

## Texas Section-ASCE Spring 2010 Meeting: April 11–13, AT&T Conference Center on UT Campus, Austin, Texas Call for Papers and Posters

A general call is announced for papers to be presented and posters to be displayed during the Texas Section Spring Meeting at the AT&T Conference Center on the UT Campus in Austin, Texas, from **Sunday April 11 to Tuesday, April, 13 2010**.

Papers and posters may be the result of a research project, a technical description of a unique project, an innovative idea that has been implemented, a new and useful technology, or an improvement of present practice. Papers may also be the result of a case study of an ethical or legal question pertaining to civil engineering. A total of 35 papers will be selected for 45 minute presentation and discussion at the technical sessions.

### Requirements for Papers

Interested persons are encouraged to contact the relevant institute chairs, other committee chairs, or the vice president-technical for advice about preparing and presenting papers. **Abstracts in Microsoft Word (.doc) format with titles of 10 words or fewer and text of 100 words or fewer** will be evaluated by the VP-technical with the assistance of the topical institute or technical group chair. The name of the author(s), mailing and email address(es), telephone and fax numbers must be included on the same page as the text.

Each abstract should be sent to the appropriate chair, with a copy to the VP-technical, no later than **December 1, 2009**. Authors of papers selected for presentations will be notified by **December 15, 2009** and will be given guidelines for the written papers. A written paper (maximum 25 pages) is mandatory for presentation and will be due by **January 25, 2010**. Abstracts are published in the *Texas Civil Engineer* and papers are published in the *Section Meeting Proceedings*. If more information is needed, contact the vice president-technical.

### Requirements for Posters

Poster materials, including written descriptions, drawings, photographs, graphs, charts, and/or other visual aids, will be displayed on boards (30" x 48" up to 42" x 60") in the Exhibit Hall during the Meeting. Presenters will be asked to be available to answer questions about their poster presentations during the Exhibit Hall Open House. Abstracts (Word document) with titles of 10 words or fewer and accompanied by thumbnail sketches of the presentation layout will be evaluated by the vice president-technical. The name(s) of the author(s), email and mailing address(es) and telephone fax numbers must be included on the same page as the abstract text. Send a copy of your submittal to the vice president-technical no later than **January 25, 2010**.

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Calendars!

**ABSTRACT DEADLINE**

December 1, 2009

**NOTIFICATION DATE**

December 15, 2009

**PAPER AND POSTER  
SUBMITTAL DEADLINE**

January 25, 2010

# Abstracts

## Fall 2009 Civil Engineering Papers

### Construction Institute Construction

#### Galveston Causeway Replacement Endures a Perfect Storm and 2 Hurricanes

Scott A. Turnpaugh PE

With a notice to proceed date of October 13, 2003 and initial contract value of \$135 million, Traylor Bros., Inc. commenced replacement of the TxDOT's twin 8,592 lf Galveston Causeway bridges while stormy market conditions and multiple hurricanes brewed ahead. The twin bridges utilize 59 spans of Type VI girders approaching the 740 lf, 3 span cast-in-place twin segmental box over the navigation channel. It included over 100,000 lf of 36–78" diameter drilled shafts, 35,000 lf of 24" diameter steel pipe pile, 175,000 cubic yards of concrete, 127,000 lf of Type VI prestressed girders, and over 1,170,000 square feet of bridge deck.

#### 5-ft Pipe in a 10-ft Easement: Design and Construction Challenges

Kurt Staller PE and Jerry Snead II PE

CH2M HILL provided design services and services during construction of 4,260 feet of 60-inch water main. The project was designed to allow contractor to bid ductile iron pipe, cement mortar lined and coated steel pipe, or bar-wrapped concrete cylinder pipe. Tunnels were used to minimize traffic and business impact. Costs were reduced by allowing multiple pipe materials to be bid, an option for owners to award only a portion of the project, and a geotechnical baseline report providing bidders with detailed information on soil/rock/groundwater conditions along project alignment. Challenges encountered included a compressed design and construction schedule, narrow easements, tunneling 20% of project, and proximity to businesses.

#### Value of Becoming a PE? Possibilities Expanded to Those in the Field of Construction...

Jackie L. Borman EIT

Understanding the professional engineer (PE) licensure process is only part of the battle. Experience and education requirements can become overwhelming for an applicant in the construction industry. Varying state regulations also impact the exams. Different educational backgrounds and work experiences easily dictate preparedness for taking the PE Exam. