Geo-Strata

May/June 2013

Offshore Geotechnics

ALSO

Lessons Learned from Geo-Legends:
Robert D. Holtz

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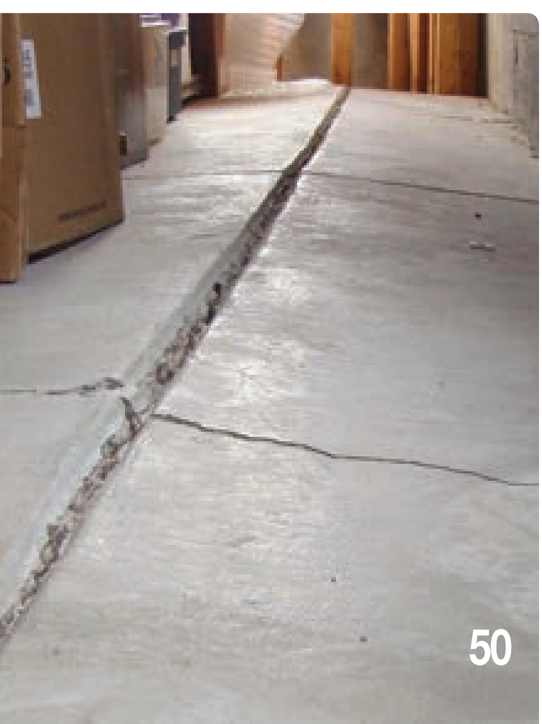
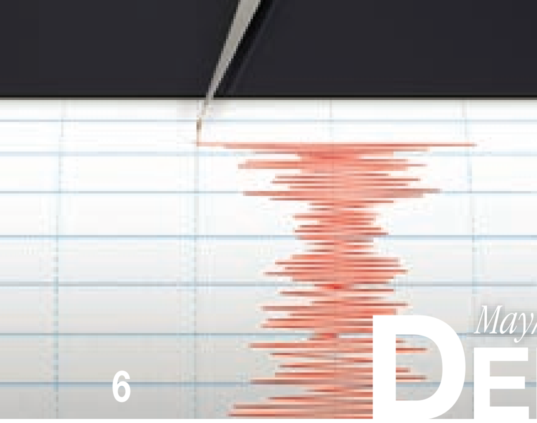
FEATURES



ON THE COVER: Photo shows offshore geotechnical exploration for windfarm interconnector cables in the North Sea. More than 350 exploratory holes were advanced along 13 cable routes. Vibrocore samples up to 6 m depth were drilled at 1 km centres along the routes.

Photo: Geotechnics Limited / Osiris Projects – Offshore Survey in the German Bight

DGI MENARD



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DATA FORENSICS

Geo-Poem by Andrew Summerfield

The Stressed Fault and the Small Fracture

The Stressed Fault and the Small Fracture
Met outside San Fran.
They wept like anything to see
The city's buildings stand.
"If this would only all fall down,"
They said, "it would be grand!"

"The time has come," the Stressed Fault said,
"To shake up many things.
Like homes and cars and mini-marts,
And libraries and things.
And jungle gyms and hospitals,
And office building wings."

"I shall begin," the Stressed Fault said,
"With a shift along myself,
Sending body waves through the ground
To knock things off the shelf.
Surface waves will follow them
To break apart all else."

"What magnitude," the Fracture asked,
"Of earthquake are you planning?"
"I feel one of 8 or 9
Would be the most enchanting!"
The Fracture cried with bated breath,
Practically panting.

"I quite agree," replied the Fault,
"But you must lend a hand,
Since the difference between 8 and 9
On the Richter scale is grand.
How few quakes that measure 9
Have ever shook the land!"

So the Stressed Fault and the Fracture
Summoned all their power,
And sat there, thinking shaky thoughts
Of toppling great towers,
When finally, they released their waves,
To wreak havoc within the hour.

But as they watched, expecting
All the buildings soon to tumble,
They realized that they would stand tall
Despite the greatest rumble.
It is most accurate to say
This really burst their bubble.

The Stressed Fault and the Small Fracture
Scoffed at what they witnessed.
"The buildings of that city must
Be of insane thickness.
There could not be a problem with
Our earthquake-making fitness."

So the Stressed Fault and the Small Fracture
Let the city be.
And yes, the buildings of San Fran
Are strong, we can agree.
But the quake the Fault and Fracture made
Was only magnitude 3.

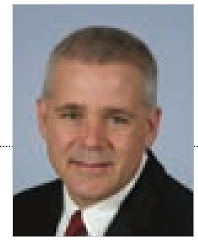
AUTHOR

Andrew Summerfield is a senior at Tufts University. This poem was part of his final project for Professor Swan's Soil Mechanics class in the fall semester of 2011.

Mentoring for the poetry project was provided by **Mary C. Nodine, P.E.** Mary is a geotechnical poet and a project engineer with GEI Consultants, Inc. in Woburn, MA. She can be reached at *mnodine@geiconsultants.com*

BENTLEY

Thoughts from the President by Craig Benson

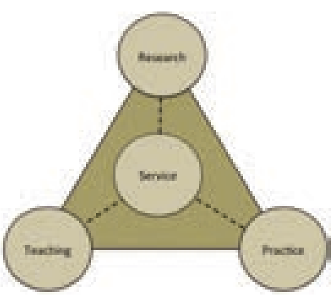


The Research-Triangle-Practice (RTP) Triad – Something for All of Us

How do we continue to raise the bar in our profession? How do we raise the expectations of our clients for the technology we provide and the risks that we manage, and command a fair fee with a higher margin? Brand awareness and promotional campaigns can only do so much to raise the bar. Long-lasting success in elevating our profession will be driven by technological innovation that clients are interested in purchasing. Providing innovative and efficient solutions that reduce risk and managing costs while ensuring public safety is essential to achieving this goal.

Innovation is defined as the process of bringing a new method, idea, product, etc. to the marketplace. Effective technical innovation provides technology that creates attention and demand. The experience in the high technology industry is a great example – consider the remarkable growth and success of technology companies where innovation thrives (e.g., Samsung Electronics or Apple Computer) and the fate of those where innovation is sluggish (e.g., Research in Motion).

How do we stimulate innovation? One of the best approaches is to continuously question the efficacy of our methods and ask: is there a better way? The "RTP Triad" – the continuous flow of information between research, teaching, and practice (RTP) in our professional lives – is one of the most effective ways to promote innovation and provide fresh ideas that define "the better way."



The RTP Triad

At this point some readers are probably thinking – here we go again, another academic pushing for more research. But I argue that each of us should be involved in all three components of the RTP Triad regardless of the area of our practice, including the vertex of research. Some may emphasize one component of the triad more than others, but all three vertices are important for all geo-professionals.

Research expands our knowledge regarding mechanisms, techniques to predict behavior, and appropriate methods to parameterize the tools we use for prediction. Through research we develop new methods and tools that allow us to propose more efficient designs that permit more cost-effective risk management or improve safety. Practice validates our knowledge and refines our approaches so they are both reliable and practical. From my own experience, there is no better test of knowledge (or opportunity to be humbled) than having to prove your technology works as touted in the field at full-scale. Teaching challenges our understanding. Anyone who has taught a webinar, a full-blown course, or mentored a junior engineer or peer knows that there is no better test of knowledge than having to teach principles or concepts to someone else. Service in our profession, through organizations like the Geo-Institute, provides opportunities to meet new collaborators and to share information readily between the vertices of the RTP Triad.

We put more emphasis on different vertices of the RTP Triad depending on our role in the profession. Design engineers put more emphasis on practice through design and implementation, whereas academics put more emphasis on research or teaching. Regardless of our role, however, we all benefit from being engaged in all three vertices and by collaborating with others who emphasize different vertices. My graduate education was based on this philosophy, and I have embedded it in all aspects of my own practice. I have also infused this philosophy into my interactions with others in my roles as educator, scholar, and practitioner. Recognizing the value of all three components of the triad, and promoting the collaborations between those with different points of emphasis, is critical to stimulating innovation and success in our profession.

When I reflect on the most significant technical accomplishments of my career, the RTP Triad has been integral in each case. My research on water balance covers for waste containment is a good example. I began research in this area in the early 1990s after being involved in a landfill closure project in the semiarid west where a client was looking for a more cost-effective and sustainable technology for closing her site in an environmentally-sound manner. I collaborated with her consulting engineer, and we devised a technology that achieved the project objectives using hydrologic principles adapted from natural processes. The project worked exceptionally well, but at the time, the consulting engineer and I had many questions about our assumptions and methods (our client may have had these same concerns, but she did not share them with us!). That initial project led to more than two decades of innovation in water balance cover technology that involved basic and applied research, model and method development, demonstration using full-scale projects, and lots of teaching through technology transfer programs. Humbling experiences and sudden leaps forward in understanding were commonplace.

Water balance cover technology is now mature and widely adopted in the drier parts of the world, but this was only possible because all three aspects of the RTP Triad were emphasized, and through collaborations with practitioners and clients who put more emphasis and had more experience and strength than me in different vertices of the RTP Triad. Everyone involved in the process learned a great deal from each other. The clients managed their risks with greater confidence and with lower capital and long-term costs, the engineering practitioners developed a new area of expertise with the opportunity for higher margins, I had the opportunity to develop an entire new set of scientific and communication skills, and the public benefitted from a safe and effective technology.

There are many similar examples in our profession. The successes all have a common theme that involves each vertex of the RTP Triad, as well as the engagement of others who emphasize different vertices. For practitioners this may require engaging academics who use nonstandard tools and methods and who work at a different pace. For academics, this may require emphasis on practicality and relevance in methods in addition to fundamental scientific underpinnings, and pushing faster than is comfortable. By doing so, we all benefit professionally by expanding our knowledge and our competencies, and most importantly, benefiting our profession through innovation. Many of these connections can be made through functions and activities offered through our Geo-Institute.

Like so many areas today, our profession is at a transition point where great opportunity exists for distinction and growth. At the same time, there is an equally large potential for commoditization to become the norm. Industries change today at rates that were unprecedented even a decade ago. I recommend that we focus on opportunity and we do so by emphasizing innovation that brings new ideas to our professional marketplace, and we do so by creating collaborations that emphasize strength in all three areas of the RTP Triad. Through this innovation, we can command greater respect and higher margins from our clients, enjoy a more fulfilling and satisfying profession, and provide safe and economic solutions that benefit the public.

Craig H. Benson, Ph.D., P.E., D.GE, NAE, F.ASCE,
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From the Editorial Board by James L. Withiam

For those of us not experienced with offshore, and in particular, deepwater geotechnics, it can seem like a world unto itself with exploration, design, and construction challenges we landlubbers can only imagine. *Geo-Strata* ventured into this realm six years ago for its May/June 2007 issue to learn about exploring and testing soil in deepwater, offshore geohazards and their evaluation, and suction caissons for deep-water moorings. Of course, we only scratched the surface, albeit to water depths of 500-2,000 m, so we offer this issue to help us understand this fascinating area of geotechnics.

The articles in this issue cover topics like numerical modeling, jack-up drilling rigs, and recent advances in the design of deep-water risers that connect seafloor installations to host vessels at the surface, but two pieces in particular caught my attention. In "A Historical Review of the Geotechnical Offshore Site Investigation Practice," Don Murff and Alan Young summarize the evolution of offshore exploration methods and tools. They describe the advances that were made to explore soils at ever increasing great water depths, to develop new sampling and in situ test tools and methods, and to improve the recovery and quality of the soil samples extracted from the seafloor.

In his "*As I See It:* Offshore Geotechnical Engineering," geotechnical engineer Ed Clukey discusses some of the challenges he has faced during his career. He comments that while much of the initial "…geotechnical effort focused on developing a technical practice for piles," offshore geotechnical engineers have developed alternative foundation systems, new methods for site characterization in extreme environments, and soil-structure interaction design of deepwater pipelines, cables, and riser/conductor systems. And today, geotechnical expertise is needed "…to address foundations for offshore wind energy, help resolve downhole well issues, and to better understand geomechanics issues for hydrocarbon exploration." As a truly technology-driven discipline, he closes by saying the next generation of offshore geotechnical engineers will witness exciting opportunities.

In the seventh in a series of "Lessons Learned from Geo-Legends," this issue introduces us to Robert D. Holtz, Ph.D., P.E., D.GE, Dist. M.ASCE. Interviewed by Dan VandenBerge, Alex Reeb, and Andy Kost, we learn about Bob's career as an educator, researcher, practitioner, and author. Many know Bob as a co-author of *An Introduction to Geotechnical Engineering*. If you are familiar with the text, you may recall the subtle humor in it. The interview closes by divulging the source of that humor.

In closing, we hope you enjoy this issue of *Geo-Strata* as much as we enjoyed working with the authors to bring it to you. If you have questions for the authors, you can contact them by e-mail using addresses provided at the end of each article. If you have a question for the editors, please send them to *geo-strata@asce.org*

AUTHOR

This message was prepared by *Geo-Strata* editor-in-chief
James L. Withiam, Ph.D., P.E., D.GE, M.ASCE

This Geo-Poem should have run in the March.April 2013 Geo-Education issue.

Geo-Poem

Sonnet No. 90: Trigonometry

Though many concepts learned by rote in school
Use word problems to demonstrate their clout
In real-world applications – I'm no fool –
I know which subject I can't live without.
Its strict rules keep me grounded in a mess
Of gammas, deltas, betas, taus and phis.
Lacking cosines, I would be hard pressed
To calculate a lowly sigma-three.
Presented with a rogue retaining wall,
Slopes askew and forces all in tangles,
I make order from chaos – it won't fall! -
By resolving into right triangles.
I dare not think what turmoil life would be
If not for noble trigonometry.

Sonnet No. 114: Phase Diagrams

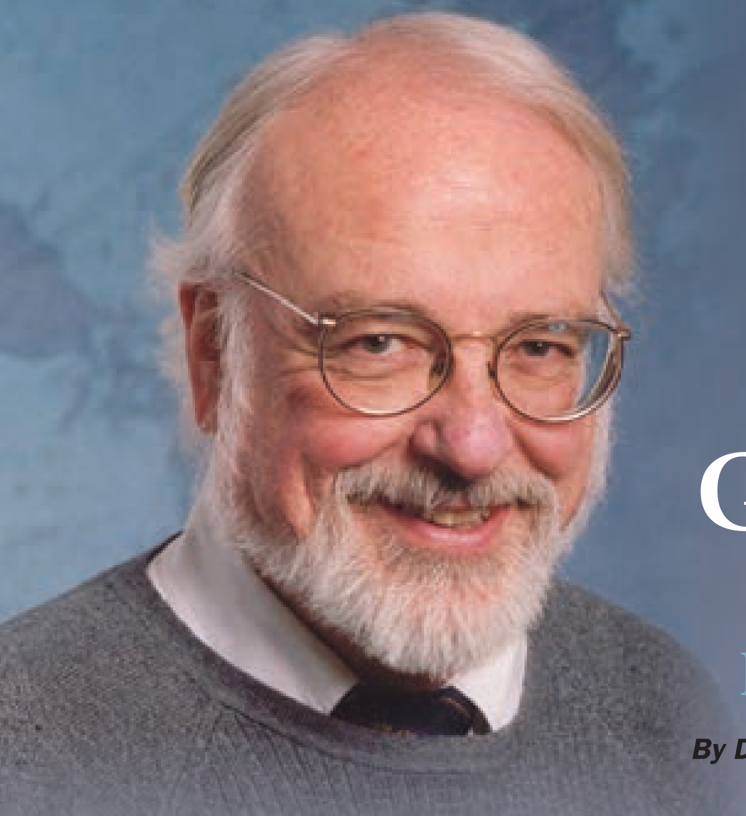
When life demands I calculate in haste
Void ratio of saturated sand,
I cannot keep a smile from my face…
For now I get to use phase diagrams.
I draw a picture, simple as can be:
Just solids, water, air (of which there's none).
My only clue is total density,
But solids volume, I assume, is one.
I'll go out on a limb and say G_s
Is two point six – now, water weight: I know!
Back to the other side, complete my quest:
Water volume, and I'm good to go.
A memorized equation may be fast,
But simple fractions, in my brain, will last.

Author's Note: In order to remain true to the age-old sonnet structure for No. 114, I chose a brief calculation to describe. I understand that a simple relationship exists among void ratio, water content and specific gravity and that to use it would likely be faster than drawing a phase diagram. However, I do love phase diagrams, and *although I might not really use one here/the spirit of the poem is quite sincere.*

AUTHOR

Mary C. Nodine, P.E., is a geotechnical poet and a project engineer with GEI Consultants, Inc. in Woburn, MA. She can be reached at *mnodine@geiconsultants.com*.

REINFORCED EARTH CO.



LESSONS LEARNED FROM GEO-LEGENDS:

Robert D. Holtz, Ph.D., P.E., D.GE, Dist. M.ASCE

By Daniel VandenBerge, P.E., S.M.ASCE, Alexander Reeb, E.I.T., S.M.ASCE, and Andrew Kost, E.I.T., S.M.ASCE

This article is the seventh in a series of "Lessons Learned from Geo-Legends." The articles are written by student members of the Geo-Institute's Student Leadership Committee (SLC) who believe the insights they convey will benefit students and younger G-I members by providing an opportunity to learn from those who have excelled in advancing the geotechnical engineering profession. Due to space constraints, this article is a condensed version of the author's interview with the Geo-Legend. The full interview is available on the G-I web site at www.asce.org/geo.

Dr. Robert D. Holtz has been an influential figure in the geotechnical engineering community for many years. He earned a B.S. and M.S. in civil engineering from the University of Minnesota in 1960 and 1962, respectively. After working for the California Department of Water Resources for a few years, he began teaching at California State University in Sacramento. In 1966, Dr. Holtz had the opportunity to attend the Special Program in Soil Mechanics run by Arthur Casagrande at Harvard. From Harvard, he went to Northwestern University and earned his Ph.D. in 1970 under Professors Jorj Osterberg and Raymond Krizek.

After his doctoral studies, he worked briefly in consulting in northern Illinois and then accepted a job as a research engineer with the Swedish Geotechnical Institute (SGI) in Stockholm. He returned to academia in 1973, accepting a position at Purdue. In 1988, he became a professor at the University of Washington, where he currently holds emeritus status. Throughout his career as a professor, Dr. Holtz has remained active as a consultant, working on a wide range of projects including geosynthetics, soil reinforcement, foundations, soil improvement, slope stability, landslides, and geotechnical failure investigation. He also has consulted in Sweden, Canada, France, and Italy.

His extensive research topics include geosynthetics, soil improvement, foundations, and laboratory and in-situ measurement of soil properties. As a result, he has authored or co-authored more than 280 technical publications and has been involved in the publication of more than 25 books as author, co-author, or editor. Notably, Dr. Holtz co-authored the widely-used and well-respected textbook, *An Introduction to Geotechnical Engineering*, with W. D. Kovacs, and now T. C. Sheahan.

Dr. Holtz's deep commitment to the civil and geotechnical engineering profession is also evidenced by his dedicated membership in many professional societies, including ASCE, the Geo-Institute, ISSMGE, ASTM, USUCGER, TRB, IGS, ADSC, ASFE, and several other international geotechnical societies. In addition to being a longtime member, he has served as president, chair, or board member for many of these organizations.

Throughout his distinguished career, Dr. Holtz has received many honors and awards, including the annual R.M. Quigley Award, given to authors of the best paper published in the *Canadian Geotechnical Journal* the preceding year; recognition as an International Geosynthetics Society Pioneer; Puget Sound Academic Engineer of the Year; and symposiums held in his honor at GeoAmericas 2008 and the 2013 Geo-Congress; and the First Pan-American Geosynthetics Conference and Exhibition. He has given many named lectures, including the M. S. Kersten Lecture, the Cross-Canada Lecture, the Stanley D. Wilson Memorial Lecture, the Lymon C. Reese Lecture, the Anwar Wissa Memorial Lecture, and the 46th Karl Terzaghi Lecture in 2010.

Q: Tell us a little about yourself. Where did you grow up?

My father worked for the Indian Bureau, and for the first 12 years of my life, we lived on reservations in Arizona and New Mexico. We moved to Phoenix for a few years when I entered high school, then on to Gallup, NM and finally on to Minnesota. Everything after that, like where I got a job after I graduated, was just accidental as opportunities came along.

Q: How did you come to be interested in geotechnical engineering?

I always enjoyed the idea of constructing things. It may sound silly, but as a kid I loved playing in the sandbox – not that I understood the principles of capillarity and effective stress! I also enjoyed going out on the reservation with my dad, where I was fascinated with seeing roads built on the sides of hills and mountains. When I asked my dad about it, he encouraged me to consider engineering.

In college, I got into a soils course my junior year; Miles Kersten was my professor. He would go down to the lab and get his hands dirty. I thought, wow, this is neat stuff, and that got me interested in soils. I worked some summer jobs with the highway department, and I enjoyed construction, so geotechnical engineering seemed like a good place to be.

Q: What are some of your hobbies or interests outside of engineering?

My wife and I are interested in the arts. We enjoy the opera, the Seattle symphony, and the theatre. We also enjoy going to the University of Washington football games and occasionally go to a Mariners game when they're doing well.

Q: What is your favorite thing about being a geotechnical engineer?

Geotech offers so many challenges. Every job is different, every project is different. I've learned so much from every job I've ever worked on, and I have learned from my students. It's all new, and I just love it; I really still do. I can't think of doing anything differently with my life.

Q: What have been the most challenging and interesting projects you have worked on?

A lot of the research I've been involved with has been very challenging. I've really enjoyed getting into geosynthetics, soil reinforcing, and related topics. I've worked with drainage, separation, and pavements on highway jobs, and in virtually every aspect of geosynthetics. There are still so many things that we don't understand that would make very interesting research projects.

Q: Who has helped you the most in your career?

I think every boss that I ever had, and certainly my professors, have all been very important mentors. These people were very forgiving of stupid things I did at the time, and I benefited from that generosity. They would put a hand on my shoulder and say, "Come on. Let's go over and talk about this. Try not to do that again, pleassseee." It was enormously beneficial.

Q: Are there specific people who have influenced you professionally?

There were several engineers at the Department of Water Resources (DWR) who helped me, especially Bernie Gordon and Bill Hammond, who ran the soils lab. We spent a lot of time trying to understand triaxial tests that we were doing for the California aqueduct and embankment dams. That was all very useful. At Northwestern, Professors Osterberg and Krizek strongly influenced my professional career. I worked for Clyde Baker one summer, and I learned an enormous amount about foundations from him. We got into the instrumentation of drilled shafts that I wouldn't have gotten into otherwise. Bengt Broms, Oleg Wager, and Bengt Fellenius at SGI had a big influence on me.

And then at Purdue, I enjoyed working with Jerry Leonards, Milt Harr, and Bill Lovell. And of course there was my friend

(l-r) Dan VandenBerge, Robert Holtz, Andy Kost, and Alex Reeb.

Bill Kovacs. Also, I should mention Francois Schlosser in France and Mike Jamiolkowski in Italy, whom I worked with while on sabbatical in 1984-85. They were all really good people and I learned an enormous amount from each of them. I'm still learning from my present UW colleagues who are a lot younger than me, but, boy, they sure are smart! It's somewhat nostalgic when you start thinking about past mentors who were so important at some stage in your career. I think that one of the really nice things that you can do is to thank your mentors. I've tried to do that, even though some are already gone.

I always enjoyed the idea of constructing things. It may sound silly, but as a kid I loved playing in the sandbox.

Q: What drew you to become an educator?

Oh, that was just by accident. I was working in the soils lab at the DWR, and there was a guy who worked at the lab and also taught soils at California State University in Sacramento. He was told to get a PhD, so he left for Berkeley. I had been a TA for my graduate work in Minnesota, and I had helped with the concrete and soils labs. I went to Sacramento State to teach on a temporary basis to fill in in for this guy while he was off studying.

I had to teach four or five courses each semester, and it was a lot of work to keep ahead on the lectures and set up the labs, but I really enjoyed it. Lester Gabriel, a structural engineer, was my boss. One day he told me, "Well, if you like teaching, you've got to get your union card." I responded, "Oh, I didn't know Sacramento State has unions." He replied, "Ph.D., dummy!" and stormed off. So I figured I had better get a Ph.D. That led me to Northwestern and also to Harvard with Casagrande's program, which was really fun.

Q: Is there anything that you would like to say about the state of graduate or undergraduate civil engineering education?

I worry about the reduction in credits that seems to be imposed by people that don't understand the needs of the profession. The mentality seems to be, "We've got to get these students to graduate fast, so they shouldn't have to take more than 120 semester hours." When you start looking at the stuff that gets cut out, it makes me think, "Geez, how can you cut that out?" How do you know as a junior or senior what you're going to need 30 years from now, or even five years from now? And how can you say that you shouldn't have exposure to environmental engineering, water resources, pavement design, etc. I worry about that because I don't think that the cuts have been well thought out.

I would really like to see ASCE do its own accreditation separate from ABET. The way ASCE has handled it so far is by requiring a B.S.C.E. plus 30 credits, which is basically an M.S. Of course, state licensing boards need to buy in on this approach, but that's just not happening very fast, so I just don't know how to solve the problem.

Q: On that note, what advice do you have for an aspiring geotechnical engineer?

I think it's really important to complete an M.S. I think it makes you a more valuable engineer. Many students have the self-awareness to appreciate that they don't know everything and want to get that additional training. They realize that they can do some things with a B.S., but that it sure would be nice to know a little more. As for practical problems of money, debt, and families, I really appreciate and understand that. It drives people to forgo an M.S. degree because of those things. I've had a number of very bright students in those situations.

You certainly want to learn as much about geology and rock mechanics as you can. That can be difficult to do in a prescribed curriculum. At some universities, the geology department can be separate from the civil engineering department. It makes it hard for students to get that exposure to geology, especially engineering geology.

The other thing I would tell students is to get as much practical experience as you can. If students are unsure of what they want to do, they should go out and work, and they'll find out very fast whether or not they really enjoy it. And, the experience should be as varied as possible. I know that can be easy to say but sometimes hard to do. We have some wonderful professional challenges because of the nature of geo-materials and the imperfect models and the imperfect methods of solving construction problems. But some of the real issues that designers face have nothing to do with their knowledge of bearing capacity, pile foundations, or slope stability. They're "people" problems, political and economic problems, which can all be very, very challenging. So get some experience and keep an open mind.

Also, learn from your peers and try to work with people who are willing to mentor you. You certainly want to work for somebody that is already a P.E. because that helps you get your license early in your career. I think the ideal first supervisor is a geotech who is about 5 to 10 years out of school because they still remember when they didn't know everything either, and they are willing to show you the "tricks of the trade," so to speak. I was really lucky to have mentors like that.

Q: Can you tell us a little bit about how you originally developed *An Introduction to Geotechnical Engineering* with Kovacs?

We never expected that book to be such a success. It was just fulfilling a need we had at Purdue for a suitable textbook for that course at the time. There were several good books, of course, but they were too hard or too superficial for our junior-level students, especially non-geotechnical majors. So, we put together some notes, and then we started passing out these thick manuscripts in our classes. That gave it a chance to be vetted by students, and by the time we put together version five or six, we had it printed, and it really wasn't too bad.

