STGEC 2016

Southeastern Transportation Geotechnical Engineering Conference

November 7-10, 2016

Biloxi, Mississippi

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Dear 2016 STGEC Attendees:

The Mississippi Department of Transportation – Geotechnical Branch is pleased to host the 47th Annual Southeastern Transportation Geotechnical Engineering Conference (STGEC) in Biloxi.

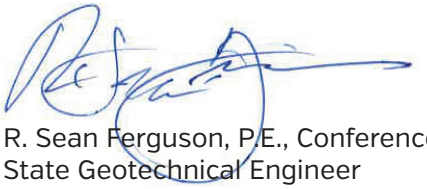
There have been many changes in transportation since the first year of the conference. This is especially true of the practice of geotechnical engineering. I believe we have assembled a variety of presentations which can serve as a backdrop for the exchange of ideas and experiences to continue to push the profession forward into the future.

I appreciate the full support we have been provided regarding the conference and its preparations from MDOT Executive Director, Melinda McGrath, P.E., Deputy Executive Director and Chief Engineer, Mark McConnell, P.E., and Assistant Chief Engineer- Operations, James Williams, P.E.

The planned attendance of geotechnical consultants, product, service and contracting representatives is as strong as any I can remember. The participation and support of private industry is vital to the success of STGEC.

Finally, I appreciate all of the assistance and support from South Carolina. They did a wonderful job, as always, with the conference last year in Greenville. I hope that each of you enjoys the conference and that you are able to find some time to spend in the city of Biloxi. Thank you for your attendance. We look forward to seeing you on the Mississippi Gulf Coast.

Sincerely,



R. Sean Ferguson, P.E., Conference Chair
State Geotechnical Engineer
Materials Division - Geotechnical Branch
Mississippi Department of Transportation

Hosting this conference always involves tremendous effort by many people.
I would like to personally thank Kristi Cheek, Colleen Campbell, Kathie Lamey, Mike Stroud, Ben Rivers, Bill Broyles, Don Moore, Susan Puckett, and all in the Geotechnical Branch and Human Resources. The conference couldn't happen without your assistance and contributions.

Thank you to the companies who support the conference. We can't do this without your participation.

Thanks to FHWA and TRB for continued support since the inception of the conference in 1969.

AGENDA

Monday, November 7

11:00 am - 4:00 pm	Exhibitor Registration and Setup
1:00 pm - 7:00 pm	Registration
6:00 pm - 9:00 pm	"Monday Night Football" Welcome Reception, Magnolia Ballroom, Beau Rivage Brought to you by: Terracon Consultants, Inc.

Tuesday, November 8 Morning

7:00 am - 8:00 am	Breakfast Buffet, Magnolia Ballroom Brought to you by: Neel-Schaffer, Inc. and SoilTech Consultants, Inc.
7:00 am - 5:00 pm	Registration
8:00 am - 8:15 am	Opening Session, Camellia Ballroom
	SESSION 1 - DEEP FOUNDATIONS, CAMELLIA BALLROOM Mike Stroud, MDOT - Moderator
8:15 am - 8:45 am	Enhancing Reliability and Quality of Drilled Shafts Through Thermal Integrity Profiling Matthew L. Silveston, Terracon
	Evaluating Drilled Shafts Based Upon Thermal Integrity Profiling Acceptance Criteria George Piscsalko, Pile Dynamics Inc.
8:45 am - 9:15 am	Geosynthetic Encased Column a Deep Foundation Solution for Very Soft Soils Mike Clements, HUESKER Inc.
9:15 am - 9:45 am	Geotechnical Challenges – The I-40/I-240 Interchange Project Ashraf S. Elsayed, Geotechnology, Inc.
9:45 am - 10:15 am	Break, Magnolia Ballroom Brought to you by Thompson Engineering
	SESSION 2 - FOUNDATION INTEGRITY EVALUATION, CAMELLIA BALLROOM Larry Jones, FDOT - Moderator
10:15 am - 10:45 am	Control Longitudinal Cracking in Prestressed Concrete Cylinder Piles Dan A. Brown, Dan Brown Associates
10:45 am - 11:15 am	Numerical Analysis of Settlement-Induced Bending Moments in Battered Piles Alex Reeb, Burns Cooley Dennis, Inc.
11:15 am - 11:45 am	Bridge Pile Foundation Evaluation for a Soil Remediation Project Will Tanner and Njoroge Wainaina, Geosyntec Consultants, Inc.

Tuesday, November 8 Afternoon

11:45 am - 1:00 pm	Lunch and Presentation, Magnolia Ballroom Brought to you by: Burns Cooley Dennis, Inc.
12:15 pm - 12:45 pm	Studies Conclude and Guidance Development Begins: Formalization of FHWA's Guidance for Post Grouted (Base-Grouted) Drilled Shaft Design and Construction, Magnolia Ballroom Ben Rivers, FHWA

SESSION 3- GEOTECHNICAL DATA MANAGEMENT, CAMELLIA BALLROOM
Darrin Beckett, KYTC - Moderator

1:00 pm - 1:30 pm	The Long Wait is Over … DIGGS is Here Bob Bachus, Geosyntec Consultants, Inc. and Silas Nichols, FHWA
1:30 pm - 2:00 pm	Single Source Data Entry via Data Interchange Scott Deaton, Dataforensics, LLC
2:00 pm - 2:30 pm	Information Modeling Systems Nicholas Loubier, Bentley
2:30 pm - 3:00 pm	Break, Magnolia Ballroom Brought to you by: Ardaman & Associates, Inc.

SESSION 4 - CASE STUDIES, CAMELLIA BALLROOM
Kaye Chancellor, ALDOT - Moderator

3:00 pm - 3:30 pm	Micropiles in Karst Terrain Stephen M. (Matt) Revell, ALDOT
3:30 pm - 4:00 pm	Large-Diameter Pipe Pile Installation at Kentucky Lake Darrin Beckett, KYTC and Ronald Ebelhar, Terracon
4:00 pm - 4:30 pm	Fast Fix 8 Matt Bullard, TTL, Inc.
4:30 pm - 5:00 pm	TDOT Utilization of Accelerated Bridge Construction Techniques Aaron Crowley, K. S. Ware and Associates, LLC
5:00 pm - 6:00 pm	Steering Committee Meeting – Azalea A Ballroom
6:00 pm - 8:00 pm	Reception, Hard Rock Hotel Brought to you by Geostabilization International

Wednesday, November 9 Morning

7:00 am - 8:00 am	Breakfast Buffet, Magnolia Ballroom Brought to you by: Southern Earth Sciences, Inc.
7:00 am - 5:00 pm	Registration

AGENDA

Wednesday, November 9

SESSION 5 - GROUND IMPROVEMENT TECHNOLOGIES, CAMELLIA BALLROOM
Kwame Adu, VDOT - Moderator

8:00 am - 8:30 am	GDOT Approach to Wall Foundation Investigations (WFI) – LRFD Methodology Adebola Adelakun, GDOT
8:30 am - 9:00 am	Cove Lane Interchange, Lake Charles, LA Dan Tix, Keystone Retaining Wall Systems
9:00 am - 9:30 am	Subsurface Utility Engineering (SUE) – State of Practice and Lessons Learned Uday Bhate, BHATE
9:30 am - 10:00 am	Break, Magnolia Ballroom Brought to you by: HDR Engineering, Inc.

SESSION 6 - GROUND IMPROVEMENT TECHNOLOGIES, CONT'D, CAMELLIA BALLROOM
Chris Nickel, LA DOTD - Moderator

10:00 am - 10:30 am	Mitigating Drainage and Moisture Failures in Foundation Systems Natalia Castro, TenCate
10:30 am - 11:00 am	"Sinkholes" Recognition, Remediation and the Latest Technology Matthew Dettman, Western Kentucky University
11:00 am - 11:30 am	Maree Michel GRS-IBS Abutment: Lessons Learned Jesse Rauser, LA DOTD
11:30 am - 12:00 pm	Advances in Case Histories of GRS/GCS Structures Nate Beard, GSI
12:00 pm - 1:00 pm	Lunch and Presentation, Magnolia Ballroom Brought to you by: Acker Drill Company
12:15 pm - 12:45 pm	Full Depth Reclamation Process in North Carolina – Update, Magnolia Ballroom Mohammed Mulla, NCDOT

SESSION 7 - GEOTECHNICAL INSTRUMENTATION AND IN-SITU TESTING
Nick Harman, SCDOT - Moderator

1:00 pm - 1:30 pm	Route 301 Bridge Using Seafloor Direct Push System for CPT and DMT Soundings Roger Failmezger, In-Situ Soil Testing, L.C.
1:30 pm - 2:00 pm	Monitoring of Retaining Wall Lateral Earth Pressures Within High Plasticity Expansive (Yazoo) Clay Colleen Campbell, MDOT
2:00 pm - 2:30 pm	Geohazard Management: Toward a National High Priority, Geotechnical Asset and Event Initiative John Metzger, IDS North America

Wednesday, November 9 Afternoon

2:30 pm - 3:00 pm	Break, Magnolia Ballroom Brought to you by: Ardaman & Associates, Inc.
	SESSION 8 - CASE STUDIES, CAMELLIA BALLROOM Mohammed Mulla, NCDOT - Moderator
3:00 pm - 3:30 pm	U.S. 17 Bridge Over Brunswick River, NC Using Base Grouted Drilled Shafts Mike Muchard, Applied Foundation Testing, Inc.
3:30 pm - 4:00 pm	Foothills Parkway: Micropiles Support Closing the Missing Link Anthony Sak, Hayward Baker Inc.
4:00 pm - 4:30 pm	Design and Construction Aspects of Micropiles Used for I-595 Corridor Improvement Project Bridges Michael Woodward, Amec Foster Wheeler Environmental and Infrastructure
4:30 pm - 5:00 pm	SR-959 Through Birmingham – Challenging Karst and Rock Cut Construction Lance Kitchens, Russo Corporation and Allen Cadden, Schnabel Engineering
5:00 pm - 6:00 pm	Lighthouse Tour, Biloxi Visitors Center
6:00 pm - 9:00 pm	Reception, Biloxi Visitors Center Brought to you by: A.H. Beck Foundation

Thursday, November 10 Morning

7:30 am - 9:00 am	Closing Brunch, Camillia Ballroom Brought to you by: Geotechnology Inc.
	SESSION 9 - EARTH RETAINING STRUCTURES AND GROUND STABILIZATION, CAMELLIA BALLROOM Glen Foster, GDOT - Moderator
8:00 am - 8:30 am	Expansive Clay Problems in Transportation Geotechnics: Site Investigation, Performance, Monitoring and Sustainable Solutions Sadik Khan, Jackson State University
8:30 am - 9:00 am	TDOT Retaining Wall Installations Robert Jowers, TDOT
	SESSION 10 - EARTH RETAINING STRUCTURES AND GROUND STABILIZATION, CAMELLIA BALLROOM Katherine Lamey MDOT - Moderator
9:15 am - 9:45 am	Slope Stability Analysis Using Finite Element Method Sean Johnson, Plaxis Americas LLC
9:45 am - 10:15 am	Investigation of Signal Matching Software iCAP on Driven Piles in Alabama Eric Steward, University of South Alabama

AGENDA

Thursday, November 10

10:15 am - 10:45 am	Mechanically Stabilized Earth Retaining Wall Project Case History, Parklands of Floyd's Fork-Phase 3A-Louisville, Kentucky Clint Hines, JC Hines & Associates, LLC
10:45 am - 11:45 am	Comprehensive Barrier Island Restoration for Ship Island Susan Rees, USACE Mobile AL District
12:15 pm - 5:00 pm	Ship Island Field Trip, Gulfport

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FOUNDATION CO. Inc.


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DRILL COMPANY


amec
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wheeler


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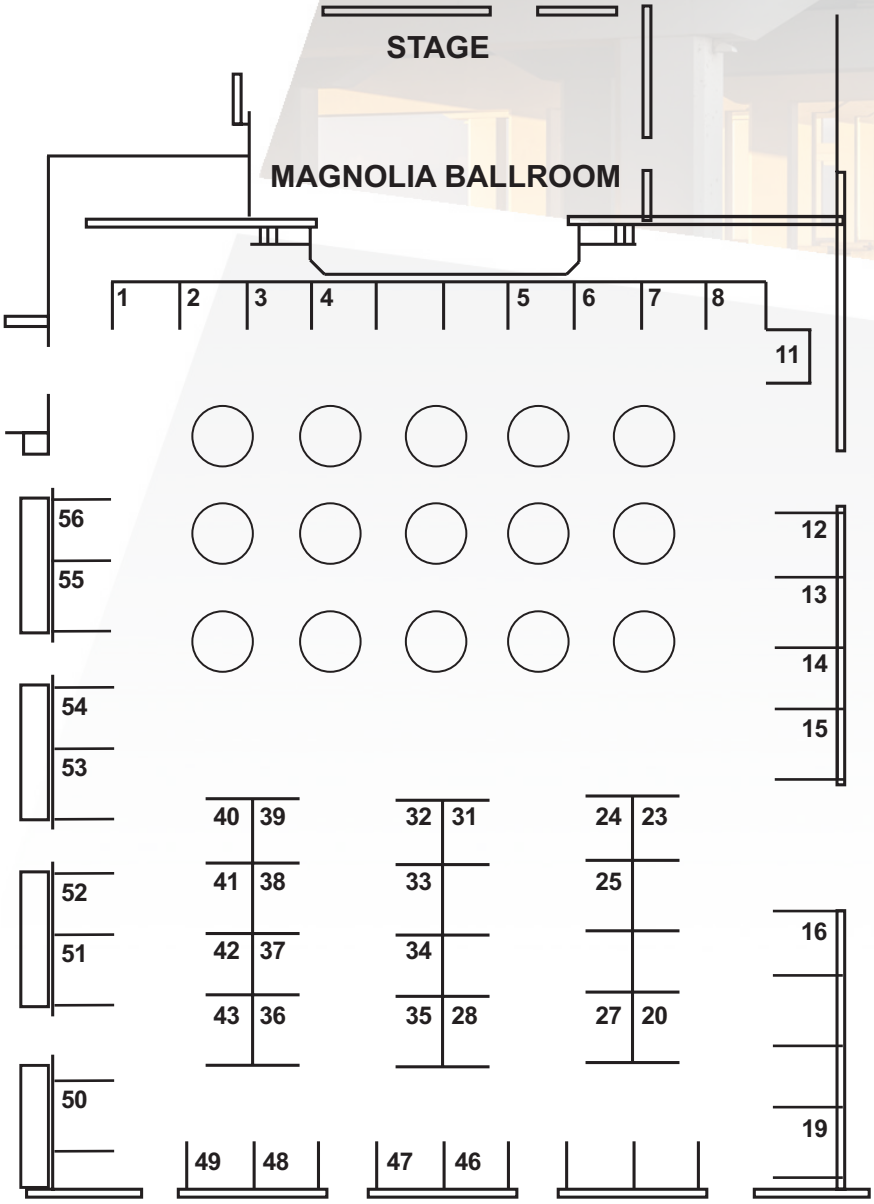

Entrances from Meeting Room to Exhibitor Area

1. Skyline Steel LLC
2. Thompson Engineering
3. Redi-Rock
4. CMEC
5. Carmeuse
6. SIMCO Drilling Equipment, Inc
7. Terracon Consulting, Inc.
8. Controls Group USA Inc
11. HUESKER Inc
12. Ameritech Slope Constructors, Inc.
13. Pyramid Geophysical Services
14. Applied Foundation Testing, Inc.
15. Humboldt MFG. Co.
16. DYWIDAG-Systems International, USA, Inc.
19. Tensar International Corporation
20. Acker Drill Company
23. Amec Foster Wheeler Environmental & Infrastructure, Inc
24. Geopier Foundation Company
25. Geobrugg North America, LLC
27. Williams Form Engineering Corp
28. Schnabel Foundation Company
31. Keystone Retaining Wall Systems LLC
32. GEO-Instruments
33. Hubbell Power Systems, Inc
34. TenCate Geosynthetics
35. Rocscience, Inc
36. The Reinforced Earth Company
37. Menard USA
38. HDR Engineering, Inc.
39. Pile Dynamics, Inc/GRL Engineers, Inc
40. Central Mine Equipment Company
41. Geokon, Inc
42. Foundation Technologies Inc.
43. GeoStabilization International
46. Intertape Polymer Corp
47. Dataforensics
48. Plaxis Americas LLC
49. Moretrench
50. Durham Geo Slope Indicator
51. Hayward Baker Inc.
52. Case Foundation Company
53. Loadtest USA
54. A.H. Beck Foundation Company, Inc
55. Atlas Tube
56. Monotube LLC

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TECHNICAL SESSION 1 - PRESENTATION 1A

Enhancing Reliability and Quality of Drilled Shafts through Thermal Integrity Profiling

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ABSTRACT

Drilled shafts are commonly used to support large concentrated foundation loads. With their significant size, drilled shafts can be cumbersome and expensive to load test. To avoid the large cost associated with load testing, many engineers and owners choose to perform integrity testing of drilled shafts. Integrity testing is performed to verify that the shaft has been constructed as specified. The most common method for evaluating integrity is through the use of Cross-hole Sonic Logging (CSL).

However, CSL testing has drawbacks. CSL testing is performed between tubes attached to the shaft reinforcing steel cage. One limitation is that CSL testing can only measure shaft integrity within the reinforcing cage. From a performance perspective, the concrete outside the reinforcing cage is critical since it provides the soil structure interaction through skin friction. The concrete outside the reinforcing cage also provides protection from corrosive environmental effects.

Thermal Integrity Profiling is an emerging testing methodology that measures temperatures with respect to depth within the drilled shaft. It has been introduced in the past several years and is progressing from demonstration projects into more conventional use. Thermal Integrity Profiling can evaluate the presence of anomalies inside as well as outside the reinforcing cage. Using temperatures, the amount of concrete cover beyond the reinforcing cage can be calculated leading to the development of a complete model of the drilled shaft with respect to depth.

This presentation will examine several examples of real shafts and include a brief primer on the theory and testing methodology which will allow the audience to evaluate the condition of the example shafts. The presentation will summarize the analysis for each shaft and point out defects and bulges that were detected through Thermal Integrity Profiling. Finally, it will compare Thermal Integrity Profiling results with CSL results.

TECHNICAL SESSION 1 - PRESENTATION 1B

Evaluating Drilled Shafts Based Upon Thermal Integrity Profiling Acceptance Criteria

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ABSTRACT

Quality control of drilled shafts is greatly dependent upon the practices of the site personnel. For drilled shafts cast under slurry, inspection of the hole prior to concreting is very difficult or impossible. There are several non-destructive test (NDT) methods currently available to assess the integrity of drilled shafts. The Thermal Integrity Profiling (TIP) method measures the elevated concrete temperatures that occur during the hydration process. These temperature measurements are made along the length of the shaft. The TIP method evaluates the shaft both inside and outside the reinforcing cage, providing evaluation for 100% of the shaft cross section. With the known shaft volume information, TIP can evaluate the effective shaft radius at each measurement location. With the increased use of TIP on highway projects, there is a need to have

standard criteria for shaft acceptance. Shaft acceptance criteria can be based upon thermal measurements and subsequent analysis of the data to determine the average shaft radius, local concrete cover, and cage alignment. With this additional information obtained via the thermal testing method, acceptance methods based upon concrete cover and effective shaft radius can be developed. In this presentation, the theory and use of Thermal Integrity Profiling will be described, results from a case history will be discussed, and an acceptance criteria based upon concrete cover and effective shaft radius will be proposed.

TECHNICAL SESSION 1 - PRESENTATION 2

Geosynthetic Encased Column a Deep Foundation Solution for Very Soft Soils

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ABSTRACT

There are many deep foundation techniques currently applied in large infrastructure projects. For embankments on very soft soils, load transfer to a competent layer no longer needs to be restricted to solutions like the inclusion of rigid elements, soil replacement, chemical stabilization, etc. Geosynthetic encased column (GEC) is a technique developed in Germany that became a proven foundation alternative for embankments on soft ground.

The GEC system is comprised of aggregate columns contained by high strength seamless geotextiles and horizontal geosynthetic reinforcement above the column head plane. The static and variable loads from the embankment are transferred to the columns, which besides carrying vertical stresses to a deeper layer, control settlement through circumferential tensile resistance while also working as large wick drains.

This presentation will present a conceptual presentation of the GEC mechanics, design considerations and installation methods. More than thirty projects have successfully applied the technology in Europe and South America in the past twenty years. Two specific cases are herein discussed to illustrate the system's performance and reliability. The first study regards the land reclamation project for the production of the Airbus A 380 in Hamburg, Germany. The columns were installed to support a dike in lieu of the initially proposed sheet piling solution. The former provided a technically sound alternative which translated into material and time savings. Secondly, a project for housing involving landscape embankments on extremely soft soil in the Netherlands is discussed. The challenging soil was predicted to cause large settlements and posed global stability concerns. Many alternatives were analysed and finally the selected solution was the design consisting only of geosynthetic applications. The study describes the geotechnical issues to be addressed, and the design and responses expected from the geosynthetic treated soil elements. It concisely shows that the GEC system is not only viable for large projects but is an interesting and advantageous alternative for smaller projects as well.

TECHNICAL SESSION 1 - PRESENTATION 3

Geotechnical Challenges - The I-40/I-240 Interchange Project

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ABSTRACT

The I-40/I-240 interchange is formed by I-40 to the north and east, I-240 to the south, and Sam Cooper Boulevard (SCB) to the west. The current average daily traffic (ADT) on I 40 is approximately 200,000 vehicles and is expected to be over 350,000 vehicles by 2035. The project includes modifying four existing bridges, and constructing two new bridges and 23 retaining walls. The existing low-speed ramps will be replaced by two-lane, high-speed fly-over structures. The final interchange configuration will include four levels, the first of its kind in west Tennessee. The estimated construction period is 39 months and started in October 2013. Two types of driven piles are used to support the bridges. These are 14-inch square, pre-stressed concrete piles and open-ended steel pipe piles. The pile embedments vary from 15 to 85 feet. Approximately 97,500 feet of concrete and steel pipe piles will be driven to support the bridges. Additional concrete piles were also required to support ten (10) wrap-around retaining walls. The design team concluded that utilizing dynamic testing of at least two production piles per site condition, but no less than 2% of the production piles, would yield a more economical approach because of reduced testing cost and expedited pile installation time. The project created several geotechnical challenges, and the geotechnical team needed to answer the following questions:

1. Can pile setup in western Tennessee be estimated with an acceptable accuracy?

2. Can one or more of the available pile driving formulae (i.e., dynamic formulae) be used to predict the long-term nominal axial resistance indicated by the dynamic testing results?

3. How should the pile terminal driving resistance be used for quality control?

4. How can the impact of driving displacement piles into liquefiable soils be assessed and utilized in terms of increasing the soil driving and liquefaction resistance?

5. How can the global stability of existing bridge approaches that will be widened be improved to meet the minimum required factors of safety in both static and seismic conditions without flattening side slopes due to right-of-way restrictions?

6. How can the abutment slopes of existing bridges be upgraded to current AASHTO seismic requirements without closing the bridges?

7. How can the bearing resistance of existing soil be significantly improved to support retaining walls up to 35 feet in height?

These challenges created opportunities for innovation. The geotechnical team developed a formula for predicting long-term pile resistance using early-stage test results. Recommendation for specific pile driving formulae and the terminal blow counts were made based on statistical analyses of the available data. The team also utilized soil reinforcement techniques to improve soil bearing resistance. A combination of soil nails and anchors was utilized to stabilize existing abutment slopes. Light-weight backfill was utilized for constructing specific retaining walls. The impact of pile driving with respect to liquefaction mitigation was assessed using Cone Penetration Testing (CPT) and consequently utilized to reduce pile embedments. The team also utilized deep foundations to improve the factor of safety against global stability failure for the first time in West Tennessee.

TECHNICAL SESSION 2 - PRESENTATION 1

Control of Longitudinal Cracking in Prestressed Concrete Cylinder Piles

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ABSTRACT

Longitudinal cracking has been a recurring problem with concrete cylinder piles for many years, in large part because the phenomenon is poorly understood. Concrete cylinder piles are a popular choice for construction of marine causeway structures in the southeastern coastal areas, and a robust solution to potential issues associated with pile damage is important for this region. Cracking can lead to undesirable corrosion and reduced design life, and the superior performance of undamaged piles in marine environments is one of the desirable properties associated with cylinder piles.

This presentation describes the mechanisms that can cause longitudinal cracking, presents a straightforward methodology to analyze the potential for longitudinal cracking, and outlines steps needed to avoid this condition. Longitudinal cracking can be associated with tensile hoop strains resulting from high compressive driving stress, even when current maximum compressive stress guidelines are followed. Additionally, longitudinal cracking can be associated with internal pressures when the interior air cushion is lost through either soil plug heave or underwater driving. The presentation includes analyses of both of these sources of hoop tension. Transverse reinforcement demands are also addressed.

TECHNICAL SESSION 2 - PRESENTATION 2

Numerical Analysis of Settlement-Induced Bending Moments in Batter Piles

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ABSTRACT

T-walls, which are reinforced concrete floodwalls shaped like an inverted “T” and supported on batter piles, are used in the Greater New Orleans area to reduce flood risk. Since the soils in southern Louisiana often include very soft and compressible clays, and placement of fill nearby T-walls is common, the batter piles need to be designed to resist the stresses and bending moments that can develop due to settlements. In order to investigate this issue, the US Army Corps of Engineers (USACE) commissioned Virginia Tech to perform numerical analyses of pile-supported T-walls subjected to both long-term settlements and flood loading and to develop a simplified analysis procedure. Concurrently, Rensselaer Polytechnic Institute was commissioned to perform a series of eight centrifuge tests to physically model the effects of settlement-induced bending moments on T-walls and provide experimental data to validate the numerical analyses.

The eight centrifuge tests all followed the same general construction and testing procedure. First, a soft clay foundation soil was consolidated beneath a surcharge in the centrifuge to establish the desired soil profile and initial conditions. Second, the surcharge was removed, the T-wall was installed, and the model was spun in the centrifuge to establish null conditions. Third, multiple loading phases were performed during which sand fill was placed and the clay foundation soil was consolidated. The final conditions, including settlements, pore pressures, and pile strains, were recorded after consolidation under each fill increment.

Corresponding numerical models were developed for each of the eight centrifuge tests using the two-dimensional finite difference software FLAC. In the numerical models, large strains were represented by updating the soil grid based on displacements during the analysis. Linear elastic, perfectly plastic constitutive models with a Mohr-Coulomb failure criterion were used for all soils; however, the elastic properties of the clay foundation soils were continuously updated during the analysis to account for nonlinear consolidation. Three-dimensional pile-soil interaction was simulated by connecting the pile structural elements to the soil grid with coupling springs. The springs oriented normal to the piles were assigned properties based on traditional p-y curves.

