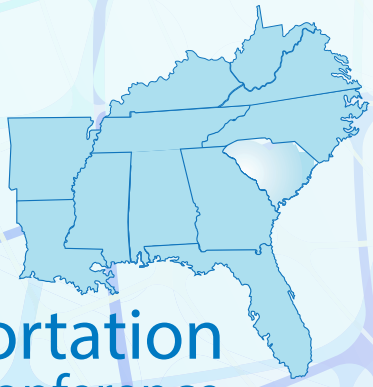
STGEC 2015



Southeastern Transportation Geotechnical Engineering Conference

October 19-22, 2015

Greenville, South Carolina

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Dear 2015 STGEC Attendees:

On behalf of the South Carolina Department of Transportation, our Secretary of Transportation Christy Hall, and the SCDOT Commission, it is my pleasure to welcome you to Greenville, South Carolina, and to the annual Southeastern Transportation Geotechnical Engineering Conference. We are excited that you are here and hope that your visit to South Carolina will be educational and enjoyable.

Time sure has flown by since we were in Mobile, Alabama just a year ago. SCDOT began planning for this event after STGEC 2013 in Baton Rouge, Louisiana. I have been fortunate to have the full support of our Secretary and our Engineering leadership. Secretary Hall, Leland Colvin, Chief Engineer for Project Delivery, and Ladd Gibson, Director of Preconstruction, have offered their support and assistance throughout the planning process. During the last year, I have also worked closely with our Event Planning office, and appreciate the work Tina Kennedy and Meagan Hare have done to make this conference successful.

As you review your agenda, you will notice that there is one significant change from previous years. This year we are hosting the final banquet on Thursday during lunch instead of in the evening. The final banquet has routinely been a great event, and we believe it will be a fitting end to STGEC. But before we get to the banquet, we have 23 excellent presentations that we hope you will find informative. We have had tremendous support from our industry partners and will have a number of networking events for you during the week.

I sincerely hope you enjoy your stay in downtown Greenville. Please take an opportunity to explore the Main Street area just outside the hotel. I believe you will find downtown Greenville a refreshing place to visit.

Thank you again for attending STGEC 2015. It is our sincere pleasure to serve as your host and I look forward to spending time with each of you. If there is anything our staff or I can do to help you during the conference, please do not hesitate to let us know.

Welcome to Greenville and STGEC 2015!

Sincerely,

Nicholas E. Harman, MS, PE
2015 STGEC Conference Chair
Assistant Geotechnical Design Support Engineer
South Carolina Department of Transportation

Monday, Oct. 19th

11:00 - 4:00	Exhibitor Registration and Setup
1:00 - 7:00	Registration
6:00 - 9:00	"Monday Night Football" Icebreaker Reception, Exhibit Area *Brought to you by: S&ME, Inc. and PDCA*

Tuesday, Oct. 20th

7:00 - 8:00	Breakfast in Exhibit Area *Brought to you by: HDR Engineering, Inc.*
7:00 - 5:00	Registration
8:00 - 8:30	Opening Session, Regency Ballroom
	SESSION 1
8:30 - 9:30	Experiences with Micropile Foundation for Transportation Structures *Robert Thompson, Dan Brown and Associates* Drilled Shaft Skin Resistance Design in the Cooper Marl *William Gieser, F&ME*
9:30 - 10:00	Break in Exhibit Area *Brought to you by: Froehling & Robertson, Inc.*
	SESSION 2
10:00 - 11:30	Thermal Integrity Profiling to Assess Integrity in Drilled Shafts *Jim Zammataro, GRL Engineers/PDI* Thermal Integrity Profiling (TIP) of Drilled Shafts in South Carolina *David Schoen,S&ME* LA DOTD Drilled Shaft Design and Construction *James Melton, LADOTD*
11:30 - 1:00	Lunch in Exhibit Area *Brought to you by: S&ME, Inc.*

Tuesday, Oct. 20th

SESSION 3

1:00 - 2:30	A New Device for Measuring Drilled Shaft Bottom Sediment Thickness *John Ding, DMY, Inc.* Quality Control Methods for Drilled Shafts *Scott Webster, GRL Engineers/PDI* Decision Making and Communication in Geotechnical Engineering *Silas Nichols, FHWA*
2:30 - 3:00	Break in Exhibit Area *Brought to you by: HDR Engineering, Inc.*

SESSION 4

3:00 - 4:30	Seismic Site Coefficient Model from Simulations and Data in South Carolina *Shimelies Aboye, Tetra Tech-AAI* Applications of Geotechnical Centrifuge Modeling in Transportation System *Inthuorn Sasanakul, USC* US701 Bridge Replacements - A South Carolina Case Study in Nonlinear Seismic Response Analysis for the SCDOT *Ryan Keiper, Terracon*
5:00 - 7:00	Reception, Studio 220 @ NOMA *Hosted by: ADSC*

Wednesday, Oct. 21st

7:00 - 8:00	Breakfast in Exhibit Area *Brought to you by: Terracon Consultants, Inc.*
7:00 - 5:00	Registration

SESSION 5

8:00 - 9:30	Out of Sight, Out of Mind *Doug Chappell, Wurster Engineering* The I-85/385 Interchange Improvement Project *Randy Cannon, Civil Engineering Consulting Services, Inc.* Measurement While Drilling: Quite Possibly the Hot GeoGadget for Christmas 2015 *Ben Rivers, FHWA*

Wednesday, Oct. 21st

9:30 - 10:00	Break in Exhibit Area *Brought to you by: Froehling & Robertson, Inc.*
	SESSION 6
10:00 - 11:30	Assessment, Risk Management and Rehabilitation of Existing Structural Foundations *Jerry DiMaggio, Applied Research Associates*
	North Carolina I-73 Taxiway Bridge Geostructural Design: Micropile, Soil Nail Wall, Driven Pile, and Aircraft Approach Slab *Bon Lien, Amec Foster Wheeler Enviornment & Infrastructure, Inc.*
	Jenga Should Be A Team Game *Robert Jowers, TDOT*
11:30 - 1:00	Lunch in Exhibit Area *Brought to you by: Geosyntec & GeoStellar*
	SESSION 7
1:00 - 2:30	26th Street Emergency Retaining Wall Replacement, Baltimore, MD *Joe Cavey, Hayward Baker*
	Slope Stabilization and Scour Protection using Small Diameter Reticulated Microplies Along Minisceongo Creek *Nate Beard, GeoStablilzation International*
	Limit Equilibrium Analysis including Shear Capacity for Launched Soil Nails *Matt Birchmier, GeoStabilization International*
2:30 - 3:00	Break in Exhibit Area *Brought to you by: CDM Smith*
	SESSION 8
3:00 - 4:30	Instrumentation of Steel Sheet Pile Wall and Cut Slopes in Piedmont Residual Soils for Research *Michael Valiquette, NCDOT*
	Geotechnical Instrumentation and Performance Monitoring for Deep Excavations in Atlanta, GA *Alexi Neill, Geocomp Corporation*
	Vibration Monitoring *Chad Bruorton, S&ME*
	Vendor Teardown

Wednesday, Oct. 21st

4:30 - 5:00	Social Hour/Field Trip Briefing
5:00 - 6:00	Steering Committee Meeting, Think Tank @ NOMA
6:00 - 9:00	"A Taste of South Carolina" Reception at Old Cigar Warehouse *Brought to you by: F&ME*

Thursday, Oct. 22nd

7:00 - 8:00	Breakfast *Brought to you by: Thompson Engineering*
	SESSION 9
8:00 - 9:00	Accounting for System Performance Risks of Geotechnical Assets, Elements and Features *Scott Anderson, FHWA* An Introduction to Cellular Concrete and Advanced Engineering Foam Technology - Not Just a Product - Solutions *Nico Sutmoller, Aerix Industries*
9:00 - 9:30	Break *Brought to you by: Froehling & Robertson, Inc.*
	SESSION 10
9:30 - 11:00	Case History: Ground Improvement Test Section and Ground Improvements for Downtown Crossing Section 1, Louisville-Southern Indiana River Bridges Project *Mike Minton, Hayward Baker* Electrical Resistivity Imaging: Applications to Karst, Mining, and Slope Stability *Ted Dean, ATS International* The Use of Compaction Grouting for Ground Improvement; Karst and Beyond *Tom Szynakiewicz, GeoStabilization International*
11:00 - 1:00	Closing Banquet *Brought to you by: Acker Drill Company*
1:30 - 6:00	Field Trip to Denver Downs

EXHIBITORS

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American Drill Shaft Corporation ..... Tuesday Reception
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Geosyntec..... Wednesday Lunch
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TECHNICAL SESSION 1 - PRESENTATION 1

Experiences with Micropile Foundation for Transportation Structures

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ABSTRACT

Micropiles are becoming more common as a foundation for transportation structures as designers, contractors, and owners seek innovative and economical foundation systems. Both subsurface and surface conditions that are challenging for driven piles or drilled shafts are often well suited for micropiles. This presentation will illustrate the use of micropiles to solve difficult design and construction challenges at four bridge projects from around the U.S. with a variety of subsurface conditions.

TECHNICAL SESSION 1 - PRESENTATION 2

Drilled Shaft Skin Resistance Design in the Cooper Marl

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ABSTRACT

As drilled shafts have become a more popular foundation type in the Charleston, South Carolina area, there has been an ongoing goal of optimizing drilled shaft design while maintaining the structural integrity of the foundation. In the Charleston area, the primary bearing stratum for deep foundations is the Cooper Marl, a calcareous Oligocene formation. Research performed from 2002 to 2004 on load test data from drilled shafts constructed in the Cooper Marl and soil properties from three test sites for the Cooper River Bridge explored the relationship between the measured skin resistance and geotechnical properties. In the 15 years since the load tests for the Cooper River Bridge were performed, additional load tests have been performed throughout the Charleston area. Evaluation of this load test data, the Cooper River Bridge load test data, and earlier load test data allows better understanding of drilled shaft skin resistance in the Cooper Marl as well as the ability to use in-situ geotechnical properties to better predict axial capacity when a load test is not performed. Drilled shafts founded in the Cooper Marl are designed primarily for using skin resistance and LRFD design methodologies and load factors.

Using data from 27 drilled shaft load tests at 15 test sites in the Cooper Marl, the relationships between load test measured unit skin resistance and undrained shear strength, overburden pressure, and SPT N-values were evaluated. The distribution of unit skin resistance with elevation was also studied across the Cooper Marl. To derive a design unit skin resistance for use when a load test is not feasible, a statistical method evaluating the 97.5% confidence interval and the historical load test method were used. Finally, an empirical method was used to verify the LFRD resistance factor currently required for design in the Cooper Marl.

Based on the performed analyses, there is not a correlation between unit skin resistance and SPT N-values. Across the Cooper Marl, the unit skin resistance distribution was found to be constant with depth up to -80 ft-MSL. When evaluating the relationship between undrained shear strength and unit skin resistance, the αvalue was found to be 0.85, which is approximately 60% larger than the αvalues for clay presented in the literature. Based on the load test data, a design unit skin resistance of 3.2 ksf is supported using the historical load test method and a unit skin resistance of 2.88 ksf is supported using the 97.5% confidence interval method for typical sites. Additionally, the current resistance factor for LRFD design of 0.45 is data supported. Finally, although the Cooper Marl is treated as a homogeneous formation, there are known geologic discontinuities that should be accounted for during design.

TECHNICAL SESSION 2 - PRESENTATION 1

Thermal Integrity Profiling to Assess Integrity in Drilled Shafts

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ABSTRACT

Quality control of drilled shafts is greatly dependent upon the practices of the site personnel. In many applications it is difficult, or not possible to fully inspect the shaft prior to concreting, such as when the shaft is drilled under slurry. The inability to fully inspect the shaft prior to concreting can lead to poorly built shafts. There are now several tools available to help with the QA/QC inspection. This presentation will discuss a new non-destructive test method known as Thermal Integrity Profiling (TIP). The TIP method measures the elevated temperatures associated with the hydrating cement to determine shaft integrity. The TIP test method has the ability to assess integrity across 100% of the shaft cross section, including the areas outside the reinforcing cage as well as the ability to determine concentricity of the reinforcing cage within the borehole. The TIP method has several advantages over other currently available non-destructive test methods. The presentation will discuss the TIP theory, TIP advantages over other methods, and several TIP case histories will be presented.

TECHNICAL SESSION 2 - PRESENTATION 2

Thermal Integrity Profiling (TIP) of Drilled Shafts in South Carolina

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ABSTRACT

Thermal Integrity Profiling (TIP) is a relatively new non-destructive test (NDT) method which can be used to assess the integrity of cast-in-place deep foundations. TIP uses the heat of hydration to assess the quality of drilled shafts. The heat generated during curing is directly related to the cement content and shaft geometry and is therefore a useful indicator of anomalies. The temperature can be measured at a discreet time with an infrared probe slowly lowered into the shaft through a conduit, or continuously by dataloggers attached to thermal wires embedded within the concrete. The South Carolina Department of Transportation (SCDOT), as well as many other state DOTs, presently use Crosshole Sonic Logging (CSL) to help assess drilled shaft integrity. Several states are supplementing or replacing CSL with TIP, and SCDOT has participated in several TIP studies comparing CSL and TIP.

Three case studies are presented demonstrating TIP use in drilled shafts. The first study compares the results of 22 bridge shafts tested with CSL and TIP, using both an infrared probe and thermal wires, with a focus on the effects of bleed water on NDT results. The second study compares CSL and TIP on a test shaft instrumented with dual level O-Cells and manufactured defects consisting of bags of gravel to simulate segregated concrete. TIP was performed with thermal wires embedded within the concrete as well as wires placed within the water filled CSL tubes to determine the effectiveness of defining the known anomalies. The third project consisted of 300 drilled shafts constructed with five rigs over a six week period for a building foundation in which TIP was performed with embedded wires on 93 shafts. TIP identified anomalies, and those anomalies which were thought to impact shaft performance were confirmed regularly with coring.

TECHNICAL SESSION 2 - PRESENTATION 3

LA DOTD Drilled Shaft Design and Construction

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ABSTRACT

Drilled shaft design and construction practice for highway structures in Louisiana. Overview of current drilled shaft design methods and case studies of past projects illustrating design and construction issues encountered.

TECHNICAL SESSION 3 - PRESENTATION 1

A New Device for Measuring Drilled Shaft Bottom Sediment Thickness

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ABSTRACT

The sediment thickness at the bottom of a drilled shaft prior to the placement of concrete plays a significant role in the development of drilled shaft bearing capacity and settlement, especially for an end-bearing shaft where side shear resistance is limited and only end-bearing resistance is considered significant. Load tests have demonstrated that conscientious bottom cleaning is necessary to achieve suitable load transfer in end-bearing. Inspection and measurement of the bottom sediment thickness prior to concreting is challenging, expensive, and often time consuming for contractors and inspectors when direct visual inspection is not possible, as for shafts drilled through slurry or water.

The Ding Inspection Device (DID) was developed by John Z. Ding for measuring the sediment thickness at the bottom of a drilled shaft without human access into the excavation. Laboratory model tests and field comparisons to the mini-SID have demonstrated repeatability and accuracy of sediment thickness measurements using the device.

TECHNICAL SESSION 3 - PRESENTATION 2

Quality Control Methods for Drilled Shafts

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ABSTRACT

Quality control of drilled shafts is greatly dependent upon the practices of the site personnel. In many applications it is difficult, or not possible to fully inspect the shaft prior to concreting, such as when the shaft is drilled under slurry. The inability to fully inspect the shaft prior to concreting can lead to poorly built shafts. There are now several tools available to help with the QA/QC inspection. These tools can inspect the shaft bottom prior to concreting, assess the integrity and determine the as built shape of shaft, and dynamically load test the shaft to assess shaft capacity. This presentation will detail a new quality control device known as a Shaft Quantitative Inspection Device (SQUID) which will provide an inspection/assessment of the shaft bottom prior to concrete placement. The SQUID device can quantify the thickness of debris or soft deposits on the shaft bottom and determine the strength of the bearing layer beneath this debris layer. Additional method discussed will be dynamic load testing utilizing the GRL APPLE system for shaft capacity assessment.

TECHNICAL SESSION 3 - PRESENTATION 3

Decision Making and Data Management in Geotechnical Engineering

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ABSTRACT

This presentation will provide an overview of two strategic focus areas for the FHWA National Geotechnical Team. The first is the web-based decision making and solution guidance product GeoTechTools, which is a comprehensive catalog of geotechnical solutions with detailed information on approximately 50 geoconstruction techniques. GeoTechTools also contains a technology selection system to aid Project Managers, Planners, Resident Engineers, and Consultants and Contractors in identifying potential solutions, and making better informed decisions in project delivery based on user defined project constraints and risks. The second is management and communication of geotechnical data which will discuss the use of DiGGS as a protocol to manage different forms of electronic data and make it available for future use.

TECHNICAL SESSION 4 - PRESENTATION 1

Seismic Site Coefficient Model from Simulations and Data in South Carolina

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ABSTRACT

In the current application of the national seismic codes, seismic demand on structures is quantified by obtaining reference rock accelerations from the national hazard maps and adjusting them for local conditions by seismic site coefficients. The widely used site-class-based site coefficients, herein referred to as the NEHRP Fa and Fv, have limitations as noted by several researchers and practitioners. Some of these limitations include: (1) the applicability of the NEHRP Fa and Fv where conditions are characterized by shallow hard reference rock and high frequency content ground motions, such as the Eastern U.S.; (2) the appropriateness of using a single coefficient for a site class, regardless of variations in stiffness within the site class; (3) the appropriateness of using depth-independent coefficients to adjust rock accelerations. A generalized seismic site coefficient model suitable for simplified design in South Carolina has been developed based on results of over 60,000 total stress, one-dimensional equivalent linear and nonlinear ground response analyses and compared with the NEHRP factors. Variables found to be most influential, in addition to the average shear wave velocity in the top 30 m (VS30) and spectral accelerations, are stiffness of material in top 100 m, depth to top of soft rock and hard rock, and frequency content of the rock motions. Significant differences were found between the computed site coefficients and the NEHRP Fa and Fv, particularly where VS30 < 180 m/s and where the rock is at shallow depths. Partial validation of the proposed model is presented by using borehole-geotechnical and strong motion data from the 1989 Loma Prieta Earthquake. Because the model is based on a broad range of soil/rock conditions, it can be applied in areas with similar seismic and geologic settings.

TECHNICAL SESSION 4 - PRESENTATION 2

Applications of Geotechnical Centrifuge Modeling in Transportation System

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ABSTRACT

Geotechnical centrifuge model testing represents a valuable tool to the geotechnical engineer since it enables the physical study and analysis of design problems by using geotechnical materials. Centrifuge modeling has emerged as a valuable research and educational tool for geotechnical and geoenvironmental engineering. A centrifuge is essentially a sophisticated load frame on which soil models can be tested. Analogues to this exist in other branches of engineering: the hydraulic press in structural engineering, the wind tunnel in aeronautical engineering, and the flume in hydraulic engineering. In all cases, a model is tested and the results are then extrapolated to a prototype situation. The model is often a reduced scale version of the prototype. The model and prototype should exhibit similar behavior and that similarity is achieved by appropriate scaling laws. This is achieved by using dimensionless groups to relate events of different scales. Thus, the use of the centrifuge enables modeling of complex soil behavior and soil-structure interactions as opposed to standard geotechnical laboratory experiments where the focus is usually on a small soil element response. Centrifuge modeling is an economical and effective method for studying the response of soil systems (slopes, dams, etc.) and soil-structure systems (shallow and deep foundations, tunnels, retaining structures, etc.). Contrary to actual soil systems, instrumented centrifuge soil models can be tested to failure for students and engineers to observe and analyze. This presentation will cover the fundamental principles of centrifuge modeling such as basic scaling laws, model preparation, and testing procedures. Examples of centrifuge modeling applications for transpiration system will be presented and discussed.

TECHNICAL SESSION 4 - PRESENTATION 3

US701 Bridge Replacements—A South Carolina Case Study in Nonlinear Seismic Response Analysis for the SCDOT

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ABSTRACT

To better capture how the deep soil, coastal plain conditions impact the seismic hazard, Terracon performed a nonlinear, effective stress seismic response analysis as part of the design for the US701 Bridge Replacements near Conway, South Carolina. The nonlinear constitutive models more accurately modeled soil behavior at higher shear strains, where the more common equivalent linear frequency-domain approach falls short. Nonlinear, effective stress analyses involve modeling the hysteretic stress-strain behavior and associated pore pressure generation as the earthquake waves arrive in time. In addition to the project's subsurface investigation data, SCDOT provided nearby deep borings and Vs profiles, up to 500-feet. This information, in conjunction with geology, was used to develop the site response models. Model development, both for the equivalent-linear and nonlinear analyses, will be discussed, including the systematic sensitivity analysis. Results of nonlinear analysis were compared to the equivalent-linear, Seed et al. Simplified Geotechnical Method, and IBC/ASCE 7-10 spectra.

TECHNICAL SESSION 5 - PRESENTATION 1

Out of Sight, Out of Mind: Collaborative design build approaches that reduce the visual impact of deep and shallow slope stabilization repair projects from concept to completion

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ABSTRACT

Techniques for repair and stabilization of shallow and deep seated slope stability issues can be as varied as the sites on which they occur. Unfortunately, due to the nature of transportation projects, haste to implement repairs often results in situations where the repair is visually obvious, and may even look worse than the slope distress itself. Due to the often emergency nature of many of these repairs, little consideration is given to the end product appearance, forcing the owner to live with the visual results long term. This presentation advocates a collaborative design-build approach to such repairs which marries the four goals of efficacy, speed, cost, and appearance. Even on design-bid projects, collaboration between the awarded contractor and the contracting agency may result in modifications which reduce both the cost and visual impact of the repair. The focus will be on various case studies where this approach was utilized, and will describe the tools, techniques, and strategies used to reduce repair cost and improve the end product appearance. Each of these case studies resulted in reduced cost to the owner versus the originally considered techniques, better or equivalent timeframes, and an end product which blended better with the landscape that that originally proposed. The presentation will provide both owners and designers with a toolbox of techniques to consider when such situations come up, both during the bid and construction phases, and alternatives to standard exposed concrete, shotcrete, MSE, or conspicuous pile walls.

TECHNICAL SESSION 5 - PRESENTATION 2

The I-85/385 Interchange Improvement Project

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ABSTRACT

The I-85/I385 Interchange Improvement project in Greenville, South Carolina is one of the largest design Build Projects undertaken by the SCDOT and includes the full replacement of an active highway interchange with over five miles of roadway improvements, twelve new bridges, and numerous retaining walls. The design build contractor (Flatiron/Zachry Joint Venture) assembled a comprehensive design team lead by Civil Engineering Consulting Services, Inc (CECS), with ECS Carolinas, LLP (ECS) as the Geotechnical Engineer and four bridge design firms (Stantec, Mead and Hunt, TY Lin, and CECS). The geotechnical design and reports are reviewed by both the SCDOT and FHWA, along with a Geotechnical Consultant (HDR/ICA) retained by the SCDOT. Although the geotechnical challenges on the project are numerous, including Mechanically Stabilized Earth Walls over 50 feet, the complexities of coordinating a subsurface exploration program in an active interchange and interacting with a variety of bridge and roadway designers presented as many unique challenges. This presentation will provide an overview of the coordinated effort to complete the interchange design and discuss some of the unique geotechnical conditions present within the interchange.

TECHNICAL SESSION 5 - PRESENTATION 3

Measurement While Drilling: Quite Possibly the Hot GeoGadget for Christmas 2015

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ABSTRACT

Measurement While Drilling (MWD) is also known as Diagraphy Drilling, Instrumented Drilling and the Use of Drilling Parameters. MWD involves instrumenting a drill-rig, typically rotary or rotary-percussive, and recording measurements of fluid pressure, torque, effective crowd, penetration depth and rotation-speed with respect to time. The technology has been used for years in the Oil and Gas and Mining Industries, and was recently standardized for geotechnical applications in Europe. The concept has been applied in a recent research study conducted by the Florida DOT and University of Florida in an effort to relate a compound drilling parameter known as Drillability Strength to design resistance values for drilled shafts. The technique has also been used in the US to aid in the geotechnical site characterization within karstic terrain. Several other studies within the US and abroad are identified in recent literature. This presentation introduces the method and explores its potential usefulness for geotechnical applications in transportation.

TECHNICAL SESSION 6 - PRESENTATION 1

Assessment, Risk Management and Rehabilitation of Existing Structural Foundations

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ABSTRACT

This presentation will address the program, process and project issues associated with the assessment, risk management and rehabilitation (reuse and enhancement) of existing structural foundations (both shallow and deep). The reuse of existing structural foundations, both shallow and deep, is an emerging technical subject which provides significant opportunities (benefits of cost and schedule) as well as risks (compatibility, long term reliability and costs) for the highway engineering and construction community. The materials and techniques which may be applied to underpin and enhance the structural and geotechnical resistance of an existing foundation include micropiles, augercast piles, drilled shafts and several ground improvement methods including grouting, and controlled modulus columns. These technologies are at various levels of maturity; many have well developed design, construction and monitoring protocols yet some are new, some are old or not used routinely at a local or regional levels.

Each project has unique and specific requirements and constraints and application of these materials and techniques may not always be appropriate. When appropriate, however, they collectively provide significant and measurable benefits in terms of improved performance and savings of time and cost.

TECHNICAL SESSION 6 - PRESENTATION 2

North Carolina I-73 Taxiway Bridge Geostructural Design: Micropile, Soil Nail Wall, Driven Pile, and Aircraft Approach Slab

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ABSTRACT

A new taxiway bridge, a critical section of the North Carolina I-73 connector design-build project near Piedmont Triad International Airport in Guilford County, has been under construction. The bridge site involves designs and construction of large scale site excavation, permanent roadway underdrains, bridge end bent abutment walls supported by driven H-piles with reinforced earth, permanent soil nail walls, and micropile-supported interior bridge bents.

The presentation will cover design and construction aspects for each of the geotechnical and structural components. Specific topics will include: 1) Use of micropiles for supporting the bridge foundations and considerations of soil-structure interaction at pile cap connections and structural stability of the micropile. 2) Design of an abutment comb-wall consisting of reinforced earth and soil nail wall; 3) Evaluation of stress increases induced by heavy aircraft surcharge considering interaction between the bridge approach structural slab and soil subgrade; 4) Potential mobilized ground movements due to soil nail wall construction; and 5) Design and performance of roadway underdrains and its effects of lowering ground water on the soil nail wall design and construction.

TECHNICAL SESSION 6 - PRESENTATION 3

Jenga Should Be A Team Game

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ABSTRACT

In an evolving world where the environment and safety is a constant focus, we find ourselves wishing for efficient traffic flow to make life in our vehicles safer and more enjoyable. When the Tennessee Department of Transportation (TDOT) envisioned safety improvements along a stretch of Interstate 40 near Nashville, Tennessee, the concept was straight forward: Provide one additional lane to allow truck traffic to climb two miles of steep grade in a dedicated lane.

TDOT and the project geotechnical consultant, Stantec Consulting Services, soon realized the project was very similar to Jenga. This game involves players attempting to build a taller tower with wooden blocks by removing pieces from the structure and placing them on top. One mistake can send the tower crashing down.

This project required a collaborative approach to the game. Like the Jenga tower, each block represented a design feature or construction condition of the I-40 Truck Climbing Lane project. The geotechnical "blocks" and their relation to the physical and design constraints were of the utmost concern. A previous slide repaired in 2010 along the alignment provided an ominous clue as to the risks and difficult challenges that the design team was facing.

This paper presents the selection and design processes considered by the design team to achieve the best solutions for the I-40 Truck Climbing Lane. A number of geometric and geotechnical construction alternatives were evaluated to shoehorn the new traffic lane into the available area, which required collaborative project solutions.

TECHNICAL SESSION 7 - PRESENTATION 1

26th Street Emergency Retaining Wall Replacement, Baltimore, MD

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ABSTRACT

On April 30, 2014, record breaking rainfall occurred in Baltimore, MD, causing the retaining wall between 26th Street and the CSX railroad tracks to collapse. This event, captured on video by on-lookers who stood at an unsafe distance to the edge of the stone retaining wall, was covered extensively on national news. 26th Street was closed between Charles Street and St. Paul Street while the roadway was stabilized, utilities were replaced, and construction began for a new retaining wall. Unique to the project were requirements for immediate engineering decisions regarding public safety, maintaining the busy CSX rail service below, and appropriate precautions for working around an unstable slope. Furthermore, the design of the temporary support of excavation was performed on the fly as construction began before the design was finalized. Within hours after the wall failed, excavation equipment mobilized, removing cars, boulders and soil from the railroad tracks. Safety fencing was placed in front of the failed slope and geotechnical instrumentation was installed. Due to ruptured utilities and other safety concerns along 26th Street, residents were relocated. The City of Baltimore worked with the Contractor to secure emergency permits to move heavy drilling equipment to the site with less than 24 hours' notice. In non-emergency situations, this equipment requires 7 to 10 days to secure permits and transport. After receiving direction to mobilize on Friday, the drilling equipment was transported during the weekend and mobilization was complete on Sunday. The final design for the new wall included a temporary soldier pile and lagging wall that was constructed to accommodate a permanent 38-foot tall gravity wall. The soldier pile wall was aligned generally in the center of 26th Street, and the permanent gravity wall was constructed between the temporary wall and the railroad tracks. The soldier pile wall was braced by 3 rows of temporary anchors. Drilling for soldier piles and anchors was challenging due to variable conditions of sand, silt, decomposed rock, and competent rock. The capacity of the tieback anchors was affected by the drilling method and soil conditions encountered; in the softer silt, it was necessary to perform post-grouting to attain the required load capacity. Limited access on the narrow upper bench along 26th Street and restricted space adjacent to the railroad caused additional difficulties. The design and construction of this emergency project was performed in 8 months. Highly effective communication between the City of Baltimore, Whitman Requardt & Associates, Concrete General Inc. and Hayward Baker Inc. allowed the quick response to be possible.

TECHNICAL SESSION 7 - PRESENTATION 2

Slope Stabilization and Scour Protection using Small Diameter Reticulated Microplies Along Minisceongo Creek

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ABSTRACT

This technical paper will discuss the design, installation, and constructability of small-diameter reticulated micropiles and associated technologies. We will present a case study on a project in New York that had limited access and unstable, scour-prone glacial till slopes.

Minisceongo Creek is a tributary river to the Hudson River located in Rockland County, New York. In recent years, a significant amount of scour has occurred along a nearly 1,000-foot stretch of the stream situated in glacial till. The scour occurred predominately in an area where multiple subsurface utilities cross the stream. In 2012, Hurricane Sandy eroded an adjacent cutbank, further degrading the stability of the site. The erosion was mainly found in the sandy gravel embankment that overlies a large gravel boulder till of the riverbed. Results of the Sandy event included a cut back of approximately 60 feet into the hillside that had dramatically over-steepened the slope. The remaining exposed slopes were nearly 90-feet tall and at grades of up 2V:1H.

In order to protect the subsurface utilities, a large concrete buttress in combination with grouted riprap was installed. However, that buttress did not address the long-term stability of the embankments, future scour, and stability of associated areas above the river. The optimized design included the installation of a combination of soil nail walls, reticulated micropiles, and shored Geosynthetically Confined Soil (SGCS) walls to protect the steep embankments while maintaining adjacent property lines. Reticulated micropiles were also used in combination with riprap for scour protection.

The paper will highlight the unique design and construction efforts for this project with focus on reticulated micropile design and constructability, including an overview of the design methodology using limit equilibrium modeling in conjunction with L-Pile (for p-y analysis) and Excel (for t-z analysis) as well as the design of reticulated micropiles for scour mitigation.

TECHNICAL SESSION 7 - PRESENTATION 3

Limit Equilibrium Analysis including Shear Capacity for Launched Soil Nails

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ABSTRACT

Limit equilibrium (LE) slope stability programs provide a critical tool in understanding the analytical metrics of an existing and potential failure or mitigation solution. When used for analyzing soil nail systems, programs generally provide a result using known parameters for the structural elements and engineering judgment for the bond capacity to be later verified by testing.

Slide is an LE program developed by RocScience that has an additional input for shear capacity, permitting the full analysis of Launched Soil Nails. The input shear parameter is obtained by an iterative process of analyzing the location of the slip surface at each nail using methodology outlined in the Application Guide for Launched Soil Nails to develop the shear capacity and reevaluating in Slide with the shear capacity input. The process can be tedious and time consuming, depending on the number of Launched Soil Nails and complexity of the slide.

Similar to Slide, LSNAP is a limit equilibrium slope stability program used for analyzing soil nails. LSNAP was developed by the programmers behind SNAP2 and is freeware. LSNAP essentially streamlines the iterative shear calculation process discussed above for launched nails and performs the calculations internally. Additionally, features such as 3D visualization of the solution and facing calculations are included in the program.

This presentation will consist of an evaluation of LSNAP and comparing case studies with the manual calculation process using Slide. Launched nail details and research to date will be provided to provide a background for the structural inputs and internal shear calculations.

TECHNICAL SESSION 8 - PRESENTATION 1

Instrumentation of Steel Sheet Pile Wall and Cut Slopes in Piedmont Residual Soils for Research

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ABSTRACT

North Carolina State University and North Carolina Department of Transportation installed a tall steel sheet pile retaining wall and three steep cut slopes in piedmont residual soils to investigate soil mechanics related to temporary walls and excavations. The steel sheet pile retaining wall was instrumented with welded on vibrating wire strain gauges to measure induced bending moments. Push in pressure cells were installed near the back face of the steel sheeting to measure lateral earth pressures. Wall horizontal deflections and cut slope mass movements were monitored with vertical inclinometer casings and LiDAR scans. Readings were taken on all instruments as excavation stages were advanced deeper.

TECHNICAL SESSION 8 - PRESENTATION 2

Geotechnical Instrumentation and Performance Monitoring for Deep Excavations in Atlanta, GA

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ABSTRACT

We live in a world that is constantly growing and changing. As the world grows, so does the demand for new infrastructure to support our population. The supply of appealing property is running low, particularly in large urban areas, while the demand for construction of modern facilities and upgraded infrastructure remains high. As a result, an increasing number of projects are constructing deep excavations and supportive shoring wall systems adjacent to existing structures. Due to the close proximity, construction of deep excavations systems involve a considerable amount of risk to people, property, and infrastructure. Fortunately, these inherent risks can be reduced substantially by incorporating instrumentation and monitoring into the project.

This presentation will showcase one or two challenging projects with deep excavation support systems in the Atlanta

area where state-of-the-art instrumentation and monitoring systems were used to manage risk by monitoring theoretical performances determined via calculations against actual field performance in real time. The instrumentation and monitoring system successfully reduced risk by recording real-time engineering data on a project website while simultaneously sending email alarms to key site personnel when data exceeded pre-determined alarm thresholds. Finite element analysis was used to model deformations of the deep excavation support system for predictive measures and to define alarm threshold values for performance monitoring. The monitoring data uncovered unexpected performance at an early enough stage so that contingency plans could be engaged and mitigation efforts devised in order to limit the consequences.

In addition, special design considerations will be presented for piles anchored into varying rock conditions along with the resulting field performance from monitoring data correlated to construction activities.

TECHNICAL SESSION 8 - PRESENTATION 3

Vibration Monitoring – Leaphart Road

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ABSTRACT

The Leaphart Road replacement bridge over I-26 will be carried out within 20 feet of a high speed webpress operation that could be impacted by vibratory densification. S&ME was retained to carry out a preconstruction/preletting condition survey of the structure and a pilot vibration test program. The peak particle velocity (PPV) and maximum associated frequency (in hertz) between the ambient and test program were compared against various industry standards. The recorded vibration measurements and comparisons were used to estimate 1) vibration attenuation relationships, 2) potential for vibration-induced settlement and 3) to provide a recommended modification for construction to the Vibration Criteria adapted from AASHTO R8 standard.

TECHNICAL SESSION 9 - PRESENTATION 1

Accounting for System Performance Risks of Geotechnical Assets, Elements and Features

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ABSTRACT

Risk-based asset and performance management was passed into law for federally funded highway projects in 2012 and it has also become part of the business plans of many highway agencies. Implementation guidelines for transportation asset management were published by AASHTO in 2011 to help states in this regard. In parallel with these developments, geotechnical asset management approaches are being explored and developed by state highway agencies. As developments continue, the need for 1) consistent use of precisely defined geotechnical asset management terminology, and 2) an understanding of how the collective condition, performance and threats imposed by geotechnical assets, elements and features and other asset classes impact national safety, condition, reliability and environmental performance goals have become apparent. This presentation will introduce a geotechnical taxonomy

for transportation infrastructure assets with the goal to facilitate communication and advancement of geotechnical and transportation asset management. Likewise, a three-dimensional representation and visualization tool called the "risk cube" will be introduced here with the intent of aiding the identification of system performance risks and allowing for clear communication, thereby facilitating the collaboration of the communities of asset managers and geo-practitioners, and helping to ensure that agencies make the best risk-based decisions for their programs.

TECHNICAL SESSION 9 - PRESENTATION 2

An Introduction to Cellular Concrete and Advanced Engineered Foam Technology – Not Just a Product – Solutions

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ABSTRACT

This presentation qualifies for one (1) PDH and is an introduction to Cellular Concrete and advanced engineered foam technology. Beginning with a brief history of the technology, this presentation will answer the basic questions of cellular concrete. This presentation will also showcase project histories to relate the applications to real world geotechnical challenges. Finally, this presentation will expose the audience to emerging engineered foam technologies and the exciting new applications these products bring to an already versatile product line, as well highlighting how traditional cellular concrete technology is advancing to meet challenging project parameters.

4 learning objectives for attendees:

1. Discuss the history, definition, and properties of cellular concrete
2. Review mix design requirements and testing procedures
3. Explore typical applications and highlight some case studies
4. Introduce emerging technology, and how traditional cellular concrete technology is advancing to meet challenging project parameters

TECHNICAL SESSION 10 - PRESENTATION 1

Case History: Ground Improvement Test Section and Ground Improvements for Downtown Crossing Section 1, Louisville – Southern Indiana River Bridges Project

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ABSTRACT

The Ohio River Bridges – Downtown Crossing Project consists of construction of a new cable stayed bridge that will carry northbound traffic on I-65 across the Ohio River from Louisville, KY to Jeffersonville, IN. Associated with the new main river bridge is a major redesign and realignment of the ramps and interchange junctures where I-65, I-71 and I-64 converge along with the Kentucky approaches to the downtown Ohio River bridges. The reconstructed interchange includes the widening, reconstruction and construction of more than 40 bridges, 27 retaining walls and about 34 miles of roadway, ramps and connectors to allow for more efficient traffic management. The Walsh Design Build Team consisting of Jacobs and Stantec concluded that ground improvements would be required for many of the new ramps, embankment sections and MSE walls that are associated with the interchange reconstruction.