Q: And how about the subtle humor throughout the book?

I'm innocent. The jokes are all Bill's. I don't have a sense of humor.

Geotech offers so many challenges. Every job is different, every project is different.

AUTHORS

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As I See It: OFFSHORE GEOTECHNICAL ENGINEERING

The offshore environment has offered continuing challenges to geotechnical engineers ever since Bramlette McClelland was first engaged to acquire soil borings from a small barge in approximately 20 ft of water in the Gulf of Mexico in 1946. Since then, the discipline of offshore geotechnical engineering has expanded to become truly global, involving work for a range of industries throughout the world.

Initially, much of the geotechnical effort focused on developing a technical practice for piles used to support steel piled jackets, the most common type of offshore platform. But as the demands for geotechnical input have increased, the global offshore geotechnical community has also needed to provide expertise related to alternate foundation systems; various geohazard conditions; geotechnical issues related to pipelines, cables, and riser/conductor systems; and site characterization in extreme environments. Geotechnical expertise has also been required to address foundations for offshore wind energy, to help resolve downhole well issues, and, to a limited extent, to better understand geomechanics issues for hydrocarbon exploration.

The offshore geotechnical community has benefitted tremendously from a range of technological advancements. Tools to more efficiently characterize marine soils have evolved. For example, cone penetrometer testing is now common in most regions of the world and is used with on-bottom and downhole systems, as well as through innovative coupling with piston cores. Full-flow penetrometers have been particularly helpful in characterizing near-seafloor soils, which is very important for pipeline/cable applications. Soil samples can now be acquired with on-bottom systems operated by remotely operated vehicles, reducing the need for large and expensive geotechnical drilling vessels.

The ability to visualize seafloor and subsurface conditions has always been provided through geophysics. Important developments in this technology include 3-D high-resolution surveying and processing and Autonomous Underwater Vehicles (AUVs) capable of collecting data without tethering to a host ship. AUVs have not only improved data quality, but have also reduced survey time. AUVs typically provide swath bathymetry data which can be used to develop 3-D renderings of the seafloor and provide sub-bottom profiler data. This data can be merged with the 3-D high-resolution and soil boring information to provide an integrated subsurface picture.

In addition to slope stability issues, the impact of shallow faulting and debris flows on offshore facilities has also challenged offshore geotechnical engineers. An exciting area with regards to these geohazard assessments involves the expanding capabilities of finite element modelling. Until recently, engineering-based codes could not reliably model the large displacements required for many geohazard problems. However, advancements using combined Lagrangian-Eulerian approaches and adaptive remeshing have greatly improved this capability.

With the expansion to deepwater, the need for new foundation systems arose owing to pile driving challenges in water deeper than 4,000 ft. While several different systems evolved to fill this need, suction caissons are the predominant new foundation used to anchor deepwater facilities. This foundation is typically 15-25 ft in diameter, embedded to 30-120 ft, and derives much of its capacity from reverse end bearing for uplift loading. An important part of suction caisson technology development has involved geotechnical centrifuge testing, which has evolved from a research-oriented tool to one which has made significant contributions to technical practice. Geotechnical centrifuge testing's lower costs and reduced schedule time have been an important advantage for meeting the requirements for suction caissons and other deepwater foundation systems.

Recently, the fatigue of risers connecting deepwater pipeline systems to floating facilities has become another challenge with deepwater environments. The risers can either be a continuous extension of a pipeline or a vertical riser, either from a well or a pipeline termination point. The fatigue is caused by repeated loadings from waves and currents as well as vortex-induced vibration from flow around the surface facility or the risers themselves. Most of the damage occurs from small environmental events with many cycles of loading, making the small displacement soil response along the risers a significant part of the fatigue life assessment. Geotechnical engineers have worked closely with riser engineers to develop more robust approaches to this problem.

These few examples help illustrate that offshore geotechnics is truly a technology-driven discipline that will only become more so in the future as greater depths are explored and more challenging environments are encountered. As in the past, solutions will undoubtedly require input from the next generation of offshore geotechnical engineers, and the scientists and engineers with whom they will collaborate. Based on what I've witnessed during my career, this will be a most exciting time.

AUTHOR

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GEOKON

Figure 1. Bram McClelland testing and classifying soil samples offshore in 1947.

A HISTORICAL REVIEW OF THE GEOTECHNICAL OFFSHORE SITE INVESTIGATION PRACTICE

by Alan G. Young, P.E., M.ASCE and James D. Murff, Ph.D., P.E., Dist.M.ASCE

Like many areas of geotechnical engineering practice, offshore geotechnical engineering was pioneered by a visionary who recognized a need to help build an industry. The career interests of Bramlette "Bram" McClelland, the "father" of offshore geotechnical engineering, included engineering geology, site investigation methods, laboratory testing, and foundation design. His expertise in these areas and his engineering talents and perseverance led the industry to develop new methods and tools to improve site characterization and address the ever-increasing demands of greater water depths and larger, more complex loading on offshore structure foundations. McClelland established the early standards for the state of practice and set the stage for the evolution of that practice up to the present time.

McClelland conducted the first site investigation for offshore pile design in 1947, working from a small temporary platform with a portable drilling rig (Figure 1). His understanding of the need for high quality samples led him to initiate development of open-hole drilling and wire-line sampling methods. He also realized the need to conduct in situ testing and implemented the early design of tools for conducting in situ vane and cone penetrometer testing.

Barge Drilling in the 1950s

The procedure for drilling a soil boring from a temporary platform was successfully used from 1947 through 1953 off the Louisiana coast in water depths less than 60 ft, but weather and increasing water depths required a new approach. The first floating geotechnical investigations were conducted from a large deck barge moored on location. This method required a heavy barge and large oceangoing tugs for towing, mooring, and standby assist (Figure 2).

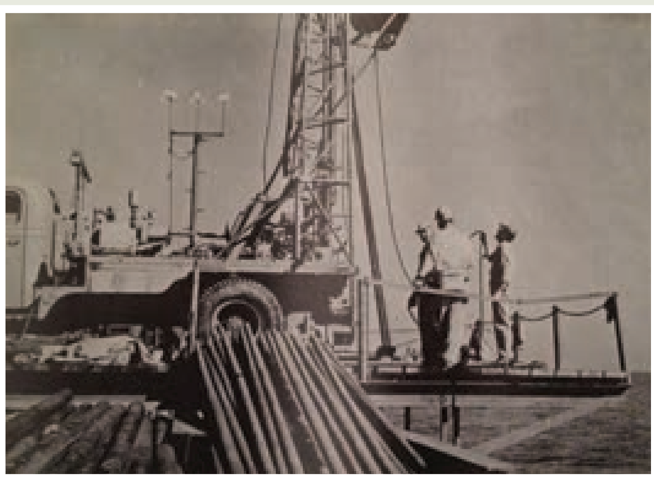
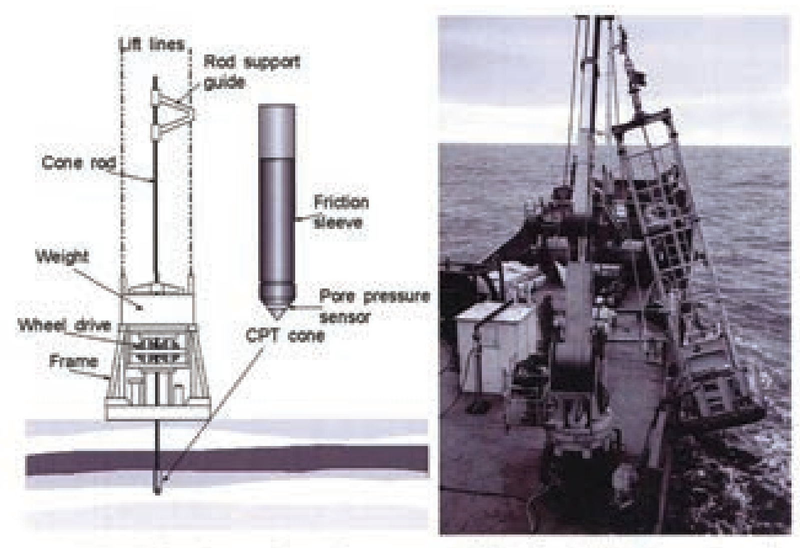


Figure 2. Drilling soil borings off moored barge in 1957.

The drilling and sampling operations were conducted with a portable drilling rig cantilevered over the side of the barge. Rotary drilling procedures were used after a casing was suspended from



Left: Dual lifting line configuration. Right: Single lifting line configuration

Figure 3. Fugro *Seacalf* CPT system in 1972.

the barge deck level down to a nominal depth below the seafloor. The boring was drilled and samples taken with a 3-in.-diameter Shelby tube using the drill rod alternately for drilling and sampling operations. The operation was slow, often requiring several days to drill a 300-ft boring in water depths up to 300 ft.

Work Boat Drilling in the 1960s

A request to drill a series of borings near the Continental Shelf break in water depths ranging from 550 to 600 ft across the Louisiana coast prompted the development of more innovative site investigation methods. On an experimental basis, engineers rigged up a conventional oilfield supply vessel with a four-point mooring system and installed a centerwell or moon pool to allow drilling to be conducted amidships. McClelland designed a wireline sampler that allowed a hammer having a 10-ft stroke to drive a sample tube with a diameter of 2.25 in. into the soil located beneath the bottom of the borehole.

The technique was used to drill more than a dozen borings, and its success led to its subsequent use around the world. While these methods became widely used, the potential for sample disturbance due to percussion sampling and small diameter tubes prompted the industry to pursue improved sampling and in situ testing methods. In addition, a new generation of vessels was needed to provide a larger stable work platform with dynamic positioning to avoid a four-point mooring system.

Field Investigation Innovations in the 1970s

The 1970s was a very active decade for the development of offshore engineering. To overcome many of the challenges of acquiring high-quality samples offshore, a wide variety of in situ testing methods was developed for this rugged operating environment, the most prominent being the vane shear test and the piezocone penetrometer test. The successful use of these new in situ methods also led to the development of specialized vessels.

Vane Shear Test (VST). A major oil company sponsored a program to develop the first borehole vane shear test for offshore operations. At that point, traditional sampling and laboratory testing methods had provided unreliable strength data in the soft, very sensitive Mississippi Delta clay. In 1970, the first use of the device took place from a floating vessel.

Piezocone Penetrometer Test (PCPT). The first PCPT tests were carried out in the North Sea using the Seacalf system in 1972 (Figure 3). The Seacalf incorporates a seafloor platform that is capable of performing continuous cone soundings down to 120 ft below the sea floor in normally consolidated clays. PCPT testing provides measurements of point resistance, side friction, and pore pressure response that can be used to infer soil type, undrained shear strength, and other important soil properties. Further developments included the Wison system in 1972 and the Stingray system in 1975, both of which could perform PCPT soundings in a downhole mode. Both systems also had the capability to take high quality 3-in.-diameter piston samples.

Specialized Geotechnical Drillships. The successful operation of these innovative sampling and in situ testing tools prompted the development of specialized vessels to serve as stationary work platforms. Larger, purpose-built, dynamically positioned geotechnical drillships such as the *Ferder* (Figure 4) were constructed that could maintain station for up to three to five days. These vessels had a specially-built drill rig positioned over a moonpool located amidship. The drill rig required heave compensation of the drill pipe to assure good sample quality and to eliminate any potential impact of vessel motion on the in situ testing results. Today there are a number of these specialized drillships operated around the world.

Deepwater Equipment Innovations in the 1980s

Data collection in deep water is expensive owing primarily to the involvement of costly, specialized vessels. It generally requires coverage of a very large seafloor area. The high costs

Figure 4. Specialized geotechnical drillship *Ferder*, 1974.

Figure 5. Portable Remotely Operated Drill (PROD).

and large areal extent mean that efficient collection of high-quality data is essential to any site investigation to achieve the reliability required by the owner and certification authorities. In the early 1980s, the need for site investigation moved into water depths greater than 3,000 ft and innovation of sampling and in situ testing tools continued at a rapid pace.

The Dolphin system, which eliminated the use of an umbilical to transmit data to the surface, was introduced to improve operational efficiency. It relied upon a downhole electronic data acquisition module to start the test and store the data until it was downloaded following module retrieval. The system included a hydraulic thruster that was activated by mudpump pressure inside the drill pipe. The umbilical-free operation allowed in situ testing capability to be extended to the water depth limits of the drillship, as much as 10,000 ft.

Long Core Sampling in the 1990s

The large areas covered by most deepwater developments led to the need for more economical site investigation methods. As a result, longer, more efficient core sampling methods were desired to improve the efficiency of conducting deepwater site investigations. The Jumbo Piston Core (JPC) had been previously used to investigate the properties of deep ocean sediments. The JPC is a larger version of a piston corer with a sample barrel ranging in length from 40 to 80 ft depth. The sampler has a continuous PVC liner that is extracted from the sample barrel after recovery and cut in sections for shipment and storage.

A joint industry program was initiated to modify the operation of the JPC to work off a conventional supply vessel. Large-diameter drop cores, such as the JPC, are well suited for

In the early 1980s, the need for site investigation moved into water depths greater than 3,000 ft and innovation of sampling and in situ testing tools continued at a rapid pace.

HB WICK DRAIN

clay soils and allow continuous large-diameter (4 in.) piston cores to be taken in water depths up to 10,000 ft. Extensive field testing has established that the quality of samples from these cores is as good, or better, than those from drilled borings. Such long cores have the added advantage of capturing continuous and thin zones during sampling. A disadvantage is that they may have limited depth range in strong soils.

Seabed Drilling and In Situ Testing Developments in the 2000s

A number of recent systems and developments have improved the capability to perform seabed and down-hole CPT testing and/or sampling. These new innovative systems have improved the quality of data and efficiency for conducting deepwater site investigations. The new systems are operated from the sea floor using a smaller vessel than is required to drill a conventional soil boring with a specialized geotechnical drillship. The time required to drill and sample a boring working down the bore of a drillpipe from a drillship located 1-2 miles above the seafloor often takes 3-4 days. On the contrary, a single CPT or JPC sample will take only 4-6 hours, meaning more sites can be investigated in a given time.

PROD System. The Portable Remotely Operated Drill (PROD) is a seabed system (Figure 5) that has the capability to take piston samples and to perform CPTs in the same borehole in water depths up to 7,500 ft. Another deepwater seabed system that includes telemetry and robotic components is the Seabed CPT System.

Rovdrill 3 System. The Rovdrill 3 is a new geotechnical sampling and in situ testing system that operates on the seafloor in up to 10,000 ft of water. This system can operate from any type of dynamically-positioned vessel and uses a remotely operated vehicle (ROV) for electrical and hydraulic power, telemetry, and high-definition video and operator interface. The system has the capability to drill, to obtain continuous cores and samples, and/or to perform in situ testing to depths of 300 ft.

In Situ Piezoprobe. In situ pore pressure measurements are often obtained to determine if excess pore pressures are present that can influence slope stability or cause water flow problems associated with conductor/well casing installation. The offshore piezometer was first developed to make pore pressure measurements by pushing the piezoprobe about 3 ft below the bottom of a borehole. Another device, the MkII piezoprobe, was recently designed to operate in water depths approaching 6,000 ft with seafloor penetrations up to 1,600 ft.

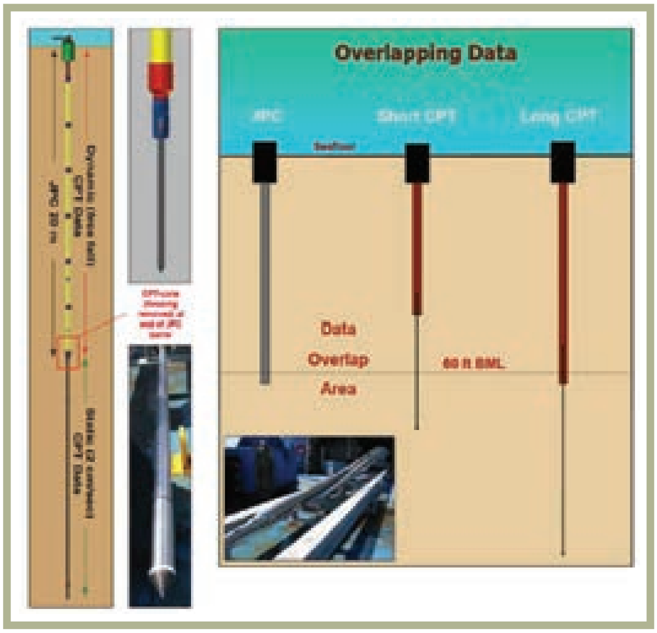


Figure 6. Overview of CPT-Stinger system.

CPT Stinger. The CPT Stinger system is an innovative tool that uses a JPC barrel to perform an in situ CPT test (Figure 6). The system simply replaces the standard JPC core liner with a module that includes a centralized PCPT attached to a thrusting rod. The tool is dropped above the sea floor and penetrates under its own weight to achieve full penetration of the barrel. The submerged weight of the system plus the soil resistance on the JPC barrel provides the required resistance to react against the vertical thrust developed as the CPT and push rod penetrate the sediments below the JPC barrel.

Hydrostatic pressure is then used to push the CPT to a set depth below the seafloor. It can perform PCPT testing to depths up to 140 ft below the sea floor in water depths approaching 10,000 ft. The operation is conducted off a standard oilfield supply vessel equipped with the same launch and recovery system as used for JPC operations. The continuous PCPT profile, especially combined with JPC samples, provides many quality and cost advantages over sampling at fixed depths in a rotary boring for applicable foundation types.

Longer, more efficient core sampling methods were desired to improve the efficiency of conducting deepwater site investigations.

Current State of Practice

The state of practice in offshore geotechnical investigations has dramatically improved since McClelland conducted the first site investigation from a temporary work platform offshore Louisiana in 1947. A number of innovative site investigation tools have evolved that allow more efficient collection of high-quality data and samples needed to achieve reliable foundation design.

The geotechnical engineer today has a broad set of innovative tools available to investigate site conditions for a myriad of geologic conditions. By combining the improved geotechnical data with high-resolution geophysical survey data, site conditions are better defined in terms of subsurface stratigraphy, the complexity of geohazards, and soil parameters needed for foundation design. The reliability of an integrated site investigation helps reduce uncertainty in foundation performance desired by certification authorities and owners of deepwater facilities.

New innovative systems have improved the quality of data and efficiency for conducting deepwater site investigations.

AUTHORS

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Offshore Jack-Up Drilling Rigs: An Engineering Challenge

By Matteo Sottile, P.E.

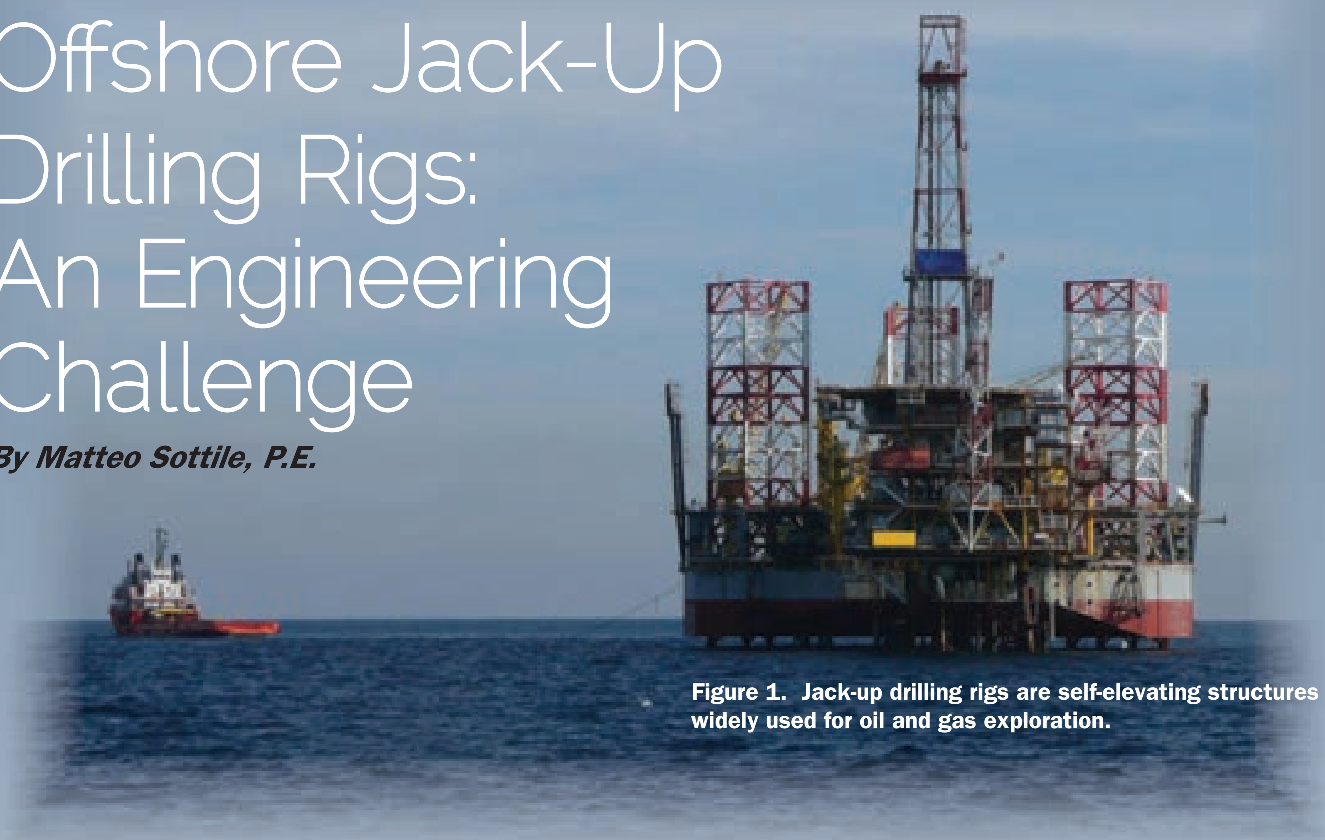

Figure 1. Jack-up drilling rigs are self-elevating structures widely used for oil and gas exploration.

Mobile jack-up drilling rigs are the backbone for the development of oil and gas wells in water depths up to 100 m. The units consist of a self-propulsive, self-sufficient drilling system, adaptable for use in different environments and soil conditions (Figure 1). The advantage of using a jack-up unit for drilling oil and gas wells is that the unit contains all the equipment and commodities to construct oil and gas wells, and it can be moved to a new location in a relatively short time.

Each unit is equipped with a power system, rotary system, and hoisting system, as well as accommodation for the drilling crew and specialized staff. It also has long extendable legs fitted at the bottom by spud can foundations, which are a plate or dish designed to spread the load and prevent over-penetration of the leg into the sea bed. The hull of the rig is usually triangular, with dimensions as large as 30-50 m or more. The legs can be more than 100 m long and are connected to the spud can foundations at the bottom. The section of the spud can is conical at the bottom and becomes gradually larger to increase its load-bearing capacity (Figure 2).

Two site-specific factors govern the design of jack-up foundations: the environmental or metocean loading conditions in the area, and the soil conditions providing foundation resistance at the site-specific location. Offshore environmental conditions can be particularly severe compared to those considered for traditional onshore foundation design. Other than the weight of the structure, a number of environmental loads must be accounted for in design.

Wind and waves on the structure contribute significantly to the loads transmitted to the spud cans. Depending on the water depth at which the jack-up rig is operating, these loads may be applied with a considerable eccentricity. Furthermore, soil conditions can vary significantly from site to site, leading to completely different spud can penetrations for the same loading conditions. The uncertainty in the response of the structure and its foundation to the combination of these severe loads and unpredictable soils is one of the reasons why engineering for jack-up rig foundations is unique.

Jack-up Foundation Design Challenges

Traditional onshore shallow or deep foundations design is based on applying an adequate factor of safety selected by the designer. Design loads are assessed depending on the type of structure and operating requirements. Soil conditions are generally characterized by a geotechnical exploration and adequate laboratory testing to establish the soil strength and deformation parameters needed for design. Then, the geometry of the foundation is determined using conventional bearing capacity formulations and a factor of safety.

Conversely, spud cans are geometrically fixed types of foundations; each class of rig has a specific spud can geometry which cannot be changed. After completion of drilling works at the site, jack-up rigs are towed to a new location using the buoyancy of their hull. At the new drilling site, the extendable legs are lowered and set on the sea bottom. Then, the hull is jacked up above the sea level. Under the applied loads, the spud can foundations penetrate the shallow soils, essentially causing a bearing failure until they stop at a depth where the soil bearing capacity is sufficient to support the rig loads.

To ensure an adequate bearing capacity during drilling rig operations, the spud cans are advanced into the soil under preloads which exceed the maximum design loads. Preloading is applied by filling special tanks located within the hull with sea water. In most cases, the ballast is increased to about 1.5 times the maximum expected operational load. Typical values for the preload are on the order of 4,000 tonnes. Because soil conditions found at the jack-up sites can vary significantly, determining the load-leg penetration curves is important to prevent issues such as excessive leg penetration, sudden punch-through of the spud cans, and buckling of the legs. The site geotechnical investigation will provide the soil parameters necessary for the spud can penetration analysis.

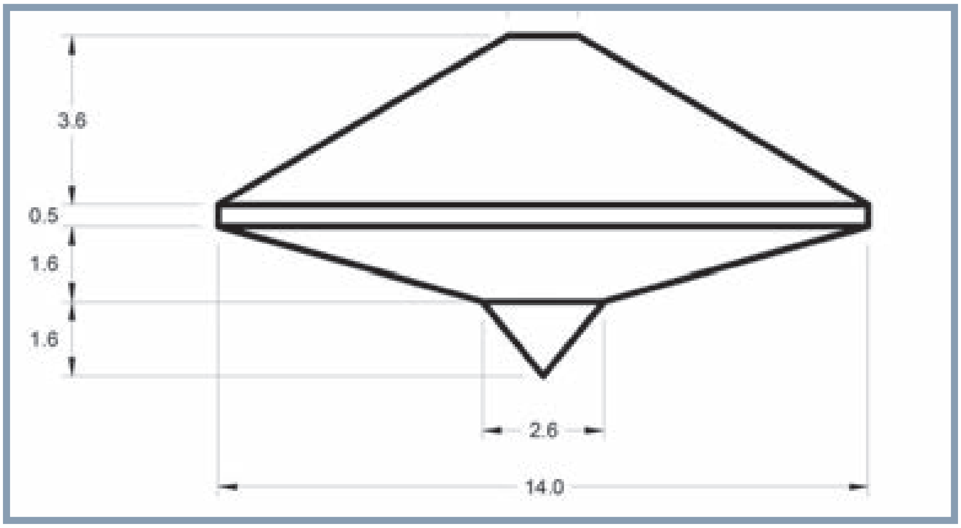

Figure 2. Example of spud can geometry (units are in m).

Geotechnical Investigations at Jack-up Sites

The main goal of the geotechnical investigation at the jack-up site is to determine the soil stratigraphy and soil properties. Usually at least one borehole is needed to adequately characterize the stratigraphy and soil parameters. In areas of variable ground, three borings are often required, one for each leg. Sometimes geotechnical boreholes are supplemented with in situ testing such as cone penetration test or geophysical test methods.