Overall, the numerical models produced results that were in good agreement with the centrifuge tests without the need for significant calibration or modifications. This good agreement indicates that numerical modeling can be used to realistically estimate the magnitude and distribution of settlement-induced bending moments for pile-supported T-walls and other similar structures.

In this presentation, the authors provide background on pile-supported T-walls, explain the supporting centrifuge testing, discuss the numerical modeling approach, and demonstrate the good agreement between the centrifuge tests and numerical models for calculating settlement-induced bending moments.

TECHNICAL SESSION 2 - PRESENTATION 3

Bridge Pile Foundation Evaluation for a Soil Remediation Project

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ABSTRACT

A plume of volatile organic compounds was detected at a rail yard in Washington D.C. during the recent installation of a new stormwater infrastructure. The stormwater construction inadvertently allowed the plume to migrate into a nearby creek and adjacent Anacostia River. The plume was delineated, and the selected remedy consisted of excavation of the contaminated soil up to 12 feet in depth and replacement with clean, select fill. However, the plume was located at the intersection of the rail line and an I-295 bridge overpass. The I-295 bridge overpass had cast in place concrete pile foundations for four primary bridge bents within the footprint of the proposed excavation.

Therefore, the project included an assessment of the effects of excavation of the 12 feet of contaminated soil directly adjacent to the four primary bridge pier foundations within the footprint of the remedy. The assessment involved: (i) code based estimation of bridge loads to the base of each affected pier; (ii) estimates for the distribution of those loads within the foundation group to find the most heavily loaded piles; (iii) non-linear p-y analyses including modifiers for pile-soil-pile effects. Boundary conditions were created to simulate both existing conditions and proposed excavated conditions.

The analyses concluded that the excavation could be performed with limited effect on the bridge pier foundations. In order to assess the bridge behavior during construction, a monitoring program utilizing optical survey points was designed and implemented featuring caution and warning thresholds as well as potential responses in the event those thresholds were exceeded. The monitoring data compiled during construction confirmed that the analyses accurately predicted the behavior of the bridge piers.

TECHNICAL SESSION 2 - PRESENTATION 4

Studies Conclude and Guidance Development Begins: Formalization of FHWA's Guidance for Post-Grouted [Base-Grouted] Drilled Shaft Design and Construction

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ABSTRACT

In 2011, the Federal Highway Administration (FHWA) and the ADSC - The International Association of Foundation Drilling (ADSC) initiated an effort to aid in the development of technical guidance for the post-grouting of drilled shafts in highway design and construction. The purpose of the effort was to identify and better define improvement mechanisms due to post-grouting, and to identify and develop practical methods for design and construction. The last phase of this work was completed in the summer of 2016, which focused on isolating and validating the predictable response from pre-mobilization as a result of base-grouting. In a related effort, the Deep Foundations Institute (DFI) coordinated a workshop on Quality Assurance for Post-Grouted Drilled Shafts during the 2015 DFI Annual Meeting in partnership with Cal-Trans, FHWA and ADSC. The findings and take-aways from the workshop were captured and published within a recent FHWA report. FHWA is now in the process of formalizing guidance for the design and construction of post-grouted drilled shafts for highways. This presentation will highlight the significant findings from these collective efforts, and provide a preliminary summary of guidance themes.

TECHNICAL SESSION 3 - PRESENTATION 1

The Long Wait is Over ....DIGGS is Here!

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ABSTRACT

The years of anticipation have (hopefully) been worth the wait, as the Geo-Institute (GI) of the American Society of Civil Engineers (ASCE) and the Ohio Department of Transportation (ODOT) are excited to announce that....

DIGGS is here!

Data Interchange for Geotechnical and GeoEnvironmental Specialists (DIGGS) was developed by a coalition of government agencies, universities, and industry partners with a goal of becoming an international data transfer standard for geotechnical and geoenvironmental data routinely needed for transportation-related projects. The coalition was coordinated by the Federal Highway Administration (FHWA) and became the Transportation Pooled Fund project TPF-5(111) titled: "Development of Standards for Geotechnical Management Systems." Since 2013, ODOT has worked in collaboration with the GI to complete the nearly 15-year development effort. The final report has been submitted to ODOT and DIGGS can be accessed through the DIGGS website (http://diggsml.org/) or at the GI website (http://committees.geoinstitute.org/people/diggs-standard/).

The purpose of this presentation will be to briefly describe the benefits, functionality, and use of DIGGS to the conference participants. Importantly, a demonstration will be included to show how users can access and incorporate DIGGS into their daily practice. In the near term, the GI has committed to host the ongoing development and coordinate training webinars for DIGGS. Accordingly, the presentation will also present a vision for the future sustainability of the DIGGS initiative and the important role that state DOTs, other owners, software developers, and geotechnical practitioners play, if DIGGS is to succeed in becoming THE international data transfer standard.

As with all "new" systems and organizations, user acceptance, support, and commitment are required. In the case of DIGGS, some change of current practice by the entire profession/industry will be required to help assure adoption and sustainable success. Numerous examples of similar initiatives exist and will be cited. At the heart of these successful efforts, there exists a supportive and engaged user community. Over the next several months, the GI will roll out a sustainable business model to advance the ongoing development and adoption of DIGGS. There will opportunities for participation by practitioners to help in the promotion, development, and business of DIGGS. This presentation provides a critical first step.

TECHNICAL SESSION 3 - PRESENTATION 2

Single Source Data Entry via Data Interchange (Field to Lab to Designer to Data Warehouse)

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ABSTRACT

In 2014, Missouri DOT began investigating how to simplify and enhance their data management process in the laboratory as well as for their designers. Their in-house built custom Laboratory Information Management System (LIMS) system had become unstable due to hardware and operating system improvements over the last 15 years. Additionally, lab personnel were using different LIMS systems for the same laboratory test depending on who needed the data ultimately (design vs construction) which was requiring more maintenance, troubleshooting and complicating the processes.

A replacement for their in-house LIMS was needed which must be compatible with pLog and gINT which were already in use by MODOT. Additionally, MODOT wanted to further facilitate the business process for designers having a more comprehensive database that includes all lab testing results, in-situ testing data, as well as the borehole data already being managed. Lastly, MODOT wanted to make their geotechnical data (borehole, in-situ testing and lab testing data) easily reusable for future projects by spatially enabling it in a geographic information system (GIS), map-based interface. From this map, any report (borehole, CPT, cross section, graph, table, etc.) used in their original design processes in gINT can be dynamically generated based on the data in the enterprise GIS-based database.

TECHNICAL SESSION 3 - PRESENTATION 3

Single Source Data Entry via Data Interchange (Field to Lab to Designer to Data Warehouse)

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ABSTRACT

Many organizations that rely on subsurface information fail to integrate this information into an information model for lack of tools to easily transfer and integrate the data to the model.

This disconnect is caused primarily by the fact that the geotechnical industry is still a report driven industry. This means that geotechnical data often ends up isolated and not part of the information modeling warehouse. Moreover, this data is usually available only on a transactional basis (when a report is finalized and handed over to owner operator), rather than being a constant data flow or "plugged in" data source.

This causes huge challenges in collaboration between disciplines and sometimes a level of mistrust to use and analyze data for multiple purposes.

In order to bridge this gap in the geotechnical area, two actions must be taken: working with digital data, and allowing the geotechnical information to be displayed in proper context

- Digital data: geotechnical data should be stored in systems that are open for multiple uses rather than "just" the generation of a paper based report; more importantly, this system should support interoperability standards (which are just emerging for now) so that data can flow from one system to another one.
- Context: Because of the Information Modeling framework, data from multiple disciplines and systems can be brought together in order to provide context for the information produced by all disciplines. It allows geotechnical data to be viewed in conjunction with transportation assets and aid in long-term management strategies organization wide.

This presentation will focus on the context aspect and how geotechnical data can be used in the context of civil workflows to help in project analysis, options development, and maintenance programs of transportation assets.

TECHNICAL SESSION 4 - PRESENTATION 1

Micropiles For Bridge Foundations in Karst Terrain
Case Study – The I-20/59 & I-65 Interchange Modification Project, Birmingham, AL

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ABSTRACT

This $208,000,000 interstate interchange modification project in downtown Birmingham, AL is the third phase of the most ambitious construction project undertaken by ALDOT in at least the last two decades, with a total cost of all four phases in excess of $500,000,000.

For this project, drilled shafts and steel H-piles driven into pre-drilled pilot holes were the foundations recommended by geotechnical engineers and placed in the contract. However, with a $10,000,000 no-excuse bonus on the line for finishing the project before September 1, 2018, the contractor was looking for ways to save time. The contractor proposed a design change from pre-drilled H-piles to micropiles to support the large hammerhead pier footings for the new interstate ramp bridges.

Birmingham, AL is one of the most geologically diverse cities in the country, lying at the intersection of three major geological provinces. Limestone dominates the subsurface, and extreme karst conditions are not uncommon. This geologic scenario, along with the time constraints of the project, large sums of money on the line, and ALDOT's relative inexperience with micropiles resulted in some very interesting challenges for ALDOT geotechnical and construction personnel.

This presentation will give an overview of all four phases of the project, describe the geological challenges of the project, and discuss the implementation of micropiles as bridge foundations in Karst terrain from an owner perspective. Topics specifically related to micropiles will include:

- Micropile design philosophy in Karst
- Specifications for Micropile construction
- Construction Quality Assurance/Quality Control
- Micropile Load Testing
- Unexpected occurrences and Karst-specific challenges
- Lessons Learned

TECHNICAL SESSION 4 - PRESENTATION 2

Large-Diameter Pipe Pile Installation at Kentucky Lake

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ABSTRACT

The Kentucky Transportation Cabinet (KYTC) is currently administering construction contracts for the replacement of the US 68/KY 80 Bridges over Kentucky Lake and Lake Barkley in Marshall and Trigg Counties, Kentucky. These crossings form the gateways to the Land Between the Lakes National Recreation Area in Western Kentucky. The original two-lane bridges were constructed in the 1930s and the replacement bridges widen the crossings to four lanes and add a multi-use path for pedestrians and bicycles. Each bridge is about 4000 feet in length, but construction also includes causeways and one smaller lagoon bridge adjacent to the Kentucky Lake crossing.

A design-phase pile load test program was performed in 2013 to study the constructability and design parameters for large-diameter steel pipe piles for the proposed Kentucky Lake Bridge. The findings of this load test program were presented at the 2014 Southeastern Transportation Geotechnical Engineering Conference. The load test program consisted of static, pseudo-static, and dynamic load testing. The load test results helped the design team to gather information regarding a viable foundation design, which included constrictor plates to mobilize additional bearing resistance in the pile design.

This presentation will focus on pile installation for the Kentucky Lake Bridge. There will be particular emphasis on the unique characteristics of the large-diameter (72-inch) open-ended steel pipe piles with constrictor plates and utilization of load test program data to project long-term resistance of the production piles. Dynamic pile testing was performed and the results were analyzed using signal matching and refined wave

equation analyses. Data obtained during the construction- phase dynamic testing was used in conjunction with results of the design-phase pile load test program to develop production pile driving criteria; these criteria included considerations for setupwhile reducing the time required for restrike testing during bridge construction.

TECHNICAL SESSION 4 - PRESENTATION 3

Fast Fix 8

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ABSTRACT

In 2015, TDOT's Fast Fix 8 project included removing and replacing eight bridges in the downtown loop of Interstate 40 (I-40) in Nashville. This $62 million bridge rehabilitation consisted of removing and replacing deck and substructure and incorporating mechanically stabilized earth (MSE) and/or cast-in-place retaining wall systems for the bridges spanning Charlotte Avenue, Jo Johnston Avenue, and Clinton Street. The purpose of the new retaining walls were to reduce the bridge deck area to minimize future maintenance, while still maintaining access for automotive, railway, and pedestrian traffic beneath I-40. The MSE retaining wall backfill serves as a subgrade for I-40. In all, the improvements consist of six walls at the aforementioned bridge abutments and two walls that encapsulate the area within the three interior bents of the Clinton Street Bridge.

TTL provided geotechnical engineering and construction materials testing for the retaining wall and subgrade improvements. Our services included performing a geotechnical exploration for the project and reporting our findings that included site conditions, geology, exploration results, and conclusions and recommendations relative to design and construction of the planned improvements as well as construction monitoring. After submitting our report, the design team informed us that the design did not consider lateral loading exerted by the proposed retaining walls on the existing bridge substructure. TTL provided an innovative solution to this challenge by incorporating a reinforced slope with a vertical face to achieve the proposed design.

The project also used an innovative process called Accelerated Bridge Construction (ABC). This method allowed prefabrication of bridge decks and other elements of the construction and reduced roadway closures to 10 weekends instead an estimated three years using conventional construction practices. The new bridge decks were prefabricated within the I-40 right-of-way.

Fast Fix 8 was performed using the Construction Manager/General Contractor (CM/GC) model. TTL worked collaboratively with Gresham Smith and Partners (designer), Kiewet, (contractor) and TDOT (client/owner) throughout the design process to meet the rigorous project deadline. CM/GC is a contracting method that involves a contractor in the design and construction phases of the project. The intent is to form a partnership with the Owner, Designer, and Contractor. Fast Fix 8 was TDOT's first (CM/GC) project.

TECHNICAL SESSION 4 - PRESENTATION 4

Tennessee Department of Transportation Utilization of Accelerated Bridge Construction Techniques

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ABSTRACT

In Tennessee, accelerated bridge construction (ABC) is increasingly being used to replace aged and deteriorated bridge structures. Recently, the Tennessee Department of Transportation (TDOT) utilized ABC techniques in Nashville, TN for their Fast Fix 8 project; a $62 million bridge rehabilitation project to replace four twin bridges along Interstate 40 in the downtown loop. This construction method has shown a reduction in construction time, enhance constructability, ensures structural integrity, and maintains safety during construction processes.

TDOT, having recent success with ABC techniques on Interstate 40, has decided to utilize ABC methods on an additional two bridges along Interstate 24 on the eastern side of the downtown Nashville loop. A consultant was hired to perform a detailed geotechnical study for the two bridges (one over a railroad and surface street) and a retaining wall to meet the fast paced schedule that was set forth by TDOT Geotechnical Engineering Section (GES). Quick and precise information gathering is essential for innovative solutions to streamline the development process and ensure successful implementation of ABC.

Approximately one-fourth of the Nation's 600,000 bridges require rehabilitation, repair, or total replacement. However, the work that occurs from on-site construction activities can have significant social impacts to mobility and safety. In many cases, the direct and indirect costs of traffic detours that result from the loss of a bridge during construction can exceed the actual cost of the structure itself. For example, full-lane closures in large urban centers, or on highways with heavy traffic volumes, can have a significant economic impact on commercial and industrial activities in the region. Partial lane closures and other bridge activities that occur alongside adjacent traffic can also lead to safety issues. Because of the potential economic and safety impacts, minimizing traffic disruptions is a goal that TDOT has elevated to a higher priority when planning bridge related construction projects.

TECHNICAL SESSION 5 - PRESENTATION 1

GDOT Approach to Wall Foundation Investigations (WFI) – LRFD

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ABSTRACT

For all projects receiving Federal funding after 2007, civil engineering designs must address Load Resistance Factored Design (LRFD) specifications regarding limit states concerning displacement and capacity. GDOT, in collaboration with the Georgia Institute of Technology, performed a research project that studied the best available means for geotechnical calculations concerning the selection of shallow foundations for bridges and retaining wall structures, specifically addressing allowable bearing stresses and tolerable settlement magnitudes. The design process is interactive between GDOT Office of Bridge Design which contains the structural engineering group and the GDOT Geotechnical Engineering Branch who analyze the foundation systems. A series of design charts and spreadsheet solutions for calculating geoparameters, factored bearing capacity and total settlement were developed which will improve the level of service and information that our geotechnical reports provide. This presentation will review the process GDOT has adopted for Wall Foundation Investigations based on outcome of this research study.

TECHNICAL SESSION 5 - PRESENTATION 2

Cove Lane Interchange, Lake Charles, Louisiana
Highway Interchange Challenges Overcome With Piles and Unique MSE Solutions

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ABSTRACT

The Louisiana Department of Transportation and Development is in the midst of a three-phase, $80 million project that addresses congestion along I-210 in the southwestern part of the state.

The first and most expensive phase, known as the Cove Lane Interchange project, began in October 2013 and was completed in the spring of 2015. This complex, fast-track overpass and road improvements endeavor involving 1.8 miles of roadway now provides long-sought relief of traffic snarls near two large resort and casino attractions.

What made the $39 million project distinctive was its use of an inventive bridge interchange design that addressed both poor foundation soils and management of traffic during phased construction. It did so with a pile-supported slab, large temporary walls, and two different retaining wall systems.

The MSE retaining wall systems used in this project are an inextensible steel reinforced MSE Wall (KeySystem I) and extensible geogrid reinforced MSE wall (KeySystem II); these were used in combination on the bridge and approaches. Because the abutment walls supported the large bridge loads, the inextensible system was used to minimize deflection for the 100-year design life. MSE wall systems provided a reliable and more cost-effective solution compared to traditional bridge and retaining wall construction with reinforced concrete.

TECHNICAL SESSION 5 - PRESENTATION 3

Subsurface Utility Engineering (SUE) – State of Practice and Lessons Learned

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ABSTRACT

This presentation will focus on how implementation of the SUE process at these projects assisted with identifying potential conflicts with existing underground utilities and proposed future construction. The SUE process helped eliminate delays caused by redesign due to utility conflicts, potential construction delays caused by cutting, damaging, or discovering unidentified utilities and contractor claims for delays.

The Federal Highway Administration has been encouraging the use of Subsurface Utility Engineering on Federal-aid highway projects for nearly 35 years. The new technologies and equipment now available has made this cost effective with real time data for decision making.

Subsurface Utility Engineering is not confined to highways. It can be used with good results on airport, railroad, building construction, military, and any other private and public works projects where underground utilities may be encountered or new utilities installed. It can also be used for environmental purposes, such as detecting and mapping underground storage tanks, septic fields, and even contaminants.

PROJECT CASE STUDIES

ALDOT Birmingham Central Business District CCBD I-20/59 Project

The CBD is an ALDOT project to rehabilitate bridges, improve capacity on Interstate 20/59, and improve access to and from downtown Birmingham. The total project value is estimated at over $400M.

This is a highly urbanized area with development that has occurred since 1880's through the present. There are a multitude of old abandoned utilities, new utilities, undocumented utilities and known and unknown subsurface structures. The inability to obtain reliable underground utility information has long been a troublesome problem for highway designers. ALDOT utilized SUE to identify and to acquire subsurface utility information needed for preparation of CBD plans.

Additionally, over 600 boring locations were scanned to identify underground utilities prior to commencing geotechnical drilling to prevent damage to existing or unknown utilities. Nearly 18% of the utilities in the field, based on the information provided by the Utility Companies, was erroneous or not shown. The SUE scanning has prevented potential damage to high value utilities and disruption.

The process also identified several potential environmental issues in the CBD construction area including undocumented abandoned underground fuel tanks. The SUE field mapping presented unique detection challenges in the foundry sand backfill materials which was commonly used in this area.

MOOT road project on Highway US 90, from SR 609 in Ocean Springs to Dolphin Drive in Gautier.

This is nearly a 10 mile long stretch that will undergo road widening. Currently the road includes two eastbound and two westbound lanes. The SUE scanning is being currently conducted ROW to ROW on both sides of the roadway. The utilities mapped include water, gas, sewer, electric, and fiber optic lines. There have been some interesting challenges due to the roadway backfill materials and shallow groundwater table.

University of Alabama at Birmingham (UAB) - New Steam Plant and Steam Line Campus Wide Expansion.

This was a $90M utility expansion project. When Alabama Power informed UAB that they planned to decommission the steam plant and would no longer provide steam to this major medical and academic

university, UAB was required to construct a new steam system to serve the entire campus in this congested and highly developed environment. The SUE process was used to assist with the final design of the new steam line alignment, avoid conflicts and accomplish a successful installation of the steam system without delays or change orders. Approximately 5+ miles of steam lines were successfully installed on the campus without damage or disruption of the existing highly sensitive utilities over the entire campus.

TECHNICAL SESSION 6 - PRESENTATION 1

Mitigating Drainage and Moisture Failures in Foundation Systems

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ABSTRACT

The use of high strength fabrics and grids for foundation reinforcements is becoming popular due to the experience gained over the last 20 years. Their use for infrastructure projects, like local and state roadways, has gained momentum due to the increased performance, cost efficiencies, and the increased life spans they provide to these applications. Designers are now able to bridge, or structurally span, subgrade areas with poor loading performance. Doing so helps decrease the cost required to build the foundation, but also helps increase the projected lifespan of the structure when compared to a design without their use.

This presentation will cover the new techniques for enhanced lateral drainage and the benefits gained by controlling subgrade and structural base course moisture contents. It will show the importance of moisture balancing as a new design component, alongside structural improvement, when the project encounters high water tables, extremely saturated subgrades, high capillarity potentials, and expansive subgrade soils underneath foundations capable of differential heave and contraction. The discussion will cover modes of failure, the root causes of moisture migration, and the newly available technologies capable of reducing the moisture content of subgrade soils and acting as an active capillary interceptor for structural base course improvement, along with new research and case studies on the subject of moisture control for foundations.

TECHNICAL SESSION 6 - PRESENTATION 2

Sinkholes: Recognition, Remediation, and the Latest Technology

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ABSTRACT

Sinkholes are a relatively common Geohazard in the United States with approximately 20% of the country susceptible to sinkhole activity. Especially vulnerable are the southern states as well as Pennsylvania. Conservative lower bound annual damages are estimated at $304 million, with the actual number likely much higher due to the challenges in many cases in assigning the damage to sinkhole activity specifically. In many cases, sinkhole damage is unreported since it may not be covered by insurance, or it is classified as subsidence or ground movement. With increased urbanization, these damages will continue to rise as sinkholes that once formed in open fields are now opening in industrialized and urbanized areas causing

significant damage. Unfortunately, sinkhole detection and prediction methods have not been accurate enough and standard Geotechnical Investigations are highly unlikely to locate a sinkhole. The current state of the practice methods are predominately Electric Resistivity Imaging (ER) and Micro Gravity Imaging (MG). While both of these methods are growing in use and accuracy, they are still simply a snapshot in time and in a few short years the subsurface could change. Advanced techniques are currently in the research and development stage which include satellite GPS monitoring and permanently installed sinkhole detection devices to continuously monitor for voids in the subsurface. This presentation will cover the basic anatomy of a sinkhole and remediation/repair techniques, however the highlight will be presentation of the latest technology for sinkhole monitoring including permanently installed sinkhole monitoring systems for new and existing construction developed at Western Kentucky University.

TECHNICAL SESSION 6 - PRESENTATION 3

Maree Michel GRS-IBS Abutment: Lessons Learned

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ABSTRACT

The Louisiana Department of Transportation recently undertook the design and construction of two GRS-IBS bridges in conjunction with the FHWA Every Day Counts program. Both bridges are located in Vermilion Parish in the southwestern part of the state. The design was done in-house by LADOTD geotechnical and bridge design staff and let out to contractors via our traditional bid process. This presentation aims to show some of the challenges and lessons learned during the design, specification writing, bidding, and construction phases of the project.

TECHNICAL SESSION 6 - PRESENTATION 4

Advances in and Case Histories of GRS/GCS Structures

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ABSTRACT

A significant number of bridge abutments across the nation have reached the end of their service life. The extensive nature of the problem, combined with ever-dwindling state and federal budgets, precludes timely replacement of all those deficient bridges. However, new and innovative technologies and construction approaches can serve to extend the service life of those structures, as well as reduce costs of eventual replacement / rehabilitation.

This presentation demonstrates the advances in Geosynthetically Reinforced Structures through the use of multiple case studies. Theses case studies will highlight bridges, culverts, shoulder reconstruction, stream realignment and will touch on some environmental and constructability considerations.

TECHNICAL SESSION 6 - PRESENTATION 5

Full Depth Reclamation Process in North Carolina - Update

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ABSTRACT

Full-depth reclamation (FDR) is a process whereby both the existing asphalt pavement and underlying materials are first pulverized, then mixed with cement, and compacted into a new base course ready for paving. Design strength gain is achieved by the measured addition of Portland cement during the mixing of these materials. FDR is an environmentally conscience approach to pavement renovation/reconstruction. One prominent benefit of FDR is that asphaltic roadway materials are not removed from the project. This saves money, time, and landfill space and reduces damage to adjacent rural roadways. Asphalt areas that are too thick for FDR (i.e., due to repeated patching or overlaying) can be milled. Such millings can be reused for widening of shoulders.

FDR should be considered when a roadway is in such poor condition that it may be more economical over the long term to make a new base course out of it than to continually patch and/or overlay it. As of 2015, there were 79,585 miles of paved road in the state of North Carolina. Of these, 64,522 miles are State secondary routes, 8,124 miles of which have been identified as “needing significant work.” That is a big problem for the North Carolina Department of Transportation (NCDOT), but one that FDR is uniquely suited.

NCDOT began using FDR in July of 2003. To date, NCDOT has performed FDR investigations in 11 out of 14 Divisions. These investigations have included 606 lane miles of roadway anticipated for FDR. Actual reclamation efforts have included 329 lane miles of secondary roadways. The FDR process begins with Division personnel requesting a FDR report from the Geotechnical Engineering Unit (GEU) of NCDOT. The GEU will visit the road in question and if the GEU agrees with the Division that the road is indeed a good FDR candidate, the GEU will perform a roadway investigation. The roadway investigation includes traffic data, subgrade shear strength testing, sampling of roadway and subgrade materials and the identification and layer depths of existing pavement structure and subgrade material. Next, the soils laboratory of the Materials and Tests Unit (M&T) perform unconfined compressive strength testing with various rates of added Portland Cement. The GEU then combines the roadway investigation results and the lab results and provides the Division personnel with the recommended FDR depth and a Portland cement application rate. The Pavement Management Unit of NCDOT recommends the type of asphalt overlay material and thickness using traffic data obtained during the roadway investigation.

If the FDR candidate goes to contract and is performed, then inspection is done by Division personnel with the aid of the GEU’s Geopavement Engineers. Division personnel are also in charge of testing the FDR for compaction with the aid of the M&T Unit.

If used correctly, FDR is an environmentally and economically friendly alternative to the more traditional patching, milling and asphalt overlaying of secondary roads needing significant repair in North Carolina.

TECHNICAL SESSION 7 - PRESENTATION 1

Route 301 Bridge Using Seafloor Direct Push System for CPT and DMT Soundings

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ABSTRACT

For the Route 301 Bridge over the Potomac River between Maryland and Virginia, a direct push system, weighing 15 tons placed on the mudline with a 100 ton capacity crane, efficiently performed cone penetrometer test (CPT) and dilatometer test (DMT) soundings. This method effectively pushed those probes and avoided many problems that occur when pushing from the barge, such as vertical movement from tides and waves, lack of lateral support between the deck and the mudline and inaccuracies of depth measurements. At one of the CPT soundings, the seafloor system pushed the probe to 135 feet below the mudline before encountering penetration refusal. Seismic (p and s) dilatometer tests (SDMT) used heavy underwater hammers that generated either the compression wave or shear wave and measured those wave velocities. The undrained shear strengths in the cohesive soils and the constrained deformation moduli from CPT, DMT, pressuremeter (PMT) and vane shear test (VST) compared well with each other.

TECHNICAL SESSION 7 - PRESENTATION 2

Monitoring of Retaining Wall Lateral Earth Pressures Within High Plasticity, Expansive (Yazoo) Clay

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ABSTRACT

For the Route 301

Construction of frontage roads on the east and west side of I-55 in Ridgeland, MS required construction of retaining walls on the northeast and northwest sides of the Steed Road interchange due to right of way limitations. The geotechnical subsurface exploration performed by MDOT determined that high plasticity, expansive, Yazoo Clay presents along the entire 443-feet length of the northeast retaining wall.

The Yazoo Formation is the upper unit of the Jackson Group of the Eocene Series. Montmorillonitic Yazoo Formation clays exhibit extremely high plasticity, with liquid limits typically ranging from 80% to 140%, and plasticity indices between 60% and 110%. Due to their high plasticity, Weathered Yazoo Clays are prone to

expand and contract significantly when subjected to moisture changes. Typically the active zone is confined to the upper 15 feet of the Weathered Yazoo Clays.

MDOT's Geotechnical and Structural Engineers for this project were Burns Cooley Dennis, Inc. (BCD) and Michael Baker Jr. Inc. (Michael Baker), respectively. BCD estimated the lateral earth pressures using design theory developed by Dr. Robert L. Lytton of Texas A&M for the expansive clay soils in Texas. Construction recommendations coordinated between MDOT and their geotechnical and structural engineers reduced estimated projected lateral earth pressures associated with the expansive Yazoo Clay to manageable pressures, strains and deflections.

Thirty six inch diameter drilled shafts were generally installed at 45-inch center-to-center spacing. The tangent caisson retaining wall facing consisted of precast panels attached to the exposed west face of the drilled shafts. MDOT instrumented two of the 101 drilled shafts used for construction of the tangent caisson retaining wall.

MDOT installed extendable pressure cells with vibrating wire piezometers at three depths within the upper 15-feet of the Weathered Yazoo Clay. Four parallel sets of sister bar strain gauges were installed at four locations of estimated maximum moment differentials along the 46 feet length of the instrumented drilled shafts. Slope indicator casing was installed within each of the two instrumentation shafts to monitor deflection. The geotechnical instrumentation was installed during the summer of 2012. Readings were taken periodically during construction at construction milestones to document pressure and strain changes during retaining wall construction. Once the retaining wall and interchange were completed in 2014, instrumentation readings have continued to be recorded annually.

MDOT and BCD reduced the geotechnical instrumentation data. The instrumentation data was compared to the estimated lateral earth pressures and the estimated bending moments predicted in the drilled shafts. This presentation will summarize the characteristics of the expansive Yazoo Clay used for design, estimation of the design lateral earth pressures and predicted structural strains, instrumentation and monitoring of the drilled shafts, and finally comparison of the estimated and measured pressures and strains.

Considering the expense of the retaining wall, the presence of Yazoo Clay over a large section of central Mississippi, and the anticipated right of way limitations within the transportation corridors within the general Jackson area, future retaining wall structures within Yazoo Clay can be anticipated. Hopefully this monitoring data provides insight as to the actual earth pressures imposed on retaining walls by the Weathered Yazoo Clay.

TECHNICAL SESSION 7 - PRESENTATION 3

Geohazard Management: Toward a National High Priority Geotechnical Asset and Event Initiative

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ABSTRACT

Departments of transportation, transportation cabinets, state and local agencies, and our national transportation management and geologic resource institutions are faced with a growing challenge to consider, detail, support and mitigate geotechnical assets and geohazards within their jurisdictions.

Efforts have been made at a national level to support acquisition, management and access to databases of State level geotechnical assets: http://landslides.usgs.gov/research/inventory/. These valuable inventories are a first step in a formula for proactive assessment, monitoring, and remediation of highest priority and risk

sites. We are promoting a multi-disciplinary, cross sectoral, science-based action initiative to create a model of a national program for a proactive and urgent response geotechnical asset monitoring and remediation task team.

We have met with USGS on this idea and want to share with the professional and practitioner community their response and next step tasks for State DOTs, sector professionals, and academics to participate in efforts going forward.

This presentation will describe an action event process, monitoring, reporting and evaluation and quality control process. Our goal is to create a simple and results driven model for applicable use across the nation. The High Priority Geotechnical Asset and Event Initiative - will engage a variety of agencies, practitioners, consultants, and vendors in a mission to consider, propose, plan, and deploy resources necessary to proactively acquire baseline data, monitoring, mitigation, and remediation of Category 4 and 5 Geohazards.

TECHNICAL SESSION 8 - PRESENTATION 1

Drilled Shaft Cost Savings Through the Use of Base Grouting and Load Testing US 17 over Brunswick River, Wilmington, North Carolina: A Case History

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ABSTRACT

Drilled shaft lengths on this project were reduced by over 50 feet through the use of base grouting and load testing. Base grouting enhances the usable axial capacity of drilled shafts through preloading of the base and improvement of the bearing soils in the right soil conditions. Load testing provides a measure of the ultimate skin and base resistance and allows the use of higher resistance factors for design. The combination of these methods on this project resulted in significant drilled shaft cost savings, schedule benefits, and greater overall drilled shaft performance reliability.

The replacement of twin bridges #103 and #105 on US 17 over The Brunswick River in Wilmington, North Carolina was delivered to NCDOT through a design build contract. The foundation design submitted by the winning team included 7 foot diameter drilled shafts with lengths ranging from 182 to 192 feet. Drilled shafts were selected as the preferred foundation system mainly to meet the deep scour design criteria and large loading associated with long bridge span lengths. All shafts included permanent casing to the scour elevation with their bearing resistance obtained in soils of the Pee Dee Formation. The upper part of this formation is medium dense to very dense sand with some calcareous layers. With depth, the Pee Dee Formation gets more silty and clayey but still mostly sand. Soil conditions at the shaft tip were about 60 percent sand with 20 percent silt and 20 percent clay. SPT “N” values at the shaft tip were approximately 12 to 24 blows per foot. We recognized that this soil type would lend itself fairly well to improvement from base grouting.

Because the design build process fosters latitude for innovation, it was decided to pursue a new foundation design utilizing base grouting and load testing. The new design was submitted by the design build team and subsequently accepted by NCDOT. The combination of increased base resistance through pressure grouting and use of a higher resistance factor of 0.7 for load testing, resulted in estimated length savings of 42 to 51 feet. However, the actual load test showed even better side and base resistance than estimated in design. Therefore, production shaft lengths were further reduced. In the end, shaft length reductions of 50 to 70 feet were realized.

This presentation provides an overview of the base grout design method, specification key points, load test program, and production shaft base grouting.

TECHNICAL SESSION 8 - PRESENTATION 2

Foothills Parkway: Micropiles Support the Closure of the Missing Link

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ABSTRACT

When completed the Foothills Parkway in east Tennessee will skirt the northern boundary of the Great Smoky Mountains National Park, offering panoramic views of America's most visited park. At the proposed length of approximately 72 miles, to date only 22 miles are open to the public, ~6 miles on the east end and ~17 miles on the west end. Another 16 miles of the Parkway will open between Wears Valley and Walland, TN with the closure of the "Missing Link", a 1.6 mile gap. The last 4,000 feet of the Missing Link are currently under construction. Five bridges are needed to traverse this last rugged section. Foundations for these bridges bear directly on rock or micropiles bonded into rock. This presentation will provide some history of the Parkway and the micropile foundations needed to close the Missing Link.

TECHNICAL SESSION 8 - PRESENTATION 3

Design and Construction Aspects of Micropiles Used for I-595 Corridor Improvement Project Bridges

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ABSTRACT

The I-595 Corridor Improvement Project was a 10.5-mile-long, $1.8 billion design-build (public-private partnership) project located in Broward County, Florida, near Ft. Lauderdale, that opened in March of 2014. The project consisted of reconstructing and resurfacing the existing I-595 mainline and adding auxiliary lanes (including associated improvements to frontage roads and ramps), as well as a new tolled reversible express lane system in the I-595 median. The project included 62 bridges and associated retaining walls.

A five-span, single-lane fly-over ramp structure (Ramp N) with a length of approximately 960 feet needed to be raised approximately 18 inches to allow for vertical clearance for the new express lanes and new I-595 eastbound alignments. A temporary pier was utilized as a jacking platform for the raising of this flyover. Construction of the temporary pier, as well as the addition of deep foundations for an adjacent existing pier that needed to be strengthened, were performed under low-overhead conditions, and the contractor elected to utilize micropiles in lieu of 18-inch diameter steel pipe piles. Similarly, micropiles were used in lieu of driven piles for the widening of a four-span bridge because of the presence of existing battered concrete piles supporting adjacent bridges on each side. This presentation will cover the design and construction aspects of the micropiles used for these two bridges.