Hayward Baker (HBI) was selected by Walsh to be the designer and installer of the ground improvement systems that are required for the project. As part of HBI's quality control program, HBI constructed a test embankment supported by ground improvement elements. The test embankment was instrumented to measure settlement, pore pressures and earth pressures. The purpose of the instrumented test embankment was to provide a full-scale validation of the performance of the ground improvement elements as well as HBI's design and installation methodology.

This presentation will discuss the results of the geotechnical investigations; predicted behavior and observations; project criteria; test embankment section, instrumentation and results; selection of production elements; and installation of production ground improvement elements.

TECHNICAL SESSION 10 - PRESENTATION 2

Electrical Resistivity Imaging: Applications to Karst, Mining, and Slope Stability

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ABSTRACT

In recent years, non-invasive geophysical methods have proven to be invaluable tools for geotechnical site characterizations. This is especially true where subsurface conditions are difficult to evaluate with conventional techniques such as borehole drilling. Of the various geophysical tools available for subsurface evaluation, surface resistivity imaging is one of the most versatile and effective methods. This emerging geophysical technology provides cross-sectional images of the resistance of subsurface materials to electric current from which valuable geologic information can be inferred. Resistivity data can be collected in a shorter time frame than traditional methods with minimal impact to the environment, lending itself to be a useful technology that can be utilized in a variety of applications.

Resistivity imaging is effective in the following applications, among others: mapping the top of bedrock, identifying fractures and faults, karst characterization, delineating the extents of landfill materials, waste pits, trenches, and contaminant plumes, mapping sand and gravel deposits, and mapping the water table. Of these applications, karst characterization is one of the most valuable. Borings alone are inadequate to characterize karst environments because of the discrete nature of karst features such as pinnacled rock, soil voids, and caves. Resistivity imaging provides continuous cross-sectional images over which the bedrock surface can be inferred, thereby revealing the nature of alternating shallow rock pinnacles and deep soil troughs. Borings and corings can miss voids and deep solution features by mere inches or feet and will thus go undetected. Additionally, resistivity cross-sections cover far more area than borings and are therefore more likely to intercept these features.

Similar to karst, abandoned mine workings can be problematic for transportation or other engineering endeavors. Old mine maps are often inaccurate or not available, and anecdotal information on mining extents is unreliable. Resistivity sections often reveal mine workings as high-resistivity anomalies within the surrounding bedrock if the mine is air-filled, or low-resistivity anomalies is the mine is flooded after abandonment.

Slope stability problems are endemic to transportation and pipelines. Soil slumps and rotational failures often occur where slopes are so steep that it is difficult to mobilize a drill rig. In these scenarios, resistivity imaging can be applied to obtain geologic information on stratigraphy, the soil-bedrock interface, and modeling input parameters necessary to characterize and mitigate the problem.

This paper presents an overview of the resistivity imaging process and examples of its uses. Case studies will be examined that reveal the utility of resistivity imaging on karst, mining, and slope stability projects that will demonstrate the effectiveness of this method.

TECHNICAL SESSION 10 - PRESENTATION 3

The Use of Compaction Grouting for Ground Improvement; Karst and Beyond

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ABSTRACT

Compaction grouting has been utilized over many years as a low-mobility grouting technique to treat karst before and after sinkhole events occur. The technique was developed over 50 years ago as a means of densifying soft and weak soils under existing structures as well as a means to relevel the structure itself once settlement has occurred. The technique when used both for densification and releveling, treats not only the symptom of the problem (settlement), but the cause (the underlying soft soil) thereby potentially extending the life of the structure by reducing the potential for further settlement. The technique and associated installation procedures will be discussed, and applications for karst in the Appalachia region will be summarized. The presenter/author will then focus on how compaction grouting is used in day-to-day applications throughout the country for ground improvement, settlement control and structure remediation.

1. 1969 Atlanta, Georgia
2. 1970 Jackson, Mississippi
3. 1971 New Orleans, Louisiana 33 2001 Roanoke, Virginia
4. 1972 Montgomery, Alabama
5. 1973 Orlando, Florida
6. 1974 Covington, Kentucky
7. 1975 Gatlinburg, Tennessee
8. 1976 Raleigh, North Carolina
9. 1977 Hot Springs, Arkansas
10. 1978 Wheeling, West Virginia
11. 1979 Charleston, South Carolina
12. 1980 Atlanta, Georgia
13. 1981 Virginia Beach, Virginia 2011 (No STGEC)
14. 1982 Jackson, Mississippi
15. 1983 Montgomery, Alabama
16. 1984 Winter Park, Florida
17. 1985 Gatlinburg, Tennessee
18. 1986 Louisville, Kentucky
19. 1987 Hot Springs, Arkansas
20. 1988 Raleigh, North Carolina
21. 1989 Charleston, West Virginia
22. 1990 New Orleans, Louisiana

23. 1991 Charleston, South Carolina

24. 1992 Williamsburg, Virginia

25. 1993 Matches, Mississippi

26. 1994 Atlanta, Georgia

27. 1995 Huntsville, Alabama

28. 1996 Cocoa Beach, Florida

29. 1997 Chattanooga, Tennessee

30. 1998 Louisville, Kentucky

31. 1999 Asheville, North Carolina

32. 2000 Little Rock, Arkansas

33. 2001 Roanoke, Virginia

34. 2002 Baton Rouge, Louisiana

35. 2003 Charleston, South Carolina

36. 2004 Biloxi, Mississippi

37. 2005 Lake Lanier Islands, Georgia

38. 2006 Florence, Alabama

39. 2007 Bowling Green, Kentucky

40. 2008 Pigeon Forge, Tennessee

41. 2009 Wilmington, North Carolina

42. 2010 Charleston, West Virginia

43. 2012 Richmond, Virginia

44. 2013 Baton Rouge, Louisiana

45. 2014 Mobile, Alabama

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