Geotechnical borings can be drilled directly from the jack-up rig. Drilling rigs are usually capable of both rotary and percussive drilling techniques. When soil borings are executed from the rig, drilling is performed using the drill pipes with an openhole winged drag bit. Sometimes the geotechnical investigations for jack-up site-specific assessment are performed from dedicated geotechnical drilling vessels. In this case, sampling and in situ testing are performed via wireline-operated downhole tools. The testing sequence usually includes one borehole with continuous sampling and one borehole with continuous piezocone penetration testing. The boreholes should extend to a minimum of 1.5-2 foundation diameters below the expected spud can penetration. Typically, borings are 30 m deep.

Geotechnical Issues in Jack-up Rig Foundations

The engineering challenge in analyzing jack-up rig foundations is predicting the maximum loads that can be applied to maintain the penetration of the foundation within an acceptable range given the site specific soil conditions. The main goal of the analysis is to select rig placement at a specific site to prevent issues such as punch-through of hard soil layers overlaying soft soil layers, squeezing of soft formations overlaying stiffer formations, or buckling of the legs.

During preloading, the spud can foundations penetrate into the soil and stop at a depth where the soil resistance is adequate to bear the applied loads. The geotechnical analysis of spud can penetration is relatively straightforward and can be carried out using the bearing capacity methods recommended by the Society of Naval Architects & Marine Engineers. The bearing capacity of the soil is evaluated at different possible penetration depths, and the foundation capacity v. penetration depth curve is plotted and compared with the planned preload.

The presence of non-uniform soil conditions makes site-specific assessment of jack-up drilling rigs challenging for geotechnical engineers, particularly when hard layers, such as stiff clay or sand, overlay softer layers, such as soft clay. This scenario is particularly problematic for the geotechnical

Sometimes geotechnical boreholes are supplemented with in situ testing such as cone penetration test or geophysical test methods.

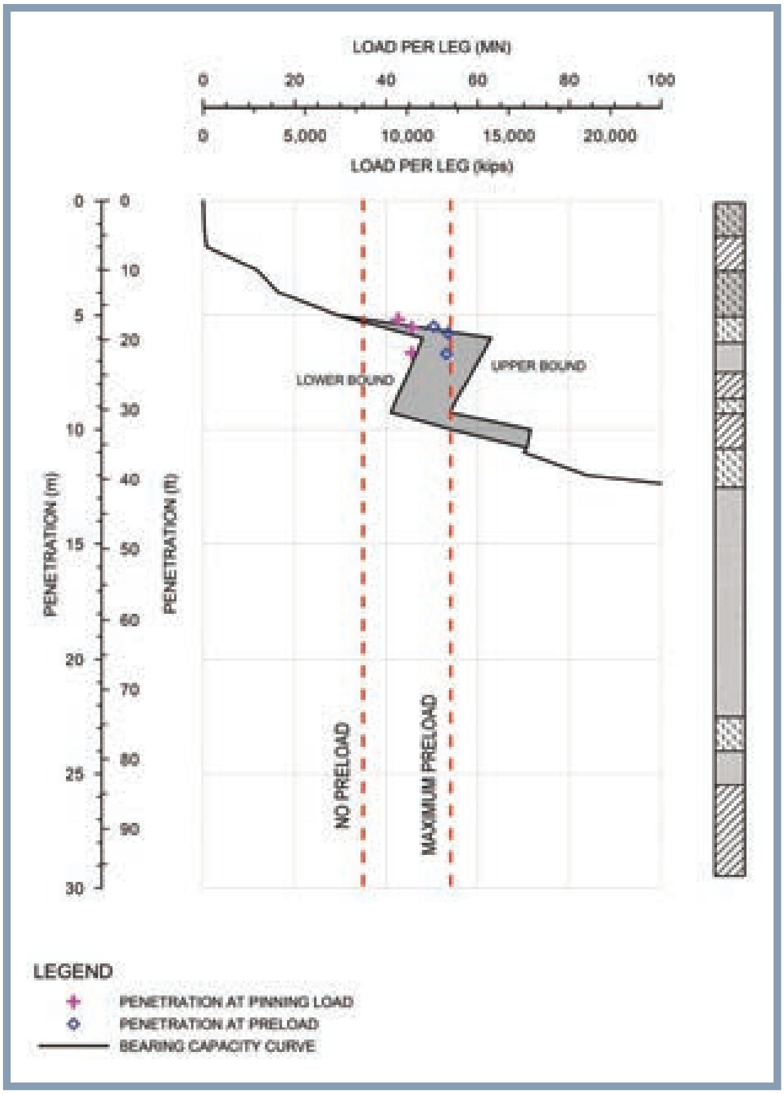

Figure 3. Load-penetration curve for a site in the Adriatic Sea, Italy.

stability of the foundations and, consequently, of the entire structure. If the capacity of the hard top layer is exceeded during the preload, the foundations could penetrate rapidly into the softer formation, causing a punch-through type of rupture. In extreme cases, the structure could eventually capsize due to damage of the rig legs and consequent overturning under the combined vertical and horizontal loads from the weight of the structure and the wave and wind loads on it over time. Prior to rig placement, a spud can penetration analysis is performed to identify the potential for geotechnical issues at the site.

Case Study: Punch-Through Risk in the Adriatic Sea

A jack-up drilling rig for the construction of gas wells was planned for a site off the Italian shore in the Adriatic Sea. A geotechnical investigation was performed to determine the soil conditions and geotechnical parameters at the site, and to evaluate the leg penetration and site-specific hazards. The field investigation consisted of 1 boring to 29.5 m penetration below seabed. The boring was advanced at 1 m sampling intervals. Drilling and sampling were carried out using the main works of the jack-up rig. Operations were performed using the 125-mm API drilling pipes available onboard, with an internal clearance of 71 mm, which was suitable for hammer sampling equipment with a 51-mm diameter.

The soils at the site consist of a highly heterogeneous sequence of loose/soft soil from the seafloor to 8.6 m, followed by a highly heterogeneous sequence of medium dense soils from 8.6 to 12.5 m. A thick uniform layer of medium dense to dense sand was encountered from 12.5 m to 22.5 m, followed by dense silt, 22.5-24.0 m, overlaying 1.5 m of sand and medium stiff to stiff clay with silt to 29.5 m. The bottom of the softer heterogeneous sequence just below the seafloor was also observed during the analysis of the geophysical data.

Leg penetration was evaluated for a proposed maximum preload of 54.1 MN per leg. The analyses were calibrated for the observed leg penetrations of 5.19, 5.54, and 6.65 m, which were achieved applying a 45-MN pinning load with 0.5-m air gap (the distance between the sea level and the bottom of the hull). The goodness of the predicted load-penetration curve is verified comparing the actual penetration measured at the three legs under the pinning load with the corresponding penetration in the load-penetration curve. Typical values for pinning load are generally between the design load and the maximum preload, and are selected using professional judgment and experience. The spud cans were 14.63 m in diameter with a total height of 4.27 m. The footings have a small cone at the base, and the maximum section is approximately 3.86 m above the tip.

The expected "spud can" load penetration curve was based on the final stratigraphy and results of the geotechnical laboratory testing. The potential for punch-through risk was checked using the bearing capacity analysis in layered soils and plotting the load-penetration curve and comparing it with the maximum pre-load. Results showed that the maximum spud can penetration was about 6 m for full preloading conditions, 54 MN per leg. Leg penetration curves for lower- and upper-bound range of undrained shear strength S_u are presented in Figure 3. The pinning load and the maximum preload per each leg are also plotted along with the penetration curves.

The potential risk of punch-through is evident at about 6 m depth, with a potential leg run of about 3 m represented by the decrease in bearing capacity for increasing load. If the lower-bound range S_u leg-penetration curve is considered, a 3-m run would occur for a load of about 48 MN, about 90 percent of the maximum preload. Conversely, if the upper-bound S_u leg-penetration curve is considered, application of the entire maximum preload does not lead to a punch-through case.

This difference highlights the relevance of measuring the soil strength parameters with the highest degree of accuracy. It is evident that the uncertainty related to measurement of the soil parameters and prediction of potential hazards during preloading make decisions during rig installation more difficult. In many cases, using a slow loading rate and watching out for punch-through or applying a lower preload are the solutions adopted by the rig operator to mitigate the risk.

The Future of Jack-up Rigs

Mobile jack-up drilling rigs are transportable, self-elevating platforms that are extensively used worldwide for oil and gas exploration. The engineering design of these gigantic structures, which can be operated in remote areas of the world in harsh and unusual environmental conditions, is a "non-conventional" problem for the onshore engineer. Although use and operability of jack-up rigs have become more prolific over the last decades, the peculiarity of this problem makes it difficult to standardize the engineering solutions and generalize them to the wide range of conditions that are likely to be encountered. As the offshore industry is moving toward remote areas of the globe in the run for natural resources, new technical solutions would be desirable for specific cases.

One of the most promising improvements currently being studied is the construction of gravel banks on the seabed at each spud can location. This application is meant to guarantee sufficient bearing capacity of the foundations and to avoid the jack-up foundation punch-through type of failure that may occur when a shallow granular soil layer is underlain by softer formations. Theoretical as well as numerical and experimental investigations are being conducted on this matter, and results are relatively successful so far. However, the real issue in this type of problem is to verify that the methodology of intervention and the results obtained by its application are valid on a site-specific basis. This is one of the aspects which make future developments in the assessment of offshore jack-up drilling rigs a unique, engineering challenge.

AUTHOR

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RISER-SOIL INTERACTION AND FATIGUE: RECENT ADVANCES IN THE STATE OF THE ART

By Edward C. Clukey, Ph.D., P.E., F.ASCE, Arash Zakeri, Ph.D., P.Eng., P.E., Anirban Bhattacharyya, and Philippe Jeanjean, Ph.D., P.E., M.ASCE

Offshore deepwater risers are structural members that connect the seafloor installations to deepwater host vessels at the surface, fulfilling one or more of a combination of functions. Selection of a specific riser type is a complex exercise and depends on a number of factors. Risers can be part of a drilling operation or, in a production mode, used to transport product to and from an offshore pipeline system. Risers can be a continuous part of a pipeline system, like steel catenary risers (SCRs), or a vertical riser that connects from a seafloor termination point to the facility (Figure 1).

Vertical risers are tensioned at the top either through buoyancy or with a top tensioning mechanical system. The structural member that enters the seafloor in a vertical riser system is called a conductor. The conductor provides initial vertical support for casing strings that comprise a well. Once the casings are cemented in place, the conductor provides lateral support for the various riser motions. Both SCRs and vertical riser/conductor systems must be designed for strength and fatigue, as well as other criteria.

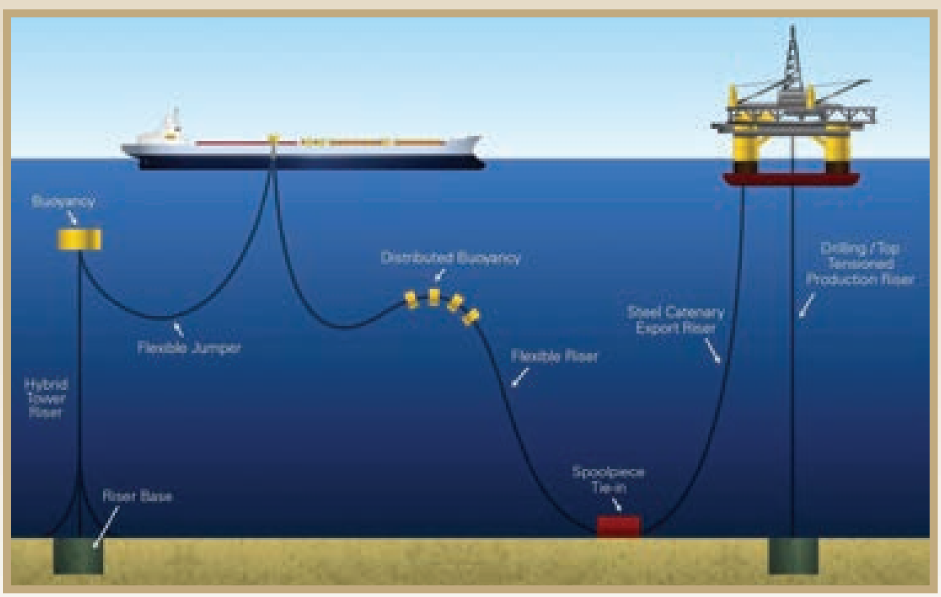

Figure 1. Schematic of offshore riser system.

Riser Fatigue

The fatigue design of both SCRs and conductors for vertical risers is complex. With both riser types, soil stiffness plays an important part in the fatigue assessment. For SCRs (Figure 2), the zone where the riser touches the seafloor, known as the touchdown zone or TDZ, incurs the most fatigue damage because this region has the greatest change in moments during environmental loading. For vertical riser/conductor systems, the critical fatigue point could occur either above or below the mudline, depending on the well configuration. Stiffer soils are more favorable for fatigue at points below the mudline while softer soils are more favorable for fatigue at points above the mudline. So while strength and fatigue are important structural design issues, geotechnical engineering is an essential part of the design for SCRs and vertical riser/conductor systems.

Steel Catenary Risers (SCRs)

SCRs are an enabling technology for oil and gas production in deep water greater than about 600 m, and in ultra-deep waters greater than about 1,500 m which offer a low-cost alternative to conventionally used rigid and flexible risers on floating platforms. Schematically (Figure 2), an SCR is connected to the vessel near the water surface, transitioning to a pipeline, well, or manifold on the seafloor. The first SCR was successfully installed on the Shell Auger tension leg platform (TLP) in 1994 in the Gulf of Mexico (GoM). Shortly thereafter, the concept was successfully implemented on the Mars and Ram-Powell TLPs in the GoM.

TLPs are predominantly subject to surge (forward lateral translation) and sway (sideways lateral translation) motions. As oil and gas reserves were discovered in deeper waters, the SCR concept was imple-

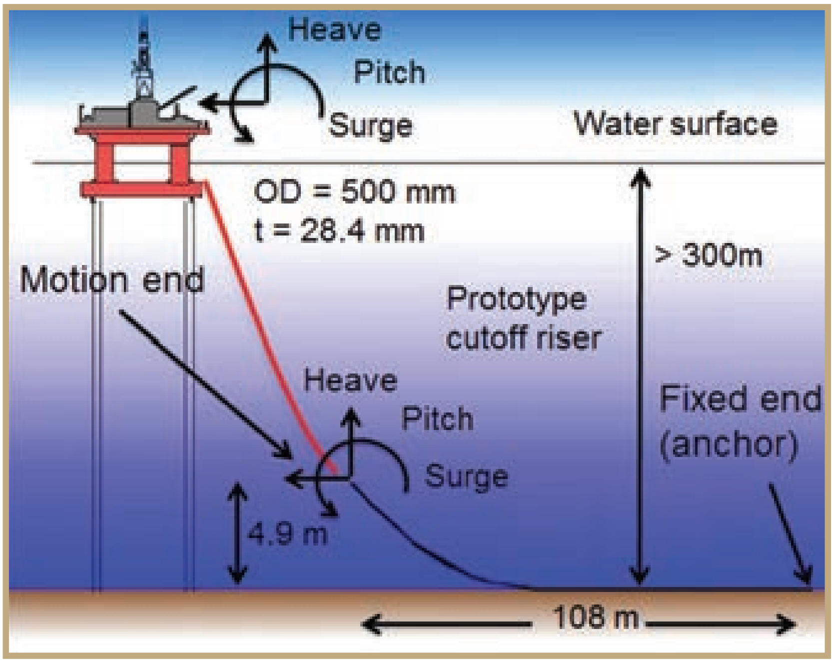

Figure 2. Schematic of steel catenary riser installed on a tension leg platform.

mented on alternative production vessels such as spars, semi-submersibles, and ship-shaped floating production systems (FPS) which are all subject to six degrees of motion, including heave and roll. For these other vessel types, the SCR response to heave, sway, and surge are particularly important for fatigue assessments in the TDZ.

The issue of fatigue damage has gained prominence with the widespread use of SCRs. Fatigue stresses due to vessel movements, vortex-induced vibrations, and interaction with the seabed in the TDZ are significant to SCR performance. The critical location for fatigue damage often is within the TDZ, where cyclic interaction of the riser with the seabed and maximum fluctuations in bending moments occur. In contrast to strength considerations, where extreme loading conditions are most important, fatigue damage occurs from the many cycles of repeated loading with smaller amplitudes. The overall problem involves a number of complex soil-fluid-structure interaction processes including trench formation, nonlinear soil stiffness, soil suction, and breakaway of the riser from the seafloor.

A number of Joint Industry Programs (JIPs) have been conducted by a number of companies to investigate the complex processes taking place during riser-soil interaction. Two important JIPs carried out in the early 2000s with respect to SCRs include the Steel Risers in Deepwater Environments (STRIDE) and the Catenary Riser-Soil Interaction Model for Global Riser Analysis (CARISIMA). The STRIDE JIP involved a series of full-scale SCR tests, truncated about 6 m above the mudline, which were carried out over a three-month period in Watchet Harbour on the west coast of England. The riser model tested was a pipe 110 m long by 0.17 m in diameter connected to a seabed anchor at one end and an actuator unit at the opposing end to simulate the wave motions of a floating vessel in about 1,000 m water depth.

The CARISIMA JIP comprised small-scale laboratory tests conducted on an approximately 2-m-long section of a 0.2-m-diameter pipe. The tests were performed in two phases; Phase 1 consisted of 14 vertical and 17 horizontal tests, and Phase 2 involved 10 vertical and 6 random motion tests. These tests were performed to estimate the non-linear soil response to vertical and horizontal motions for an element of pipe within the TDZ. The intent at this time was to provide an experimental basis for implementing non-linear soil springs into analytical design models to investigate the strength and fatigue of SCRs.

While the STRIDE and CARISIMA JIPs provided valuable insights into the riser-soil interaction behavior, they simulated only certain aspects of the interaction. For example, the influence of coupled motions in multiple directions was not investigated. Therefore, a need existed to develop testing procedures that could more properly simulate more aspects of the riser-fluid-seabed interaction throughout the TDZ.

In 2007, a program was initiated to take advantage of geotechnical centrifuge technology (Figure 3). A special container box and actuator system (Figure 4) were fabricated to simulate a truncated riser starting about 5 m, scaled to the prototype dimension by the centrifuge effect, above the seafloor and extending to a point scaled to about 100 m for the prototype beyond the TDZ. As with other geo-systems, centrifuge experiments are ideally suited for modeling complex non-linear geotechnical problems where gravity is an important consideration. The special container, actuator, and the gravitational advantage in the centrifuge provided the means for accurate testing of the SCR system in the TDZ.

Most of the important parameters to this problem, such as pipe weight, pipe dimensions, and pipe and soil stiffness, were

Figure 3. C-CORE's geotechnical centrifuge, capable of producing 200 times Earth's gravity field.

Figure 4. Special container and actuator system.

scaled correctly in the tests. However, due to centrifuge scaling relationships and limitations with the actuator system, the one parameter not scaled correctly was the water flow velocity and consequent soil erosion around the pipe. Therefore, shallower trenches were observed in the tests compared to field observations. Although a shallower trench is generally conservative with respect to fatigue, a separate test was run with the trench profile prefabricated based on field observations.

Detailed numerical modeling for various sea states was performed as part of the initial design of the centrifuge tests. Both a full SCR and the truncated model centrifuge tests were modeled. The results indicated that by simultaneously applying surge and heave motions, an SCR model truncated at a cut-off point for the prototype 5 m above the seafloor could satisfactorily replicate the touchdown behavior of a full SCR in terms of riser displacements at the TDZ, sag bend strain, and fatigue due to pipe-soil interaction. Therefore, the analyses confirmed that realistic SCR touchdown behaviors could be simulated in centrifuge model tests. The study also demonstrated that rotational degrees of freedom (pitch and roll) were not required

Fatigue stresses due to vessel movements, vortex-induced vibrations, and interaction with the seabed in the TDZ are significant to SCR performance.

Another limitation of vertical riser/conductor fatigue analysis practice is the uncertainty regarding the effect of soil damping.

at the cut-off point to simulate the conditions for the SCR near the touchdown point. This insensitivity to pitch and roll greatly simplified an already complex actuator system.

The first series of industry tests simulating 305-mm-diameter and 508-mm-diameter risers were successfully conducted in 2008. The centrifuge model simulated the response of the SCRs, from cut-off point through the TDZ, with heave and surge motions acting simultaneously with both low and high frequencies to represent wave and long period currents. GoM storms for both 10-year and 100-year return periods were modeled. The centrifuge tests showed that pipe's fatigue life was 1.3-1.8 times greater than predicted with existing analytical design solutions based on the measured moments in the pipe. Ultimately, the centrifuge tests proved to be an economic means for gaining significant insight into complex riser-soil interaction mechanisms.

The loading actuator system for the centrifuge has since been further modified to also include sway motions. Sway motions are important for floating facilities in some regions of the world with long period swell motions, so the new apparatus will help determine the impact of this type of motion on SCR fatigue in these regions. This new actuator system provides even more flexibility with respect to the applied loads and has already been used on an offshore project in 2012 with additional testing scheduled for 2013.

Vertical Risers

One of the most fatigue-sensitive locations in a vertical riser is the wellhead conductor. Traditionally, for the purpose of riser/conductor analyses, the soil-conductor interaction has been modeled using soil stiffness p-y curves derived from API RP 2A. However, finite element analyses and centrifuge tests of wellhead conductors have demonstrated that p-y curves predicted by the API RP 2A methods are too soft and will underpredict fatigue life for vertical riser/conductor systems. This finding is not surprising given that the API RP 2A p-y curves were primarily derived for pushover and stability type analyses of offshore platforms with steel piles. This type of analysis is highly dependent on the pile response near the soil limit state, whereas for fatigue analyses, the small amplitude displacement soil response is more important.

Based on the centrifuge test and 3-dimensional finite element analysis results, stiffer p-y curves, especially at small displacements, were derived that more realistically define the soil-riser/conductor interaction. The p-y behavior in the centrifuge was determined from strain gauge-moment data measured along the conductor. Although calculations with the stiffer centrifuge-derived p-y curves predicted greater fatigue life compared to those based on the API RP2A curves, the fatigue life derived directly from the measured moments in the centrifuge tests was still greater than predicted. This discrepancy was caused by the use of a tangent stiffness along the p-y curve as the cyclic stiffness for fatigue calculations.

The more appropriate cyclic soil stiffness would be an unload-reload fully degraded secant stiffness. This secant stiffness is more representative of cyclic loading conditions and was found to always be greater than the tangent stiffness values traditionally used for fatigue calculations. To further investigate the required soil stiffness to match the measures fatigue predictions, the tangent stiffness values from the centrifuge data were increased by about a factor of 4 to produce more comparable predictions with the measured fatigue in the centrifuge tests. Work is now ongoing to more rationally define procedures to determine the unload-reload fully degraded secant stiffness along the riser/conductor.

Another limitation of vertical riser/conductor fatigue analysis practice is the uncertainty regarding the effect of soil damping. Sensitivity analysis has demonstrated that if the effect of soil damping on the wellhead conductor is properly captured, its fatigue performance can be further improved. The impact of soil damping on the fatigue is now being considered based on the hysteretic soil response observed both from centrifuge tests and in finite element analyses.

Future Challenges

Geotechnical engineering has played an important role in the design of offshore risers. Proper characterization of the soil is important for the limit strength state and fatigue conditions. Detailed analyses and centrifuge model testing have helped to highlight some of the most important geotechnical aspects for these riser problems. Despite the progress, challenges remain. For example, a full non-linear soil model calibrated with either centrifuge or field test results has not been fully implemented for SCRs. In addition, a method for design of vertical riser/conductors to resolve the discrepancy between fatigue predictions and centrifuge observations due to use of the tangent rather than the secant stiffness needs to be implemented. Both these issues are currently being addressed.

The final piece of the puzzle, though, will require validation through field measurements and performance. Field data are being acquired by a number of offshore operators for both these types of risers. The challenges to collecting this type of data in the harsh deep water environments is formidable, and it is often difficult to fully differentiate the impact the soil response has on the observed measurements. Nonetheless, these results will provide the best means possible to advance the technology and provide more efficient and robust designs.

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Numerical Modeling Applications in Offshore Petroleum Developments

By William O. McCarron, Ph.D., P.E., M.ASCE

The offshore petroleum industry has existed for more than 100 years. Starting in shallow near-shore waters easily accessed from land, drilling, and production activities now extend to water depths of more than 2,000 m. Fixed platforms anchored directly to the seafloor have been installed in water depths over 500 m. Compliant platforms and floating facilities become more cost effective in deeper waters. There are approximately 3,000 active offshore platforms in the Gulf of Mexico, about one percent of which are in water depths greater than 1,000 m.

Oil and gas development in the deepwater Gulf of Mexico dramatically expanded in 1994 when the Auger tension leg platform (TLP) was installed in 872 m of water. There are also several large pipeline systems in the deep water of the Gulf. For instance, the Mardi Gras system has 780 km of pipelines from 404 mm to 762 mm in diameter, in water depths up to 2,200 m, with a total transportation capacity of 1 million barrels of oil and 42 million cubic meters of gas per day.

Architecture of Offshore Developments

Depending on the age and location of a production basin, an offshore development may have a mixture of fixed, compliant, and floating production facilities. Fixed platforms, such as the one shown on the left side of Figure 1, are anchored directly to the seafloor via driven piles. Compliant platforms, including TLPs, are found in deeper waters. These, too, are typically anchored by driven piles. In yet deeper water, floating systems are restrained laterally by remote foundation anchors connected to the facility by chains or wire rope.

Each of these facility types may be tied to remote subsea drill centers via subsea flowlines. It is common for deepwater developments to incorporate several subsea drill centers. The tiebacks to floating systems generally include a catenary-shaped riser spanning from the sea surface to the seabed. The catenary riser is likely a thicker wall version of the pipe used in the flowline, but flexible composite risers are in use. After treatment of the production fluids on the surface facility, they are usually transported to shore via an export pipeline.

Production wells at remote subsea drill centers are drilled from temporary leased floating systems and later connected to manifolds placed on the seafloor. These manifolds, perhaps supported by a pile foundation, are then connected to the intra-field flowlines. The flowline ends include equipment that is supported by a mat foundation. Where the flowline ends are expected to experience lateral production-induced loading, they may be anchored by a pile system.

