from Virginia Tech. Academy alumni are selected on the basis of their overall career accomplishments and contributions to the profession. Virginia Tech has more than 10,000 civil engineering graduates, but only 108 have been inducted into the Academy as of 2015.

Detournay Elected to NAE Foreign Membership

Emmanuel Detournay, PhD, A.M.ASCE, has been elected a foreign member of the National Academy of Engineering (NAE). Election to the NAE is among the highest professional distinctions accorded an engineer. Academy membership honors those who have made outstanding contributions to “engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature and to the pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/ implementing innovative approaches to education.” To date there are 2,275 U.S. members and 232 foreign members.

Detournay, who is a professor in the Department of Civil, Environmental, and Geo-Engineering at the University of Minnesota, was elected for his contributions to advances in hydraulic fracturing and drilling dynamics.

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Alternative Project Delivery: iPod or New Coke?

By Zachary D. Jones, JD

In the mid-1980s, Pepsi began taking market share from Coca-Cola (Coke). In response, Coke reformulated its recipe and introduced New Coke. It flopped. Within weeks Coke ditched New Coke and reverted to the old recipe that everyone now knows as Coca-Cola Classic. Fast forward to 2001, when Apple introduced a portable media player called the iPod. That introduction became a watershed event for mobile technology. Both products utilized the same marketing message: they were innovative, new, and the wave of the future. However, their very different outcomes teach us to read past the headlines.

Alternative project delivery (APD) is not necessarily a new concept. Delivering civil construction projects through a design-build framework dates to ancient Greece — though today’s design-build probably looks markedly different than the Greeks’. Even in the modern era, APD has been around for some time. Over the last decade, however, its use has dramatically increased. APD is now billed as the “wave of the future” in the construction industry.

Today’s APD takes different forms than it has in the past. Ask three insiders to define a public-private-partnership...
bonds, and the contracts are silent on the statute fails to explicitly require payment The problem arises when the P3-enabling whether subcontractors have lien rights. whether payment bonds are required or public and private, the open question is on private projects. Because P3s are liens, which are generally available only payment bonds serve as a substitute to mechanics projects can look to payment bonds for subcontractors' claims are secured. years exposed the issue of whether unpaid readies apparent before construction. APD can have important consequences at all levels. For example, a series of legal cases dealing with P3s in recent project delivery provides a degree of confidence as to the rights and obligations of each project participant. Mixing up those relationships poses potential pitfalls — some of which may not be APD has no widely accepted standard contracts. Moreover, owners have been attracted to P3s, in part, because of their “creative” funding mechanisms, and those funding mechanisms tend to drive the contractual relationships. In other words, one reason APD is attractive is that it tends to be more flexible than traditional delivery methods.

The flexibility provided by APD can be both advantageous and risky, though the benefit of predictability inherent with traditional project delivery methods is often lost. While taking the road less traveled may solve one problem, lawyers like myself are always wary that taking the less-traveled road could open a Pandora's box of other problems. Traditional project delivery provides a degree of confidence as to the rights and obligations of each project participant. Mixing up those relationships poses potential pitfalls — some of which may not be readily apparent before construction.

APD can have important consequences at all levels. For example, a series of legal cases dealing with P3s in recent years exposed the issue of whether unpaid subcontractors' claims are secured. Typically, subcontractors on public projects can look to payment bonds for security if they are not paid. Payment bonds serve as a substitute to mechanics liens, which are generally available only on private projects. Because P3s are public and private, the open question is whether payment bonds are required or whether subcontractors have lien rights. The problem arises when the P3-enabling statute fails to explicitly require payment bonds, and the contracts are silent on the point. That situation puts courts in a position to either fashion a remedy or leave subcontractors vulnerable to unsecured claims for payment against an insolvent contractor. Since this issue arose, some states have addressed it by statute, but others have not.

P3s are not the only projects to experience problems. Many states allow public projects to be delivered via other APD methods. Statutes covering these other APD methods are often overly broad or ambiguous, leaving participating unclear on their contractual obligations. And the problems are not limited to public projects either. Obligations of design consultants, for example, are often blurred where an owner contracts with a contractor-led design-build team. This can be especially problematic when the owner has provided detailed programming or preliminary design, or where the contractor has compartmentalized design, or is one of multiple primes on a design-build project. Recent trends show public agencies often experiment with APDs on large projects without testing them on smaller projects first. Familiarity of all project participants with a particular APD method is probably the best barometer of how smoothly a project will run.

Risk management is also a key component. APD may provide many potential benefits, but the risk posed by unknown factors must enter into the equation. Participants must be able to identify and then either allocate or insure against risk. If participants at any level fail to account for unknown risks, the project is placed in unnecessary jeopardy. Opportunistic behavior of engaging participants under a shroud of misunderstandings is a recipe for failure. The better approach is to ensure that all participants have a full and complete understanding of their rights and obligations.

APD will enable many projects to come to market that otherwise would not. Many of these projects will be built without any major difficulties, but some will not. In time, I am confident the industry at-large will understand how to address these growing pains. In the meantime, the best advice is to simply tread carefully, taking time to fully understand the contractual arrangement before signing on the dotted line. APD is often presented as innovative, new, and the wave of the future. If the industry is careful to embrace it, APD may well end up like the iPod — but if it does not, it may be doomed to the same fate as New Coke. ☹

ZACHARY D. JONES, JD, is an attorney with Stites & Harbison, PLLC, in Louisville, KY. His practice is primarily devoted to serving the construction industry and companies that do business with municipalities, states, and the federal government. Before becoming a lawyer, Zach bid on and managed heavy civil contracts across the southeastern U.S. As an attorney, he advises clients on procurement issues, contracts, and claims. Zach can be reached at zjones@stites.com.
Most of my 45-year professional career has been devoted to the design and construction management of underground openings. During that time, I have observed and been involved with advancements in design methodology, construction technology, and performance monitoring of these structures. These advancements have helped reduce the risks associated with underground construction, but from a business perspective, Geotechnical Baseline Reports (GBRs) have been equally important in managing the risk and cost of these ventures.

In my article “So, Why Do You Want to Write a GBR?” (March/April 2014 issue of GEOSTRATA), I describe why they have become so important in helping deal with third party impacts, resolving disputes, planning field monitoring programs, and allocating risk among project participants. In the article, I admonish geotechnical engineers who decide to write a GBR to “do a good job writing your GBR and make certain that it is compatible with all other project specifications and drawings. GBRs are not a good vehicle for on-the-job training! Know what you are doing and put a lot of thought into writing your GBR.”
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A recent lawsuit (Apex vs SHN) involving the use of a GBR has reared its ugly head in California (see Loulakis, *CE Magazine*, February 2016, p. 88). The primary objective of this commentary is to place this seemingly unfortunate outcome into the larger context of the history and purpose of GBR preparation as described in the ASCE publication entitled *Geotechnical Baseline Reports for Construction, Suggested Guidelines* (2007).

In my *GEOSTRATA* article, I noted that there are four important objectives associated with a GBR:

1. Assist the Owner with managing the subsurface risks associated with underground construction
2. Provide the Contractor with the information that is required to prepare a reasonable and prudent work plan and cost estimate for the work
3. Help all team members avoid negative impacts to overlying and/or adjacent third parties
4. Serve as the basis for the resolution of claims of differing site conditions

In the good old days (say 30 years ago), it was common practice to provide prospective Bidders with the results of test borings, and for each Bidder to decide how that subsurface information impacted that Bidder’s plan for accomplishing the work. If, or should I say when, a project experienced difficulties, then the question before the resolving body was: Did the Bidder make reasonable and prudent decisions about ground conditions and ground behavior based upon the subsurface information available at the time of bid? Over time, it became painfully obvious that the time limitations and anxiety factors associated with a typical bidding scenario did not create the best environment for making reasonable and prudent decisions about the work; thus, the GBR concept was developed to help improve that situation.

As a result, the underground industry decided that the project Engineers, in consort with the Owner, would provide what they believed to be reasonable and prudent recommendations for the work in the form of a GBR to reduce the chances for project difficulties, and to minimize the need for prospective bidders to carry substantial contingencies in their bids for unknown site conditions. In general, and based upon a couple of decades of experience, this approach has now been shown to work well, and to have greatly improved the outcomes of underground construction projects. But that doesn’t mean that some underground projects cannot still encounter serious difficulties.

Sometimes, despite all best efforts, Mother Nature throws a wrench into the works. Trying to predict every conceivable potential problem that can occur for large underground projects in highly variable ground conditions is simply not possible, and subsurface problems that occur during construction still need to be addressed either during construction or by some form of dispute resolution. This problem is, and always will be, a part of underground construction. Sometimes Mother Nature simply will not cooperate, no matter what’s done to control that risk.

And even more seriously, if a project is begun with anything less than a solid subsurface effort, then it is not surprising that the chance of something going wrong will increase dramatically. So the best advice for a project Owner and its design team when contemplating an underground project is: don’t cut corners; don’t play games; don’t bury your head in the sand; don’t put a contract on the street that you believe is less than what is required to accomplish the intended purpose.

To my knowledge, this is the first lawsuit associated with the use of a GBR. In general, projects utilizing GBRS also make allowance for the use of a Dispute Review Board and, as a result, issues associated with alleged differing site conditions have been resolved without recourse to the adversarial legal system. Hence, it will be interesting to see how this case is resolved, but one thing is clear to me based upon the case summary provided by Mr. Loulakis: the GBR was not the problem. In this case, it appears to me that the GBR was no more than a vehicle for myriad project deficiencies created by using the results of a single, remotely-located test boring, which resulted in a serious project dispute. There is nothing wrong and, in fact, there is a lot that’s right, about the whole concept of using GBRS to improve the outcome of underground projects. As always, however, there’s a right way and a wrong way to do anything, and that includes the preparation of a GBR. In addition, and more importantly, this case may serve as the best argument yet for the contractually mandated use of Dispute Review Boards for projects involving large amounts of underground construction.

**GARY S. BRIERLEY, PhD, PE, F.ASCE** is president of Dr. Mole, Inc., located in Denver, CO. Gary specializes in providing high-level underground consulting services, primarily for tunneling projects. He can be reached at gbrierley@drmoleinc.com.
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Richard D. Woods joined the faculty of the Department of Civil and Environmental Engineering at the University of Michigan in 1967 and is still actively involved in academic activities. During his 40+-year academic career, Woods developed and taught a wide range of courses in geotechnical engineering, including soil mechanics, field sampling and lab testing of soils, soil dynamics and geotechnical earthquake engineering, civil engineering vibrations laboratory, and geophysical techniques in geotechnical engineering. Woods has co-authored three textbooks: *Vibrations of Soils and Foundations*, *Distinct Element Modelling in Geomechanics*, and *NCHRP Synthesis of Highway Practice 253: Dynamic Effects of Pile Installations on Adjacent Structures*.

Besides teaching, Woods has supervised 21 doctoral theses and has authored or co-authored more than 150 publications that have greatly influenced geotechnical practice. Fortune 500 companies and government agencies have retained him to work on critical projects in the U.S. and overseas, most notably foundations for four nuclear plants in Brazil, two nuclear plants in Michigan, and the Tarbela Dam in Pakistan. He was instrumental in developing for Corning Glass a low-vibration foundation on which high-precision optical fiber could be manufactured. With his pioneering research in soil dynamics and spectral analysis of surface waves, he has greatly influenced how machine and building foundation systems are designed and constructed, and how geomaterials are non-destructively characterized in situ.

Woods chaired the Soil Mechanics and Foundation Engineering Division of ASCE in 1989 and was a co-organizer of the U.S. Universities Council on Geotechnical Engineering Research (USUCGER), as well as the Environmental and Engineering Geophysics Society. He was vice president for
North America of the ISSMGE from 2001-2005. His many awards include: member of the National Academy of Engineering (2003); G-I Hero (2012); Distinguished Member of ASCE (2004) and recipient of its prestigious Karl Terzaghi Lecturer (1997) and Collingwood Prize (1969); and the honor of being chosen to deliver multiple distinguished lectures at several universities across the U.S. and abroad.

Richard Woods received his bachelor’s and master’s degrees in civil engineering in 1957 and 1962, respectively, from the University of Notre Dame. Before he became a PhD student at the University of Michigan, Woods was an instructor at Michigan Technological University. He received his doctoral degree in 1967 from University of Michigan. He was promoted to professor in 1976 and became professor emeritus in 2002.

Q: What early life experiences influenced your career choice?
I grew up in Lansing, MI. My father was a building contractor who worked on structures in Lansing, as well as many of the important buildings at Michigan State University. This was during the period just after the Korean War. While I was in high school, I was his driver and took him to construction sites, so I became very interested in construction and eventually civil engineering. After completing my bachelor’s degree, I joined the Marine Corps and spent three years as an engineering officer. After I was discharged, I returned to Notre Dame for a master’s degree in soil mechanics and foundation engineering.

Q: How did your years in the U.S. Marine Corps influence your career?
My initial training in the Marine Corps was for embarkation officer. Later, I worked for the Navy Judge Advocate General, the legal department of the Navy. I prepared water use evaluations in a huge water rights litigation between the Navy and the landowners in the Santa Margarita River’s watershed along the Pacific Coast in California. That’s when I developed an interest in hydraulics and hydrology while working on the litigation.

Q: Who most influenced your career?
My dad got me into construction and civil engineering activities. In my undergraduate program, Professor James McCarthy, who taught concrete structures, influenced me the most. In my master’s program, Professor Leroy Graves got me started in soil mechanics and foundation engineering. After finishing my master’s, I got a job at the Air Force Weapons Laboratory, and my civilian supervisor was George Young, who later invited me to become an instructor at Michigan Tech. George was a classmate of Professor Frank Richart, Jr., when they were at the University of Illinois. Richart had just moved to the University of Michigan from the University of Florida. When he visited Michigan Tech in 1963, he offered me an NSF fellowship to come to Michigan as a PhD student. While I had many mentors, Bill Richart’s influence on me was profound and led me to a career-long interest in soil dynamics.

Q: What can you tell us about Professor Richart?
Richart received his PhD in structural...
engineering from the University of Illinois in 1948 under Nathan Newmark. His first academic position was at Harvard University to work with Professor Westergaard, who died soon after Richart arrived. While at Harvard, he met Karl Terzaghi, who interested him in foundation engineering in general, and soil dynamics in particular. Richart was a professor of civil engineering at the University of Florida from 1952 to 1962. He then joined the University of Michigan as professor and chairman of civil engineering in 1962, and served in that post until 1969. He continued on as professor until his retirement in 1985.

Richart attracted an amazing number of PhD students in soil dynamics. His students included John Lysmer, Jack Hall, Jr., Bobby Hardin, Bob Bea, Vince Drnevich, Ken Stokoe, Don Anderson, and me, among others. Richart was just the right person to work with. He stayed mostly out of your way, secured the money, facilities, and the space you needed, and was always there to help. He offered me the opportunity to co-author *Vibrations of Soils and Foundations*, and encouraged me to stay at Michigan after receiving my PhD. He was just a wonderful friend and supporter for the remainder of his life.

Q: What was your role in the development of soil dynamics?

When I started at Michigan, we were in the middle of the Cold War, and Bill Richart was working with the Corps of Engineers on foundations for radar towers. There was a strong need for dynamic foundation design methods for those towers, so he and his students were working on that issue. The results of that research were applicable to machine foundation design. One unresolved question at the time was that of isolating foundations from vibrations. One idea was to build a trench as a barrier to vibrations, and I picked up on that. For all dynamic design, one thing we needed to know was the shear modulus of the soil. At that stage, I began exploring that question and picked up the Corps of Engineers’ process of Rayleigh Wave dispersion. For that process, we determined velocities from applied frequencies and measured wave lengths.

In the early 1970s, we continued to look for ways of measuring shear modulus in situ. While on a leave of absence at the University of Karlsruhe in Germany, I learned about a dual channel waveform analyzer to get the phase between vibrations at two locations on the ground surface created by the blow of a hammer. With that information, we could get the speed of the Rayleigh wave for each frequency or wave length contained in the blow. My first PhD student, Prof. Kenneth Stokoe, II, picked up on that approach and developed the SASW soil investigation method.

From 1970 until 1985, I worked on holographic interferometry. The idea was to get the “whole” picture of ground motion by freezing one exposure and taking a second exposure at a slightly different time with the ground surface vibrating. The combined exposures led to a hologram showing contours of surface displacement. Alternatively, a diagram of contours of equal displacement could be developed that showed the whole wave front and the effectiveness barriers of any shape and depth.
Q: What’s your most significant contribution to the geotechnical engineering profession?
It’s probably the development of methods for making shear wave velocity measurements of soil with depth in the field. I suppose the screening of waves is pretty important too, because there have been several attempts to check it, and my results were always confirmed to be right. I also feel being a part of writing the Richart, Hall, and Woods textbook was significant because for a long time, that was the only available book on soil dynamics and turned out to be the foundation for a lot of dynamics work. These three things stand out.

Q: What were your two most memorable engineering projects?
The Tarbela Dam project in Pakistan was quite memorable. When the dam was almost finished and the

Woods inspects shale conditions at the bottom of a caisson that supported the Optical Fiber Draw Tower at Corning Glass Works.

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reservoir began filling, troubles started. One problem was vibration of the tunnel walls and outlet gate operating equipment caused by the water coming out of the tunnels. I spent three consecutive summers measuring the amplification of ground motion of the main dam and outlet structures. The dam’s measured natural vibrations were compared with seismic calculations because the foothills of the Himalayas are very seismically active. It was that information, along with the shear wave velocity measurements of the dam itself, that was the most satisfying for me. Our measurements on ground motions amplification were substantially confirmed as the first mode natural frequency of the dam by calculations of Professors Wylie, Streeter, and Richart at the University of Michigan using the numerical Method of Characteristics.

A similarly intensive program was the construction and licensing of a nuclear power plant in Brazil designed by Kraftwerk Union (KU). It was built at Angra dos Reis along the south Atlantic coast, about 70 miles from Rio de Janeiro. The containment vessel for the reactor was supported on 1.3-m-diameter piles in sand. An international group was hired to check KU’s design and concluded that the already-built piles were not adequately reinforced after the maximum acceleration was increased. KU chipped out the upper portions of the piles and reinforced them. The international group requested that backfilled sand should have the same shear wave velocity as it was before. Bill Richart was hired to see to it, so we ran resonant column tests and recommended a procedure. They proceeded to compact fill in one-foot lifts between the piles using vibratory compactors. Then they ran crosshole tests to see if they made the design velocity, and they did. They would go up another step and put more sand in and compact it, and they would continue with the old crosshole tests until they recognized that the shear wave velocity was diminishing. But as they put more confinement around the pile, the shear wave velocity was going down. What was going on? The contractor changed the pumps that were dewatering the sand and let the water table come up. So, they were changing the effective confining pressure by changing the water table! Those layers that were compacted above the water table had capillarity working for them, so there was additional confinement because of the capillary tension and the water being sucked up. That’s the way we learned that, in fact, the compaction was being done as we specified, but the confining pressure was significantly different to account for that decrease in velocity when the water table came up.

Q: What do you most like about being a geotechnical engineer?

I moved into soil mechanics and soil dynamics based more on perceived need for the Cold War effort and for foundations for nuclear power plants. The need for knowledge in this area and the opportunity to contribute to it was the most attractive thing for me. There were important problems to be solved that only geotechnical engineering, as I saw it at that time, was going to address. Another attraction was, unlike structural engineering, geotechnical engineering can’t be driven totally by
codes and statutes. I just believe there are more opportunities for innovation in geotechnical than in other areas.

Q: What are some shortcomings of geotechnical engineering research and practice?

For many years, soil mechanics was sort of the main focus, but environmental issues came along, and that made us look elsewhere. I think we are doing a lot more now studying biological and chemical processes because of the emergence of geoenvironmental engineering and the need to look at other sciences along with soil mechanics. Another thing I noticed, from almost the time I finished my thesis, was that we tended to ignore geophysics,
although we are now doing a little bit better. And again, the environmental side is helping drive that. Both of those areas that I think have shortcomings are slowly emerging, and people who are crossing over and doing double degrees with sciences are part of the solution.

Another problem is in the practice of geotechnical engineering. Other disciplines control some of our important work. We are treated as a supplier or sub-contractor and expected to bid a fixed price on geotechnical exploration and design. Geotechnical engineering cannot be done well under those circumstances. You need to be able to explore different solutions, instead of fixing on one thing because your bid has given you only so much money, going only in that direction. I was a principal of a geotechnical consulting firm, so I know a little bit about the practice, and I am disappointed in the way that it has gone. Some of that problem is being resolved with the design-build concept. In that case, the participating geotechnical engineer may have a little more flexibility.

Q: What’s the future of soil dynamics and geotechnical engineering?

Not many of us have this view, but in-situ dynamic measurements are going to be the standard for characterizing soil, not the exception. I say that because modulus is a fundamental property that we can measure in the field, from the surface, in a nondestructive and noninvasive way. What is bearing capacity based on? Settlement? What it comes down to is most everything must be designed on the basis of deformations, and modulus is the way to get there. The popular method for settlement analysis with Schmertmann’s technique, for example, depends on the summation of strain. How do you get strains? You get them from modulus and stress. So, now we can easily measure modulus with shear wave velocity from SASW and MASW.

Q: If you had to do it all over again, would you change anything?

I wouldn’t change anything about my career. I’ve had a very lucky sequence of positions and people to work with. I’ve been happy with the institutions that I’ve been associated with, and they have supported my learning and professional interests. I’ve been lucky in my personal life, too, having been blessed with a wonderful and supportive family. If you don’t have that, you are not going to get very far.

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Woods with the authors, Xunchang Fei (left) and Athena Gkrizi (right).
Subsurface risk may well be the aspect of most construction projects that has the greatest potential impact on a project’s success or failure. Even when a thorough geotechnical investigation is conducted as part of the design process, the owner may still be liable for differing site conditions found after construction has commenced. Thus, if managing geotechnical risk is difficult in projects delivered using the traditional design-bid-build (DBB) method, the stakes go way up when the owner decides to complete a project using design-build (DB) project delivery.

Answering the $64,000 Question

Geotechnical Risk in Design-Build Projects

In DBB, the project’s design is complete before the construction contract is advertised. However, DB delivery requires that the design-builder complete the design and the construction under a single contract. With that process comes the distinct possibility that the subsurface geotechnical investigation will be undertaken by the DB contractor after the price for the project has been established. Therein lies the proverbial $64,000 question: how much investigation, if any, should the owner conduct prior to advertising the DB contract to characterize the geotechnical conditions upon which the competing design-build teams must base their price?

It’s a Risky Business
DB project delivery is a relatively recent development in the highway construction industry. While public agencies have used it on building projects since the 1970s, it did not appear in the transportation arena until the beginning of the 21st Century. The Utah Department of Transportation implemented it as the only way to accelerate highway construction for the 2002 Winter Olympics.

A major reason for the delayed entry of DB is the difference in the physical scale of a building project and a highway project. In the architectural world, the probability that previously unknown subsurface conditions will adversely impact a construction project is generally limited to the footprint of the building. However, the sheer size and linear nature of a transportation project greatly increases the probability that a differing site condition will be encountered. Couple that risk with the fact that most utility systems have been constructed in the right of way of the nation’s roads, and the chance that the owner will be exposed to a serious differing site conditions claim soars.

To make things even more difficult for the owner’s geotechnical engineer, most public transportation agencies reserve DB project delivery for those jobs that demand an aggressive schedule. This further diminishes the time for
both owner and the winning design-builder to conduct the subsurface investigations and analyses necessary to mitigate the project’s geotechnical risk. The DB contractor is obligated to commit to a firm, fixed price before the design is complete, and in many cases, before any new subsurface investigations have been undertaken. Thus, the design-builder must include contingencies to cover the cost that will be incurred if the geotechnical design assumptions that were made during proposal development turn out to be wrong. Due to the nature of a lump sum construction contract, the owner pays contingencies regardless of whether or not they are actually realized.

If this discussion is not sufficient to convince you that dealing with geotechnical risk in DB projects is extremely difficult, then consider the latest developments affecting federally funded highway projects. In 2010, the Federal Highway Administration (FHWA) rolled out its Every Day Counts (EDC) initiative. Its aim is to better address the nation’s rapidly deteriorating roads and bridges and create incentives for state departments of transportation (DOT) to accelerate the delivery of rapid renewal construction projects. One of the elements of that initiative was to encourage DB usage as a proven tool to reduce project delivery times.

In 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) allowed the FHWA to reduce the amount of state matching funds if the DOT delivered the federal-aid project using DB. This brought a new level of complexity to the issue, and the perfect storm of geotechnical risk exposure was born. First, responsibility for conducting the geotechnical investigation and preparing the final geotechnical design report shifted to the contractor after the project price was fixed. Second, the financial incentives also gave cash-strapped DOTs a very good reason to experiment with DB delivery on projects where, previously, geotechnical conditions may have precluded that decision. These factors further increased the potential for a catastrophic loss due to unmitigated subsurface risk.

The Search for a Solution

These risk issues quickly captured the attention of the geotechnical community within the state DOTs. In 2010, the Transportation Research Board’s National Cooperative Highway Research Program (NCHRP) commissioned a synthesis study to benchmark the state-of-the-practice on managing geotechnical risks in DB projects. The results of the study were published in 2012 as NCHRP Synthesis 429, Geotechnical Information Practices in Design-Build Projects (onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_429.pdf).

Synthesis 429 contained survey responses from 42 DOTs, and analyses of DB solicitation documents and DB policy documents/guidelines from 26 states, 12 DOTs, and 5 federal agencies, respectively. Eleven DB contractors whose markets encompass over 30 states were interviewed. The synthesis contained legal case studies on DB differing site conditions claims from Colorado, Illinois, and Virginia. Methods used by DOTs to address DB geotechnical risk are illustrated with geotechnical engineering cases studies from Hawaii, Minnesota, Missouri, and Montana.

Synthesis 429 documented a number of effective practices for managing geotechnical risk. The study’s overriding conclusion is that the project owner cannot escape liability for differing site conditions using contractual risk-shedding clauses. The Washington State DOT (WSDOT) is one agency that recognizes that reality. WSDOT’s DB guidelines explicitly state that the DOT owns the geotechnical risk and must manage it through active collaboration with its DB contractors, both before and after contract award.

The other major task of an NCHRP synthesis study is to identify gaps in the body of knowledge that require further research. Synthesis 429 identified several important research needs. Consequently, the TRB Standing Committee on Foundations of Bridges and Other Structures (AFS30) successfully supported a research needs statement, which became...
NCHRP Project 24-44, Guidelines for Managing Geotechnical Risks in Design-Build Projects. The Synthesis team is continuing its work under the auspices of this project. A primary objective of NCHRP 24-44 is to develop a decision tool that can be used by DOTs to determine if DB project delivery is appropriate, regardless of the potential incentives. Figure 1 is a conceptual depiction of how the process will operate after it is developed.

Effective Practices for Managing Design-Build Geotechnical Risk

Synthesis 429 identified 15 effective practices for managing and mitigating geotechnical risk covering the procurement, post-award design, and construction phases of a DB project. The following summary outlines several of the most important points.

The geotechnical and site engineering package is typically the first major design package completed before any construction activities begin. Uncertainty about subsurface conditions is always high until this information is available. Therefore, the owner must facilitate its completion as expeditiously as possible. Two proven practices were found in the study: (1) requiring highly qualified and experienced geotechnical personnel on the design-builder’s staff, and (2) assigning the agency’s most qualified and experienced geotechnical personnel to DB project review and oversight. In both cases, the goal is to quickly identify and implement approved solutions to the geotechnical design problems found during the development of the Geotechnical Design Report. An early release for construction of the subsurface features of the work is also encouraged to facilitate discovery and resolution of differing site conditions as soon as possible in the DB project.

Another highly effective practice is using alternative technical concepts (ATC) as a part of the DB procurement. ATCs are also part of the FHWA Every Day Counts initiative and corresponding incentives. DOTs that used this practice accepted geotechnical ATCs in confidential, one-on-one meetings and often permitted competing design-builders to request or obtain additional subsurface information before submitting their final proposals. The Minnesota DOT reaped a multi-million-dollar savings from a DB contractor’s ATC that involved the use of a column-supported fill (Figure 2). Part of the ATC involved contractor-furnished instrumentation to permit the DOT to monitor settlement in the fill during the extended warranty period that was also offered by the contractor.

Another effective practice worth noting involved a series of techniques to support the expeditious design, review, and acceptance of the final geotechnical and subsurface design as follows:

- Restricting the DOT to a single, interim design review before the final release for construction review
- Maximizing the use of informal, over-the-shoulder design reviews, rather than interrupting the progress of the design to prepare a formal review package
- Permitting release of geotechnical design packages for construction before the remainder of the design is complete, thus accelerating the discovery and resolution of differing site conditions
- Treating the geotechnical and design quality management program differently than the remainder of the project by increased agency involvement in the geotechnical aspects of quality assurance, quality control, verification, and acceptance

Answering the $64,000 Question

There is no simple, single answer to the question of how much geotechnical investigation must be completed prior to advertising a DB project to protect the owner from differing site conditions claims. However, Synthesis 429 provides a nationwide benchmark of successful practices for identifying, quantifying, and managing geotechnical risk in DB projects.

Figure 2. Column-supported fill used in the Hastings Bridge DB project. (Courtesy of the Minnesota DOT.)
Due to space constraints, this article has only covered the most effective practices found in the study. (The reader can check the complete document for other results and recommendations.) The perfect storm of geotechnical risk created by DB delivery of a project with significant geotechnical issues has a simple bottom line: the decision to implement DB cannot be taken lightly.

**Answer #1:** If the consequences of the perceived risk greatly outweigh the benefits achieved by completing the project faster than the traditional DBB delivery method, DB delivery is probably not the optimum procurement solution.

The case law on the topic clearly shows that there is no simple contractual clause that, with the stroke of a pen, neatly guarantees the shift of geotechnical risk from the owner to the design-builder. The Washington State DOT’s *Guidebook for Design-build Highway Project Development* provides a very pragmatic perspective on the issue when it states: “Ultimately, WSDOT will own responsibility for Changed and Differing Site Conditions.” The Synthesis survey response from WSDOT includes the following comment describing a tool for resolving differing site conditions that may be encountered in the critical early stages of the DB project: “We [assign] all changed conditions under a certain dollar amount (different amounts for different contracts) to the contractor’s risk. If that threshold is exceeded, then the department pays for the costs above the threshold.” This is an elegant solution to a potentially thorny problem. By including this mechanism, the design-builder has an opportunity to include an appropriate contingency in its proposed price — up to the stated value of its risk. In this case, the contractor does not need to add money to cover the possibility that the agency won’t recognize a differing site conditions claim.

**Answer #2:** Recognize that no contractual risk-shedding clause will be able to indemnify the owner for differing site conditions claims. Mitigate the cost by permitting the commencement of excavations, utility relocations, etc., before the entire design is complete. This will help to identify any unknown conditions as early as possible in the project delivery process.

The final strategy for DB projects with significant geotechnical and/or subsurface issues is to focus more on “time certainty” rather than “time savings.” Once the design-builder’s meter starts running on a given project, the cost per unit of time is large and increases as more resources are committed to the job. By focusing on reducing geotechnical uncertainty, the owner is actively sharing the risk with the design-builder. Investing in geotechnical investigations has a potentially high return, particularly if the “unknowns” can be identified in a manner that allows the project to proceed according to its published schedule without the need to resort to the courts before project close-out. Unfortunately, public agency engineers are rarely praised or given awards for finishing on-budget and on-schedule. Geo-professionals will just have to pat themselves on the back and take satisfaction for a job well done.

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What Does the Case Law Say?

Geotechnical Risk on Design-Build Projects

By Michael C. Loulakis, Esq., DBIA, Aff. M.ASCE, Nancy C. Smith, Esq., DBIA, and Douglas D. Gransberg, PhD, PE, DBIA, M.ASCE

The growth of design-build (DB) contracting, particularly on public-sector civil projects, has generated a great deal of industry discussion over the age-old question of who should bear the risk of unforeseen conditions. Fortunately for the architect/engineer/construction (AEC) industry — and unfortunately for the parties that had to bear the cost and risk of litigation — there are a number of recent cases that help answer this question. As will be discussed in this article, some DB cases specifically address the enforceability of the agency’s disclaimer of liability for the geotechnical information contained in the project’s Request for Proposal (RFP). Others arise in the context of alleged differing site conditions (DSC) claims asserted by the design-builder. Yet others address conflicts encountered during the design development process for foundations and other geotechnical matters.

Geotechnical Disclaimers and the Metcalf Case

Many DB contracts require that the design-builder conduct, as part of its design process, a comprehensive geotechnical assessment of the site. These contracts often include broad disclaimers of liability for the geotechnical information furnished by the owner during the procurement process. As a consequence, when a design-builder claims that it encountered a DSC based on the owner’s geotechnical information, the owner argues that the claim should be denied because: (a) the geotechnical information it provided was preliminary and incomplete and, based on contractual disclaimers, could not be relied upon by the design-builder; and (b) the design-builder had the contractual duty to perform the full geotechnical assessment.

This argument was essentially what the Navy used in Metcalf Construction Co. v. United States (2014). While the trial court agreed with the Navy, the Federal Circuit Court of
Appeals reversed the decision, and provided an informative opinion as to how DSC claims are to be treated on DB projects. Metcalf involved a Navy procurement for a $48 million housing facility at a Marine Corps base in Hawaii. The RFP included a soils report that identified the soils as having “slight expansion potential,” and noted that this was relevant to certain features of the project, such as concrete foundations. It also stated that the soils report was for “preliminary information only,” with the contract obligating the design-builder to conduct its own soils investigation after contract award.

After award, Metcalf’s geotechnical engineer discovered that the soil’s swelling potential was “moderate to high” (i.e., not “slight”) and recommended some design changes to deal with those conditions. Metcalf also discovered higher levels of chlordane, a chemical contaminant, than expected from the representations in the RFP. Metcalf promptly notified the Navy, and the parties then held protracted discussions over what to do.

Almost a year after the issue arose, the Navy rejected the DSC claim, and Metcalf used post-tension concrete slabs to mitigate the time and cost of over-excavating and importing select fill. Metcalf was also directed by the Navy to remediate the contaminant. Metcalf’s total claim, inclusive of other alleged breaches by the Navy of its duty of good faith and fair dealing, was approximately $25 million.

In ruling in favor of the Navy, the trial court concluded that because Metcalf had to investigate the soil conditions during performance, Metcalf could not rely upon the RFP’s representations about the soil characteristics. The appellate court flatly rejected this, finding that the lower court misinterpreted the contract:

Nothing in the contract’s general requirements that Metcalf check the site as part of designing and building the housing units, after the contract was entered into, expressly or implicitly warned Metcalf that it could not rely on, and that instead it bore the risk of error in the government’s affirmative representations about the soil conditions.

The appellate court differentiated between Metcalf’s post-award obligation to conduct additional investigations and Metcalf’s pre-award right to reasonably rely upon the Navy’s geotechnical information as it bid the project. Citing decades-old precedent, the appellate court stated that the DSC clause was incorporated into the contract to “take at least some of the gamble on subsurface conditions out of bidding.” The court also highlighted that the phrase “for preliminary information only” was not an effective disclaimer. The phrase, the court held, “merely signals that the information might change (it is ‘preliminary’). It does not say that Metcalf bears the risk if the ‘preliminary’ information turns out to be inaccurate.”

Virtually all DB contracts require the design-builder to augment the owner’s geotechnical investigation as part of the project.

Footing or drilled pier — which is it?
of the design development process. Likewise, solicitation documents, regardless of whether the project is DB or design-bid-build, frequently disclaim responsibility for information contained in the owner’s geotechnical reports. The Metcalf opinion is consistent with decades of DSC precedent, as it did not enforce the disclaimer and recognized the right of the bidder to reasonably rely upon the owner’s geotechnical representations during the bidding process. Importantly, it also clarified that a design-builder’s post-award geotechnical investigation obligation will not impact its DSC rights.

Recommended vs. Mandatory Geotechnical Design Requirements

Several cases have involved conflicts between owners and design-builders over foundation designs, and particularly whether the RFP documents expressed “mandatory requirements” or simply “recommendations.” These cases are typically decided by the court interpreting the specific language of the RFP documents, as well as looking at how the parties conducted themselves during the proposal and design development process.

For example, in Appeal of PBS&J Constructors, Inc. in 2014, the design-builder filed an appeal to the Armed Services Board of Contract Appeals when the U.S. Army Corps of Engineers (USACE) refused to allow it to use spread footings to support balconies on a barracks project. The RFP documents identified drilled piers as a “recommended foundation system.” They stated that spread footings were not considered a viable alternative and, therefore, not allowed. The contract required the design-builder’s geotechnical engineer to provide design calculations to support its ultimate recommendation.

During design development, the design-builder’s initial geotechnical report showed the balconies supported by concrete piers. The final foundation design, however, contained a revised geotechnical report, and showed, for the first time, the possibility of using spread footing foundations. It appeared that the design-builder wanted to use spread footings because it was encountering installation problems with drilled piers on other areas of the project and was looking to save time and money. USACE refused to allow this, believing that it was entitled to strict compliance with the contract, which, it contended, had disallowed spread footings and required deep foundations.

PBS&J argued that the contract was ambiguous, because, among other things, the RFP’s foundation specifications were not prescriptive, as they used the terms “recommended” and “recommendations,” which the design-builder argued were not “requirements.” In rejecting PBS&J’s argument, the board was influenced by the fact that, for much of the contract performance period, PBS&J had interpreted the contract as not allowing spread footings for the balconies, as its early designs had shown the use of concrete piers.

Contrast this result with Record Steel and Construction v. United States in 2004, which likewise involved a dispute over whether geotechnical design specifications were requirements or simply recommendations. The RFP’s foundation analysis report recommended over-excavating the materials below the building’s footings. The design-builder’s proposal informed the USACE that it did not believe over-excavation would be required, and this was discussed during several design meetings, both before and after contract award. The parties agreed that the design-builder’s geotechnical firm was to conduct field investigations and tests and provide such information to both the design-builder and the USACE. If the resulting data were satisfactory, then the design-builder could proceed with its design without conducting over-excavation.

The geotechnical firm concluded that the native soils were adequate to support the building’s footings without over-excavation. However, the USACE apparently re-evaluated its position and refused to issue a notice to proceed for the footings unless the design-builder agreed to conform to “requirements” of the subsurface recommendations and over-excavate the site. The design-builder complied with this order and submitted a claim for the costs associated with the over-excavation effort.

The U.S. Court of Federal Claims ruled against the USACE, finding that the design-builder, as the designer-of-record, was expected to exercise its professional judgment in designing the dormitory and had to defer only to specific requirements contained in the RFP, not to recommendations. Looking at the
entirety of the RFP’s foundation report, the court found that the report was ambiguous as to whether over-excavated was simply recommended or was mandated. The USACE, as the drafter of the report, bore the risk of this ambiguity, and found in favor of the design-builder.

Owners, and those engineers working for owners, should be mindful of the importance of clearly depicting mandatory versus recommended approaches. As noted in Record Steel, and consistent with best design-build practices, the design-builder’s design team should be given some discretion in the design process. Because engineers can differ on how to approach an issue, an RFP’s “recommendation” will likely not be construed as a requirement by a court.

**Managing the Design Process**

One of the hardest things about executing the DB process is managing the design development process. This impacts not only how contractors interface with their designers and subcontractors, but also owners that are reviewing design submittals from design-builders.

Challenges in managing the design process was the cause of a dispute between the design-builder and foundation subcontractor in Flatiron-Lane v. Case Atlantic Company (2015). The project involved a North Carolina DOT replacement bridge project; the litigation centered around determining which party was responsible for the substantial delays to the drilled shaft foundations. The decision noted that the relationship between the parties was adversarial from the start of construction, with the key problem being that the foundation subcontractor had a different view of the shaft design than did the design-builder’s engineer.

The subcontractor’s price was based on installing oversized, temporary steel casings, and then driving a permanent inner steel casing through the temporary casing until competent material was reached and appropriate end-bearing resistance achieved. It would then fill the annular space with grout. The designers, on the other hand, anticipated achieving the required resistance by using both end-bearing resistance and skin friction. Its design was based on the use of a permanent steel casing that was larger in diameter than the shaft design.
This would result in a completed shaft where the upper part was surrounded by steel casing, and the lower part would have concrete in direct contact with the surrounding soils. Unfortunately, the designers did not know what the subcontractor was envisioning, and the design-builder did not allow the subcontractor to directly communicate with the designers. As a result, the designer faced a substantial number of challenges as it modified its design to accommodate the subcontractor’s approach. In holding that the design-builder could not recover against the subcontractor for its delay and lost productivity claims, the court concluded that the design-builder: (a) should have known that its designers were designing in a manner inconsistent with the subcontractor’s plan; and (b) failed to fulfill its duty to coordinate the work of the two parties.

**Additional Thoughts**

While understanding case law on DB projects is informative, so too is understanding the general policy behind the DSC clause – in essence, “take the risk of unexpected site conditions out of the bidding process, and pay for the costs of these only if they are actually encountered during project performance.” Unfortunately, many owners (aided by their engineering consultants) try to have it both ways, hoping to gain the benefits of low bids and no site-condition risk. Thus, geotechnical information is furnished with “warning labels” that essentially say, “Here’s the information, but you can’t rely upon it.” On design-bid-build projects, the law is well-settled, as there are a plethora of cases that will not enforce the “warning labels” and recognize a contractor’s right to contractual relief when it encounters a DSC. While to date there are only a handful of reported cases that discuss geotechnical claims on DB projects, the results to date are consistent with design-bid-build precedent. This, of course, is good for design-builders and their subconsultants and subcontractors.

On the other hand, design-builders must recognize that DB geotechnical risk is not just about DSC claims. It involves managing the design review process, as well as making professional decisions about what is really appropriate for a design assumption and what is not. It means understanding the difference between “mandatory” owner design requirements and “recommended” geotechnical approaches identified by the owner. It also means facing responsibility if the design-builder’s geotechnical design results in a deficient result.

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Challenges of Accelerated Delivery

By Kancheepuram N. "Guna" Gunalan, PhD, PE, D.GE, F.ASCE
Transportation projects have traditionally been delivered through the design-bid-build (DBB) delivery model, which continues to be the preferred method of delivering the majority of smaller and more traditional projects. Recently, however, elected officials and agency professionals have been seeking ways to accelerate delivery of infrastructure improvements in response to demands by the public to find a better way. This response has caused many transportation agencies to turn to alternative delivery methods such as public-private partnerships (P3), design–build (DB), and construction manager/general contractor (CM/GC). There are myriad reasons for agencies to ask for accelerated delivery, including environmental factors, impacts on traffic and the local economy, material and labor cost escalations over time, lost economic opportunities, and global competitiveness, just to name a few. So, what challenges do geo-professionals face when it comes to accelerated delivery of mega transportation projects?

Delivery Methods
For ages, transportation infrastructure has been vital to the economic well-being of communities worldwide, and will remain so for the foreseeable future. Communities and their elected officials are looking for ways to become more globally competitive, either through trade or tourism. They are asking their transportation officials and agencies to deliver projects faster, whether small or large, to make sure that they stay competitive with relatively no lost time. These expectations have caused projects to become larger and more complex. In turn, these demands have required innovative methods to meet the demands of the growing need for speedier project delivery.

Professionals involved with delivering mega transportation projects are aware of, or should be aware of, the various alternative project delivery methods being employed by agencies here in the U.S. and around the world. Further, most geo-professional practitioners should possess a good understanding of the differences between the various modes of delivery, including their applicability, relative merits, and business risk challenges.

One popular form of alternative delivery — design-build — is becoming more mainstream within many state agencies, whether through a public-private partnership (P3) format or a traditional, owner-funded DB model. The main difference between the two is that a P3 includes capital investment in a form of financial investment by the private sector; examples include toll revenue, differed payment, and construction gap financing. The traditional DB delivery method then takes one of three forms: low-bid, best value, or qualification-based selection DB.

In all cases, the DB delivery method places responsibility for both the design and construction with one entity, namely the design-builder. This helps mitigate risk associated with the agency coordinating and playing referee between...
the designer and contractor. It also allows for more timely collaboration, innovation, and resolution of issues. However, this is not the case when using the construction manager/general contractor CM/GC method of delivery. GM/GC is used when there are a number of issues yet to be resolved with other stakeholders that can only be handled by the agency, (e.g., right-of-way, utility, stakeholder betterments).

Size and Complexity Impacts on Delivery
Transportation projects have been historically smaller in size, with the exception of a few projects in the 1980s and early 1990s, like Boston’s Big Dig. The cost of the Big Dig was in the range of tens of billions of dollars and involved a number of complex issues associated with being located in densely populated and fully developed sections of Boston. The project was delivered through multiple contractors, most of which utilized the traditional DBB delivery model over a period of approximately 18 years. DBB provided designers an opportunity to collect and gather available information, to obtain more information through additional field investigation and laboratory testing, and to evaluate, analyze, and research new technologies to address a number of complex geotechnical challenges. The project utilized a number of cutting edge new technologies in ground improvement, such as ground freezing, which have since become mainstream approaches in geotechnical engineering practice today.

During the early days of alternative delivery, which included the development, procurement, and execution of southern California’s Foothill South Toll Road, three projects in Utah (I-15 reconstruction in Salt Lake County, the Legacy Parkway in northern Davis County, and the I-15 New Ogden Weber [NOW] Project), and the I-40 interchange in Albuquerque, NM, a reasonable amount of time was provided during the procurement phase of the project. This time was used to assemble geotechnical information and conduct any additional investigations necessary to supplement the existing data available for the project.

For the I-15 reconstruction project in Salt Lake County, UT, in addition to the early information dating back to the original construction of the freeway through the valley in the 1960s and 1970s, information was provided from an additional 1,300 boreholes. Through best-value procurement, this project made use of a number of innovative construction approaches, including wick drains with or without surcharge, one- and two-stage MSE walls, and stone columns to mitigate liquefaction. Additionally, lime-cement columns were used, as well as the largest-then-to-date use of geofoam (Figure 1) to accelerate construction. The technique also addressed the large magnitude of settlements that stemmed from the underlying sediments associated with historic Lake Bonneville, including extended secondary settlements. On the Legacy Parkway, there was time to monitor a test embankment to help estimate settlement of the Lake Bonneville sediments bearing embankment loads, and to install piles to verify drivability, embedment depth, set-up, and load transfer capacity.

Since the Big Dig, there has been a continued growth of projects in size and complexity, with project costs now ranging from $300 million to over $3 billion. Per the October 2015 issue of the Public Works Finance newsletter, the estimated global mega-project pipeline for 2016 using design-build to finance, operate, and maintain delivery is around $75 billion. If the Boston Big Dig was to be delivered today, it’s not certain that the public, and the agencies that represent them, would have the patience for an extended procurement, design, and delivery process. Mega transportation projects of more recent times, such as the Port of Miami Tunnel, Seattle’s Alaska Way Viaduct, the Tappan Zee Bridge carrying I-287 traffic over the Hudson River in Tarrytown, NY, the Kosciuszko (or K) Bridge carrying I-278 traffic over Newtown Creek between the Brooklyn and Queens boroughs in New York City, the I-595 Port Everglades Expressway in Florida, and the I-4 project in Orlando, FL, are a few of the major undertakings that have been or are being delivered through various forms of alternative delivery.

Though all of these projects are presently being delivered under the umbrella of “alternative delivery” and include DB as a predominant component, each is unique in the way it has been structured. Without going into too much detail, understanding and addressing the geotechnical challenges associated with any of these projects and delivery methods will be very beneficial to practicing geoprofessionals in the future. It is not only the understanding of the issues, but how to address the risk under different circumstances, that is paramount.

The Challenges
In an accelerated delivery scenario, the entire project schedule gets compressed, including the development, preliminary engineering, and procurement and execution phases. Of significance to this discussion is that the pursuit phase of DB procurements is getting shorter, even for mega projects. Accelerated procurement schedules are not allowing the agency, or the consultant supporting the agency, the luxury of time to research, collect, and share all of the available geotechnical information and any relevant construction details for the original project.

The information that’s available may not be comprehensive or complete in terms of frequency or number of borings, depth of borings, adequate sampling to properly characterize subsurface conditions, etc. Owner agencies are unwilling to take responsibility for the characterization of ground conditions other than those identified at the borehole location for legal reasons, such as claims of differing site conditions. However, for construction of underground facilities such as tunnels, it’s common practice for owners to generate geotechnical baseline reports (GBR) that the design-builder can rely on in developing its proposal and cost estimates. Despite this typical procedure, there are times when the information is not being provided in a timely manner for geo-professionals to utilize in development of the preliminary design for the design-builder.
Further, there is generally insufficient as-built information available to geo-professionals to calibrate the analysis model that can then be used to analyze the behavior of subgrade soils under the anticipated future loading conditions. As such, contractors are reluctant to instrument projects due to the potential risk of a non-compliant determination by the owner of performance requirements stipulated in the project agreement and insurance claim issues. Hence, the risk of relying on the information or requiring validation of the information or completeness rests with the DB team.

Another hurdle is that owner agencies are now more cognizant about the challenge and risk that surface when there’s a lack of information that causes contingencies to increase. These could get built into the proposals and add to the overall cost of the project. Hence, owners often provide proposers the opportunity to conduct additional investigation independently, or are willing to undertake additional investigation on behalf of all proposers to supplement the information already provided. In other instances, where there are specific challenges and the owner is concerned about its ability to evaluate the various proposals in a consistent manner, agencies may actually require a specific solution that can impede creativity and innovation while adding a significant cost to the project. Examples include prescribed mitigation for potential liquefaction or sinkhole formations.

Geotechnical challenges on an accelerated project are no different or more difficult than those on a traditionally

<table>
<thead>
<tr>
<th>RISK NO.</th>
<th>DESIGN RISK Y/N</th>
<th>BRIEF RISK DESCRIPTION</th>
<th>TYPE OF RISK</th>
<th>PROBABILITY (POSSIBLE, LIKELY, PROBABLE)</th>
<th>IMPACT (MODERATE, MAJOR, CATASTROPHIC)</th>
<th>DESIGN RISK MITIGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Y</td>
<td>Insufficient soil data at foundation locations.</td>
<td>Price Engineering</td>
<td></td>
<td></td>
<td>Request additional exploration or site access to perform CPTs.</td>
</tr>
<tr>
<td>2</td>
<td>Y</td>
<td>Borings do not extend to adequate depths needed for reliable estimate deep foundation quantities.</td>
<td>Price Engineering</td>
<td></td>
<td></td>
<td>Schedule permitting, perform CPTs to supplement available information.</td>
</tr>
<tr>
<td>3</td>
<td>Y</td>
<td>No clear performance criteria defined to address events such as liquefaction and sinkholes.</td>
<td>Price Engineering</td>
<td></td>
<td></td>
<td>Develop a mitigation memo and get early buy-in.</td>
</tr>
<tr>
<td>4</td>
<td>N</td>
<td>Foundations. The soil conditions for a large section of the bridge structure make installation of the pile-support structure uncertain. The foundations as designed may not reach required capacity. Time and costs associated with load verification of large foundations. Agency acceptance of test program.</td>
<td>Price Schedule Engineering</td>
<td></td>
<td></td>
<td>Evaluate/redesign foundations - increase number and/or depth of foundations, pre bore, etc. based on extensive geotechnical evaluation. Owner provides requirements for verification testing and acceptance criteria.</td>
</tr>
<tr>
<td>5</td>
<td>N</td>
<td>Lack of reliable information on utility locations or ability to relocate during proposal phase, resulting in foundation design changes or changes in proposed bridge layouts.</td>
<td>Engineering Schedule</td>
<td></td>
<td></td>
<td>Conduct subsurface utility exploration before submitting foundation packages for specific areas.</td>
</tr>
<tr>
<td>6</td>
<td>N</td>
<td>Delays in gaining access to locations where critical path activities must be executed.</td>
<td>Schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>N</td>
<td>Coordination of bridge construction activities result in delays.</td>
<td>Schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Y</td>
<td>Delays in design reviews or acceptance.</td>
<td>Schedule</td>
<td></td>
<td></td>
<td>Engage early with agency and stakeholders.</td>
</tr>
<tr>
<td>9</td>
<td>N</td>
<td>Cannot accurately determine need for casing in pier installations due to insufficient groundwater data.</td>
<td>Price Schedule</td>
<td></td>
<td></td>
<td>Collaborate, communicate, and collectively agree on approach.</td>
</tr>
<tr>
<td>10</td>
<td>Y</td>
<td>Predicted settlement magnitudes exceed time rate of settlement.</td>
<td>Price Schedule</td>
<td></td>
<td></td>
<td>Communicate, collectively agree to a strategy, e.g., accelerate settlement using wicks/surcharge.</td>
</tr>
</tbody>
</table>

Table 1. Typical risk register.
 delivered project. The variable is the time allocated for review, evaluation, analysis, and design. Typical geotechnical challenges on mega transportation projects include types of concerns that are the same as on smaller projects: settlement, time rate of settlement, stability, impacts on adjacent infrastructure and properties, high groundwater, soft subgrade conditions, frost susceptibility, corrosion potential, and clay content and relative expansiveness, to name a few. Depending on the location of the project, other challenges could include seismic impacts such as liquefaction and lateral spread, karst-related issues such as sinkhole formation, and building over construction landfills or over sources of water upstream of wetlands.

Risk and Risk Sharing

The design-builder usually requires the geo-professional to provide a design that can be relied on with a high level of confidence (75 percent or higher) to develop construction cost estimates within a given level of risk. Because many procurements are DB, the contractor assumes the risk for both cost and schedule. The risk is then passed on to the designers and ultimately to the geotechnical engineer, who bears the burden of developing an aggressive solution for design that will ultimately help the contractor price it accordingly and win the project. Presumably, the geotechnical engineer can negotiate a success fee for its services that offsets the costs it incurs and includes a reasonable fee for its profit and risk. But passing the risk from the owner to the design-builder, or from the design-builder to the designer and ultimately to the geo-professional, does not solve the problem. It only adds to the amount of built-in contingency, depending on the number of entities it gets passed on to, while the cost to mitigate potential risks still remains the same.

The response to the challenge by the geo-professional will depend on a number of things such as personnel experience, knowledge, past experience with the owner agency, design and contractor partners, and contract terms and conditions. The solution could be simple and straightforward, but will be influenced considerably by these outside elements. It’s therefore critical that the effort be transparent and collaborative so that the solution is sound, constructible, and economical.

Path Forward

The success of the mega project starts with development of a strong strategy by the owner agency. This includes identification of all risks — and specifically geotechnical risks or challenges that will have a high impact on the schedule and cost of the project — and then appropriately allocating these risks using a fair and equitable contractual vehicle. In addition, a flexible and innovative DB contract contributes to a successful project.

For the pursuit of these mega projects, it is now becoming a standard practice for the teams to develop their respective risk register (Table 1) of all major elements of work. The register for most pursuits includes identification of potential geotechnical risks, such as high groundwater, soft subgrade soils, frost susceptibility soils, shrink-swell potential of subgrade soils, depth to bearing strata, etc. Geo-professionals who have been in the business long enough understand the risk and liability of not having enough information or not having the time to adequately evaluate the above to address the stringent performance requirements being dictated by owners.

In addition, these mega projects are now being delivered by firms, or a consortium of firms, that may or may not have the benefit of local knowledge and experience, as some of them may be from outside the local region and, in some instances, could even come from outside the country. This puts a lot of pressure on the local geo-professionals, who will need to deal with limited information, rely on their experience with or without tangible evidence, and who will be challenged by members of the consortium. It will be very prudent for the geo-professional to be open and candid about the geotechnical challenges to be addressed. It is important to identify those elements that may be at risk and allocate probability (possible, likely, and probable) and impact (moderate, major, and catastrophic) of the risk based on the experience of the individuals.

When the team has a high level of confidence that a certain approach will work, it can assign a low probability of occurrence (possible) to the work and label it as having low impact (moderate). However if the assessment is that the probability is “probable” and the impact could be “catastrophic,” one should assign a high risk to the element of work and build adequate contingency in terms of both budget and schedule to address the issue and monitor it very closely so as not to impact the outcome.

Geo-professionals are very creative and will be able to develop quality solutions that will address the issues at hand. Collaborative effort will be needed between the geo-professional and the team — including the design-builder — to develop an approach that will not only reduce the net present value of the project, but will also reduce the life cycle cost of the project and serve the end users well for years to come. In addition to the technical challenges discussed above, geo-professionals will also need to deal with contractual risks like “due diligence, standard of care, and performance requirements,” to name a few of the terms that are becoming more common between the developer, design-builder, and themselves.

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Improving Cost and Schedule Performance on Municipal Pipeline Projects

Realizing the Benefits of the Construction Manager at Risk (CMAR) Alternative Project Delivery Method

By Mounir El Asmar, PhD, A.M.ASCE, Samuel T. Ariaratnam, PhD, PE, P.Eng., F.ASCE, and Tober Francom, PhD, S.M.ASCE
The water and wastewater infrastructure in the United States is failing. In its 2013 Report Card on American Infrastructure, ASCE stated: “The water and wastewater infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with a strong risk of failure.”

Failures in water and wastewater pipeline infrastructure can have many impacts on the public, including disruption in water delivery, impediments to emergency response, water pollution, and damage to roadways and other types of infrastructure. Significant reinvestment is needed to replace, rehabilitate, and expand the pipeline network. In fact, the U.S. Environmental Protection Agency (EPA) estimates that approximately $632.8 billion of investment is needed for water and wastewater systems, with $281.6 billion (46 percent) specifically allocated for pipeline investment by 2028.

Alternative Project Delivery Methods
To maximize the benefit of the money invested, engineering and construction must be completed efficiently, both with respect to cost and time. Alternative project delivery methods (APDM) have the potential to deliver projects more efficiently than conventional delivery approaches. Currently, the typical method for delivering water and wastewater pipeline engineering and construction projects is design-bid-build (DBB), a sequential process that can lead to inefficiencies and adverse relationships between owners, design engineers, and contractors. These adverse relationships are often caused by a lack of stakeholder integration and communication. For example, in most DBB projects the contractor is engaged only after the engineer had completed the design of the project. APDM helps improve integration between these key stakeholders and ultimately enhances project performance.

The complex nature of pipeline projects renders them ideal candidates for APDM because when using traditional
DBB delivery, differences in project understanding can arise, often created by a lack of technical exchange between design engineers and contractors. Complexity comes from the fact that: 1) geotechnical risks are present because subsurface conditions are always uncertain; and 2) design engineers may have limited knowledge of installation methods such as trenchless technologies, which often leads to the design of pipeline projects that are unconstructable or have high risk. Furthermore, subsurface geotechnical conditions dictate the method(s) and tooling applicable to the pipeline installation. Improved integration between design engineers and contractors leads to increased project success through better recognition and management of risk. One commonly used APDM is the construction manager at risk (CMAR) method.

How do CMAR projects perform on water and wastewater pipeline projects? The authors are part of a group of researchers at Arizona State University (ASU) that conducted a two-year study to investigate. The project involved collaborating with several organizations and professionals who generously volunteered their time to provide project data by filling out surveys and participating in several interviews and research meetings. The study, titled "Performance of the Construction Manager at Risk (CMAR) Delivery Method Applied to Pipeline Construction Projects," forms the basis for the observations in this article.

Figure 1 compares DBB and CMAR project delivery methods and highlights the contractual relationships between project stakeholders and the timing of their engagement. For both methods, the owner signs separate contracts with the engineer and the contractor. The major difference is the timing of the contractor’s engagement. In DBB, the contractor is typically engaged after the design is complete and is rarely able to provide input during the design. In contrast, the CMAR firm is engaged before the design is complete, typically between completion of 30 and 60 percent of the design development, which helps to maximize the benefit of collaboration and minimize redesign. Moreover, the design engineer and CMAR firm often are contractually required to coordinate during the design phase of the project, unlike in the traditional DBB method. These differences highlight the increased timing of engagement of the CMAR firm and the ability to provide more coordination and communication during the design phase.

Another key difference is the process of selecting the contractor. DBB frequently uses a selection process where the lowest responsible bidding contractor is selected, regardless of experience or qualifications. In contrast, with CMAR the owner typically selects the contractor based on a combination of cost and qualifications. This process
leads to the owner selecting a contractor that has more experience and/or is more qualified to complete the project. The term "construction manager at risk" means the selected construction management firm guarantees to the owner a schedule and a maximum price for the project, which is in contrast to a less popular type of delivery system called "construction management (CM) agent," where the firm typically does not guarantee the price.