TECHNICAL SESSION 8 - PRESENTATION 4

SR-959 Through Birmingham – Challenging Karst and Rock Cut Construction

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ABSTRACT
Highway construction is always challenging and today it's even more so when the good flat sites are all gone. Birmingham, AL felt this challenge with the new SR-959 construction which required significant fill heights and large cuts in challenging karstic soil and rock conditions. Finding a solution required innovative combination of soil nail, rock bolts and high capacity anchors to achieve a nearly 150 ft high cut.

TECHNICAL SESSION 9 - PRESENTATION 1

Expansive Clay Problems in Transportation Geotechnics: Site Investigation, Performance Monitoring and Sustainable Solutions

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ABSTRACT

Highway slopes and infrastructures constructed over expansive soil often experience volumetric deformation which affects the stability and performance of the structures. In addition to causing shrinkage and swelling in expansive subgrade, variations in moisture induce surficial distress, edge cracks, and shoulder drop off, which ultimately effect pavement performance. Moreover, the cyclic wetting and drying behavior and prolonged rainfall cause surficial failure of highway slopes. The current study by JSU and UT Arlington summarizes (1) the investigation, instrumentation and performance evaluation of pavement subgrade on expansive soil and (2) sustainable stabilization of the highway slopes failure over expansive soil in Dallas, Texas.

Pavement serviceability can be enhanced by obtaining an improved understanding of moisture patterns through monitoring in real time the variation of moisture beneath the pavement. The current research monitors seasonal variation of subgrade moisture content, temperature, rainfall, and pavement deformation in a section of State Highway 342 in Dallas, Texas maintained by TxDOT. Moisture sensors were installed at varying depths down to 15 ft. In addition, geophysical testing in the form of resistivity imaging was also conducted to monitor moisture flow at the pavement slope and obtain a continuous portrayal of subgrade moisture behavior. Moreover, Slab Impulse Response (SIR), another form of geophysical investigation, was deployed in order to monitor for possible honeycombing, cracking and voids below the slabs-on-grade. Collected data were analyzed in a non-parametric

environment including both temporal and seasonal variation. Based on the two years monitoring, moisture variation of 5%-14% in response of rainfall can be associated with 1.5 inch recorded deformation.

Surficial failures of highway slopes in clayey soils are quite common throughout the United States. A sustainable and cost effective slope stabilization method using the Recycled Plastic Pin (RPP) had been utilized and checked for its performance in three different highway slopes over US 287, I35 and SH 183 near Dallas, Texas. Surficial movement had taken place over the slopes, resulting in cracks over the shoulder. Ten (10) ft. long, 4-inch x 4-inch, RPPs were utilized at different spacing (3ft. to 6 ft.) to stabilize the test sections. After installation of the RPPs, the performance of the slope was monitored by using inclinometers and topographic survey. The performance monitoring results indicate that maximum deformation of the reinforced slope section is less than 1.5 inch. However, more than 15 inches of vertical settlement was observed at the control sections of US 287 slope during the last 5 year monitoring period. It should be noted that a few slope sections located on the opposite side of the reinforced slope section failed during the same period. Based on monitoring data obtained over the last 5 year period, it was summarized that RPP can be successfully utilized for slope stabilization.

TECHNICAL SESSION 9 - PRESENTATION 2

TDOT Retaining Wall Installations

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ABSTRACT

The majority of TDOT walls are being designed by the contractor. During the latter part of the 1990's it was recognized many contractors were submitting retaining wall Value Engineering Change Proposals (VECPs) immediately after the contracts were signed. Most retaining wall designs at that time involved a pile supported cast-in-place (CIP) concrete. The basis of the VECPs was to change the CIP wall design to a mechanically stabilized earth (MSE) system with a facing of a smooth concrete panel or concrete modular block. The intent of VECPs is to generate creative thinking. The project owners were apparently unconvinced that the MSE alternatives were that creative, so around 1999, an joint effort was led by the Department and FHWA to ultimately decrease the great number of retaining wall submitted to VECP. A joint committee between TDOT and FHWA was formed, and a policy was developed whereby the contractor would be responsible for designing walls. Given appropriate geotechnical design parameters, the contractor would develop a take-off estimate cost to design and construct the retaining wall. TDOT would review the design for compliance, and upon approval the contractor would build the designed wall per specifications of the contract. The focus of this presentation will be to explore how TDOT currently specifies the contract using an exemplary case history, how this contractor design-build process has changed in the last fifteen years, and what changes may still lay ahead.

TECHNICAL SESSION 10 - PRESENTATION 1

Slope Stability Analysis Using Finite Element Method

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ABSTRACT

The presentation will focus on slope stability analysis. The slope analysis presentation will discuss potential failure mechanisms and the factor of safety (FOS) of embankments. Embankments and slopes are commonly used in the construction of roads and highways to create a controlled path over the existing geology.

There will be an overview of the current analytical and numerical methods of solving potential failures. Specifically, the presentation will compare the Factor of Safety (FOS) results of a 2-D slope between the finite element method using Plaxis and the common analytical methods. The specific analytic methods discussed will include: infinite slope, method of slices, and moment equilibrium method. A brief overview of the force-moment equilibrium equations will be covered. A further explanation of the Free Body Diagrams for each analytical method will be shown.

Then the presentation will examine how a slope stability problem is solved in Plaxis. That will include: model construction, boundary conditions, and general considerations for finite element modeling. An overview of the method of calculating factor of safety (phi/c reduction using PLAXIS FEM) will be examined. Specifically, the presentation will go into detail of how a Factor of Safety is understood using phi/c reduction. Moreover, the equations that define phi/c reduction will be shown.

A case study using a simplified geometry will be included, at the conclusion of the presentation, where direct FOS comparisons are made between the common analytical methods and Plaxis FEM. The results will indicate the advantages of accuracy and calculation time of Finite Element Method using Plaxis over traditional analytical methods.

TECHNICAL SESSION 10 - PRESENTATION 2

Investigation of Signal Matching Software iCAP on Driven Piles in Alabama

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ABSTRACT

The Alabama Department of Transportation (ALDOT) often uses deep foundations consisting of driven piles, particularly in the southern half of the state, to support bridges or other highway structures. For larger projects, test piles are often installed to indicate whether or not

the piles can safely carry the service loads. This is achieved by either dynamic testing or static testing, or by both. Frequently, these piles are tested at end-of-initial-driving (EOID) and at some time later to measure the

effects of time on the axial resistance of piles. For High Strain Dynamic Testing, these piles are instrumented with accelerometers and strain transducers to obtain and relay hammer-impact velocity and force signals, respectively, to a Pile Driving Analyzer system (PDA®). Subsequently, these signals can be further analyzed with a software program, CAPWAP®, to accurately estimate the toe, shaft, and total axial resistances of piles.

There is a new, automatic signal matching software called iCAP® (which is installed onto the PDA® unit) that can be used in the field or some later time for quick evaluation of pile axial resistance. The iCAP® automatic signal matching procedure was created using the basic CAPWAP® soil and pile model, but does not require nearly as much user intervention as the CAPWAP® Method. The operator is allowed to select certain controls for qualifying data quality, but all other aspects of the iCAP® procedure is completely automatic. Furthermore, the iCAP® procedure provides results independent of an assumed damping factor.

The ALDOT has been collecting, analyzing, and storing dynamic and static pile testing data for decades and for two main reasons: 1) to indicate that the piles can hold the anticipated service loads, and 2) to use for research purposes. The author has acquired the pile testing data from ALDOT's historical records between 2009 and 2014 to further analyze and organize the information in an effort to identify relationships between the time-dependent changes, particularly set-up, associated with the driven pile axial resistance and the generalized soil surrounding the embedded pile. In that effort, an analysis was performed on the Dynamic Load Testing data todetermine the validity of the iCAP signal matching software that ALDOT recently acquired. The results from the analysis includes a comparison of iCAP to the more traditional, and lengthy process of CAPWAP, as well as a limited number of static load tests, which indicate a very favorable correlation. The time saved compared to the CAPWAP analysis, along with the confidence in accuracy, allow for the iCAP software to be a very viable choice for test pile resistance determination.

TECHNICAL SESSION 10 - PRESENTATION 3

Mechanically Stabilized Earth Retaining Wall Project Case History
Parklands of Floyd's Fork – Phase 3A – Louisville, Kentucky

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ABSTRACT

In 2011, Redi-Rock International introduced the Positive Connection (PC) Retaining Wall System. This wall system features an innovative connection between the block facing and the geosynthetic reinforcement allowing much greater structural capacity for this large, wet-cast precast modular block retaining wall technology. This presentation will discuss the system features and application advantages of the PC System as well as explore a challenging project where it was successfully used.

TECHNICAL SESSION 10 - PRESENTATION 4

Comprehensive Barrier Island Restoration for Ship Island

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