These deepwater developments, including subsea tiebacks, span large geographic areas which encompass a variety of geotechnical conditions and considerations including seafloor foundations, submarine

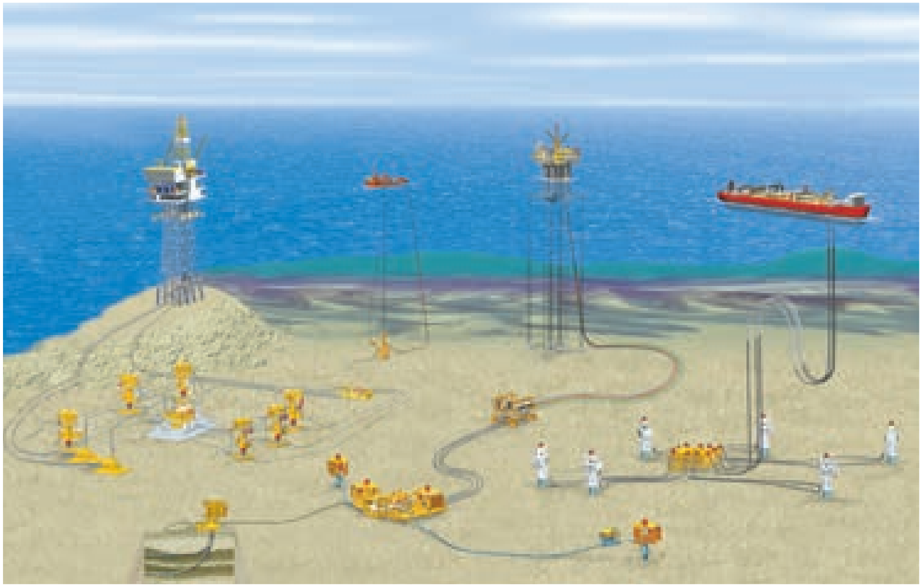

Figure 1. Offshore petroleum development (Courtesy of FMC Technologies).

slope failures, thermal buckling of flowlines, and catenary riser interaction with the seafloor. Apart from these topics, petroleum geomechanics studies include modelling of fluid flow through reservoir rock over areas of several square kilometers, hydraulic fracturing of rock, and sand production through wellbore perforations.

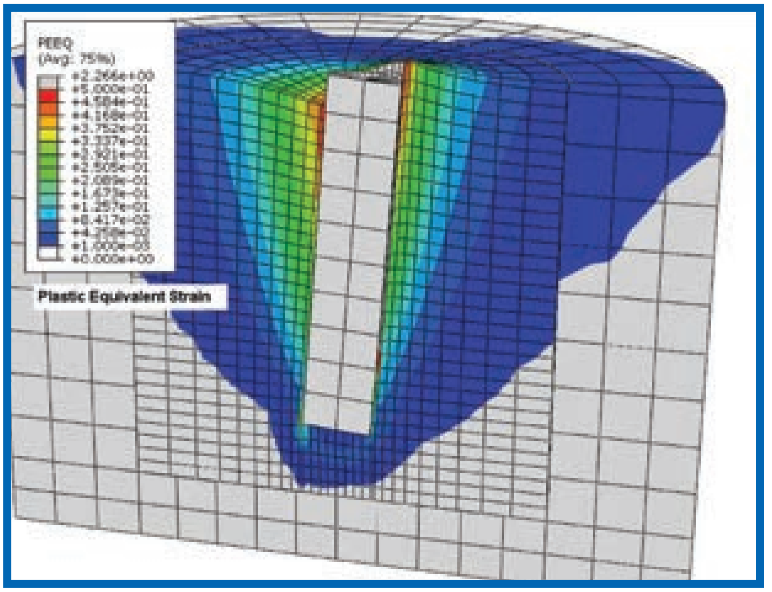

Figure 2. Finite element model of suction caisson.

Geomechanics of Offshore Structure Foundations

Geotechnical challenges evolve with new exploration basins and environmental loading sources. In the Gulf of Mexico deep water, loop currents can dynamically excite production risers which can pull them from their installed location, or induce platform motions which may induce fatigue of foundation structural components. The industry expansion to deeper waters resulted in an evolution of foundation systems. Driven piles have been supplemented by other anchor systems easier to install for facilities in deepwater, where the design loads are larger. With the large capital costs of platforms and offshore pipeline systems, the offshore petroleum industry makes extensive use of numerical and physical modeling when undertaking geotechnical design.

In the late 1980s, when TLP technology for 1,000-m water depths was in development, a primary concern was the consolidation setup of driven piles used as anchors and subjected to sustained mean tension and cyclic tension loads. To address this issue, joint industry projects evaluated the effects of installation-induced pore pressures and cyclic tensile loadings. The strain path method, an analytical solution of the installation-induced strain fields surrounding a pile, and numerical finite element consolidation studies resulted in reliable solutions for pile setup times. The same techniques were later used to develop piezoprobes to measure the in situ consolidation behavior and pore water pressures that may be above the static head as a result of geologic processes. The strain path pile setup investigations paralleled the development of Whittle's constitutive model for clays, MIT-E3, which falls within the critical state family.

In the late 1990s, while preparing for Gulf of Mexico developments in water depths up to 2,000 m, the industry invested heavily in developing analysis (Figure 2) and design methodologies for suction pile anchors that would be subjected to lateral loads of as much as 4 MN. The term 'suction pile' mainly describes the installation methodology by which a differential pressure across the pile head is used to drive the pile to the desired penetration, although some designs have taken advantage of passive transient suction for axial capacity evaluations. Industry suction pile technology development studies included centrifuge tests, numerical modeling, and analytical limit analysis solutions. Several years earlier, small scale physical tests had been performed for developments in the North Sea. Limit analysis solutions are now routinely used to assess suction pile capacities.

When determination of foundation capacity is the primary interest, elastic-plastic models are often used, with the most popular elastic-plastic models for finite element analyses being the Tresca and Mohr-Coulomb models. The Modified Cam-Clay model, the most popular critical state model, is available in numerous commercial finite element programs for effective stress analysis. It represented a significant advancement when introduced by Burland in the late 1960s. Its application is practically limited to monotonic loading conditions, or at least to stress paths not resulting in any significant hysteretic cyclic responses which induce plastic responses, and lightly overconsolidated clays. The MIT-E3 model has improved cyclic response capabilities and is valid to higher overconsolidation states, but is not widely available in commercial finite element programs and as a result has not

Driven piles have been supplemented by other anchor systems easier to install for facilities in deepwater, where the design loads are larger.

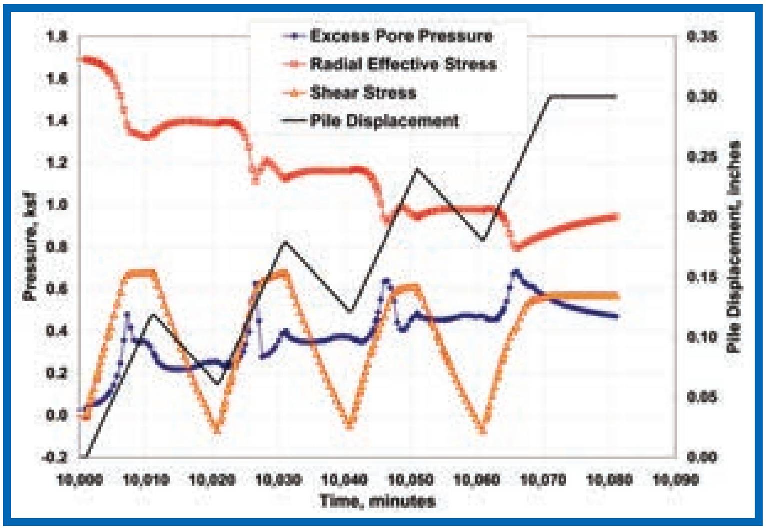

Figure 3. Simulation results for model pile under cyclic loading.

seen extensive use outside the MIT community.

A suite of models jointly described as 'disturbed state concept' (DSC) formulations represents intact and residual strength components separately. It has features of classical damage mechanics, although the damaged material supports stresses at a reduced level, in contrast to the classical formulation where the damaged material component does not support stress. A DSC model falling within the critical state family for effective stress analyses with a single closed yield surface including both plastic shear and volumetric compaction responses has been used to simulate the axial cyclic response of model piles.

Figure 3 shows partial results from the analysis, which illustrate that the numerical techniques employed reproduced the significant responses, in terms of pore pressure responses and limiting soil-pipe shear stress transfer, observed in the field tests. It is not common in the industry to rely solely on the results of numerical models when cyclic responses are significant for novel designs. Rather, physical models such as centrifuge tests have long been used in conjunction with numerical models to investigate cyclic loading of offshore structure foundations.

Pipe-Soil Interaction

Deep reservoir production fluids can be associated with temperatures of 150° C and pressures over 41 MPa. For

Seafloor-supported export pipelines, intra-field flowlines, and catenary riser design require a detailed understanding of the shallow soil strength profiles and bathymetry variations within about a meter of the seafloor.

flowlines 3 km in length, the unconstrained expansion in such conditions can amount to 6 m. The thermal expansion generates axial compression and lateral buckles develop as a result of soil-pipe frictional forces generated by relative movement. Without proper management of the buckle spacing, the induced flowline stresses may exceed the fatigue and strength design limitations. In the last 12 years, there have been significant numerical and laboratory investigations aimed at quantifying the lateral soil-pipe interaction resulting in the development of empirical soil-pipe interaction models used in global flowline finite element analyses.

Figure 4 shows the details of physical and numerical modelling of soil-pipe interaction investigations. Because of the large deformations resulting, Eulerian techniques or Adaptive Lagrangian-Eulerian (ALE) techniques are used. Figure 4a shows two physical tests at different stages. In the tests, the pipe is first embedded in a cohesive soil, and then displaced laterally, under a constant vertical load representing its submerged operational weight. Depending on a normalized parameter W/DS_u, where W is the pipe weight, D is the pipe diameter and S_u is the soil shear strength, the pipe will rise or dive in elevation relative to its initial embedment and the soil resistance will reduce or increase, respectively. Such behaviors have been reproduced in numerical simulations.

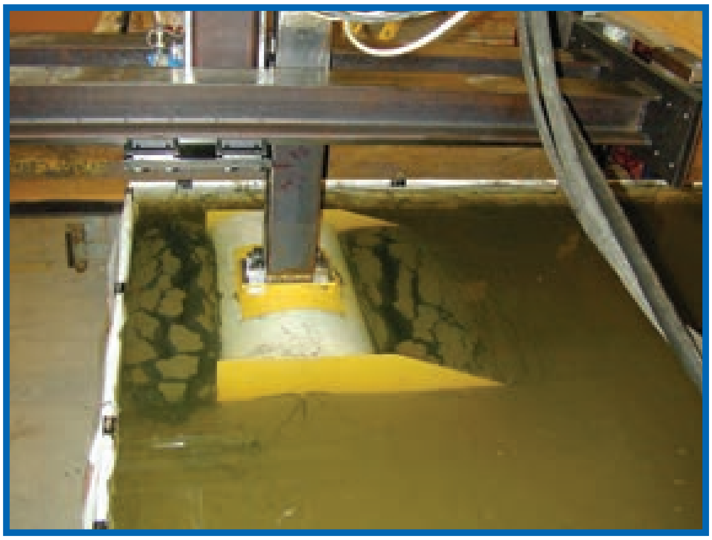

Figure 4a. Two physical soil-pipe tests; (top) after initial embedment, and (bottom) showing a soil berm after lateral displacement.

Figure 4b shows one such numerical simulation using a Eulerian formulation. In conventional finite element analyses, a Lagrangian formulation is used in which the modeled material and finite element mesh are fixed to one another without relative movement. On the other hand, Eulerian formulations allow the material to move through the mesh. Adaptive Lagrangian-Eulerian formulations simply use a remeshing algorithm that is somewhat of a hybrid of the two procedures.

Definition of Geotechnical Design Requirements

Different seafloor foundation systems drive different site investigation and laboratory test requirements. Seafloor-supported export pipelines, intra-field flowlines, and catenary riser design require a detailed understanding of the shallow soil strength profiles and bathymetry variations within about a meter of the seafloor. Mooring anchors for floating and fixed production facilities may require definition of soil design properties to 100 m below the seafloor. Early in a project, field architecture definition and geotechnical evaluations are often at an immature stage. Thus, there is a heavy dependence on geophysical survey data to select seafloor foundation locations and extrapolate available soil data to those locations. As the field architecture stabilizes, a suitable site investigation campaign is defined to collect the necessary geotechnical data and decrease uncertainties related to spatial variations.

Much of the design data are obtained from standard field and laboratory tests. Complex foundation designs may require evaluations of soil resistance to cyclic loading or an understanding of its strength evolution as a result of consolidation under imposed loads. Advanced laboratory programs, including cyclic direct simple shear tests or examination of soil strength characteristics under triaxial extension and simple shear stress states, are then undertaken. These data may then be used to calibrate effective stress constitutive models.

Future Advancements

The technology applied to offshore geotechnical investigations is at the forefront of the industry. Geotechnical samples are retrieved from water depths of over 2,000 m and subsequently used in laboratory programs of impressive scale and detail. With the aid of integrated geophysical surveys, geohazards can be avoided and uncertainties in foundation design reduced.

Numerical finite element methods have proven successful for many offshore geotechnics problems. In novel designs, they are often initially accompanied by physical testing programs, either using centrifuge or 1-g scale models. When experience is sufficient, physical tests can be discontinued and the design progressed on numerical modeling alone. Of course, one always needs to be aware of slight, but important, changes in loading or soil properties that fall outside of the experience base. Many of the widely used finite element programs have not updated their geomaterial constitutive models beyond those that were available 40 years ago. Sometimes they are suitable for use, but often they are not. Proprietary user-implemented constitutive models are often employed in such conditions. Development of constitutive models can require several months, so it is not a trivial undertaking or without pitfalls.

Challenges remain when modeling cyclic loading with significant plastic responses, very large deformation problems, dynamic loading accompanying pore pressure evolution, and conditions where strain-softening responses control the outcome. Inclusion of strain-softening responses can be associated with mesh-dependent results, so it may be prudent to test for mesh dependency through repeated analyses with different element sizes and mesh topology.

Computational power has increased so much and finite element solution procedures have become robust enough that the main cost in performing many complex analyses is often related to proper interpretation of the responses. But occasionally, Many of the widely used finite element programs have not updated their geomaterial constitutive models beyond those that were available 40 years ago.

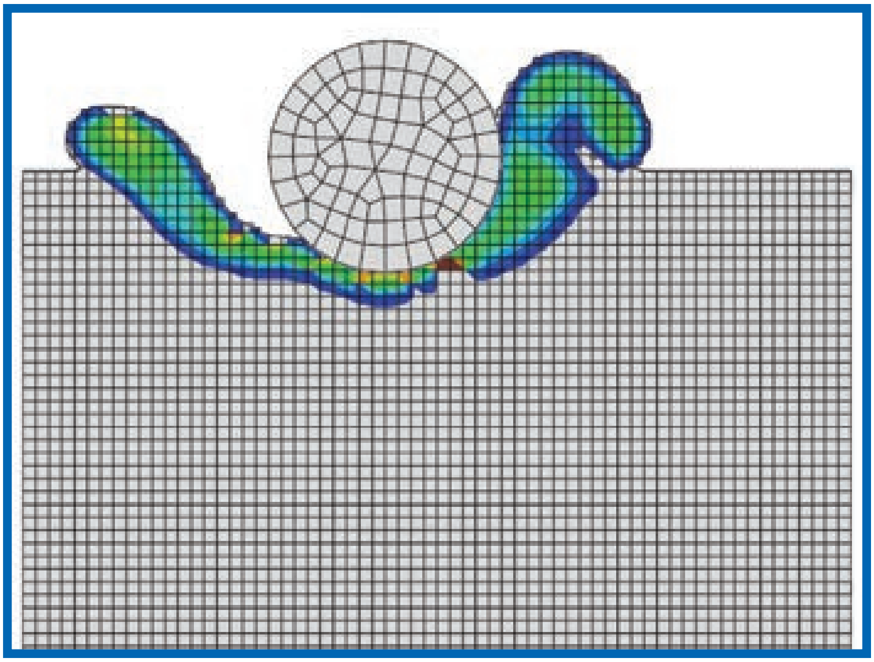

Figure 4b. An example of Eulerian finite element simulation of soil-pipe interaction.

inexperienced users errantly apply constitutive models.

Probabilistic methods are not extensively applied to offshore geotechnics to evaluate failure probability; nor are the effects of potential uncertain spatial variations of material properties. These are evolving areas of development that become important when faced with large geographic areas and loadings that are not deterministic. Significant advances in these areas can be expected.

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Geotechnical Aspects of OCAES Vessel and Anchoring System

By Mo Gabr, Ph.D., P.E., F.ASCE, Jinfu Xiao, M. Shamim Rahman, Ph.D., and T. Matthew Evans, Ph.D., A.M.ASCE

The 21st century ushers in the promise of less dependency on fossil fuel and the harvesting of renewable and environmentally friendly energy. The heightened interest in power generation from such sources includes the possibility of using offshore wind and waves on an industrial scale. Several initiatives are currently being pursued by the government and private industry seeking to capitalize on the concept of alternative energy and promote its potential growth in the near future.

Challenges of Offshore Power Generation

The first U.S. offshore wind farm is scheduled for installation off Horseshoe Shoal in Nantucket Sound off the Massachusetts coast. North Carolina has approximately 500 km of coastline with the opportunity for electric power generation from energy imparted by wind, waves, tidal currents, the Gulf Stream, and thermal variations. Regardless of the mode of energy production, however, one of the most challenging aspects to full-scale deployment of these alternative energy approaches is the storage of the generated power to affect a dependable and economically viable feed into the grid. Even if not tying into a distribution grid, a potential use of the generated offshore renewable energy is its use for the operation of existing offshore oil and gas infrastructure, which provides an opportunity to reduce fuel cost and operate these remote facilities in a more environmentally sound manner.

Both wind and wave energy sources are intermittent in nature and depend on seasonal, tidal, and climatological factors. However, electrical demand is not balanced throughout the day and power grids regulate the amount of power being supplied to the grid at all times. Industry has addressed this imbalance in supply and demand through the use of energy storage technologies as a means for power leveling. Storage facilities provide a mechanism to store and dispatch electric power to assist with both load-leveling and regulation services.

Offshore Energy Storage

The concept of compressed air energy storage (CAES) originated in Europe. The idea was to build CAES in natural geological formations such as salt domes, aquifers, and depleted oil and gas reservoirs to provide sufficient capacity and structural restraint needed to confine pressured air up to 7 MPa. There are two operational on-land CAES plants, a 290-MW plant in Huntorf, Germany built in 1978 and a 110-MW plant in McIntosh, AL built in 1991. Currently, there are seven proposed CAES projects in the U.S. in Iowa, New York, California, Ohio, Montana, and two in Texas. The concept of subsurface energy storage approach is being considered

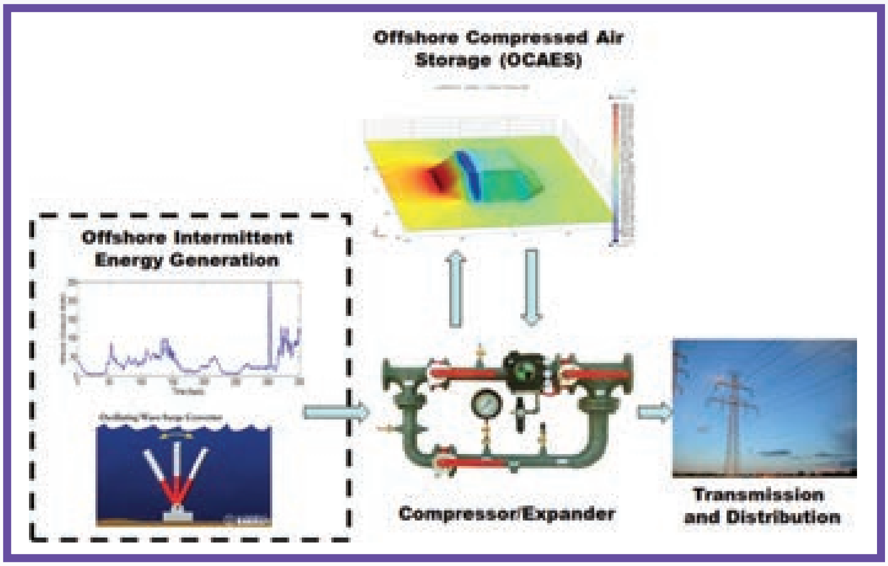

Figure 1. Compressed air storage and power generation cycle.

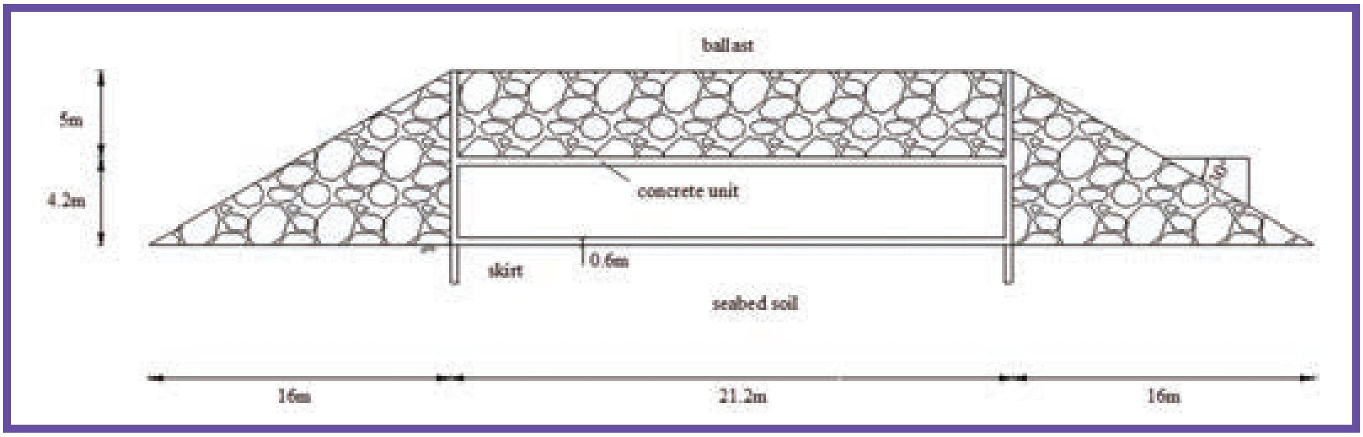

Figure 2. OCAES-proposed system configuration: concrete tank with ballasting concept.

in Britain for storing extracted natural gas to allow for its expedient dispatch when needed.

Offshore compressed air energy storage (OCAES) is an innovative concept that is based on taking advantage of the hydrostatic water pressure to balance the compressed air pressure without requiring vessels resistant to high inner pressure. The power/air/power conversion cycle is schematically illustrated in Figure 1. In this case, the captured power is used to run a compressor, and the compressed air is stored in a vessel at depth, H, below the water surface. When needed, the compressed air is then retrieved to run a turbo expander for the generation of the electricity. Assuming the air initial reference pressure is 1 atm., the energy stored in compression during an isothermal process can be calculated as:

$$W = P\,V \ln \frac{P}{P_a}$$

where V is volume of energy stored at the end of the process, P_a =1 atm., and P is the desired compression pressure. To provide a sense of numbers, a vessel with a storage space of 1,000 m^3, at a water depth of 300 m, will have a storage capacity of 10,204 MJ or 2.83 MW hr.

Two possible configurations for OCAES have been proposed. One uses reinforced synthetic fabric air bags. The second uses a rigid concrete vessel (Figure 2). It is difficult to anchor a flexible vessel on the seabed. If the mooring system fails while the vessel is filled with pressurized air, grave consequences such as rapid ascent, bursting, and uncontrolled release of compressed air energy at the site can occur. While a rigid concrete tank will have an interface of sea water and air which introduces turbulence as compressed air quickly fills the vessel, a problem that air bags avoid because air and seawater are not mixed, it has a relatively large self-weight and strength which makes vessel anchoring feasible with a reasonable level of safety.

Offshore Energy Storage Developments

Work at North Carolina State University to develop OCAES technology is being pursued by a multi-disciplinary team from civil, mechanical, aerospace, electrical, computer, and economic disciplines. The team is investigating operational aspects of OCAES including optimum pressures, container size and type, anchorage mechanisms, compressor selection, grid transmission and distribution, and achieving the maximum end-to-end efficiency through the energy storage and retrieval process. This effort is integrated under the umbrella of economic life cycle cost analysis to discern the value of storage versus dispatching energy directly into the grid.

Since the late 1960s, international standards agencies such as the American Petroleum Institute (API), Det Norske Veritas, and others have published guidelines about the recommended practice for design and construction of several types of foundation systems supporting offshore platforms and submarine pipelines. But there are significant differences between offshore platforms and the proposed OCAES device, and these are not limited to the different sizes and natures of the structures.

Geotechnics of Concrete Storage Vessel

From a geotechnical perspective, several issues related to the design, construction, and installation of an OCAES vessel must be

> OCAES is…based on taking advantage of the hydrostatic water pressure to balance the compressed air pressure without requiring vessels resistant to high inner pressure.

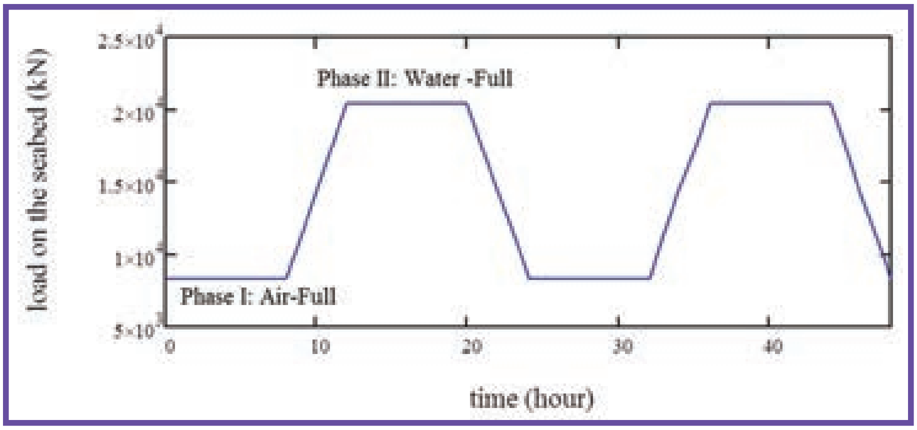

Figure 3. Idealized cyclic loading during system operation. The "time" scale varies in accordance to the relative periods of air storage/retrieval cycles.

investigated to achieve a viable installation and lifetime integrity of such a system. A partial list of issues to resolve includes:

- Establish the magnitude and type of loadings as well as buoyancy of the storage vessel when full of air, water, or an air-water combination.
- Depending on the depth needed to drive the turbo expander for power generation, assess the potential for significant current flow, and associated pressure, over the vessel.
- Select the vessel anchorage system, considering the material makeup of the vessel (i.e., ballast for concrete vs. a structural tie-down for reinforced polymeric materials).
- Decide whether the vessel will be installed on the ocean bottom or in a trench, considering such factors as soil-structure interaction, static and dynamic seafloor slope stability, constructability and installation, and the likely need for several vessels at the same location to accommodate a higher storage capacity.
- Develop a plan to respond to loss of anchorage and potential system failure modes.

Preliminary work on the geotechnics of the conceptual OCAES vessel design has investigated possible loading modes and the resulting vessel response. The preliminary studies have investigated a reinforced concrete storage vessel focusing on long-term maximum deformation, shear stress/strain, and tensile stress/strain to minimize cracking and therefore possible degradation due to corrosion effects.

Loading Characterization

The loading on the storage vessel includes an uplift effect due to the nature of alternating air and seawater storage cycles. In this case, seawater enters the vessel to keep the air compressed at the depth-equivalent hydrostatic pressure. Ballasting using rocks/boulders placed on the vessel (Figure 2) represents an option for maintaining the position of the storage vessel for long-term service. Other options such as piles, suction caissons, and plate anchors were not pursued due to questions about the precision of construction in the relatively deep water, unknown near-surface geology that may include relatively shallow hard layers, and the complexity of the approach with which the vessel will be tied into the seafloor foundation.

Assuming deployment in a water depth H of 300 m, the maximum hydrostatic pressure is about 3 MPa. Because the hydrostatic pressure varies with depth along the wall height of the vessel, the differential pressure between the top and bottom is limited to no more than 1 percent of maximum at the depth of 300 m, so the maximum height inside the vessel is taken as 3 m. However, this is a limitation that is more related to convenience of the analysis.

Based on the operational concept, the loading condition (Figure 3) can be classified into the Air-Full and Water-Full phases. In the Air-Full phase, the compressed air pressure inside the vessel is counterbalanced by the confining pressure from the surrounding seawater, and the buoyancy of the air inside the vessel is counterbalanced by the buoyant weight of the ballast. A safety margin is incorporated in the design which leads to an induced ballast pressure on the vessel and the seabed. In the Water-Full phase, the pressure from the surrounding seawater equals the pressure inside the vessel, and the buoyant weight of ballast and the tank are transmitted to the seabed.

Equation 2 is used to determine the factor of safety for a given thickness of ballast on the top of concrete tank with a target FS ≥ 1.5:

$$FS = \frac{\rho_c(V_t - V_s) + G_s\rho_w(1-n)V_b}{\rho_w V_t + \rho_w(1-n)V_b}$$

where:

ρ_c = density of concrete
V_t = total volume of vessel using outer dimensions
V_s = storage volume of vessel
G_s = specific density ballast
ρ_w = density of seawater
n = porosity of ballast
V_b = volume of ballast on top of vessel

Numerical Modeling and Analysis

Based on preliminary analysis, the proposed configuration and cross-section of the vessel and ballast are shown in Figure 2. To protect the storage vessel from potential collision hazards, the ballasting on the side is also proposed. The ballast and the vessel are formed into an embankment shape with a cross-section crest width of 21.2 m, a base length of 53.1 m, and a side slope of 30°-35°. The total height of the vessel and ballast is 9.2 m. The displacement and tensile stresses in the vessel are estimated by numerical modeling.

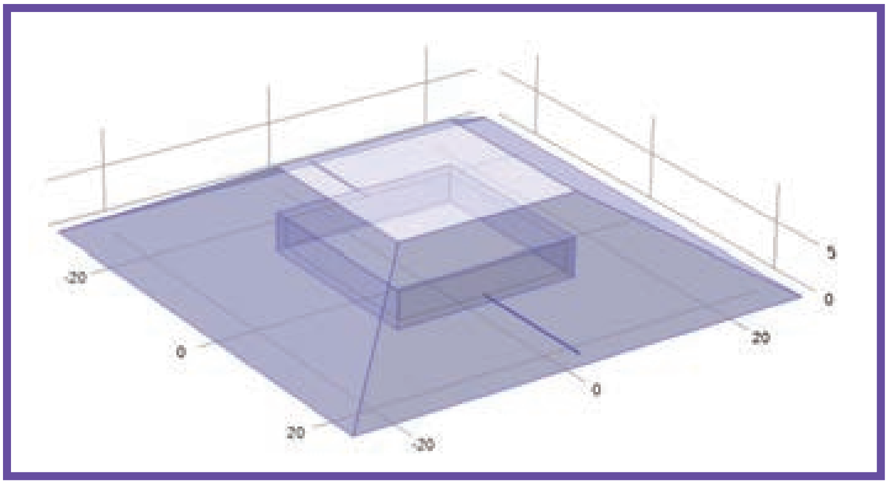

Figure 4. Configuration of OCAES System: storage vessel is shown inside the truncated pyramid representing the ballasting; inlet/outlet pipes are shown in dark blue on the sides of the vessel.

Structural Response

Numerical modeling of the vessel and ballast has been conducted using the computer program COMSOL. COMSOL allows for the coupling of fluid flow dynamics, geomechanics, and structural analysis in a 3-D domain. Figure 4 shows the model domain with one air inlet pipe at the top of the vessel having an outside diameter of 0.2 m and a water outlet pipe with the same diameter connected at the bottom of storage vessel on the side. In this model, the base of the vessel is assumed to be fixed in x, y, and z directions, and only the structural response of the vessel is analyzed.

The operation loading condition of the OCAES system is cyclic, oscillating between the Water-Full and Air-Full phases. Table 1 summarizes the maximum stresses and displacement of each loading sequence. The tensile and shear stresses are relatively high so shear reinforcement under the significant tensile stress will be needed along with a possible increase in the wall thickness. The deformation levels are tolerable provided the vessel is adequately reinforced.

Soil Response

In addition to analyzing the response of the OCAES vessel to cyclic pressurization, it is also necessary to assess the soil-structure interaction for what is essentially a slab-on-grade placed on the seabed. The dimensions of the storage vessel and ballast remain the same, but the model domain is expanded to include a volume of soil 200 m × 200 m × 100 m beneath the OCAES vessel. The soil is modeled as an elastic-perfectly plastic material subject to the Mohr-Coulomb failure criterion. The analysis proceeds in two stages, the first being the formation and consolidation under self-weight of the surface profile and the second being the placement of the storage vessel and ballast on the seabed. The material properties used in the analyses are shown in Table 2.

Table 1. Summary of stresses and displacement of each loading sequence

Phase	Maximum Tensile Stress (MPa)	Maximum Compressive Stress (MPa)	Maximum Shear Stress (MPa)	Maximum Displacement (mm)
Water- Full	6.5	8.4	2.4	16
Air- Full	2.9	3.8	0.87	7
Location	0.6 m from roof edge at top	0.6 m from roof edge at top	At edge of roof	At center of roof

Table 2. Material Properties

Feature	Density (kg/m^3)	Young's Modulus (MPa)	Poisson's Ratio	Friction Angle (deg)	Cohesion (kPa)
Concrete Tank	2300	25,000	0.33	–	–
HDPE Pipe	760	20,000	0.30	–	–
Ballast	1300	20,000	0.30	35	1

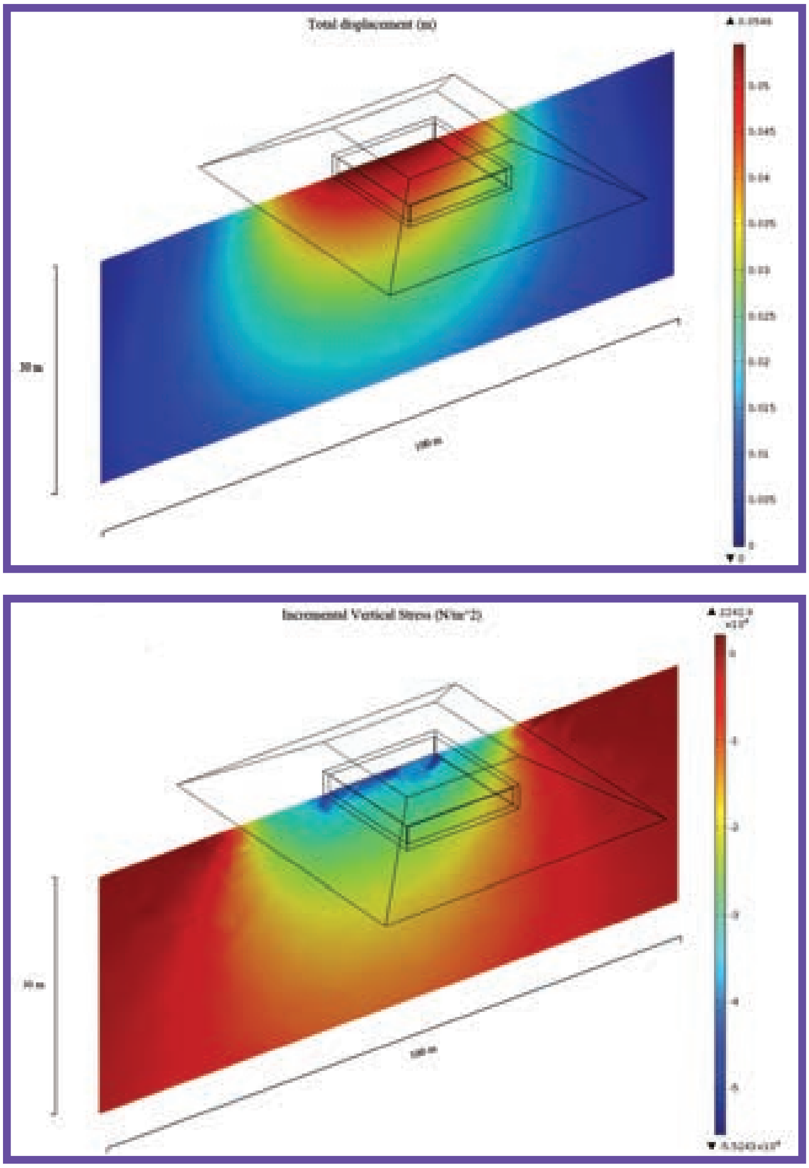

Figure 5. (a) Vertical total displacement at the center of the domain, and (b) stress increase with depth at the edge of the domain (mesh size is 30,000 elements).

Numerical results in terms of the total displacement and vertical stress are shown in Figure 5. The maximum displacement of the ballast is approximately 60 mm and occurs at the center of the vessel roof, with the seabed displacement of 50 mm also under the center of the vessel. The maximum displacement of seabed soil occurs at the edge of the storage vessel and is 55 mm. This is due to the arching of the ballast load due to the relatively stiff walls of the vessel. The angular distortion is 0.0005. The stress increase on the seabed under the edge of the vessel is 69 kPa. The stress influence zone has a depth of about 40-50 m beneath the seabed.

The Future of OCAES

As production-scale ocean power generation systems are developed, deployed, and operated offshore, the feasibility of storing, dispatching, and transmitting the generated electricity will play a key role in rendering these resources as a substantial benefit to the nation's and world's economies, but much work remains to get there. While preliminary evaluation and possible configuration of OCAES technology are underway, additional development of the vessel and its connecting systems is needed. In particular, the vessel must be air tight and sustain relatively high tensile and shear stresses. Options for vessel construction include the use of pre-stressed concrete elements, high strength concrete, fiber-reinforced concrete, and fiber-reinforced polymers.

Looking ahead, it seems that one of the most sensible applications for OCAES should prove to be a viable technology for storing energy from renewable ocean sources for servicing individual offshore platforms where diesel fuel is normally used for power generation. The larger-scale application of storing energy on the scale of tens of megawatts will necessitate addressing challenges related to back-converting the compressed air and transmitting and tying the electricity in the proper phase into the grid. Regardless of the application, geotechnical issues will need to be addressed, most likely on a site-by-site basis. In addition, life-cycle cost analyses are needed to demonstrate the extent to which the end-to-end cost efficiency of the OCAES-supported energy storage and retrieval process compares to the "business as usual" approach.

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SUBSURFACE CONSTRUCTORS

EXERCISE, MOTIVATION, AND EMPLOYEE PERFORMANCE

By Dan Kemlage, EIT

Managers in all lines of work need to know how to motivate their employees to make each day at work as effective as possible. Highly motivated employees who put in the effort to improve the overall success of the company will most likely be the ones up for promotion. Employees with a desire to reach their full potential will learn more from their superiors in a shorter amount of time, qualifying them to advance in the company a little bit quicker than their colleagues.

These motivation concepts certainly work both ways. The relationship between an attentive manager and an achieving employee is successful through its symbiotic nature. Motivating employees is often a difficult task for managers, and certain jobs are not conducive to having highly motivated employees—scrubbing dishes, collecting garbage, or other mundane, mentally unchallenging tasks that are nonetheless an integral part of our society. Sometimes senior management views this lack of motivation among their lower-level employees and decides to hire outside help or training programs for their managers. These can be expensive, time–consuming, and can interfere with productivity as they must be done during normal business hours. They can be unsuccessful as well.

There is, however, one motivational concept that, when followed with marginal diligence from week to week, can increase employee motivation; be less time-consuming, less expensive, and less intrusive than professional training programs; foster the manager-employee symbiotic relationship; and make that manager's department the shining star of the company. Physical activity and regular exercise will not only promote long-lasting health and physiological well-being, but can also lead to higher performance, higher set goals in the workplace, and higher self-confidence. When these attributes are brought to the workplace every day, there is no doubt the employee's professional performance will be noticeably improved.

Links between Exercise and Employee Performance

Self-determination theory, the first link between exercise and self-improvement in the workplace, implies that external motivators, such as the trainers hired by senior management to come into the office on a regular basis, are often more detrimental to motivation than internal motivators. Most people don't like being told what to do or how to do it... that's simply human nature. Intrinsic motivation is believed to be more essential and fundamental; it's a more sincere, believable motivator than a pep talk from a supervisor or a poster of a cat in a perilous predicament. Exercise often leads to intrinsic benefits that will enhance an employee's motivational core. Intrinsic benefits that are direct results from exercise can include improved mood, higher energy levels, a sense of accomplishment, and improved self-efficacy.

So how do improved moods or higher energy levels improve employee performance? A better question is how often do salesmen that have negative attitudes and are stand-offish towards a potential consumer sell their product? Customer satisfaction and customer service can be greatly improved with positive employees at the forefront, greeting them with nothing but smiles, being knowledgeable about their products, and identifying and meeting customer needs. The positive mood exemplified by such employees will radiate to any clients they encounter, creating an environment of genuine amiability. Good moods between co-workers in any type of company will create a more positive working environment, promote healthy work relationships, and reduce stress.

Self-efficacy, the second link between exercise and self-improvement in the workplace, is a measurement of a person's confidence level in completing certain tasks. Exercising a few times a week can promote self-efficacy through small accomplishments and improved self-image. Thirty minutes of exercise twice a week will give most people a modest sense of pride, boosting their self-confidence.

An employee with high self-efficacy will look at new assignments in a positive light and will be more capable of succeeding, even if it is an assignment unlike anything the employee has ever encountered before. These employees will also set higher personal performance goals for themselves, be more trainable, and be more motivated to build on their previous accomplishments. There is no doubt that self-confidence and self-efficacy will improve an employee's performance. Equally, there is no doubt that achieving personal goals of physical activity will boost one's self confidence and self-efficacy.

Exercising a few times a week can promote self-efficacy through small accomplishments and improved self-image.

The third and final link between exercise and increased performance in the workplace is possibly the most personal and most obvious. Physical activity leads to lower risk of major illness and disease and increases an employee's life expectancy and overall health. The mindset of being healthy can lead to exercise, improving one's physical well-being. Employees with this healthy mindset and health-conscious focus will again be dedicated to achievements and performance, and can help develop a healthy atmosphere within the company. In addition, absence due to illness is less likely, making the work day a little less stressful for others who may need to work a bit more to cover for an absent co-worker.

Motivation

While the benefits of regular exercise are clear, motivating oneself to actually exercise can be hard. New habits are hard to form, especially as an adult. Other things get in the way, like doing home chores, taking the kids to soccer practice, or helping them with homework. Although these may seem to be excuses to avoid exercising, they are reasonable occurrences in an American adult's life that need to be attended to. With that in mind, sufficient time must be set aside for exercise to realize the short- and long-term benefits of physical activity.

One possible motivation for exercising may be a financial commitment. The combined investment of a new pair of running shoes and a gym membership may motivate a cost-conscious individual to make use of these new assets. Another motivator may be to set personal weight-loss goals, with a reward once the goal is accomplished. Achieving any goals set will naturally act as additional motivators that build on themselves, like a snowball rolling down the side of a mountain. Remember, intrinsic motivators such as these are typically more successful than external ones.

Just Do It!

Not everyone is the most coordinated athlete, or the swiftest, or the most graceful. Not everyone has the physical capabilities to jog a mile or bench press more than 45 pounds. But just about everyone can set goals. By setting attainable goals, motivation for success has already been started, no matter how small the goal may seem to others. Once these goals are achieved, more and more goals can be set with the bar maybe a little higher than the last time, leading to self-improvement in mind, body, and career.

AUTHOR

Dan Kemlage is a recent civil engineering graduate of the University of Dayton and is currently pursuing a Master's degree in engineering management while working full time as a project engineer for a heavy construction company. While continuing his development as an entry-level engineer, he plans on getting his Professional Engineering license and becoming a project manager within five years. He can be reached at *d.kemlage@gmail.com*

TENCATE

Figure 1. Cracks of concrete slabs due to heaving of expansive soils.

Design of Deep Pier Foundations for Expansive Soils

By John D. Nelson, Ph.D., P.E., D.GE, F.ASCE, Kuo Chieh (Geoff) Chao, Ph.D., P.E., M.ASCE, and Daniel D. Overton, P.E., F.ASCE

One of the greatest challenges for geotechnical engineers is the design of foundations on expansive soils. Expansive soils can exert very large forces and cause foundation movement in amounts that are generally well beyond what ordinary soils produce (Figure 1). Light structures, such as residential or light commercial buildings, are generally most susceptible to damages from these soils. As a result of expansive soil damage, the costs of appropriate foundations for light structures are well beyond what developers, builders, and owners are accustomed to. This places an additional burden on the engineer who then needs to explain to clients why the cost is greater than that for an ordinary site.

Foundation Concepts

An important part of the engineering is the selection of an appropriate foundation type. Highly over-consolidated claystones are frequently encountered in the Rocky Mountain region from Colorado north into Canada and west to California. These claystones can exhibit very high expansion potential. These claystones are generally referred to as bedrock, although the term "expansive soil" can be used to refer to both expansive clay and claystone.

In these types of expansive soils, more robust foundation types are necessary than those used for soils exhibiting lower expansion potential. The most reliable foundation type that is commonly used consists of a deep foundation supporting a grade beam, with a structural floor. A void space must be placed

Helical piles or micropiles are often used for remediation of foundations that have experienced intolerable heave.

beneath the grade beam so that the foundation soils do not exert upward forces on the grade beam walls as they expand.

Helical piles or micropiles are often used for remediation of foundations that have experienced intolerable heave. Helical piles consist of one or two helices on either a square or round shaft. Micropiles are basically a small-diameter drilled pier. The shaft is drilled using a pneumatically driven drilling apparatus that can be attached to the existing wall. This has the advantage of facilitating the drilling to fairly deep depths. Typically a No. 9 or No. 10 bar is inserted into the shaft and the space around the bar is grouted using a tremie method. Common depths of micropiles for these applications range up to 60 or 65 ft.

A PVC casing is often inserted into the upper 20-30 ft to reduce uplift skin friction from the expansive soil. The upper 10 ft or so of the casing is usually steel to facilitate connection to the foundation wall or grade beam. It is very important that the deep foundation element be attached to the bracket on the wall or grade beam so that it can resist uplift forces due to uneven potential movement of the micropiles or external forces exerted on the foundation walls due to backfill or foundation soil heave.

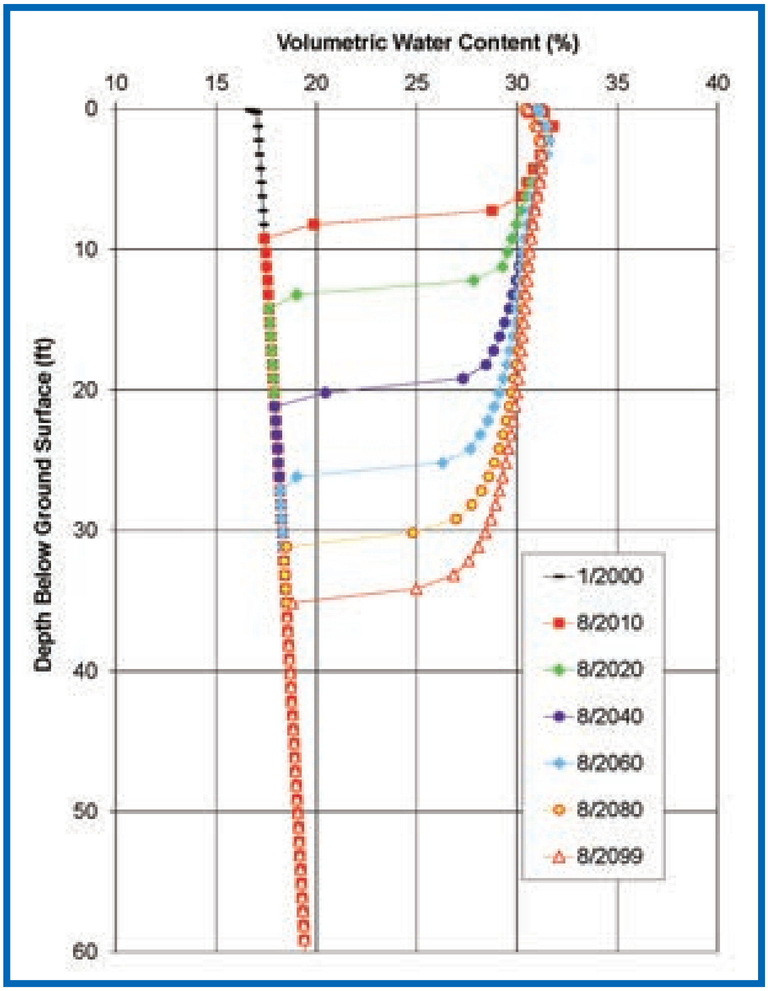

Figure 2. Water content profiles for claystone calculated by Vadose/W.

Foundation Design

Determining the required length of the piers is an important part of deep foundation design. The basic design principle is to embed the pier sufficiently deep so that the lower part of the pier can develop sufficient anchorage skin friction to resist uplift forces from the expansive soil. The design procedure consists of first calculating the expected free-field heave and then determining the length of pier so that the calculated pier heave is within tolerable limits.

Pier heave calculations are based on free-field heave, the heave that would occur at the surface of a soil profile if no surcharge or stress is applied. Methods for calculating free-field heave have been developed that use the results of either oedometer or soil suction tests. The method based on oedometer test results has particular advantages, such as direct measurement of percent swell and swelling pressure. That is the method commonly used for pier design.

Depth/Degree of Wetting

The depth of soil that is contributing to heave at a particular time depends on two factors: the depth to which water contents in the soil have increased since the time of construction and the expansion potential of the various soil strata. As water migrates through a soil profile, different strata become wetted, some of which may have more swell potential than others. Consequently, the zone of soil that is contributing to heave varies with time. Movement of the soil surface will begin almost immediately after construction, whereas some time will be required for the soil at deeper depths to become wetted. Thus, the surface of the soil and slabs-on-grade will begin to heave almost immediately, but movement of piers will be delayed, usually by several years.

Design of foundations on expansive soils must consider the zone of potential heave that can develop during the design life of the structure. The most important factors to consider include the structure's design life, the depth of wetting that can occur during the design life, and the degree of saturation at the end of the design life. If full wetting of the subsoils is not expected to occur, analyses must be conducted to determine the water content profile at the end of the design life.

The depth of wetting and corresponding degree of saturation can be calculated using readily available software, such as Vadose/W, SVFlux, or Hydrus 2-D. The main soil properties needed in the water migration analysis include soil water characteristic relationships, hydraulic conductivity functions, and values of hydraulic conductivity ratio. Using the results of these analyses, the amount of heave that is expected to occur in the partially wetted zone can be calculated. Example results of the analysis of wetting due to irrigation and precipitation are shown in Figure 2. The water migration analysis was conducted using the computer program Vadose/W. The soil properties used

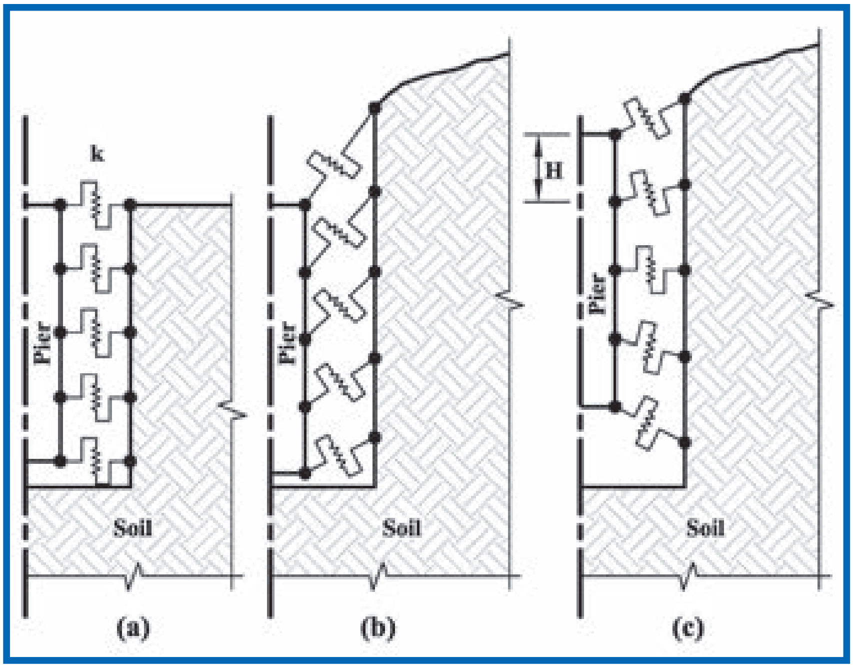

Figure 3. Schematic of pier and soil interface: (a) initial-no force on pier, (b) soil heave-upward force on pier, (c) pier heave-resultant force on pier is zero.

in the Vadose/W model were calibrated to the observed water content profiles before and after construction of the structure. The seepage models were calibrated and validated to the observed water migration conditions at other sites.

Figure 2 shows that the predicted depth of wetting continues to increase to a depth of approximately 35 ft in 100 years, a typical foundation design life. This wetting front occurs as a result of new construction due to evapotranspiration from the surface of uncovered areas being reduced by the placement of slabs-on-grade, and the introduction of on-site irrigation water. Significant variation may exist in the pattern of wetting and the consequential time rate of heave due to the effects of irrigation practices, surface drainage conditions, and underground water sources. Experience indicates that the amount of infiltration can be reduced significantly for sites with good irrigation practice and well-maintained surface drainage conditions. It should be noted however that if drainage is corrected at a site that originally had poor drainage control, the heave rate will not be reduced to the heave values for a site with good drainage control because the water already introduced into the soil profile will continue to migrate with time.

Pier Heave Prediction

Rigid Pier Method. The principle on which the piers are designed is to found them in a stable stratum at a sufficient depth to provide sufficient anchorage to minimize movement under the uplift forces exerted by the expansive soil. If a stable non-expansive stratum exists at a reasonably shallow depth, the pier may be designed as a rigid body anchored in the stable soil stratum to prevent unacceptable movement. This approach assumes that the pier does not move. The Rigid Pier Design method assumes that the negative skin friction below the depth of potential heave plus the dead load on the pier resists the uplift pressures produced by the swelling pressures exerted on the pier above that point. The required pier length can then be calculated by equating the uplift forces above the design active zone to the anchorage forces.

Rigid pier design works well if the stratum of expansive soil is not thick and is underlain by a stable non-expansive stratum. However, in a deep deposit of expansive soil, the required pier length approaches a value equal to twice the depth of the design active zone. In such cases, the design rigid pier length is generally not practical for a light structure, and it would be appropriate to use a shorter pier designed using the Elastic Pier Design method.

Elastic Pier Design Method. If the design depth of active zone is large, the design length of a pier designed as a rigid pier will be too long to be practical. Typically, some movement of the pier would be tolerable. A more economic approach would be to design the pier by calculating the required length of pier such that the tolerable movement is not exceeded. The pier should then be designed as an elastic member in an elastic medium, using Elastic Pier Design methods.

Pier heave calculations are based on free-field heave, the heave that would occur at the surface of a soil profile if no surcharge or stress is applied.

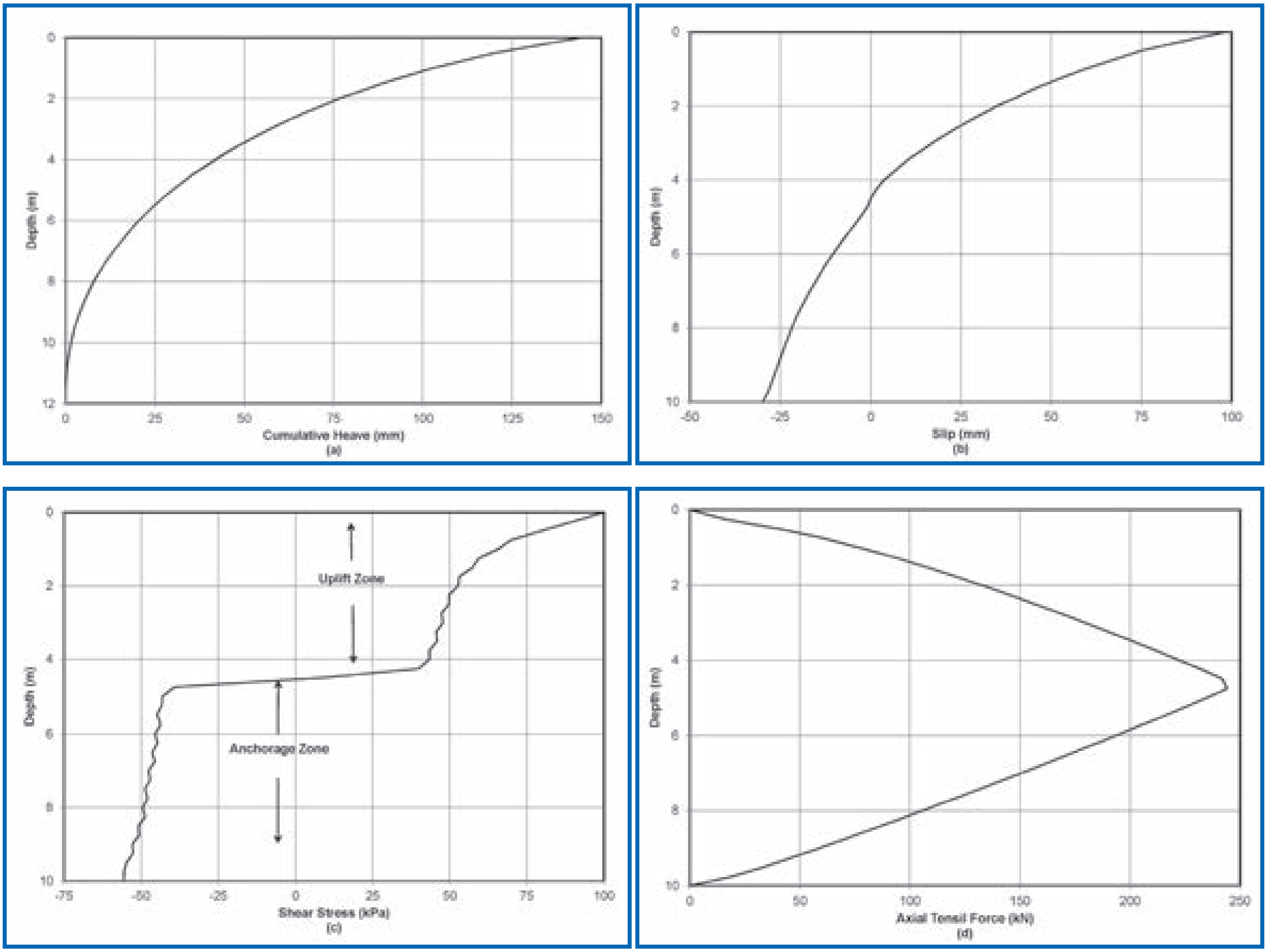

Figure 4. Typical output from finite element analysis: (a) cumulative heave used as input, (b) variation of slipalong pier, (c) shear stress distribution along pier, (d) axial force distribution.

These methods for calculating pier heave are based on a finite element solution. They consider the pier to be a relatively rigid inclusion in an elastic half-space. Using these methods, the required pier length is usually shorter than for the Rigid Pier Design method. One method is based on a finite element method (FEM) of analysis but is presented in the form of design charts. A second method describes a FEM computer code that is capable of analyzing more complex pile geometry and soil profiles.

Finite Element Based Analysis

In many cases, the various strata of expansive soil that are penetrated by the pier exhibit widely varying properties. Also, with increasing use of micropiles in expansive soil applications, very large L/d ratios are common. An FEM of analysis has recently been developed. In this method, the pier is modeled as a rigid body connected to an elastic, expansive medium by springs (Figure 3).

Figure 3a illustrates the conditions before the soil swells with no external load. In this state, there is no uplift force on the pier. Figure 3b illustrates the conditions after swelling takes place but before any pier heave. The shear forces exerted by the expanding soil create an upward force on the pier, and the pier is no longer in equilibrium. To bring the pier into equilibrium, it must be allowed to move up, creating both upward and downward forces acting on the pier. This is illustrated in Figure 3c. An iterative solution procedure is used. Simultaneous adjustments are made of the pier heave and the spring parameters during each iteration.

Figure 4 shows a typical output from the FEM program for a soil profile with uniform expansion potential with depth. The cumulative heave profile shown in Figure 4a is the input for the

FEM program. Figure 4b shows the distribution of slip along the pier. In this case, slip occurrs over the entire length. This reflects the fact that the soil's shear strength was sufficiently high that failure occurred as slipping between the pier and the soil at the pier-soil interface. For a soil with a lower shear strength, failure would have occurred in the soil at some distance into the soil away from the interface.

Figure 4c shows the distribution of shear stress along the pier. In the upper portion of the pier the shear stresses are positive. This defines the uplift zone and the lower portion defines the anchorage zone. Figure 4d shows the axial force in the pier. The maximum value occurs at the change from the uplift to the anchorage zone. This is the tensile force in the pier for which the reinforcing steel must be designed. If the upper portion of the pier is cased in a material such as PVC, the skin friction in the uplift zone can be reduced and the required total length will be less.

Where Are We?

Just as the settlement of a foundation on soft soil must be calculated and analyzed, so must the heave of a foundation on expansive soils. It is incumbent on the design engineer to develop adequate geotechnical information to permit accurate analyses and design. This usually entails convincing the client that the added cost of investigation and design has benefit. While it falls upon the design engineer to do that, the rate of foundation failures that are occurring, coupled with bad experiences reported by builders and developers, aid in demonstrating the benefits of a geotechnical exploration and design. As a result, designers must work with their builder/developer clients to understand their foundation performance expectations and conduct sufficient exploration, testing and analysis to ensure to help meet them.

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RST

THE WAY WE WERE... 2013 GEO-CONGRESS MEMORIES

By Linda Bayer, IOM

Though the 2013 Geo-Congress with its 1,031 attendees are now behind us, the memories linger on. So, for our friends who were unable to attend the Congress and for our guests who did, here are some of our favorite memories — memories that not only include the "words of wisdom" from more than 230 presenters, but the smiles, new and old friends, and experiences of numerous others.

The conference, "Stability and Performance of Slopes and Embankments III," kicked off on Sunday with three full-day short courses and one half-day short course followed by a well-attended Student Program and AGP's Ethics Workshop. The Geo-Institute Annual Business meeting followed with President Craig Benson PhD, PE, D.GE, NAE, F.ASCE, pointing out that "We need diversity to innovate" and ISSMGE President Jean-Louis Briaud, PhD, PE, D.GE, F.ASCE, highlighting the need to "improve the image of the geo-profession."

Sunday night continued with the H. Bolton Seed Medal Lecture delivered by Steve G. Wright, PhD, PE, M.ASCE, who presented "Slope Stability Computations." Dr. Wright shared two lessons learned from Professor Seed that he never forgets: "Know the answer to the problem before doing the computations" and "Know your fundamental soil mechanics."

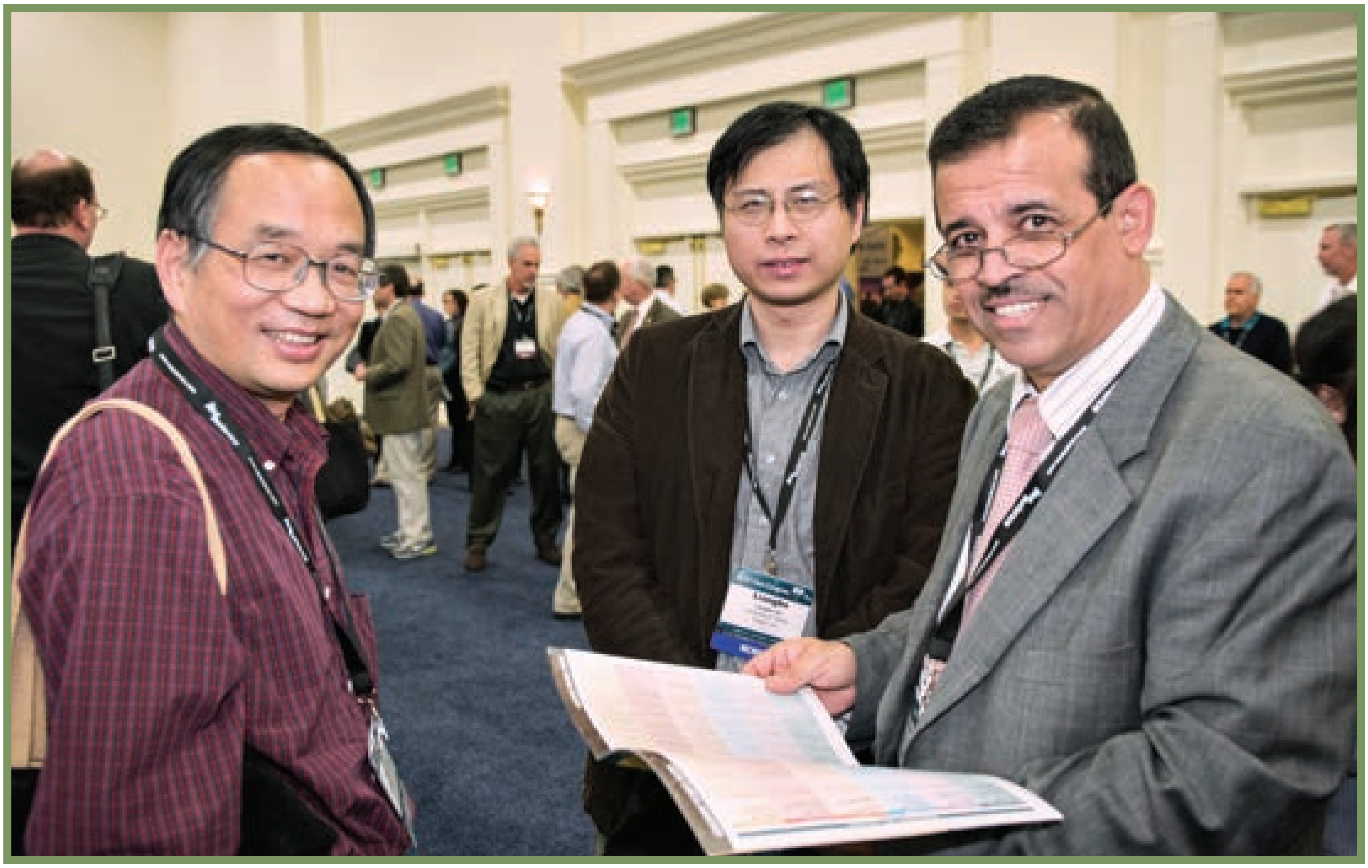
On Monday, Jonathan Bray, PE, F.ASCE, presented the Ralph B. Peck Lecture, "Liquefaction Effects on Structures," preceded by the plenary lecture "Slope Stability Then and Now" by

Mike Duncan, PhD, PE, Dist.M.ASCE, plenary lecture. Two of Duncan's key statements included "Computers produce results incredibly quickly. Reliable results take longer." and "The three most important things in slope stability are shear strength, shear strength, and shear strength."

Monday also included the always-exciting student GeoChallenge competition which included the GeoWall, GeoPrediction and GeoPoster competitions. Seventeen teams competed in the GeoWall student competition that resulted in a 3rd place win for Rensselaer Polytechnic Institute, a 2nd place win for the University of Kansas, and Cal Poly Pomona in1st place.

Monday's events continued into the evening with the ASCE's Academy of Geo-Professionals induction of 17 candidates who were awarded the Diplomate in Geotechnical Engineering (D.GE) certification. That brings the number of engineers who have earned the D.GE to more than 250.

Tuesday morning brought keynote speakers Tom Brandon, PhD, PE, M.ASCE; John Christian, PhD, PE, D.GE, NAE, Dist.M.ASCE; Richard Goodman, PhD, M.ASCE; and Francisco Silva-Tulla, ScD, PE, M.ASCE, to the podium to explore the topics of shear strength measurement, slope stability reliability, toppling, and dam troubleshooting. John Christian's words "The lack of a safety culture and belief that 'it can't happen here' are major causes of failures" gave many audience member pause for thought as the day continued. Many other words and experiences gleaned from other insightful presenters will remain in attendee memories far into the future as



demonstrated by statements of three post-conference survey respondents: "All those plenary and session speakers I heard were excellent…" and "Very interesting topics! Great speakers!" and, "Nice broad range of topics."

Technical sessions continued throughout the day on Tuesday with topics focused on seepage, fully-softened shear strength, risk assessment, desiccation cracking, and soil/rock characterization.

Tuesday's Hero and Awards Luncheon honored Charles C. Ladd, ScD, PE, D.GE, NAE, Dist.M.ASCE, whose words were vocalized by Don de Groot when he stated "check, check, and re-check until you are correct 100 percent. That is my way...and the only way!"

Other awardees honored during the Luncheon included:

- John S. McCartney, PhD, PE, M.ASCE/ Casagrande Award
- Tuncer Edil, PhD, PE, D.GE, Dist.M.ASCE/ Terzaghi Award
- Jim Collin/ Wallace Hayward Award
- John McCartney, PhD, PE, M.ASCE, and Jorge Zornberg, PhD, PE, M.ASCE/ Croes Medal
- Timothy D. Stark, PhD, D.GE, GE, M.ASCE, and Manzoor Hussain, PE, M.ASCE/ Middlebrooks Award
- Dominic Assimaki, A.M.ASCE/ Shamsher Prakash Research Award
- Jie Han, PE, M.ASCE/ Prakash practice award

Tuesday's activities concluded with an attendee-packed ballroom to hear Alfred (Skip) Hendron, PhD, NAE, M.ASCE,

To enjoy the 2013 Geo-Congress experience, *http://visualnatureimages.photoshelter.com/gallery-collection/2013-GEO-Congress/C00006x.YYamectY.* When prompted, enter this password: GEO2013

deliver his Terzaghi Lecture "Improving Dam Safety with Lessons Learned from Case Histories of Dam Failures and Unacceptable Dam Performance."

The conference's final day kicked off with morning plenary sessions dedicated to offshore slope stability, remote sensing applications, instrumentation and monitoring, and seismic slope stability presented by Allen Marr, PhD, PE, DGE, NAE, F.ASCE; Liam Finn, PhD, PEng, M.ASCE; Suzanne Lacasse, DEng, PE, F.ASCE; and Scott Anderson, PhD, PE, M.ASCE. The day's technical sessions included the fascinating panel session, "Levees: Lessons from Tohoku to Katrina" moderated by Daniel E. Pradel, PhD, GE, D.GE, M.ASCE.

Marietta Zarogiannopoulou, marketing director for Geoengineer, ended her 2013 Geo-Congress online report with some interesting words taken from Erik Malvick's presentation at the Seismic Design and Analysis breakout session: "1250 dams in California DSOD's jurisdiction, 95% of them designed for Mw 6.5 or greater!"

As 2013 Geo-Congress details slowly fade into the corners of our mind, the written words echoed by one attendee on the post-Congress survey "…the conference was perfect and left me speechless" spur us forward into planning an even more "perfect" Congress for 2014 when we move to Atlanta, GA, February 23-26, 2014.

A FEW WORDS FROM THE 2013 OPAL LIFETIME EDUCATION AWARD WINNER

CHARLES C.LADD, SC.D., P.E., D.GE, NAE, DIST.MASCE

By Linda Bayer, IOM

Charles Ladd is a man of numerous talents, as was conveyed in the January/February 2013 *Geo-Strata* magazine's Geo-Legend article. "(He) is internationally renowned for his leadership and contributions to geotechnical engineering research, teaching and practice," states the author, Alain El Howayek. So, is it any wonder that this "Geo-Legend" was this year's winner of the ASCE OPAL Lifetime Achievement Award in Education?

Ladd, the Edmund K. Turner Professor Emeritus at Massachusetts Institute of Technology (MIT), is one of the most important educators in geotechnical engineering. His research specialties in soil behavior studies, soft ground construction, foundation stabilization, offshore engineering, in situ and laboratory testing and risk analysis have helped him guide his former Ph.D. students to become university and engineering firm world leaders.

Dr. Ladd's devotion to the improvement of the practice of geotechnical engineering to safely construct on and in soft clays, has resulted in his name being inseparably linked to Stress History and Normalized Soil Engineering Parameters (SHANSEP) – a procedure developed at MIT which is now widely adopted for evaluating the undrained stability of construction in and on soft clays. His work on the properties of the clays of southern Louisiana was vital to investigations of the cause of levee failures during Hurricane Katrina.

A portion of Ladd's OPAL acceptance speech is captured here.

"I'm deeply appreciative of the award …During my senior year at MIT, I was studying to be a building contractor and I got offered a part-time job for Prof. Harl Aldrich on one of his building projects. It involved the settlement of a storage tank on soft ground that I used for my undergraduate thesis. He only gave me a B grade in it, but I still continued in geotechnical engineering and graduate school under the supervision of Prof. T. William Lambe. And, after six years of work, I finally joined the MIT faculty. I would not be standing here if it was not for Bill Lambe for at least 4 reasons.

First he got me a contract for research for the Army Corps of Engineers so that I could support students and pay for 40 percent of the salary that I had to cover myself.

Secondly, I had a wife and four kids and my salary had been raised to $6,000 a year, so, extra income was essential and Bill Lambe always had consulting projects. One of these involved the stability of storage tanks in Tokyo that led to the development of SHANSEP…

Third, Bill stressed the importance of going to conferences and lecturing and serving on committees, which I've continued.

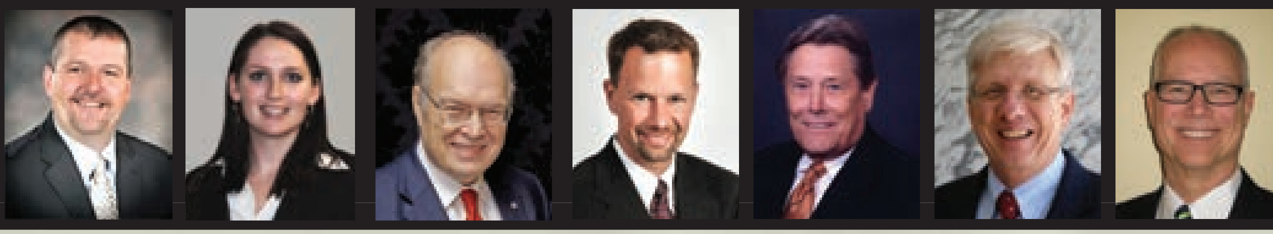
And fourth, Bill believed in socializing to enhance cooperation and cohesion of the group. My late wife Carol and I gave a Christmas party for 20 years that attracted up to 150 people, students, staff, and alumni from all over the Northeast and even abroad. The Ladd punch helped!"

Congratulations Chuck.

(l-r) Pat Natale, ASCE Executive Director; Charles Ladd; and Greg E. DiLoreto, ASCE President

Looking Out for You from the G-I Organizational Member Council

Join us in standing behind the Geo-Institute. Become an Organizational Member. Download the application at http://www.asce.org/uploadedFiles/geo/About_GeoInstitute/Organizational_Member/Organizational%20brochure%205.16.12(1).pdf



From l to r: Scott Mackiewicz, P.E., D.GE, M.ASCE, Kleinfelder; Michelle Bolding, P.E., LEED AP, M.ASCE, Schnabel Engineering; Howard Thomas, P.Eng., P.E., F.ASCE, CH2M Hill Canada Ltd; Kord Wissmann, Ph.D., P.E., D.GE, M.ASCE, Geopier Foundation, Inc.; John Bischoff, P.E., M.ASCE, URS; Jay Beech, Ph.D., P.E., M.ASCE, Geosyntec Consultants; James D. Hussin, P.E., M.ASCE, Hayward Baker

The OMC Welcomes the G-I's Newest OMs

Stantec

Serving clients throughout North America, Stantec's geotechnical, civil, and environmental engineers have tackled some of the most complex technical challenges. The firm offers specialized geotechnical engineering expertise related to dam and levee safety and major transportation infrastructure. Stantec also is a national leader in coal combustion residuals (CCR) management. Additional services include design of deep and shallow foundation systems, earth and rock-filled dams, roadway embankments and deep rock cuts, seismic hazard evaluations for dams and bridges, waterfront developments, industrial and municipal waste landfills, numerical modeling, major highway bridges, and large above and below ground tank systems.

Stantec has established AASHTO-, AMRL-, and USACE-validated soils, rock, and materials laboratories and maintains a fleet of more than 22 drilling rigs.

Densification, Inc.

Densification, Inc. is a national geotechnical specialty contracting and consulting company formed to provide geotechnical consultants a personal and practical contracting link with owners/developers and to allow an attractive alternative when poor soils or questionable fills are encountered. The firm's personnel have experience in a wide range of ground improvement techniques, however the company specializes in Dynamic Compaction consulting and contracting. Their goal is to provide a unique combination of specialized engineering expertise and contracting experience for successful applications of Dynamic Compaction to questionable building sites.

Joe C. Drumheller, the firm's president, has performed more than 190 Dynamic Compaction projects, which represents approximately half of the entire Dynamic Compaction work done in the U.S. during the last 14 years.

Geo-Congress 2013 OM Executive Leadership Workshop

34 percent of the Geo-Institute's Organizational Members' leaders participated in the inaugural Executive Leadership Workshop on March 4, 2013 to explore if firms' technical and business-related interests are being addressed by the Geo-Institute. Several key areas of consensus evolved which included:

- The G-I has "mastered" the art of hosting relevant content/activities for students at the Congress.
- The Geo-Congress is not the venue to bring clients, but rather where "we network with our peers. We go to other meetings to meet clients."
- The focus of the Congress should be to provide value to all attendees – not specifically for developing business.

ORGANIZATIONAL MEMBERS

"Thank you for supporting students and the geo-profession."

AECOM
Agru America, Inc.
AMEC
Ardaman & Associates, Inc.
Atlas EPS
Bechtel
Bentley Systems
Berkel and Company Contractors, Inc.
CH2M Hill
ConeTec, Inc.
Dan Brown and Associates, Inc.
D'Appolonia
DBM Contractors, Inc.
Densification, Inc.
ECS Corporate Services
Fudo Construction, Inc.
Fugro Consultants LP
Gannett Fleming, Inc.
Geocon Incorporated
GeoEngineers, Inc.
Geokon, Inc.
Geopier Foundation Company
Geo-Solutions, Inc.
Geosyntec Consultants
Geotechnology, Inc.
Golder Associates Inc.
GRL Engineers, Inc.
Haley & Aldrich, Inc.
Hayward Baker Inc.
Insulfoam
Jafec USA, Inc.
Kleinfelder, Inc

• OMC should consider hosting regional meetings – perhaps use G-I award lectures as topic or send top Geo-Congress speakers

• Incorporate PE review questions and answers into *Geo-Strata* magazine.

• Present portions of top Congress papers in *Geo-Strata* magazine.

• Suggest that Geo-Congress session chair write a report about the session – create an executive summary for promoting a conference session.

Layne GeoConstruction
Loadtest, Inc.
Magnus Pacific Corporation
Malcolm Drilling Company, Inc.
McKinney Drilling Company
Menard, Inc.
Moretrench
Nicholson Construction Company
NTH Consultants, Ltd.
PB Americas, Inc.
RADISE
The Reinforced Earth Company
Rembco Geotechnical Contractors, Inc.
Richard Goettle, Inc.
RocScience
S&ME Inc.
Sanborn, Head & Associates, Inc.
Schnabel Engineering
Schnabel Foundation Company
Shannon & Wilson
Soil and Materials Engineers, Inc.
Stantec
Strata Systems, Inc.
TenCate Geosynthetics
Terracon, Inc.
Terra Insurance Company
Tolunay-Wong Engineers, Inc.
TTL, Inc.
URS Corporation
ZETAS Zemin Teknolojisi A.S.

Geo-Congress Organizational/ Student Career Fair

31 percent of the Geo-Institute's 64 Organizational Members participated in the third annual G-I Organizational Member/Student Career Fair on the evening of March 4 in San Diego. This year's event brought about a change in venue as the 45 students who were selected to receive the G-I/OM $275 travel grant had the 20 OM firms "all to themselves!" Comments at the conclusion of the event from students and participating OM firms included:

• "What an awesome event"

• "It was just like a real interview, only more relaxed"

• "A great opportunity to learn from these enthusiastic, motivated young people!"

• "We would definitely hire some of these 'kids' down the road."

Geo-Congress OMs and Students Wind Down in Tiki Pavilion

More than 250 registered students, Organizational Members, and new D.GEs had a chance to meet, swap information, and enjoy food and drink in the poolside Tiki Pavilion during the 2012 Geo-Congress. See for yourself!

G-I Organizational Member News

G-I Members

Catch Up on G-I's Newest Videos

Take a few minutes to view an Organizational Member's video, or one that's been thoughtfully selected by the Geo-Institute at *http://www.youtube.com/user/GeoInstituteofASCE.*

Got a video to share with us that's already posted on YouTube? Send us the link so we can add it to our YouTube page. Or, send us your video for posting. Send to *geo-institute@asce.org.*

The G-I Follows Its Organizational Members

The G-I not only follows its Organizational Members on Twitter, but retweets news and lists it at @GeoInstitute/GIOrgMembers. We also follow OMs who are on Facebook. E-mail us at *ecuscino@asce.org* when you join Facebook and Twitter so we can follow you and add your name to our list.

Schnabel Project Wins 2013 USSD Award of Excellence

Schnabel Engineering, Inc., Glen Allen, VA, announced that its "Deep Creek Watershed Dam 5D" was selected as recipient of the 2013 United States Society on Dams' (USSD) Award of Excellence in the Constructed Project category. This honor is the second award received by Schnabel during the past year from the nation's top dam engineering organizations.

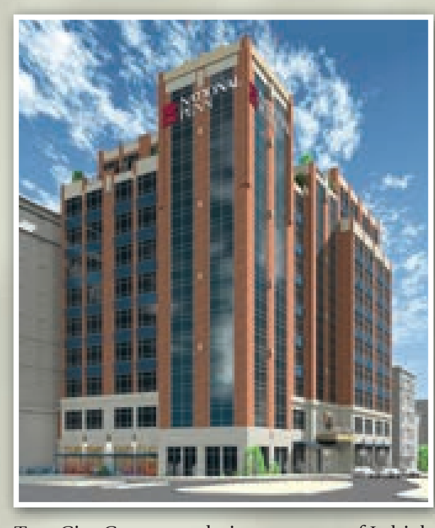
Schnabel is the principal designer and engineer of record for the new Deep Creek Watershed Dam 5D constructed in Yadkin County, NC. The project was made possible through joint cooperation and funding made available by the USDA Natural Resources Conservation Services (NRCS), the North Carolina State Conservation Commission, and the local sponsor, Yadkin County. Throughout the design, Schnabel closely collaborated with the owner and the NRCS, which served as the technical review agency.

A composite dam design was selected to efficiently make use of the complex existing foundation conditions. The composite arrangement was selected as being the least costly of 12 alternatives evaluated by Schnabel and reviewed by Yadkin County and the NRCS. However, designing a large high hazard roller compacted concrete (RCC) gravity dam and zoned earth embankment on a variable foundation presented considerable challenges. Particular attention was needed at the connection between the two dam types where differential settlement and seepage may occur.

The Deep Creek project included the first use in the U.S. of grout-enriched roller-compacted concrete (GERCC) as the sole upstream barrier. This innovative process includes addition of a cement grout to the no-slump RCC at each lift along the upstream face, and then mixing the grout and RCC using hand-held vibrators to consolidate the material and provide a seamless lower permeability zone of concrete. GERCC resulted in considerable savings to the project and its successful use at Deep Creek Dam has gained considerable attention from the U.S. engineering community.

Completed Deep Creek Watershed 5D Dam.

Nicholson Completes Foundation Work at Two City Center in Allentown, PA



Two City Center rendering courtesy of Lehigh Valley Live (VCU).

Nicholson completed foundation work at Two City Center, a new 11-story building being constructed as part of a major urban redevelopment plan in Allentown, PA.

When finished, the building will be 330,000 sf, with office and retail space.

Two City Center is being constructed at the site of the 62-year-old First National Bank Building, which was demolished as part of the redevelopment. It will be the second-tallest building in Allentown.

Two City Center is part of a larger revitalization plan for Allentown, which includes the construction of a $220 million ice hockey arena for the Phantoms, the minor league affiliate of the Philadelphia Flyers.

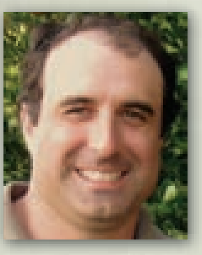
The geology at the site of Two City Center is composed of primarily karstic limestone, which is prone to voids and sink holes. To support the new structure, Nicholson installed nearly 200 micropiles, with some piles reaching depths of well over 100 ft below the existing grade to the competent bedrock.

"Nicholson has extensive experience with construction in this type of geology," said Fred Tarquinio, PE Business Development Manager, Nicholson Construction. "In our history, we've installed over 15,000 micropiles in similar geology using a similar drilling method."

Two City Center is expected to be completed in 2014. Both Two City Center and the new hockey arena are part of the Neighborhood Improvement Zone, a tax-favored district set up to encourage further development in downtown Allentown.

Expansion of Louisiana GRL Office

Mohamad Hussein



Brian Mondello

Mohamad Hussein, PE, M.ASCE, senior vice president of **GRL Engineers, Inc. (GRL)** and managing engineer of its Florida office, announced that the GRL Louisiana office will expand operations to better serve the growing needs of the region.

Brian Mondello, PE, will manage the Louisiana office and Jon Honeycutt will relocate to the area from GRL's central office. Mondello, an accomplished engineer who has been with the GRL Florida office since 2001, assumed this additional role on March 1. Honeycutt, who holds an MS in civil engineering from Auburn University, was one of the instructors at the Dynamic Testing and Analysis workshop held in New Orleans in late February. He also has worked on numerous job sites throughout the Midwest, East Coast, and South.

Hussein will continue his involvement in Louisiana and other southeastern states, and commented that "together, the three of us bring almost 50 years of foundation testing experience to the GRL Louisiana office."

Bentley Highlights New 2103 Priorities in Annual Report

Bentley Systems, Incorporated recently announced the release of its 2012 Annual Report, which is posted on the company's website. In addition to providing Bentley's 2012 performance highlights, the publication sets the stage for Bentley's 2013 priorities, which include:

- revenues grew 5 percent to a record $550 million on an historical GAAP basis; in constant currencies, GAAP revenues grew 8 percent and organic growth was 6 percent;
- subscriptions reached a record 74 percent of revenues;
- applications use was logged by over 1 million users in 165 countries – and nearly 2 million users when including Passports and iWare apps; and
- investment in R&D and acquisitions was at a record level of nearly $200 million, bringing the total invested since 2005 to more than $1 billion.

CEO Greg Bentley, A.M.ASCE, commented, "Our annual reporting to our user organizations this year goes beyond performance metrics. It also introduces groundbreaking Bentley innovations and initiatives that support our agenda for 2013 – *Connecting Globally*. Among them are new apps for mobile devices that empower users to secure information mobility on construction sites and field locations; new products and services for persistent point clouds across infrastructure lifecycles; new strategic alliances with major organizations, including Siemens, Trimble, and AASHTO, that will result in new connectivity among systems; and newly reprogrammed events for in-person global connections, including The *Year in Infrastructure 2013* Conference for thought leaders." The 2013 conference will be held in London, October 28-31, 2013.

Deao Receives ASCE Young Engineer Award

Andrew Deao

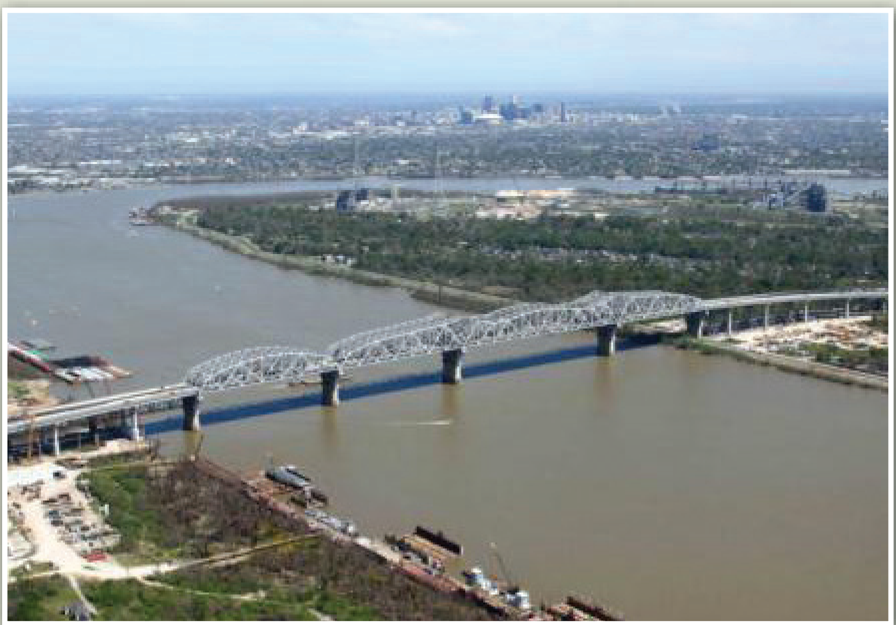
Andrew Deao, PE, a project geotechnical engineer in the **Gannett Fleming's** Pittsburgh, PA office, received the 2012 Edmund Friedman Young Engineer Award for Professional Achievement from ASCE at the organization's annual conference in October 2012.

The award recognizes ASCE members, age 35 years or younger, who have advanced the profession; exhibited technical competence, high character, and integrity; developed improved member attitudes toward the profession; and contributed to public service outside their professional careers.

Deao has been involved in projects such as the Gilboa Dam in New York's Schoharie County and major improvements to the Pennsylvania Turnpike and I-79. A past president of the Younger Members Forum of ASCE's Pittsburgh Section and current Student Award Foundation chair, he received the section's Young Engineer of the Year Award in 2011.

Dan Brown and Associates Consults on LA Bridge

The Huey P. Long Bridge in New Orleans, LA will be officially completed in June 2013, according to the LADOTD. A recent article in the Times-Picayune on-line announced that another ramp opened in April. The last overpass



The Huey P. Long Bridge, New Orleans (Photo Credit: Louisiana TIMED project photo album)

ramp on the east bank of the bridge will partially open as part of the $1.2 billion bridge widening project, bringing the project one step closer to completion. Dan Brown and Associates was brought onto the project by the contractor team to consult on the design, load testing, and construction of the 9-ft-diameter, 184-ft-long base grouted drilled shafts.

Kleinfelder Wins ACEC Engineering Excellence Award

Kleinfelder was announced as the winner of The American Council of Engineering Companies of New Hampshire (ACEC-NH) 2013 ACEC-NH Engineering Excellence Award in the Special Projects category for the $1.6 million Merrimack River Crossing project.

Initiated by Manchester Water Works (MWW), the New Hampshire Merrimack River Crossing project required the installation of nearly 5,000 ft. of 20-in. water main including a 900-ft crossing of the state's largest river, the Merrimack, and an adjacent, active railroad line. The goal of the project was to improve water reliability to thousands of customers.

As MWW's prime consultant, Kleinfelder engineered the most ambitious pipeline project of its kind ever attempted in New Hampshire using horizontal directional drilling (HDD) for the 20-in. pipe. Engineers called for the careful integration of two trenchless technologies into one, which offered a number of advantages. With trenchless technology, construction crews would not have to disturb the river, the surrounding environment or the community that relies on the river for both commercial and recreational purposes.

In response to the railroad owner's concerns, the project team employed pipe ramming to install a 42-in. sleeve in the railroad right of way then directional drilling to thread a 20-in. carrier pipe through the sleeve and beneath the river.

View looking down the HDD rig towards the railroad crossing.

Pipe ramming the 42-in. steel sleeve under the railroad.

Overall, the project met MWW's goals across the board. Despite the complexity of the project and the construction challenges encountered, the project finished well under budget by almost 14 percent and with no change orders.

Completing the river crossing and closing the loop in this critical part of the water distribution system has improved drinking water quality in the city by reducing the potential for nitrification, provided more stable water pressures, provided redundancy in the event of unexpected shutdowns or emergencies, and otherwise improved the overall level of service in this section of the distribution system.

Terracon Advances Work on Wetlands Project

Terracon Consultants, Inc. engineers **Chris Roberts, A.M.ASCE,** and Matt McCullough recently investigated the subsurface conditions in a wetlands area at Lakeside Park in Pell, AL, where the Logan Martin Lake Protection Association (LMLPA) and the city are partnering to build a boardwalk and observation platform. The engineers tested the ground conditions and collected soil samples and confirmed that there is firm to stiff clay to support the foundation for the proposed 70-ft-long walkway which will provide visitors a 360-degree view of the wetlands at the park.

The walkway platform is expected to be built with composite materials to extend the life of the boardwalk and observation platform. Though the structure will not weigh much, the foundation must withstand the lateral load from the flow of water in and out of the wetlands area.

The observation platform is about 12 ft x 40 ft. The actual boardwalk is wide enough for two side-by-side wheelchairs to pass each other and will have banisters to prevent children from falling from the walkway or platform into the water.

Construction of the new boardwalk and observation platform could begin between November 2013 and February 2014.

GeoEngineers CEO Becomes 43rd ASFE President


Kurt Fraese

Kurt R. Fraese, LG, CEO of GeoEngineers, Inc., became the new president of ASFE/The Geoprofessional Business Association (GBA) during GBA's annual meeting in Charleston, SC. Fraese is the 43rd individual to serve as GBA's president and will chair the group's board of directors.

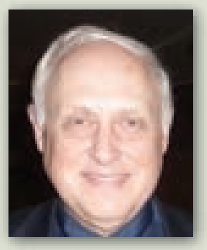
Fraese, an environmental-science specialist with expertise in brownfield redevelopment, has provided consulting services in the energy, development, transportation, federal government, and water-and-natural-resources markets since beginning his career in 1983 with Woodward-Clyde Consultants. He joined GeoEngineers in 1988 and became CEO in March 2007. He has served as project manager and/or principal in charge of more than 1,200 site studies, as well as a qualified expert in a variety of dispute-resolution proceedings. Fraese, a trusted advisor, has served clients as a regulatory liaison and participated as a client representative in numerous negotiations with attorneys, lenders, insurance companies, contractors, and real-estate professionals. He earned his BA in geology in1982 from Humboldt State University.

Other officers and directors-at-large who will serve during GBA's 2013-14 fiscal year are:

- President-Elect **Steven D. Thorne, PE, D.GE** *(Birdsall Services Group, Cranford, NJ)*
- Secretary/Treasurer Gordon M. Matheson, PhD, PE, PG *(Schnabel Engineering, Glen Allen, VA)*
- Joel G. Carson *(Kleinfelder, Omaha, NE)*
- Chuck A. Gregory, PE *(Terracon, San Antonio, TX)*
- Stewart G. Osgood, PE *(DOWL HKM, Anchorage, AK)*
- Laura R. Reinbold, PE *(TTL, Inc., Nashville, TN)* and
- Woodward L. Vogt, PE, D.GE *(Paradigm Consultants, Inc., Houston, TX)*.

Pile Dynamics People News


Frank Rausche


Garland Likins

Frank Rausche, PhD, D.GE, GE, M.ASCE, founder of **GRL Engineers, Inc.**, president for many years, and currently a principal and consultant to **Pile Dynamics, Inc.**, was conferred the title of Diplomate, Geotechnical Engineering by the Academy of Geo-Professionals.

The Academy of Geo-Professionals was founded in October 2008 by the members of the Geo-Institute to provide advanced certification to geotechnical engineers. An engineer becomes a Diplomate through achieving advanced experience, licensure, and education. Rausche's certification was conferred during a ceremony at the 2013 Geo-Congress in San Diego, CA in March.

Garland Likins, PE, president of Pile Dynamics, Inc. is the winner of this year's Robert B. Cummings Distinguished Leadership Award from the Cleveland Technical Societies Council (CTSC).

CTSC was founded in 1942 and represents 21 area professional societies and organizations that serve the scientific, technical, engineering, and education professions in Northeast Ohio. The Robert B. Cummings Distinguished Leadership Award is bestowed annually upon an individual who is or has been closely associated with engineering or technical work, and who has contributed greatly to the advancement and welfare of the engineering or technical professions. The individual must have achieved true and lasting prominence over a period of years, and must also have shown community spirit and leadership in worthy non-professional activities.

LOOK WHO'S A D.GE Kenneth R. Bell, Ph.D., D.GE, GE, F.ASCE

Dr. Bell received his BS degree in civil engineering at the University of Maryland at College Park, MD in 1974, his MS in 1976, and his PhD in civil engineering in 1983. While completing his PhD work, he joined Bechtel in Gaithersburg, MD as a staff geotechnical engineer in June 1980. His work there included an assignment as a resident field geotechnical engineer at the South Texas Nuclear Power Plant Project. After leaving Bechtel in 1987, he worked two years for a regional engineering firm heading their geotechnical and material testing division, followed by a year with Woodward-Clyde Consultants before returning to Bechtel in late 1990.

Since returning to Bechtel, he has risen through their Geotechnical & Hydraulic Engineering Services (G&HES) group and was appointed chief geotechnical engineer for Bechtel Power Corporation in 2006, and in 2011, was appointed the corporate manager of the G&HES group providing oversight to all G&HES activities worldwide for Bechtel's Global Business Units.

In 2011, Bell was recognized by Bechtel by being elected a Bechtel Fellow, an honor currently awarded to only 21 Bechtel engineers. He joined ASCE as a student chapter member and was elected a Diplomate, Geotechnical Engineer in 2011.

Bell has authored more than 20 publications that have appeared in many international conference proceedings and peer-reviewed journals. The majority of his committee work has been with the ASTM International and specifically Committee D18 – Committee on Soil and Rock. He was awarded the Woodland G. Shockley Memorial Award from ASTM for his years of distinguished services to Committee D18.

What was the most fun project you worked on?

Over the last 32 years, I've worked on many projects spanning six continents from conceptual engineering through final design and construction. I guess what I've always enjoyed, and found the most rewarding, was being a part of the onsite construction team of a project.

Where was most of your childhood spent? What was it like growing up there?

From the age of 3 until I left home for college at age 17, my childhood was spent in Rockville Centre, NY where I attended elementary, junior, and senior high school. It was a great place to grow up, good schools, 20-minute ride to the beach, and close enough to New York City to take advantage of the many wonderful things the city had to offer.

What is your message to professional engineers regarding specialty certification and what lead you to become a Diplomate in the Academy?

I believe currently there is only one or perhaps two states that have a designated PE registration in geotechnical engineering. As a result, it is not possible with a normal PE registration and having a PE after your name to be easily recognized as geotechnical engineer. Therefore, by becoming a D.GE, and having this additional designation it allows you to receive the recognition one deserves in being a geotechnical engineer. For me personally, when I first heard of the D.GE certification I really wasn't sure what to make of it. Then after taking the time to read and learn more about the program I realized the importance of becoming certified as a D.GE. This is a great avenue to show that I am a geotechnical engineer and proud to be recognized for obtaining a much higher level of competency within this specific area of civil engineering. Although I must add that it is very important that more and more geotechnical engineers obtain the D.GE so this designation is better known in the industry.

How do you feel about the state of civil engineering and the profession as it is today?

Certainly one of the biggest changes I've seen since the time I was an undergraduate is the diversity within the civil engineering population, and this has been an important change to the industry and is essential for the civil engineering profession to flourish by attracting the best students regardless of their race or gender.

What do you feel are the biggest future challenges for the profession?

Professional liability. Yes, we all need to make sure that the products and designs we complete are always of the highest standards and will pass the test of time. But we shouldn't always be working in fear of being sued for making a mistake. I've often reviewed geotechnical design reports that the disclaimer section of the report is longer than the rest of the entire report, and essentially make the recommendations meaningless. I know this very much over-simplifies the issue, but we need to find a way that we can work and be innovative and risk-adverse at the same time without the fear of liability.

Read the complete article at *www.geoprofessionals.org.*

SCHNABEL

GeoCurmudgeon by John P. Bachner

Say It Isn't Sew

Professionals are society's best. We expect them to be intelligent, well educated, and technically capable. We also expect them to communicate well. (How would you respond to an oncologist who tells you, "I think you got some of that there cancer.")

Although geoprofessionals – the world's most important professionals – write more than any others, they are not the best writers. Or speakers. A principal failing: Their penchant for language inflation; e.g., they "utilize" instead of "use"; "provide with" instead of "give"; offer "further" information, not "more"; use "with respect to" and "regarding" instead of "about"; and prefer "at this point in time" to "now." And let's not forget the however-heads who believe something's wrong with "but."

As off-putting as word inflation may be, the biggest professional image-crusher is using words and phrases that are just plain wrong. I try to ignore the violations because I'm a pedant who employs judicious silence to keep friends. Now, to help you improve your image, I break my vow of silence.

We do not "hone in" on things. We "home in," explaining why honing pigeons are mythical.

People who offer foolish insights have another "think" [not "thing"] coming.

It's "right of first refusal" not "first right of refusal."

Eliminate the "s" of "towards," unless you live in the UK. And in both nations, it's "anyway," not "anyways."

While the don't-end-a-sentence-with-a-preposition rule is no longer valid (Churchill called it "nonsense up with which I will not put"), "Where are you at?" is an unprofessional question; substitute "Where are you?" Likewise, it's "these," not "these ones."

Most Unique?

"Iterate" means to repeat. To "reiterate" is to say something at least three times.

"Irregardless" is wrong; "regardless" is right.

"I could care less" is a confusing corruption of "I couldn't care less." Assuming you care.

Do not say or write "is comprised of." The phrase was devised by those who don't know what the word means. Why say "the USA is comprised of 50 states" when "the USA comprises 50 states" says it more intelligently and with fewer words?

When you give people a status update, you "apprise" [not "appraise"] them of the situation. And when generalizing what happened, you could say "For all intents and purposes," not "For all intensive purposes."

"Unique" – which means "one of a kind" – cannot be used as a comparative; it's an absolute, which is why "very unique" or "most unique" is incorrect. "Perfect" and "ideal" are absolutes, too; nothing can be "more perfect" or "more ideal" than anything else. Geometrically, "square" and "circular" also are absolutes, meaning that you can never get rid of a car that's parked in your circular driveway.

"Full" is also an absolute; nothing can be "fuller" than "full" because, when something's full, there's no more room for anything else. This explains why "fullest extent of the law" is so silly; and why any firm claiming to offer "full-service" is guilty of false advertising.

Stop using "different" when it's useless. Consider "Ten different strategies are available to deal with employee turnover." Of course the ten strategies are different from one another. If they weren't, there'd be fewer than ten. "Actually" is usually useless, too, as in "We actually got here at 5PM." "Received" is useless when you write something like "We are responding to the received RFP." If you didn't receive it, how could you respond?

Don't know if an adjective or adverb is useless? Chances are, if its opposite is absurd, the modifier is unneeded; e.g., skip the "thorough" from "We performed a thorough review," given that "We performed a slipshod review" sounds absurd. So, too, do "Our lines were busy yesterday. An operator will be with you soon." and "liberal compliance." ("Strict compliance" is another silly legalism; either you comply or you don't.)

Stop using "a number of." It's a confusion-creator, because it means who-knows-what to you and something different to whoever else reads it.

When writing, note that you:

- "toe [not "tow"] the line";
- have your curiosity "piqued" [not "peaked"];
- cite [not "site"] "a case in point" [vs. "a case and point"];
- have an assistant "at your beck and call" [not "at your beckon call"];
- "whet" [not "wet"] your appetite;
- declare a point is "moot" [not "mute"]; and
- report to a firm's "principal" (who may have "principles" but isn't one).

My final thought: "Having said that" is not a transitional phrase; it's a verbal road apple.

AUTHOR

John P. Bachner is the executive vice president of ASFE/The Geoprofessional Business Association (GBA), a not-for-profit association of geoprofessional firms; i.e., firms that provide geotechnical, geologic, environmental, construction-materials engineering and testing (CoMET), and related professional services (en.wikipedia.org/wiki/Geoprofessions). GBA develops programs, services, and materials to help its members and their clients confront risk and optimize performance. Contact *john@asfe.org*

CORE BITS

Check these sources for breaking G-I news:

- The G-I webpage at *www.asce.org/geo*
- The G-I April eUpdate sent on April 8, 2013.
- Twitter at *http://twitter.com/GeoInstitute*
- Facebook at *www.facebook.com/GeoInstitute*
- G-I LinkedIn at *http://www.linkedin.com*

According to LinkedIn's Geotechnical Engineering Experts: Here's What's Been on People's Minds

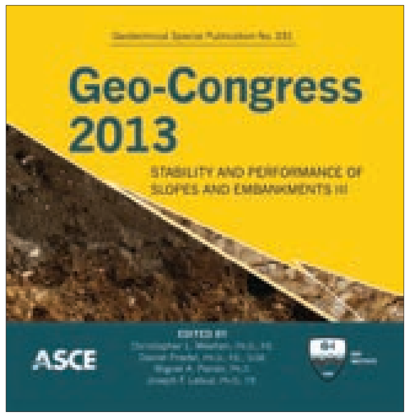
- Landslide stops production at Bingham Canyon Mine.
- Raft foundation on swelling clay; ground improvement methods.
- What are the systems for displacement monitoring on mines in your area?
- Information about triaxial test mechanism (UU, CU, CD), interpretation and parameters of soils.
- Jet grouting as sealing method with diaphragm walls.
- Limitation on anchor length.
- Is it better to measure employee performance by time or by tasks?

G-I NEWS

2013 Geo-Congress Photos and Proceedings

Thank you to the more than 1,030 people who traveled to San Diego to experience the excitement of the 2013 Geo-Congress. From award-winning lectures by industry legends, dozens of technical sessions to help solve slope stability problems, challenging student events, book signings, the G-I Organizational Member Career Fair and reception, D.GE ceremony, and so much more, every day provided attendees true value for their dollars.

Enjoy the 2013 Geo-Congress experience at *http://visualnatureimages.photoshelter.com/gallery-collection/2013-GEO-Congress/C00006x.YYamectY.* If prompted, enter the password: GEO2013



Couldn't attend the Congress? You can order the complete proceedings on CD-ROM. It contains 229 peer-reviewed technical papers and case studies focusing on the stability, performance, and rehabilitation of slopes, embankments, and dams. To order: *www.asce.org/BookSearch.aspx?id=2147487208* and enter 41278 in the Stock No. box.

A Contested Election for a New G-I Governor

Beginning in June, the G-I will conduct a contested election for the one open governor position on the G-I Board. The official election dates will be announced following the end of the petitions process which runs April 8-May 23, 2013. The petitions process is the period during which additional candidates can be added to the ballot. As this issue of *Geo-Strata* went to press, there were two candidates on the ballot for the open position. To provide all candidates with an equal opportunity for publicity, the candidate names will not be announced until after the petitions process ends. Check the G-I website at *www.asce.org/geo* for candidate information in late May.

Wanted: Ethics Articles for *Geo-Strata* Magazine

The *Geo-Strata* Editorial Board is on the lookout for ideas about geo-ethical topics to include in upcoming issues of the magazine. If you have an idea or two, or would like the opportunity to write a brief article or case history regarding an ethics topic, send your ideas and/or article to *Geo-Strata* at *geo-strata@asce.org*.

2013 ASCE Report Card App

The 2013 *Report Card for America's Infrastructure* is now available anytime, anywhere as a free digital interactive "app" optimized for smartphones and tablets. With the swipe or tap of a finger, you can easily access information in each of the 16 Report Card categories, share the findings with others, bookmark favorite sections for easier access, and print any or all of the report.

The app includes the Report Card in its entirety, complete with category summaries for each grade, tables and charts, more than 100 infrastructure projects "success stories," an executive summary, and an introduction by ASCE President Gregory E. DiLoreto, PE, PLS., D.WRE, F.ASCE.