Research found CMAR has been successfully implemented in the building and transportation industries, offering owners numerous benefits over DBB, including significant improvements in project cost and schedule performance. In fact, CMAR's documented ability to improve project performance is leading to its continuous and substantial increase in popularity in these industries. The use of CMAR has the potential to improve performance over DBB on pipeline projects, too. Until our recent research, comprehensive studies comparing the performance of CMAR to DBB in the pipeline engineering and construction industry had not been performed. Our findings fill this gap in knowledge by comparing the cost and schedule performance of CMAR pipeline projects to that of projects using the traditional DBB method.

**Pipeline Industry Perceptions of APDM**

The first step in the research study was to understand the perception of APDM in the pipeline industry. Pipeline industry stakeholders were surveyed to investigate the utilization rate, industry comfort level, and perceptions of performance of APDM. Thirty-four owners, engineers, and contractors completed the survey, which was shared with a total of 57 professionals in the engineering and construction industry. The results of the survey indicate that the most utilized project delivery system is still the traditional DBB system, followed by design-build (DB), and then CMAR. Respondents had a medium comfort level for implementing and using CMAR on their pipeline projects. About a quarter of respondents perceived CMAR as the project delivery method that can offer the best schedule performance when compared to other prominent delivery methods. However, a third to a half of respondents still felt the traditional DBB delivery method offers superior performance. Given that (1) the use of CMAR in the pipeline industry is not yet widespread, and (2) these perception results are not in line with what we have learned from other industries more experienced with CMAR, these results formed a strong motivation for the next step of the research. In fact, understanding industry perceptions on performance helped focus the research scope and provided a foundation for a quantitative performance study in which we collected actual (as opposed
to perceived) performance data on completed pipeline projects.

**Measuring the Performance of CMAR Pipeline Projects**

With CMAR gaining popularity in the pipeline engineering and construction industry in general, there is a need to understand its performance. Through collaboration with a large municipality in the state of Arizona, 66 CMAR pipeline projects were identified and studied. The projects ranged from 2003 to 2015, had a total construction value of slightly over $400 million in 2015 dollars, and total scope of approximately 40 miles of pipelines.

Figure 2 illustrates the characteristics of the CMAR projects, including the diameter, utility type, and construction type. The pie charts on the top of Figure 2 show percentages based on the number of projects, while the pie charts on the bottom of the figure show percentages based on total cost. The majority (by number of projects) were wastewater pipeline projects; however, the total cost of the water and wastewater projects was nearly identical. This is due to the municipality delivering several sizeable water projects using CMAR. Nearly 70 percent of the projects were for rehabilitation or installation of pipelines with diameters greater than 24 in., totaling approximately $350 million (88 percent of the total cost). Roughly half of the projects involved rehabilitation of deteriorating pipelines using trenchless construction methods such as sliplining, cured-in-place pipe (CIPP), and pipe bursting. The other half consists of new construction pipelines installed using traditional, open-cut methods.

Cost and schedule data for the 66 CMAR projects were collected, in addition to 41 comparable DBB projects. The dataset was then reduced to only similarly sized projects to allow for a fair comparison of performance for the CMAR and DBB projects. This resulted in 89 projects (49 CMAR and 40 DBB), each of which was under $5.5 million.

Project cost and schedule are two critically important metrics. Deviations from the budgeted cost or schedule can have significant impacts for the owner and the contractor. Schedule growth was calculated for each project based on the collected schedule data, and is defined as the percentage increase from the intended schedule at the time of the award, to the final actual time it took to complete the project. Figure 3 shows the schedule growth for the DBB and CMAR projects, displaying the sample lower quartile, median, and upper quartile. The thick black line, dividing the dataset in half, represents the median value. The colored box represents the 50 percent of data around the median, whereas the remaining 50 percent of data are divided equally above and below the box between the thin horizontal lines called whiskers. The small circles outside of the horizontal lines represent statistical outliers.

The median schedule growth was 18.33 percent for the DBB projects and 5.83 percent for the CMAR projects. As shown in Figure 3, that is a significant difference of 12.50 percent. In fact, statistical validation provides even greater confidence in these results and confirms that CMAR projects are being delivered with less schedule growth as compared to similar DBB pipeline projects. We learned that CMAR helps control project schedule.

Similar to schedule growth, we compared cost growth for both DBB and CMAR pipeline projects to determine which delivery system offers superior performance. Cost growth is defined as the percentage increase from the
contracted price at the time of the award to the actual final cost of the project. Figure 4 illustrates a comparison of cost growth for DBB and CMAR. Even prior to performing any statistical analyses, one can see that CMAR projects experience considerably less cost growth than their DBB counterparts. The DBB projects had a median cost growth of 0.55 percent, while the CMAR projects had a median cost savings (the opposite of cost growth) of 6.05 percent. This means CMAR pipeline projects are being delivered with 6.50 percent less cost growth than similar DBB projects. Again, the observed differences are statistically significant, indicating that CMAR offers pipeline projects a superior cost growth performance compared to DBB. Similar to the schedule performance finding, we also learned that CMAR helps control project cost.

Our analysis stemming from more than 100 comparable CMAR and DBB projects provides the first statistical evidence that CMAR offers greater performance compared to traditional delivery methods for pipeline projects. Based on additional qualitative evaluations, we believe the major reason for this observed superiority is engaging the CMAR firm before the design is complete. This allows the contractor to provide input during the design, which leads to fewer changes and rework, and ultimately better control of cost and schedule.

**Case Study: Water Transmission Main Rehabilitation**

After quantitatively measuring the performance of CMAR, we examined a case study of the use of CMAR to deliver a critical, 10-year rehabilitation program by the City of Phoenix, AZ. When deterioration became evident, the City began an extensive condition assessment of the entire Val Vista Water Transmission Main.

![Figure 5. Val Vista Water Transmission Main sliplining. (Photos courtesy of Kiewit Infrastructure West Co.)](image)

<table>
<thead>
<tr>
<th>PHASE</th>
<th>LENGTH (LF)</th>
<th>INITIAL COST ($)</th>
<th>FINAL COST ($)</th>
<th>COST SAVINGS ($)</th>
<th>TARGET SCHEDULE (DAYS)</th>
<th>SCHEDULE (DAYS)</th>
<th>SCHEDULE SAVINGS (DAYS)</th>
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<td>A</td>
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<td>379</td>
<td>396</td>
<td>(17)</td>
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<tr>
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<td><strong>$74,919,461</strong></td>
<td><strong>$72,859,827</strong></td>
<td><strong>$2,059,633</strong></td>
<td><strong>816</strong></td>
<td><strong>788</strong></td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>
Main in the fall of 2003. The pipeline originates from the Val Vista Water Treatment Plant, the largest treatment plant in the Phoenix metropolitan area, and ranges in diameter from 72 to 108 in. The gravity-fed line delivers up to 190 MGD to Phoenix and another 100 MGD to suburban Mesa, AZ, at a maximum operating pressure of 70 psi. The program consisted of phases A through D to rehabilitate the large-diameter, pre-stressed concrete cylinder pipe (PCCP) water transmission main using sliplining (Figure 5).

The overall program of about $73 million and 788 days had a total schedule savings of 3.40 percent and a total cost savings of 2.75 percent under the contract amount. The details of each phase are presented in Table 1. An in-depth analysis of the cost performance of Phase B revealed some of the benefits that the City realized by adopting CMAR. These benefits include: 1) amending the CMAR contract to complete emergency repair work; 2) paying for needed changes during Phase B by using the cost savings from Phase A; and 3) improved coordination between the stakeholders to deal with unforeseen conditions (e.g., location adjustment). The Val Vista Water Transmission Main program is a successful example of using CMAR for the delivery of a large pipeline rehabilitation program, while also resulting in cost and schedule savings.

Making the Case for CMAR
This study provides a quantitative analysis of the CMAR delivery system applied to municipal pipeline engineering and construction projects. The findings show that adopting CMAR provides superior performance over DBB for the municipal pipeline projects investigated. Analysis of similar CMAR and DBB projects of comparable size, type, owner, location, and labor pool indicates that the cost growth of CMAR is about 6.5 percent better than DBB. Additionally, we found the schedule growth of CMAR to be about 12.5 percent better. The use of CMAR on municipal pipeline projects allows stakeholders to have greater control of their project cost and schedule, reducing the risk of schedule or cost growth they may not be able to afford. The results provide owners and other stakeholders with a benchmark and a sound basis for selecting an appropriate delivery system for their municipal pipeline engineering and construction project.

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David Elton presents 35 serious but entertaining experiments that teach the fundamentals of soil mechanics to budding scientists and engineering students in an exciting and novel way. In this sequel to the popular Soils Magic, Elton has assembled a wealth of fascinating new experiments to illustrate the dynamics of how soils behave and how they can be manipulated.
The Geo-Institute Chapter of the Colorado Section of the American Society of Civil Engineers (ASCE), the Rocky Mountain Section of the Association of Environmental & Engineering Geologists (AEG), and the Colorado Association of Geotechnical Engineers (CAGE) have hosted the Rocky Mountain Geo-Conference since 1984. This conference focuses on geotechnical projects in Colorado and the Rocky Mountain Region, and is a one-day opportunity for geo-professionals to share experiences and state of the practice with their colleagues. Papers will be published by ASCE as a Geotechnical Practice Publication (GPP) and distributed at the conference.

**2016 Paper Topics include**

- Dams and levees
- Landslides and rockfall
- Debris flows
- Tunnels
- Mechanically stabilized earth retaining walls
- Slurry piers
- Compaction grouting
- Post-fire ground treatment
- Permeable pavements
- Osterberg cell testing

**Sponsorship and Registration**

For questions related to conference registration, exhibits, and/or sponsors, please contact Becky Roland (staff@coloradoasce.org). If you have questions with regards to the conference please contact conference chair, Christoph Goss, (christoph.goss@deereault.com). Registration forms are due by October 28, 2016.
I Am So Write

By John P. Bachner

Few professionals, if any, write as much as geoprofessionals do. And none I know of have so much riding on the outcome of what they write. After all, geoprofessionals’ services are fraught with risk, making disputes distressingly common. Many of these disagreements have to be resolved through formal procedures, and, when that occurs — especially when litigation’s the procedure — the best evidence is what’s in writing. If that writing is ambiguous, or if it for any other reason is “lacking,” the writers and the firms behind them have that much tougher a row to hoe.
It’s somewhat unfortunate, then, that few geoprofessionals enjoy writing. In fact, for many, an early-onset antipathy toward writing encouraged them to find refuge in the sciences, where numbers, for most, are far more important than words. Is it any wonder, then, that so many geoprofessionals don’t write well, enabling their antagonists — plaintiffs and their attorneys — to point out how something written poorly in a proposal, report, or explanatory note or memo of some kind allegedly caused a problem that only a geoprofessional’s money can fix.

I cannot in this column provide anything even close to a complete course of correction. However, I can point out a few styles, phrases, and words that geoprofessionals really should attend to, because — in my “geo-experience” — they create severe problems that can easily be avoided.

**Passive Voice:** Unquestionably, this is the biggest problem of all. The passive voice — concealing who did what — creates the ability to omit important information. Passive voice often requires tortuous sentence organization to say what needs to be said, unfortunately in a manner that all too often makes meaning indelible. “A study was conducted” you might write, using what some geoprofessionals glorify as “traditional scientific style.” Not to be too much of a naysayer, but the tradition merits euthanasia; the passive voice has survived all these years because the passive voice is what so many senior geoprofessional practitioners and educators are comfortable with, and — because they know it so well — it’s what they teach their protégées and students. It typically takes me two minutes or less to identify serious ambiguities in geoprofessional writing that relies on the passive voice. **The fix:** Use simple declarative sentences organized as subject/verb/object or, in the case of intransitive verbs, subject/verb/preposition/object; e.g., “Jack ran the machine,” or “Jill ran around the block.” Isn’t that better than “The machine was run by Jack,” or “The block was run around by Jill”?

**Personal Pronouns:** You know these: I, me, mine, ours, theirs, their, his, hers, and so on. Using personal pronouns correctly requires a far better grasp of English than many people — including geoprofessionals — actually possess. It’s not just that their errors (e.g., “It’s me”) reveal imperial garments, although that’s somewhat embarrassing, especially for intelligent, well-educated, professionals. The real problem occurs when the resulting errors cause writers to say things they don’t mean and, correspondingly, fail to communicate what they do mean. Let’s say you write “Because of lawyers, a professional must be careful about their word choices.” In that sentence, “their” refers to “lawyers.” (Try using “You should have known what I meant” as a defense!) **The fix:** Learn how to use personal pronouns correctly and/or refrain from using them.

**Subjective Modifiers:** These are dangerous, because what they mean to the writer almost invariably differs from what they mean to the reader. Take, for example, “several.” How many is that? Three? Five? Eight? Chances are the writer knows, or could provide a range — “six to nine,” say — but finds it easier to be vague. Perhaps the worst offender in this category is “a number of,” which I know to be the cause of at least one costly dispute (the
geoprofessional
lost, by the way). How many is a
number of? Two? Two million? And,
of course, we have useless subjective
modifiers, like “very”; “Yesterday
was cold. In fact, it was very cold.” In
fact, we have no way of
knowing what temperature “cold” implies, making the
word “very” useless, unless one
believes a failure to communicate accurately is worthwhile. The fix: Don’t use subjective modifiers.

**Flatulence:** Yes, that word has more than one meaning (another problem I don’t have space to address); here, I use it to indicate inflated or pretentious language. Typical examples are “regarding,” “in regards to,” “concerning,” “with respect to,” and similar — including the ever-popular “in re” for those who forget that Caesar is dead — instead of the simple, but effective, “about.” Sadly, “however” is not only used as a multisyllabic substitute for “but,” but most often it’s used (do you prefer “utilized”? in situations where “however” is wrong and “but” is right. And don’t you just love the folks who find it appropriate to write “in lieu of” in lieu of “instead,” or “tantamount to” rather than “equal to”? Flatulence also shows up when people write “We conducted a study of the issue,” instead of “We studied the issue.” (This underscores another reason the passive voice is so problematic; you can’t condense “A study of the issue was conducted.”) The fix: Make your writing so sophisticated it uses words just about anyone can understand; i.e., “Less is more.”

**Needless Words:** Another example of “Less is more,” except here I use it to refer to quantity, not (as above) quality: “We visited six different sites today.” (Translation: “Six different sites were visited today.”) Well, of course they were different sites (!), which is why “We visited six sites today” says exactly the same thing, but with the useless “different” deleted. Similarly, “Your message was sent successfully” is no different (needed here) from “Your message was sent,” because, were it not sent successfully, it could not have been sent at all. The fix: Don’t use needless words.

**Taboo Words:** You should be aware of these; words like “certify” (it means “guarantee,” which is itself an uninsurable, taboo word, along with its cousins “warrant,” “ensure,” “assure,” and “insure”); “inspect” (in most cases, geoprofessionals “observe”; “monitor” (it means “inspect”); “investigate” (too often used instead of “explore” or “study”); “work” (it’s what constructors do; geoprofessionals perform a service, implementing a scope of service, not a scope of work); and “work product” (which can create a seriously nasty threat to your professional-liability insurance protection). Note that terms such as “in substantial compliance with” and “in general compliance with” can be particularly toxic unless you define them. The fix: Learn what the taboo words and terms are and use them only when called for.

As it so happens: English is an exceptionally complex language, which is why the foregoing is pathetically brief and incomplete. As professionals who write, and who face severe penalties for failure to write well, geoprofessionals need to do it well. (Take two verbs and call me in the morning.)

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**JOHN P. BACHNER** has been an independent consultant since 1971. Through Bachner Communications’ association-/foundation-management division, he served as the Geoprofessional Business Association’s (GBA’s) executive vice president from 1973 through 2015. GBA is a not-for-profit association that develops programs, services, and materials to help its member firms and their clients confront risk and optimize performance. GBA-Member Firms provide geotechnical, geologic, environmental, construction-materials engineering and testing (CoMET), and related professional services (en.wikipedia.org/wiki/Geoprofessions). GBA invites geoprofessional constructors, educators, and government officials to become involved. Contact GBA at info@geoprofessional.org.
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Look Who’s a D.GE

Peggy Hagerty Duffy, PE, D.GE

Peggy Hagerty Duffy, PE, D.GE, graduated in 1989 from the University of Louisville in Louisville, KY, with a bachelor’s degree in civil engineering. In 1990, she earned a master’s degree from the same institution, focusing on civil engineering with a concentration in geotechnical engineering. After working for several consulting firms, she launched Hagerty Engineering in 1997 in Jeffersonville, IN, part of the metro Louisville, KY, area.

Peggy has a background in deep and shallow foundations for a wide variety of structures, including municipal facilities, wastewater and water treatment plants, multi-family and single-family housing, and industrial facilities. She is experienced with tunnel and dam design and with dam remediation, as well as slope stability evaluations. She has extensive experience in karst terrain and has worked on hundreds of projects involving sinkhole treatment and design and construction of structures over sinkholes. For over 10 years, she designed foundations for cellular towers and observed construction of those towers in remote locations. In addition to her consulting work, Peggy has served as the Technical Advisor for the ADSC, the International Association of Foundation Drilling, since 2013.

What class did you enjoy the most while in school?
Either advanced geomechanics lab or French conversation.

What was your favorite project?
Liberty Green and Sheppard Square are two projects in downtown Louisville where old, bunker-style public housing has been replaced with multi-income housing and multi-use structures. It has been fascinating to make decisions on a daily basis where the subgrade is a product of 200 years of urban development and is different everywhere.

Where did you spend most of your childhood, and what was it like for you growing up there?
I grew up in Louisville, KY, part of a happy, Irish Catholic family. My parents are very big believers that you can’t just live somewhere, you have to contribute. So we were active in our church, in local charity efforts, in sports, in our schools, in EVERYTHING. They also stressed that you have to always respect others and have good manners, and I try hard to keep that at the forefront still. My dad taught in the Civil Engineering Department at the University of Louisville, so we all were passionately supportive of
The geotechnical profession is rarely understood and less often appreciated.

Why are you certified as a D.GE, and what made you choose to become a Diplomate in the Academy? At first I wasn’t interested because so often additional credentials work against an engineer when you’re working on construction sites. Many contractors think lots of initials mean you have no common sense. But the geotechnical profession is rarely understood and less often appreciated. I wanted to make a point that understanding and experience in our field mean more than just, “How many psf are you going to give me for that footing?” There’s an art to our voodoo that takes years to develop.

What are some of your personal hobbies and interests? I am chair of our city beautification organization, and I spend a lot of time trying to improve our quality of life here. I’m the (token) engineer on the Jeffersonville Arts Alliance, bringing logic to creative chaos and reminding artists that gravity is a law, not a suggestion. I also volunteer with the Feed My Neighbor program, feeding the homeless in downtown Louisville, and raising money to run the kitchen. In the remaining time (between 2:00 a.m. and 2:12 a.m. on Wednesdays) I run, garden, and ballroom dance. All of this becomes secondary during college football season, when I cheer rabidly for the Louisville Cardinals and venture out on the road to experience many other college game-day atmospheres.

For the complete interview, please visit geoprofessionals.org.
G-I Welcomes New Organizational Members

The Geo-Institute is pleased to introduce our two newest Organizational Members: American Engineering Testing, Inc., and Hart Crowser.

Learn more about our Organizational Member program at geoinstitute.org/membership/organizational-membership.

American Engineering Testing, Inc.

With more than 400 employee owners, American Engineering Testing, Inc. (AET) has developed a strong reputation for its geotechnical and pavement engineering, as well as for providing high-quality services in petrographic analysis, concrete chemistry, building forensics, and construction materials and environmental testing. With corporate headquarters in St. Paul, MN, and 18 offices throughout the upper Midwest, AET has connections that extend nationally and internationally to clients in a variety of market sectors. In addition to providing conventional geotechnical services, AEC also has specialized testing capabilities that include seismic piezocone testing, high strain dynamic pile testing, falling weight deflectometer testing, and ground penetrating radar.

Hart Crowser

Hart Crowser is an award-winning firm that provides geotechnical, seismic, hydrogeology, environmental, natural resource, stormwater, and disaster resilience services. It works worldwide from offices in WA, OR, AK, and HI. The staff of 110 specializes in developing sites with complex geological and environmental issues. While Hart Crowser supports projects of all sizes, its work has included some of the highest-profile projects in the world. It designed the largest, mechanically stabilized earth wall in the western hemisphere, the longest floating bridge in the world, and elements supporting the largest-diameter bored tunnel in the world.

This message was prepared by R. JEFFREY DUNN, PhD, PE, GE, D.GE, M.ASCE. Jeff can be reached at jeff.dunn@arup.com.
The Geo-Institute Organizational Member Council (OMC) invites your organization to join us. Enjoy the numerous benefits that G-I organizational membership offers, including the following:

- Up to a 50 percent discount on the G-I annual Geo-Congress for one person.
- A 5 percent discount for advertising in GEOSTRATA magazine.
- Forty percent ($400) of your annual G-I OM dues goes directly to fund G-I student activities. A portion of that money finances student travel to the annual Geo-Congress and the OM/Student Career Fair.
- Each year during the annual Geo-Congress, the OMC hosts an OM Career Fair/Reception. Two OM members from each OM firm are invited to participate, along with 45-50 students carefully chosen by the OMC.
- Opportunity to publish news about your company, including awards, new staff and promotions, company projects, etc.
- Your company logo posted on the G-I website at geoinstitute.org/membership/organizational-membership.
- Your company name listed in Organizational Member News in each issue of GEOSTRATA magazine.
- Opportunity to display the G-I logo on your website and on printed materials.
- Opportunity to display a G-I Organizational Member placard at your exhibit booth.

For more information, visit the G-I website at geoinstitute.org/membership/organizational-membership, where you can download the Organizational Membership application.
UCA of SME Offering Tunnel Project Program, Speakers Program

The Geo-Institute and the Underground Construction Association of the Society for Mining, Metallurgy & Exploration (UCA of SME) are jointly funding two interrelated educational initiatives to promote careers in underground construction and engineering to civil and geotechnical engineering students. Because of the limited number of programs in this sector — despite high industry demand — exposure to major infrastructure construction projects is one of the ways to attract and engage students. The goal of these initiatives — a tunneling project tour program and a university speakers program — is to attract and sustain student interest in the underground construction professions. The tunneling project tour program will include annual tour(s) of one or more underground construction projects. The 2016 tours will include the Central Subway Project Chinatown Station in San Francisco and the White River Tunnel and Lower Pogues Run Tunnel project in Indianapolis. The speakers program is designed to bring project case histories to university students. The professionals involved in these initiatives will bring experience and expertise to a number of topics dealing with underground engineering and construction.

Students interested in the tunneling project tour may apply at: students.geoinstitute.org/student-tunnel-tour-program-application.

Professionals interested in participating in the speakers program should contact Liza Dwyre, PE, D.GE, M.ASCE, chair, G-I Technical Committee on Underground Engineering and Construction, at dwyre@pbworld.com.

DFI Educational Trust Announces Scholarship Fundraiser

The Deep Foundations Institute (DFI) Educational Trust has launched Scrap for Scholars, a fundraising initiative targeted at companies with construction sites and manufacturing plants that produce such metal waste as used tools, excess rebar, and steel templates. These companies are encouraged to donate the proceeds received from recycled waste to the general fund of the DFI Educational Trust. The Trust’s programs help civil engineering students achieve their educational goals and advance to careers in the deep foundations industry.

Benefits of donating to Scrap for Scholars include tax deductions, raised awareness of recycling on construction job sites, enhanced recognition among civil engineering students, and greater company awareness. Companies that choose to participate in this program will be recognized in DFI’s Deep Foundations magazine and the DFI Trust eNewsletter, as well as at the DFI annual conference. More information is available at dfitrust.org.

Engineers Developing Multiline Anchor System for Floaters

According to an article published in the May 3 edition of Offshore Wind Journal, a team of researchers is developing a new mooring system for floating offshore wind turbines that employs an integrated network of anchors and lines to hold turbines in place. The article, “Engineers Developing Multiline Anchor System for Floaters,” which was authored by David Foxwell, reports that these researchers include engineers Sanjay Awade, PhD, and Don DeGroot, Sc.D, PE, from the University of Massachusetts, Amherst. Charles Aubeny, PhD, PE, M.ASCE, from Texas A&M University, and Melissa Landon, PhD, A.M.ASCE, from the University of Maine, are collaborating on the research. The project is operating under a three-year grant from the National Science Foundation in conjunction with Vyrof Anchors.

The goal of this research is to develop floating offshore wind farms that feature a network of anchors and cables that hold the farm in place. At this time, individual wind turbines have their own individual anchor and cables. Integrating the anchors and cables would save money by reducing the number of anchors needed, as well as the number of geotechnical site investigations. The researchers will also develop wind and wave models to determine the best placement and orientation for the wind farms. Additionally, they will investigate the best designs for mooring lines, which connect the floating wind turbine with the anchors. To accomplish this goal, the team will develop models for evaluating the behavior of the anchors on the ocean floor, as well as the best design for the multiple anchors.
### Sunday, August 14, 2016
- **7:00 am – 5:00 pm** Registration
  - Registration will close from 12:00 p.m. – 1:00 p.m. for lunch
- **8:00 am – 5:00 pm** SC1/ Designing Sustainable Pavements
- **8:00 am – 5:00 pm** SC2/ Vertical Barriers for Geoenvironmental Applications
- **8:00 am – 5:00 pm** SC3/ Field and Laboratory Characterization of Coastal Deposits and Sediment Remobilization Process
- **8:00 am – 12:15 pm** SC4/ Principles of Sustainability in Geotechnical Engineering
- **1:00 pm – 5:00 pm** SC5/ Sustainable Remediation of Contaminated Sites
- **1:00 pm – 4:30 pm** Exhibitor Move-In
- **6:00 pm – 7:30 pm** Welcome Reception

### Monday, August 15, 2016
- **7:30 am – 5:00 pm** Registration
  - Registration will close from 12:00 p.m. – 1:00 p.m. for lunch
- **8:30 am – 10:30 am** Welcome Plenary Presentations
- **9:30 am – 4:30 pm** Exhibit Hall Hours
- **10:30 am – 11:00 am** Break
- **11:00 am – 12:30 pm** Concurrent Technical Sessions IA-IIE
- **12:30 pm – 2:00 pm** Lunch with Poster Presentations I
- **2:00 pm – 3:30 pm** Session Honoring Legends: David E. Daniel
- **2:00 pm – 3:30 pm** Concurrent Technical Sessions IIA-IIIE
- **3:30 pm – 4:00 pm** Break
- **4:00 pm – 5:30 pm** Session Honoring Legends: Robert M. Koerner
- **4:00 pm – 5:30 pm** Concurrent Technical Sessions IIIA-IIIIE
- **6:00 pm – 7:30 pm** Awards by the River Reception

### Tuesday, August 16, 2016
- **8:00 am – 5:00 pm** Registration
  - Registration will close from 12:00 p.m. – 1:00 p.m. for lunch
- **9:00 am – 10:30 am** State of the Art/State of the Practice Lectures
- **9:30 am – 4:00 pm** Exhibit Hall Hours
- **10:30 am – 11:00 am** Break
- **11:00 am – 12:30 pm** Concurrent Technical Sessions IVA-VIIE
- **12:30 pm – 2:00 pm** Lunch with Poster Presentations II
- **2:00 pm – 3:30 pm** Concurrent Technical Sessions VA-VE
- **3:30 pm – 4:00 pm** Break
- **4:00 pm – 5:30 pm** Concurrent Technical Sessions VIA-VIIE
- **6:00 pm – 11:00 pm** Cubs vs. Brewers at Wrigley Field (Ticketed Event)

### Wednesday, August 17, 2016
- **8:00 am – 3:00 pm** Registration
  - Registration will close from 12:00 p.m. – 1:00 p.m. for lunch
- **9:00 am – 10:30 am** State of the Art/State of the Practice Lectures
- **10:00 am – 1:00 pm** Technical Tour: Chicago Industrial Sustainability Project/Method Soap Factory (Ticketed Event)
- **10:30 – 11:00 am** Break
- **11:00 – 12:30 pm** Concurrent Technical Sessions VIIA-VIIIE
- **12:30 – 2:00 pm** Luncheon with Panel on Education: The Interface of Professional Practice, Research, and Education
- **2:00 – 3:30 pm** Concurrent Technical Sessions VIII A-VIIIIE
- **3:30 pm – 4:00 pm** Break
- **4:00 pm – 5:30 pm** Carl Monismith Lecture on Pavement Engineering, 2016
- **4:00 pm – 5:30 pm** Panel: Geosustainability: Opportunities and Threats
- **4:00 pm – 5:30 pm** Concurrent Technical Sessions IXA, IXD, IXE
- **6:30 pm – 8:30 pm** Chicago River Dinner Cruise (Ticketed Event)

### Thursday, August 18, 2016
- **8:00 am – 2:00 pm** Technical Tour: Northern Indiana Steel Mill Visit (Ticketed Event)
- **9:00 am – 12:00 pm** Technical Tour: Chicago Architecture Foundation: Sustainability in Chicago (Walking Tour, Ticketed Event)

### Concurrent Technical Sessions

### Program and Session Cancellation
ASCE/G-I reserves the right to cancel programs, tours, and/or sessions because of low registration. In the event of a cancellation, all registrants will be notified and will receive a full refund, if applicable. Programs and sessions are subject to change, and ASCE/G-I reserves the right to substitute a program, session, and/or speaker of equal caliber to fulfill the educational requirements.
THE GEOENVIRONMENTAL ENGINEERING COMMITTEE of the Geo-Institute (G-I) of the American Society of Civil Engineers (ASCE) invites you to attend Geo-Chicago 2016: Sustainability, Energy, and the Geoenvironment in downtown Chicago on August 14-18, 2016.

Geo-engineers and geo-scientists have been playing a major role in providing, protecting, and preserving infrastructure and the environment. Many innovative technologies and practices are constantly being developed and implemented. Evolving global climate change and exploding world population are leading to major concerns such as extreme geohazards, increased environmental pollution, and rapid depletion of natural resources. These new challenges can be addressed with new and innovative concepts, materials, energy sources, technologies, and practices. Sustainability and resiliency have become essential in the development of new materials and infrastructure systems.