The app goes even further with videos, interactive graphics, and news feeds that will display real-time updated information about issues brought up in the report.

The free app is available for the iPhone, iPad, and all Android devices at the Apple App and Google Play stores (search "American Society of Civil Engineers"), and via the official Report Card website at *www.infrastructurereportcard.org/*

Cross Country Lecture Series

Thomas D. O'Rourke

The G-I recently announced **Thomas D. O'Rourke, PhD, PE, Hon.D.GE, GE,** as the 2013-2014 Cross Country Lecturer. The lucky host sites will be announced on May 31, 2013. Once the host sites are selected, Dr. O'Rourke will provide each group with a choice of one or more lecture topics. Each group will then jointly decide with the lecturer the final topic to be presented at its location.

Professor O'Rourke is the Thomas R. Briggs Professor of Engineering in the School of Civil and Environmental Engineering at Cornell University. His research interests cover geotechnical engineering, earthquake engineering, underground construction technologies, engineering for large and geographically distributed systems, and geographic information technologies and database management.

He is a member of the U.S. National Academy of Engineering and a Fellow of the American Association for the Advancement of Science. He served as president of the Earthquake Engineering Research Institute and is a member of the U.S. National Science Foundation Engineering Advisory Committee and the National Academies Committee for New Orleans Regional Hurricane Protection Projects. He authored or co-authored more than 300 technical publications and has won numerous awards including ASCE's Collingwood and Huber Research Prize for his studies of soil and rock mechanics applied to underground works and excavation technologies; the C. Martin Duke Award for his contributions to lifeline earthquake engineering; and the Stephen D. Bechtel Pipeline Engineering Award for his contributions to pipeline engineering.

Carlos Santamarina Selected as 2014 Terzaghi Lecturer

J. Carlos Santamarina

The G-I Board of Governors approved the nomination of J. Carlos Santamarina, PE, as the 2014 Terzaghi Lecturer. Santamarina is a professor of civil and environmental engineering at the Georgia Institute of Technology in Atlanta, GA where he holds the Goizueta Foundation Faculty Chair. He graduated from Universidad Nacional de Cordoba (Ingeniero Civil) and completed graduate studies at the University of Maryland (MSc) and Purdue University (PhD).

He taught at NYU-Polytechnic University and the University of Waterloo in Canada. He has authored two books and more than 200 publications that summarize salient concepts and research results.

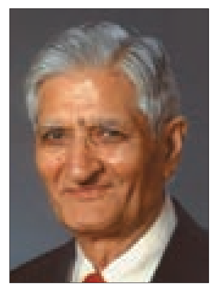
Santamarina is a frequent keynote speaker at international events; a member of the Argentinean National Academies (Sciences and Engineering); and a member of the standing Committee on Geological and Geotechnical Engineering at the USA National Academies. He is a recipient of numerous prestigious awards including the ASTM Hogentogler Award.

His lecture is planned for the 2014 Geo-Congress in Atlanta, GA.

Improve Your Leadership Skills

ASCE, as a partner in the Emerging Leaders Alliance (ELA), will sponsor eight members to attend the 2013 ELA leadership conference. This conference provides rising leaders with tools to more effectively lead their organizations and serve the professional community. The program also allows you to network with engineers and scientists from other disciplines and earn PDHs. For information: *www.emergingleadersalliance.org* or contact *professional@asce.org*. The workshop runs November 11-13, 2013 at the Hyatt Regency Reston in Reston, VA. ASCE members must apply for sponsorship online by July 1, 2013 at *www.asce.org/Leadership-Resources/Leadership-Training/Emerging-Leaders-Alliance-Conference-Sponsorship-Application/*

G-I Assumes Ownership of Case Histories Conference



Shamsher Prakash

The Geo-Institute has reached an agreement with the Missouri University of Science and Technology to become the new owner and manager of the International Conference on Case Histories in Geotechnical Engineering (ICCHGE). The G-I assumed ownership following the Seventh International Conference held in Wheeling, IL, April 29-May 4.

"The G-I hopes to continue and expand the clear vision set for the Conference by Shamsher Prakash during the past four decades and thanks him for his strong leadership in organizing such a reputable event," stated G-I Director Rob Schweinfurth.

Shamsher Prakash, PhD, PE, D.GE, Dist.M.ASCE, has dedicated his career to advancing the profession of civil engineering and mentoring tomorrow's engineers. ASCE recently honored him by awarding the Distinguished Membership of the Society – the highest recognition the Society confers on its members, second only to the title of ASCE president. Since 1852, only 615 individuals have received this ASCE recognition.

CORE BITS

The International Foundations Congress & Equipment Exposition (IFCEE 2015)

March 18-21, 2015
The JW Marriott San Antonio Hill Country Resort & Spa
San Antonio, TX, USA

The G-I, as it did in 2009, will join with The International Association of Foundation Drilling (ADSC) and the Pile Driving Contractors Association (PDCA) to present The 2015 International Foundation Congress & Equipment Expo 2 (IFCEE 2015). The Deep Foundations Institute (DFI) has also joined the partnership for the Congress.

IFCEE is the largest foundation drilling expo in the world. More than 2,000 industry leaders from 40 countries will have a first look at the transformation of the geo-industry and find out how technology, best practices, and emerging trends are impacting the deep foundations business.

Responses to the 2015 IFCEE Call for Proposals are due June 14, 2013 to *IFCEE2015@adsc-iafd.com*

PROFESSIONAL DEVELOPMENT CORNER

ASCE/G-I Co-Sponsored Online Webinars

Designing Water Balance Covers (ET Covers) for Landfills and Waste Containment
Tuesday, June 18, 2013
11:30 am-1:00 pm

LRFD for Geotechnical Engineering Features: Best Practices in Subsurface Investigations and Soil and Rock Testing
Thursday, June 27, 2013
11:30 am-1:00 pm

Integrity Assessment of Deep Foundations: Principles and Limitations
Wednesday, July 10, 2013
11:30 am-1:00 pm

Energy Piles: Background and Geotechnical Engineering Concepts
Thursday, July 18, 2013
11:30 am-1:00 pm

For more webinar information: *www.asce.org/geo/Continuing Education/Webinars/Webinars*

ASCE/G-I Co-Sponsored Seminars

Instrumentation and Monitoring Boot Camp: Planning, Execution, and Measurement Uncertainty for Structural and Geotechnical Construction Projects
June 27-28, 2013
Crowne Plaza Memphis Downtown
Memphis, TN

Deep Foundations: Design, Construction, and Quality Control
August 15-16, 2013
Radisson Hotel Manchester Downtown
Manchester, NH

Design of Foundations for Dynamic Loads
September 11-13, 2013
The Westgate Hotel San Diego
San Diego, CA

Introduction to Dam and Levee Safety: Evaluation and Rehabilitation
September 19-20, 2013
Hamilton Crowne Plaza
Washington, DC

For more seminar /information: *www.asce.org/geo/Continuing-Education/Seminars/Seminars/*

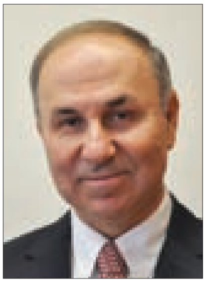
MEMBERS

Ladd Wins OPAL Education Award

Charles C. Ladd, III, ScD, PE, D.GE., NAE, Dist.M.ASCE, a professor emeritus in the Civil and Environmental Engineering Department at the Massachusetts Institute of Technology (MIT) and a consulting geotechnical engineer, was honored for his numerous contributions in education at ASCE's March 21, 2013 OPAL Awards ceremony. (See "A Few Words from the 2013 OPAL Lifetime Education Award Winner" on page 61 in this issue.)

Established in 1999, the prestigious OPAL awards recognize and honor outstanding civil engineering leaders whose lifetime accomplishments and achievements have made significant differences in one of five categories: Construction, Design, Education, Government, and Management. For information about these winners visit *ASCE News*.

Edil, Vanmarcke, and Zoino Elected Distinguished Members


Tuncer B. Edil


Erik H. Vanmarcke


William S. Zoino

Tuncer Edil, Erik H. Vanmarcke, and William S. Zoino were recently elected by the ASCE's Board of Direction as Distinguished Members. The Distinguished Member status is the highest honor conferred by the Society with the exception of ASCE president. 638 Distinguished Members now hold this designation. The 2013 class will be inducted at ASCE's 143rd Annual Civil Engineering Conference in Charlotte, NC, Oct. 9-12, 2013.

Tuncer B. Edil, PhD, PE, D.GE., Dist.M.ASCE, is honored for his significant service to the profession and seminal contributions to geotechnical engineering pertaining to compressibility and settlement of organic soils, soft ground engineering, environmental geotechnics, and sustainable geotechnical construction.

Professor in the Department of Civil and Environmental Engineering at the University of Wisconsin-Madison since 1980, Edil has achieved acknowledged eminence in the field of offshore geotechnical engineering. A pioneering leader and researcher in the areas of peats, organic soils, and soft ground engineering, his research has been published in more than 250 publications. Edil earned his bachelor's and master's degree in civil engineering from Robert College, and his doctoral degree in civil engineering from Northwestern University and is a member of Sigma Xi and Chi Epsilon.

His service to the profession and ASCE is significant. He served as president of ASCE's Wisconsin Section in 1997, founding chair of the Geo-Institute International Activities Council in 2000, and editor of ASCE's *Journal of Geotechnical Engineering* in 1984. He is currently editor-in-chief of *Geotechnical and Geological Engineering*. He also is the founding chair of the American Society for Testing and Materials' Subcommittee D18.14 on Geotechnics of Sustainable Construction.

Edil's accomplishments have been recognized by more than 20 national and local awards— most prominent is ASCE's 2013 Karl Terzaghi Award. Among his other notable honors, Edil was also awarded the Distinguished Researcher Award from the U.S. Universities Council on Geotechnical Education and Research.

Erik H. Vanmarcke, PhD, Dist.M.ASCE, is honored for his pioneering contributions to probability and reliability applied to geotechnical and earthquake engineering, for contributions to engineering education, and his service to the profession.

Vanmarcke has been a professor in the Department of Civil and Environmental Engineering at Princeton University since 1999. He pioneered the application of probabilistic methods in geotechnical practice, and his work in this area forms the basis for most probabilistic methods used in geotechnical practice today. His early work on earthquake risk analysis is now applied in the development of performance-based earthquake engineering (PBEE). His book, *Random Fields: Analysis and Synthesis,* remains the definitive work on the subject and is used exclusively by earthquake engineering researchers and practitioners, as well as seismologists and geophysicists.

He graduated with a bachelor's degree from Katholieke Universiteit Leuven, a master's degree from the University of Delaware, and a PhD from the Massachusetts Institute of Technology. He has been involved in many ASCE committees, including chair of the Risk and Vulnerability Committee, Natural Disaster Reduction Council (1998-2003); chair and member of the Geo-Institute's Committee on Risk Assessment and Management (1997-2001); and chair of the Multi-Hazard Risk Task Committee, ASCE Technical Council on Lifeline Earthquake Engineering (1994-99).

He has received numerous awards in recognition including ASCE's Raymond C. Reese Research Prize in1975 and Walter L. Huber Civil Engineering Research Prize in 1984. Vanmarcke also was honored with foreign membership in the Royal Academy of Arts and Sciences of Belgium.

William S. Zoino, PE, Dist.M.ASCE, is honored for his lasting contributions to the civil engineering profession demonstrated by co-founding Goldberg Zoino and Associates (GZA), his encouragement of countless young people to pursue civil engineering, and his mentoring of many throughout their careers.

Now retired, Zoino was responsible for helping to establish the field of geotechnical consulting in the Boston, MA area in the 1960s. He served GZA from 1964 to 1994 as treasurer, on the Board of Directors, chairman of the Pension Committee, manager of Risk Management, president of the GZA New York Corporation, developer of project management training, and liaison to several GZA offices. Thanks to Zoino, GZA has grown to 27 offices in 12 states with services that include environmental sciences, drilling services, construction drilling, and an environmental testing laboratory.

He specialized in dam engineering, having worked on projects throughout the U.S. and overseas. Part of his legacy is an enduring dam practice at GZA, which is one of the strongest in the northeast. He also served as vice president of ASCE and president of the Boston Society of Civil Engineers, in addition to president of the Association of Soil and Foundation Engineers.

Boland and Kan Named ENGEO Associates

Jonathan Boland

Janet Kan

Jonathan Boland, GE, M.ASCE, since joining ENGEO in 2005, has collaborated with developers, land owners, and public agencies providing geotechnical consulting, project management, and quality assurance for residential communities, hospitals, schools, water storage facilities, levees, and other public works projects throughout California and Nevada.

"My colleagues are top-notch professionals and I'm so pleased to be a part of this remarkable team," says Boland. He leads a group in the Rocklin,

Cal Poly Pomona Team Watches Their Victory

CA office. Originally from San Diego, CA, Boland received his BS in civil engineering from Cal Poly San Luis Obispo and an MS in civil engineering from UC Davis. He is a member of ASCE, PAGES, and participates in ACEC functions and events.

Janet Kan, PE, GE, CEG, LEED AP, M.ASCE, was born in Hong Kong, studied in Canada, worked in Seattle, and then moved to California to obtain her MS at UC Berkeley in 2003. She joined ENGEO and is a registered geotechnical engineer and a certified engineering geologist. She has managed large-scale public projects such as BART to San Jose (SVRT), High Speed Rail, and the new San Mateo County Jail. She also is the project manager for various private residential, mixed use, and master-planned developments.

Kan is an active ASCE member and is currently the San Jose Branch president. She is committed to promoting civil engineering to the public and in advancing the quality and practice of civil engineering in the counties of Santa Clara, San Benito, Monterey, and Santa Cruz.

She will transfer from ENGEO's San Jose office to lead a group in the San Ramon office in Summer 2013. "It is a great honor to work every day with my colleagues and clients, whom I deeply respect," says Kan.

STUDENT NEWS

Cal Poly Pomona Takes 2013 GeoWall First Place

The Cal Poly Pomona GeoWall team placed first out of 18 schools in the technical design paper for the National GeoWall Competition. This year's GeoWall competition was held at the annual Geo-Institute's 2013 Geo-Congress in San Diego. They also placed first in the national competition out of the 16 teams invited to participate. This GeoWall team has placed first in the national competition for two years in a row.

G-I CHAPTER NEWS

2012 Outstanding Chapter Award

The new G-I Outstanding Chapter Award will be awarded annually by the Geo-Institute in recognition of a Chapter's accomplishments towards its members and the community. The winning Chapter will be provided the opportunity to select a presenter from the G-I Speakers Bureau to present at its local meeting during the following year (speaker expenses will be covered by ASCE). In addition, the Chapter's accomplishments will be highlighted in an article in *Geo-Strata*. For information contact *jcanning@asce.org*

Alabama Chapter…A Cooperating Organization for DFI 38th Annual

The Geo-Institute Alabama Chapter is a cooperating organization for The Deep Foundations Institute's (DFI) 38th Annual Conference on Deep Foundations, September 25-28, 2013 at the JW Marriott Desert Ridge Resort in Phoenix, AZ.

The conference will include technical presentations about a broad range of topics including: seismic design considerations in deep foundations, telecommunications and energy, design optimization and value engineering, implications of LRFD design procedures, and performance in special soil/rock conditions and earth retaining structures. Case histories about lessons learned and solutions for challenging projects also will be covered.

The conference includes an exhibition hall with approximately 100 industry organizations, a student program featuring a driven pile testing competition, and a golf outing to benefit the DFI Educational Trust.

DFI's principal awards — the Distinguished Service Award, Outstanding Project Award (OPA) and C. William Bermingham Innovation Award with its $5,000 prize — will be presented during the Annual Banquet. The winners of the Young Professors Paper Competition and the Student Paper Competition will be recognized by the DFI Educational Trust. For information: *www.deepfoundations2013.org*

San Francisco G-I Chapter Hosted Lecture Series

The San Francisco Geo-Institute Chapter was proud to sponsor its 31st year of hosting great lectures for audiences in the geo-engineering community. In addition to this year's May 3, 2013 lectures on the UC Berkeley campus, the event included a social and poster session and a dinner that celebrated the geo-engineering profession in the San Francisco Bay Area.

G-I member, **Peter K. Robertson, PhD, A.M.ASCE,** Technical/Management Advisor, Gregg Drilling and Testing, Inc, Signal Hill, CA was one of the three lecturers who presented "Interpretation of In Situ Tests – Some Insights," which focused on some of the major in-situ tests used in practice (SPT, CPT, and DMT). Robertson also discussed the use of in situ methods to delineate project zones/regions that warrant additional and more detailed in situ testing as well as sampling and laboratory evaluation.

ISSMGE NEWS

Jean-Louis Briaud

ISSMGE President, **Jean-Louis Briaud, PhD, PE, D.GE, F.ASCE,** outlined two important messages in his 1,275 Day Progress Report.

The new e-Lexicon (Electronic Lexicon or e-Lexicon of ISSMGE) was launched in March on the ISSMGE website at *www.issmge.org*. The e-Lexicon includes a web-based application that allows users to query the database and find the translation of a total of 1,590 geotechnical terms in 12 languages. ISSMGE member countries interested in translating the terms into an additional language for inclusion in the e-Lexicon, contact the Chair of the IDC, Dimitrios Zekkos at *zekkos@geoengineer.org*

Readers are encouraged to publish a case history in the *International Journal of Geo-engineering Case Histories* (IJGCH) to give to those less fortunate. It can be your intellectual gift to your fellow geotechnical engineers in developing countries. Since the IJGCH is a free online journal, it is accessible regardless of income and in that respect publishing case histories in IJGCH is an intellectual gift.

ALLIED ORGANIZATIONS NEWS

AGI Presents "Faces of Earth" Videos

AGI, the international organizer of Earth Science Week, has released its award-winning "Faces of Earth" series on YouTube in full high definition to promote wider use in K-12 classrooms. From the cacophony that originated Earth 4.6 billion years ago to the changes that shape it today, "Faces of Earth" explores the many facets of planet Earth.

"Building the Planet," episode one in the four-part series, travels back in time and strips away layers of Earth to witness the explosion that formed the planet. Earthquakes rumble, volcanoes explode, and lands transform as viewers explore the science behind plate tectonics in "Shaping the Planet," the second episode. In "Assembling America," the third installment, viewers explore how time and natural forces have shaped the U.S. Finally, in "A Human World," viewers learn how Earth has shaped human evolution and how humans, in turn, are shaping the world.

Viewers will experience spectacular imagery, exclusive interviews, and captivating commentary from distinguished geoscientists online at *www.youtube.com/user/AmericanGeosciences*

CORE BITS

Well-Healed Faults Produce High-Frequency Earthquake Waves

Much like our voices create sound waves with a variety of low and high pitches, or frequencies, earthquakes produce seismic waves over a broad spectrum. The seismic waves' frequencies determine, in part, how far they travel and how damaging they are to human-made structures. However, the inaccessibility of fault zones means that very little is known about why and how earthquakes produce different frequencies. With the help of a new tabletop model, scientists have now identified how a process known as fault healing can shape seismic waves and potentially alter their frequencies. Read more at *www.agiweb.org/news/EARTHMar_PR3_13.pdf*

ASFE is Changing Its Name to GBA

ASFE is changing its name for the seventh time by dropping "ASFE." Is John Bachner sad to see "ASFE" go (since he's been working with it since 1973)? "Sure I am. But I am really a lot happier about welcoming GBA. The transition will take a while and, in the interim, we will be ASFE/The Geoprofessional Business Association (GBA)." Find out why at *www.asfe.org*

GBA Presents Proofing 101 Webinar

The webinar "Proofing 101" will be presented by **John P. Bachner,** president and CEO, Bachner Communications, on June 5 at 12-1:00 pm Eastern time.

The webinar, qualifying for 1 Professional Development Hour (PDH), is $95 for each GBA-Member Firm connection, no matter how many people participate. Non-members will receive a special $250 per connection rate to help them learn more about GBA and its efforts to enhance the quality of services geo-professionals provide. For information: *www.asfe.org/index.cfm?cdid=13337&pid=10466*

ARMA Symposium in June 2013

The American Rock Mechanics Association (ARMA) hosts its 47th US Rock Mechanics/Geomechanics Symposium in San Francisco, CA June 23-26, 2013. The focus of the symposium is on fundamental, practical, and educational issues facing the profession. The symposium will be held at the Westin San Francisco Market Street in the heart of the city. For information: *www.armasymposium.org/index.html*

DFI Educational Trust

The Deep Foundations Institute (DFI) Educational Trust, the charitable arm of DFI, announced a new At-Large Scholarship program for the 2013-2014 academic year.

The Trust will award three $2,000 At-Large Scholarships, which can be used for funding, tuition, fees, books, and/or living expenses. Applicants must be enrolled full time in a U.S. college or university; be pursuing a graduate or undergraduate degree in an accredited civil, geotechnical engineering, or related deep foundations curriculum; and have a minimum 3.0 GPA.

"DFI recognizes that the future of our industry depends on our ability to encourage and engage promising young engineers to consider careers in the deep foundation construction field," says David Coleman, chair, DFI Educational Trust.

The deadline for applications is June 30, 2013. Awards will be announced no later than July 31, 2013. For information: *www.trust.dfi.org*

GMA Lobby Day, September 12-13

Lobby Day takes place in Washington, D.C., with a day of scheduled Congressional visits. The "Day" is sponsored by the Geosynthetic Materials Association (GMA), a division of the Industrial Fabrics Association International (IFAI). For information: *www.ifai.com/events/item/346*

New GSI Webinars

The Geosynthetic Institute (GSI) will begin hosting monthly webinars on the second Wednesday of each month beginning on June 12, 2013. Among the offerings are:

MSE Wall Failure Data Base of 171 Cases – June 12, 2013

Geosynthetics in Hydraulic Applications – November 13, 2013

Landfill Bioreactors – March 12, 2014

Robert Koerner, PE, D.GE, NAE, Dist.M.ASCE, director emeritus of GSI, presents each 90-minute webinar which runs from 11:30 am-1:00 pm Eastern time and carries 1.5 Professional Development Hours (PDHs). For information: *www.geosynetheic-institute.org/webinars.htm*

Sueoka is New Japanese Geotechnical Society President

Toru Sueoka is the newly elected president of the Japanese Geotechnical Society. He recently outlined his three major areas of focus: compilation of surveys on geotechnical aspects of the disaster caused by the Great East Japan Earthquake, and implementation of recommendations, studies, and overseas publication; surveying of historical and cultural geotechnical heritage, succession of technical tradition, and public relations; and promotion of branch technical meetings attractive to a varied audience. Read his complete letter at *www.jiban.or.jp/e/message-from-the-president*

INDUSTRY NEWS

Metro Tunneling Reaches Breakthrough in Chinese City

The New Civil Engineer (NCE) website reports that work to build the first two of five planned metro lines in the Chinese city of Wuxi has reached a milestone with 16 km of tunnels completed by a fleet of eight tunnel boring machines (TBMs) in just 20 months.

The first of the eight 6.3-m-diameter earth pressure balance machines was launched in July 2011 by Wuxi Metro Group and the fleet has achieved tunneling rates of up to 33 m a day and 164 m a week to complete the new tunnels despite challenging ground conditions.

The tunnels are being constructed with small overburdens in some areas and close to existing building foundations. Ground cover on Metro Line 1 was as little as 7 m in some places and the tunnel also passed just 3.7 m below piled foundations, so ground freezing was used to minimize ground movements.

Wuxi's Metro Lines 1 and 2, with a total length of 58.5 km, are expected to start operation by the end of 2014. Line 1 crosses the city from north to south, and Line 2 from east to west.

The city, which has a population of 4 million, is planning to increase the network with three further metro lines.

National Drilling Association 2013 Convention

More than 100 drillers, drilling managers, drilling company owners. and manufacturers are expected to attend the 2013 National Drilling Association Annual Convention, October 17-19, 2013 at the Wyndham Lake Buena Vista Resort in Lake Buena Vista, FL. The convention will feature presentations offering Professional Development Hours and allotted time for networking with manufacturers and suppliers.

Presentation topics include Phosphate Industries and Sinkhole Related Projects, Small Business, by Larry Madrid, P.E, Madrid Engineering; Geophysics Relationship with Drilling, by Mike Wightman, president of Geoview; Business and Asset Values, Appraisals and Related Topics, by Michael A. Salvadore Jr., SPA, MPPA, president, Salvadore Auctions, Inc.; Drilling and Production Thread Compounds, presented by Joe Large, Jet-Lube Inc.; Geotechnical Uncertainty - Magnifying Profits in Foundations Design, presented by W. Ray Wood, executive VP of Fugro Consultants, Atlantic Division; The Critical Basics that Every Manager/Supervisor Must Understand, Embrace and Implement, by Tim Connor, management and leadership speaker and trainer; New Revenue Streams for Drillers, presented by Bill Dahl, Emagineered Solutions; Safety, presented by Rick Hutchings, CME; Hurricane Dam Project, by Chuck Valenta, Terracon; plus more.

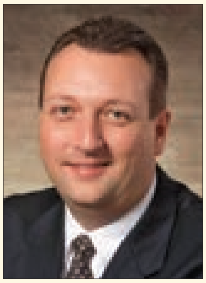
For information: *www.nda4u.com*

To submit information for *Geo-Strata* magazine, send your brief news about your recent honors, awards, special appointments, promotions, etc. to *geo-strata@asce.org*. High resolution photos must be sent as separate files. Refer to production guidelines on the Geo-Institute website at *www.asce.org/geo/*. Sales-oriented copy should be directed to Dianne Vance, Director of Advertising at *dvance@asce.org*.

Organizational Member News Correction

An incorrect photo of Thomas G. Zink ran on page 66 of the March.April Geo-Strata issue. Included below is the the correct photo with a reprint of the news item.

Gannett Fleming Names Zink Stockholder



Thomas G. Zink

Thomas G. Zink, P.E., M.ASCE, was named a stockholder of Gannett Fleming. Based in the firm's Mt. Laurel, N.J., office, Zink has 19 years of experience with the company. He is the bridge practice manager for the firm's Northeast Region, in addition to serving as the deputy director of transportation for its New Jersey operations. Zink provides direct oversight of the Bridge, Highway, and Geotechnical Design Units in the Mt. Laurel office.

Zink served as Gannett Fleming's lead structural engineer for the design and engineering of the reconstruction of New Jersey Route 18 in New Brunswick, N.J. This award-winning project transformed a congested, failing roadway with more than 85,000 motorists daily to an efficient regional thoroughfare. At its groundbreaking, this complex $215 million project was the largest ever undertaken by the New Jersey Department of Transportation.

He also served as Gannett Fleming's lead structural engineer for NJ Transit's Hudson-Bergen Light Rail 8th Street Extension project, which lengthened the reach of the system by one mile. The $100 million design-build project in Hudson County, N.J., carries 40,000 passengers each day, providing mobility in the corridor and supplying intermodal connections into New York City, as well as to other NJ TRANSIT bus and rail services in an area not served by passenger rail in more than 30 years.

Zink holds bachelor of science degrees in architectural engineering and civil engineering from Drexel University and is a registered professional engineer in NJ and PA.

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