This conference provides you with a unique opportunity to explore recent advances, new directions, and opportunities for sustainable and resilient approaches to design and protect infrastructure and the environment. The conference will feature the latest research developments and engineering-practice innovations with a focus on characterization, modeling, design, construction, and field performance. This is the perfect opportunity to expand your technical knowledge while experiencing the dynamic city of Chicago.

Geo-Chicago 2016: Sustainability, Energy, and the Geoenvironment will build on the success of GeoCongress 2008: Sustainability in the Geoenvironment (New Orleans) to bring you a wide range of knowledge-enhancing technical sessions, short courses, workshops, and technical tours. Around 600 U.S. and international participants from academia, industry, and government agencies are expected to attend the conference.

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University of Illinois at Chicago

Conference Co-Chair
Nazli Yesiller, Ph.D., A.M.ASCE
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Begin your Geo-Chicago 2016 experience and gain Professional Development Hours (PDHs) by completing a full-day or one or two half-day short courses. Only limited space is available in each course, so don’t wait to register!

FULL-DAY SHORT COURSES

**SC1/ Designing Sustainable Pavements**

Highway personnel are typically faced with challenges such as limited budget, limited quality materials, environmental restrictions, and increasing traffic volumes, yet are expected to design pavements that minimize short- and long-term impacts of the transportation network growth on the environment in general low-impact development. Typical solutions include long-lasting pavement, local materials, recycled materials, less pollution, low maintenance, low urban heat island effect, quality construction, life cycle cost analysis, environmental management systems, and training personnel. Current conventional pavement design and construction methods are not sustainable. This course defines sustainable pavement requirements, provides examples of sustainable design technologies and covers concepts that assist pavement engineers and highway personnel in developing sustainable solutions that make pavement long-lasting and sustainable.

**Instructor:** Michael S. Mamlouk, Ph.D., P.E., F.ASCE, Arizona State University

**SC2/ Vertical Barriers for Geoenvironmental Applications**

Vertical cutoff walls have been widely employed in geoenvironmental applications as both primary containment barriers and in conjunction with other remediation techniques such as funnel and gate and pump and treat. In the current framework of remediation they should be considered a sustainable option. Course instructors, one from the construction industry and one from academics, will offer a balance of theory and practice to inform attendees of the issues across the spectrum of design, construction, monitoring, and performance (short and long term), providing both breadth and depth so that attendees can understand and properly choose the type of vertical barrier for their application and understand the design and construction considerations of their selection.

**Instructors:** Jeffery C. Evans, Ph.D., P.E., F.ASCE, Bucknell University; and Daniel G. Ruffing, P.E., M.ASCE, Geo-Solutions

**SC3/ Field and Laboratory Characterization of Coastal Deposits and Sediment Remobilization Process**

This short course will focus on new and emerging in-situ and laboratory techniques, tools, and methods for characterizing coastal soil deposits and remobilization processes.

Coastal property development, oil and water extraction, sea level rise, coastal subsidence, loss of barrier islands and other factors have resulted in water quality degradation, decline in fisheries, regional settlement, wetlands loss, beach degradation, reduced storm and surge protection, and other challenges in coastal areas throughout the world. In response, a number of coastal protection and restoration programs have been initiated, all of which depend on mathematical models used to predict their long-term performance. In turn, these models depend heavily on the proper characterization of near secondary, erosion, sedimentation, re-suspension, permeability, surface and deep coastal soil deposits. Comprehensive evaluation of shear strength (undrained and drained), consolidation (primary and seepage), and other engineering properties of coastal soils depends on utilization of innovative and improved field, laboratory, and geophysical techniques. Therefore, proper characterization of these sediments is of utmost importance in the correct design of coastal restoration, conservation and land building projects.

**Instructor:** Krishna R. Reddy, Ph.D., P.E., ENV SP, D.GE, F.ASCE, University of Illinois at Chicago

**SC4/ Principles of Sustainability in Geotechnical Engineering**

In this short course, attendees will explore general notions of sustainability in geotechnical engineering, as well as the sustainability assessment methods applicable to geotechnical engineers. The course will focus on the latest research activities, including utilization of recycled materials and use of alternate materials and construction methods to reduce carbon footprint. The life cycle based methods (LCA, LCE, etc.) for assessing sustainability of geotechnical projects will be introduced, as well as the different sustainability rating systems and their applicability in geotechnical engineering. Examples will be given from actual case and research studies so that the attendees can connect the concepts to real life applications.

**Instructors:** Dipanjan Basu, Ph.D., C.Eng, MASCE, University of Waterloo; and Anand Puppala, Ph.D., P.E., D.GE, F.ASCE, University of Texas at Arlington

**SC5/ Sustainable Remediation of Contaminated Sites**

Traditional site remediation approaches typically focus on the reduction of contaminations to meet cleanup goals or risk based corrective levels with a primary emphasis on remediation program cost and timeframe. Such an approach, however, may result in ancillary impacts that, when considered in totality with the remediation activity, result in a net negative impact to the environment. Green and Sustainable Remediation offers a holistic approach to remediation that considers these ancillary impacts, and aims to optimize net effects to the environment. This approach addresses a broad range of environmental, social, and economic impacts during all remediation phases that achieve remedial goals through more efficient, sustainable strategies that conserve and protect resources. Attendees will explore the Green and Sustainable Remediation decision framework, provide qualitative and quantitative assessment tools, including multi-disciplinary metrics, to assess sustainability of Green and Sustainable Remediation, and review emerging related technologies.

**Instructor:** Malay Ghose-Hajra, Ph.D., P.E., ENV SP, M.ASCE, The University of New Orleans; and Nina Stark, Ph.D., Aff.M.ASCE, Virginia Tech
In Potential Failure Modes Analysis, several approaches have been investigation, and full-scale modeling. Starting from a foundation rooted these processes by using empirical studies, laboratory testing, forensic in the late 1980’s and early 1990’s, several groups began investigating of defensive measures designed to resist the hydraulic loads. Beginning inadequate understanding of the process of internal erosion and a lack Strategies around sustainability prioritize energy efficiency, reuse and recycling, reduced consumption, and lower emissions. Designing to meet these initiatives provides a new opportunity for geo-engineers to create new value for clients, and new technical and economic opportunities for engineers. This presentation describes the technical case for making sustainability a priority, provides examples of how geo-engineers can incorporate sustainability into design, and illustrates the social and economic benefits that can be accrued by geo-engineers and their clients.

**Keynote Speaker:** Craig H. Benson, Ph.D., P.E., D.GE, NAE, F.ASCE, University of Virginia

**Assessment of Bentonite Barriers Performance by Coupling Intrinsic and State Parameters**

**Monday, August 15, 9:45–10:30 am**

A theoretical framework, able to describe chemical, hydraulic and mechanical behaviors of bentonites in the case of one-dimensional strain and flow fields, is described. In particular, the relationships, linking the chemico-physical and mechanical intrinsic and state parameters of a given bentonite with its hydraulic conductivity, effective diffusion coefficient, osmotic efficiency and swelling pressure under different stress-histories and solute concentration sequences, are presented. Thereafter, some examples are illustrated in order to assess, within a series of laboratory test results, the influence of pretreatments, as the pore water salt removal through a cyclic squeezing process, and confining stress history on the long-term hydraulic behavior of the tested bentonites when permeated with highly concentrated salt solutions. Moreover, the osmotic coefficient and swelling pressure variations, versus the ion valence and concentration in solution, have also been experimentally investigated and the test results have been simulated by the use of the proposed theoretical framework. The proposed model seems to make possible a comprehensive understanding of the involved chemico-mechanical phenomena and to provide a reliable assessment of the hydraulic conductivity, osmotic and self-healing efficiency of the considered bentonites.

**Keynote Speaker:** Mario E. Manassero, Ph.D., P.E., M.ASCE, Politecnico di Torino

**Geotechnical Risks Posed by Dams and Levees: Advances in the Science and Practice of Internal Erosion**

**Tuesday, August 16, 9:00–9:45 am**

During the 1970’s and 1980’s, many dams and levees failed due to inadequate understanding of the process of internal erosion and a lack of defensive measures designed to resist the hydraulic loads. Beginning in the late 1980’s and early 1990’s, several groups began investigating these processes by using empirical studies, laboratory testing, forensic investigation, and full-scale modeling. Starting from a foundation rooted in Potential Failure Modes Analysis, several approaches have been developed to characterize the risks posed by internal erosion. As a result, the industry has made significant progress towards our understanding of how structures fail from these mechanisms. Today, there are also many universities, private consultants, and government agencies worldwide that are investing significant resources to better understand the problem. This presentation will discuss the history, current practices, and ongoing research being conducted to better characterize risks posed by internal erosion. Additionally, efforts to improve design and construction practices to reduce these risks will be described and a brief discussion of the opportunities that exist to further advance the science will also be included.

**Keynote Speaker:** Nathan J. Snorteland, P.E., Risk Management Center, U.S. Army Corps of Engineers

**Geoenvironmental Challenges and Opportunities for Coal Combustion Residuals**

**Tuesday, August 16, 9:45–10:30 am**

Coal-fired power accounts for 40 percent of electricity worldwide. However, even if that were to cease today, there would still be more than ten billion tons of coal combustion residuals in various impoundments and landfills. This presentation provides a perspective on the technical challenges and opportunities associated with their disposal and reuse.

**Keynote Speaker:** John L. Daniels, Ph.D., P.E., University of North Carolina at Charlotte

**Geoenvironmental Challenges and Opportunities for Coal Combustion Residuals**

**Wednesday, August 17, 8:00–8:45 am**

Mining is a key industry for the economy of many regions. These operations can also raise various environmental concerns. One of the main issues is the production of large amount of the solid and liquid wastes, which must be properly managed. Detailed planning of the disposal facilities needs to take into account the geotechnical and geochemical stability of the waste materials and infrastructures. Innovative management and reclamation practices are being developed to address critical geoenvironmental concerns. This presentation will recall some of the main challenges associated with the disposal of reactive (sulphidic) wastes from hard rock mines, including coarse-grained waste rock and fine-grained tailings. Typical geotechnical and hydrogeological properties of these materials will be summarized, and commonly used disposal and construction methods will be described. The main factors that affect the stability of reactive wastes and retaining works will be reviewed. An emphasis will be placed on the assessment and potential effects of natural conditions and critical events such as large precipitations, droughts and earthquakes. Specific problems with conventional disposal methods will be illustrated with various examples based on field cases. Alternative disposal techniques and a perspective for the future will be presented and discussed.

**Keynote Speaker:** Michel Aubertin, Ing., Ph.D., M.ASCE, École Polytechnique de Montréal

www.geoenvironmentconference.org
The Great Lakes Legacy Act: Using Partnership Approach to RemEDIATE Contaminated Sediment Sites in the Great Lakes

Wednesday, August 17, 9:45–10:30 am

The Great Lakes Legacy Act (GLA) is a cost-sharing program specifically designed to remediate contaminated sediment sites in Great Lakes Areas of Concern. The program requires a minimum of a 35 percent non-federal cost share. This presentation will discuss some of the parameters of the program, as well as describe a number of sediment cleanup projects that have been conducted to date.

Keynote Speaker: Marc Tuchman, Great Lakes National Program Office, U.S. Environmental Protection Agency

Luncheon with Panel on Education: The Interface of Professional Practice, Research, and Education

Wednesday, August 17, 12:30–2:15 pm

Geoenvironmental engineering practice, research, and education are intimately intertwined. Panel participants will briefly present their perspective on the state of each of these aspects of the field, followed by questions and open discussion from the floor on the challenges, opportunities, and future directions on each aspect.

Moderator: Jeffrey C. Evans, Ph.D., P.E., F.ASCE, Bucknell University

Panelists:
- Edward Kavazanjian, Jr., Ph.D., P.E., D.GE, NAE, F.ASCE, Arizona State University
- James L. Hanson, Ph.D., P.E., M.ASCE, California Polytechnic State University
- Rudolph Bonaparte, Ph.D., P.E., D.GE, NAE, F.ASCE, Geosyntec Consultants

Panel: Geosustainability: Opportunities and Threats

Wednesday, August 17, 4:00–5:30 pm

Join these invited panelists for an in-depth review and discussion of some of the challenges facing geotechnical engineers focused on incorporating sustainability principles into their daily practice.

Moderator: Doug Hermann, P.E., D.GE, M.ASCE, Independent Consultant

Panelists:
- Shale Gas, Geologic Carbon Capture, and Storage in the U.S. and China, and a Close Look at the Marcellus Shale Role: Tim Carr, Ph.D., West Virginia University
- Sustainable Water, Materials, and Energy Strategies and the Role for Intelligent Compaction: Timothy C. Lindsey, Ph.D., Highlander Innovations

Carl L. Monismith Lecture on Pavement Engineering

Wednesday, August 17, 4:00–5:30 pm

The ASCE Geo-Institute (GI) has established a Lecture in recognition of Professor Carl L. Monismith’s contribution to Pavement Engineering. Professor Monismith’s teaching and research career in pavement technology, at the University of California, Berkeley, spans more than 50 years. Throughout this period, he has mentored numerous graduate students who have disseminated advances in pavement technology, at the University of California, Berkeley, spans more than 50 years. Throughout this period, he has mentored numerous graduate students who have disseminated advances in pavement technology. His pioneering work has not only created an understanding of the design and manufacture of hundreds of geosynthetic products worldwide, but has helped generations of educators, researchers, designers, manufacturers, and regulators address countless geo-environmental and civil engineering challenges using geosynthetics. This mini-symposium honors Robert Koerner’s contribution to geosynthetics engineering through a series of papers and presentations from those who worked closely with him throughout his career.

Honoree: Robert M. Koerner, Ph.D., P.E., D.GE, NAE, Dist.M.ASCE, Deputy Chancellor, The University of Texas System


Wednesday, August 17, 4:00–5:30 pm

The pavement engineer must consider the pavement as a system in order to meet the demanding challenge of achieving sustainability, which often involves little or no perceptible damage and/or permanent deformation in the lower asphalt-bound layers and the supporting base layers. To achieve this goal the pavement engineer is often charged to do the job that he or she does so well: serve as an integrator of interdisciplinary knowledge, in this case geomechanics and geoscience. This lecture highlights key examples where cross-cutting of knowledge from these areas of geotechnology has made a significant difference in the sustainability of the pavement system.
Welcome Reception and Exhibit Hall Grand Opening

Sunday, August 14, 6:00–7:30 pm
Catch up with friends and acquaintances from around the globe during this lively reception. Enjoy light appetizers and beverages while viewing the latest innovations from a wide variety of vendors focused on sustainability and the geoenvironment.

LUNCH with Poster Presentations I and II

Monday, August 15 and Tuesday, August 16, 12:30–2:00 pm
Poster presentations provide your best opportunity during the entire conference for in-depth conversations with others as interested in the same topics as you are. So grab a box lunch in the Exhibit Hall on Monday and Tuesday and dive deep into research and case studies from your colleagues, or new products and services from conference exhibitors.

Awards by the River Reception

Monday, August 15, 6:00–7:30 pm
After a day packed full of technical programming, come outside to the riverside patio to celebrate GI award winners, relax in the summer warmth, and relish the Chicago River with colleagues, snacks, and a cold drink.

Chicago Cubs vs. Milwaukee Brewers at Wrigley Field

Tuesday, August 16, 6:00–11:00 pm
Join us for an evening at the ballpark! The first 100 registrants will enjoy an iconic baseball experience at one of America’s most historic ballparks. No matter what happens on the field, you’ll win with $20 in Chicago Cubs Cash to spend on the food, drink, or merchandise of your choice.
(Not included in registration; purchase ticket)

Chicago River Dinner Cruise

Wednesday, August 17, 6:30–8:30 pm
The conference may be almost over, but there’s still time to dine with new friends and acquaintances as you explore the iconic skyline of Chicago from the deck of a river cruise boat. Limited to the first 100 registrants.
(Not included in registration; purchase ticket)

Chicago Industrial Sustainability Project/Method Soap Factory

Wednesday, August 17, 10:00 am–1:00 pm
Method is one of the first companies to be recognized as a Cradle to Cradle® company. They consider the past, present, and future implications of everything they do, from the ingredients selected for their products to how these products are manufactured. Their plant is located in the Pullman Park district in the south side of Chicago utilizing solar trees and wind turbines, and was built on the Ryerson Steel brownfield site. It is an integrated industrial facility encompassing the liquid soap factory, AMCOR (plastic bottle manufacturer for the soap products), and a roof top greenhouse operated by Gotham Greens. The facility is one of two Platinum LEED certified industrial complexes in the U.S.
(Not included in registration; purchase ticket)

Northern Indiana Steel Mill Visit

Thursday, August 18, 8:00 am–2:00 pm
Phoenix Services, LLC will host a half-day tour of its iron recovery and slag processing facilities at ArcelorMittal Burns Harbor, one of four northern Indiana Steel Mills. The tour will begin with an overview of the geotechnical, environmental and geochemical characteristics of slag material, and its use in multiple branches of civil engineering.

Chicago Architecture Foundation: Sustainability in Chicago

Thursday, August 18, 9:00 am–12:00 noon
Chicago is known around the world for its architecture. Join your colleagues on a walking tour of sustainable sites around the Chicago downtown. Wear comfortable shoes and bring a water bottle!
Conference Hotel

Sheraton Grand Chicago
Geo-Chicago 2016 has chosen the Sheraton Grand Chicago as the official hotel of the conference. You will receive the group rate when you book your rooms at this hotel.

301 East North Water Street
Chicago, IL 60611

Room Rates: Single/Double: $199
Room Booking Deadline: Wednesday, July 20, 2016

Registration Information

Register Now! www.geoenvironmentconference.org/registration

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Receive Member Rates
Not a member of ASCE/G-I? Join today and save on your Geo-Chicago 2016 registration. Simply visit www.asce.org/join or call (800) 548-ASCE (2723) to request an application and/or register for the conference. For more information on member benefits, go to www.asce.org/member_benefits. Note: You must be a member in good standing to qualify for the member rates.

Confirmation of Registration
Confirmation will be emailed to all Early-Bird and Advance registrants within one week of registering for the Conference. Online registrants should receive immediate notification following submission of the registration information. Pre-registered attendees will receive their name badges and any tickets ordered at the on-site ASCE Registration Desk during Registration Hours. If you do not receive confirmation within one week, please contact ASCE Registrations at (800) 548-2723 and ask to speak with Customer Service. Please reference Geo-Chicago 2016 Conference in the subject line of your email.

Cancellations/Refunds
Cancellations must be received by ASCE in writing or via e-mail. A refund will be issued, minus a $65 processing fee, if the cancellation notice is received by ASCE by July 13, 2016. No refunds will be made for cancellations received after July 13, 2016.
Send cancellations to ASCE Registrations or fax to (703) 295-6144.
Geo-Institute Staff Visit Turner-Fairbank Highway Research Center

On April 20, the Geo-Institute staff visited the Federal Highway Administration’s (FHWA) Turner-Fairbank Highway Research Center in McLean, VA. Hosted by the FHWA’s chief scientist, Jonathan Porter, PhD, and the geotechnical lab’s director, Mike Adams, staff visited several labs and research facilities, including test bridge abutments, the crash testing facility, geotech labs, and several structures labs. Observed Helen Cook, the Geo-Institute’s board and program specialist, “While working on Geo-Institute conferences I see a lot of technical paper details, and over time much of the terminology has stuck in my mind even though I’m not an engineer. But until this trip, it’s just been words. Now I know what fly ash looks like, I’ve stuck my fingers in abutment cracks caused by overloading, and I’ve held a piece of foam glass in my hand. It makes what I work on every day so much more real, and just makes me even prouder of the civil engineering discipline I get to serve.”

Geo-Institute staff will visit local members from time to time for outreach and to gain a better understanding of our members’ work.

Please Submit
company news and career achievements to GEOSTRATA via geostrata@asce.org.
ASCE/G-I Co-Sponsored Online Live Webinars
All posted webinars offer professional development hours (PDHs) as indicated.

- In-Situ Stabilization of Soil Slopes Using Nailed (or Anchored) Geosynthetics (1.5 PDHs)
  July 19, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Geotechnical Properties of Transported vs Residual Soil (1.5 PDHs) – NEW
  July 25, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Dynamically Loaded Machine and Equipment Foundations: A Design Primer (1.5 PDHs)
  July 28, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Recycled Base Aggregates in Pavement Applications (1.0 PDH)
  August 3, 2016
  12:00 p.m. – 1:00 p.m. (ET)
- Seismic Assessment and Design of Water and Sewer Pipelines (1.0 PDH)
  August 8, 2016
  12:00 p.m. – 1:00 p.m. (ET)
- Load and Resistance Factor Design (LRFD) for Geotechnical Engineering Features: Earth Retaining Structures: Fill Walls (1.5 PDHs)
  August 15, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Ethics: The Road All Engineers Must Follow (1.5 PDHs)
  August 23, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Geosynthetics Used in Unpaved and Paved Roads (1.5 PDHs)
  August 24, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Introduction to Grouting in Rock (1.5 PDHs)
  August 30, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Considerations of Induced Ground Deformations on Deep Foundation Designs (1.5 PDHs) – NEW
  September 12, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Geosynthetic Reinforced Mechanically Stabilized Earth Walls (1.5 PDHs)
  September 21, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Risk Management and Rehabilitation of Existing Structural Foundations for New Infrastructure Facilities (7319W2016) (1.5 PDH) – NEW
  September 26, 2016
  11:30 a.m. – 1:00 p.m. (ET)
- Underpinning and Strengthening of Foundations (1.5 PDHs)
  September 28, 2016
  11:30 a.m. – 1:00 p.m. (ET)
ASCE/G-I Seminars

All posted seminars offer continuing education units (CEUs).

- **Earthquake-Induced Ground Motions**
  (1.6 CEUs)
  July 21-22, 2016
  Sacramento, PA

- **Earth-Retaining Structures: Selection, Design, Construction, and Inspection - Now in an LRFD Design Platform**
  (1.4 CEUs)
  July 28-29, 2016
  Boston Metro Area, MA

- **Earthquake-Induced Ground Motions**
  (1.6 CEUs)
  September 15-16, 2016
  Boston Metro Area, MA

- **Earth-Retaining Structures: Selection, Design, Construction, and Inspection - Now in an LRFD Design Platform**
  (1.4 CEUs)
  September 22-23, 2016
  Salt Lake City, UT

- **Deep Foundations: Design, Construction, and Quality Control**
  (1.4 CEUs)
  September 29-30, 2016
  Las Vegas Metro Area, NV

- **Soil and Rock Slope Stability**
  (1.4 CEUs)
  September 15-16, 2016
  Denver Metro Area, CO

- **Deep Foundations: Design, Construction, and Quality Control**
  (1.4 CEUs)
  September 22-23, 2016
  Salt Lake City, UT

- **Deep Foundations: Design, Construction, and Quality Control**
  (1.4 CEUs)
  September 29-30, 2016
  Las Vegas Metro Area, NV

Webinar Packages offer CEU credit and savings of up to 50 percent.

For more information about webinars, seminars, and on-demand learning, visit the ASCE Continuing Education website: asce.org/geotechnical-engineering/education-and-careers.

**Internships Available**

Are you looking for an internship? Explore the positions listed on the ASCE website to help you obtain the experience you need to further your career path. New opportunities are added all the time, so start your search today: careers.asce.org/jobs?keywords=internship
On May 12, nearly 200 geotechnical professionals and 20 exhibitors from the New York metropolitan area attended the 40th Annual Metropolitan Section Geotechnical Seminar in Manhattan. This year’s seminar was entitled “Geotechnical Aspects of Safeguarding Infrastructure: Applying Risk Management to Build Resiliency.” The one-day seminar began with “Geosynthetic Reinforced Soil: From the Experimental to the Familiar,” a lecture by G-I Past President and University of Washington Professor Emeritus Robert D. Holtz, PhD, PE, D.GE, Dist.M.ASCE. Another highlight was the awarding of the Chapter’s inaugural scholarship to Erin Zeqja, BCE, EIT, A.M.ASCE, of Columbia University. There were 10 papers presented at the seminar — each focused on practical lessons learned and innovative engineering solutions for challenging projects around the New York metropolitan area. Over the past 40 years, this meeting has become the “go-to” event for the local geotechnical community.

East Central Florida G-I Cospensors Jim Jammal Lecture Dinner

On April 6, the keynote speaker was Kord Wissmann, PhD, PE, D.GE, M.ASCE, president of the Geo-Institute. His presentation, “Finding Love on the Dark Side,” described the ups and downs of his profession and encouraged students and established engineers to “find the love in geotechnical engineering.” More than 70 engineers, including 15 University of Central Florida engineering students, attended.

ASCE Wisconsin Section Participates in 2016 Spring Technical Conference

On March 24, the Wisconsin Geo-Institute participated in the ASCE Wisconsin Section 2016 Spring Technical Conference in Green Bay. This annual event includes multiple general interest sections and technical sessions. Tom Bucholz, PE, of the Wisconsin Department of Transportation, presented “Leo Frigo Bridge Corrosion Monitoring.” Jim Botz, PE, M.ASCE, and Marty Kemps, PE, M.ASCE, of Mead & Hunt, presented “Improving Safety and Recreation at Montello Dam.” Greg Greenlee, PE, of Engineering Partners International, presented “University of Minnesota Northrop Auditorium Renovation Underpinning and Micropile Foundation Case Study.” Mark Meyers, PhD, PE, F.ASCE, of the University of Wisconsin, Platteville, presented “Slope Stability Analysis Using Residual Shear Strengths: The Development of a New USACE Design Criterion.” Doug Bath, PE, M.ASCE, of GESTRA Engineering, presented “Wick Drains on the I-41 Project in Brown County.”

Bacon Gives Update on US 181 Harbor Bridge Project

On May 3, the Region 6 Local Involvement Committee representative Dexter Bacon, PE, M.ASCE, spoke at the ASCE Corpus Christi monthly luncheon. His talk was entitled “Update on the US 181 Harbor Bridge Project Geotechnical Study.” The bridge is replacing the current Harbor Bridge in Corpus Christi, TX. When completed in 2020, the new bridge will become the longest main span cable-stayed bridge in the U.S. At 1,655 ft, it has overtaken the current record holder, the John James Audubon Bridge, that spans the Mississippi River in St. Francisville, LA. Compared to the current 138-ft clearance, the new bridge will have a 205-ft vertical clearance that will allow modern Panamax container ships to access the inner harbor. Geotechnical topics included large-diameter drilled shafts for the main towers, ground modification of soft soils in areas of tall embankment fills, expansive soil remediation, and statnamic pile loading. The presentation attracted more than 50 attendees, including six new ASCE life members, who were recognized.
Ground Improvement

As I See It: Ground Improvement – Coming Full Circle
By Vernon R. Schaefer

What’s New in Geo? The Rise of UAVs Signals a New Era in Geotechnics
By Dimitrios Zekkos, William Greenwood, John Manousakis, and Jerome Lynch

The Evolution of Launched Soil Nails
By Colby Barrett and Graeme Quickfall

A History of Deep Vibratory Methods for Ground Improvement
By Jeffrey R. Hill, Allen L. Sehn, and Mark Koelling

Limited Mobility Grouting Arrests Movement of Emergency Room
By Shad E. Hoover and Whitney E. Greenawalt

Ground Improvement for Underground Construction
By Paul C. Schmall

How an Innovative Combination of Ground Improvement Technologies Improved Interchange 14A
By Gillian M. Williams, Sarah Ramp, Sonia S. Swift, Justin Labrozzi, Michael P. Walker, and Frederic Masse

Lessons Learned from GeoLegends: Thomas D. O’Rourke
By Suguang (Sean) Xiao, Hai (Thomas) Lin, and Hanna Moussa Jabbour

4th GeoChina International Conference
July 25-27, 2016
Shandong, China
geochina2016.geoconf.org

Geo-Chicago 2016: Sustainability, Energy, and the Geoenvironment
August 14-18, 2016
Chicago, IL
geoenvironmentconference.org

3rd International Conference of Transportation Geotechnics
September 4-7, 2016
Portugal

19th International Conference on Soil Mechanics and Geotechnical Engineering
September 17-22, 2016
Seoul, Korea

IACGE 2016
October 12-13, 2016
Beijing, China

Geo-Risk 2017
June 4-7, 2017
Denver, CO

Grouting 2017: Deep Mixing and Diaphragm Walls
July 9-12, 2017
Oahu, Hawaii

GeoMEast 2017
July 15-19, 2017
Sharm Elsheikh, Egypt
gomeast2017.org

Geo-Risk 2017
June 4-7, 2017
Denver, CO

PanAm-UNSAT 2017: Second Pan-American Conference on Unsaturated Soils
September 10-13, 2017
Dallas, TX

IFCEE 2018
March 13-17, 2018
Lake Buena Vista, FL

Geotechnical Earthquake Engineering and Soil Dynamics V 2018
June 10-13, 2018
Austin, TX

For more seminar information:
asce.org/continuing-education/face-to-face-seminars
GeoPoem
By Mary C. Nodine

When you cannot use spread footings
’Cause your bearing layer’s deep,
And the nice abutting neighbors
Ask that you kindly keep
Construction noises to a minimum
Or else a fine you’ll pay —
The Mighty Micropile
Spins in to save the day.

He doesn’t look imposing,
His diameter so small —
You wouldn’t think that he’d support
Much axial load at all.
But with a big steel bar and casing
And a socket into rock
Those nine- or twelve-inch piles
Take 200 tons a pop.

Apart from their capacity
To support such heavy weights
There are other superpowers
That make the micropile great.
Perhaps you need foundations
In a space with low headroom...
You simply need to find a drill rig
With the right size boom.

And — Voilà! Yes, you may need to drill them
Five feet at a time...
But in those situations
The micropile shines.
Installed with roller bits as tough
As nails — or even more —
They’ll drill through almost any big
Obstruction that’s in store.

Nimble, strong and versatile,
The Mighty Micropile
Can even underpin old buildings
As they come back into style.
But he has limits — for example,
Skyscrapers aren’t his craft.
So he calls upon his sidekick:
The Daredevil Drilled Shaft.

MARY C. NODINE, PE, M.ASCE, is a
geotechnical poet and a project engineer
with GEI Consultants, Inc. in Woburn,
MA. She can be reached at mnodine@geiconsultants.com.
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Groundwater Control    Earth Retention    Deep Foundations    Ground Freezing    Grouting
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Providing a streamlined workflow from design to construction for faster, more cost-effective project delivery.

Shoring, excavation, groundwater control, and deep foundations for a luxury condo.

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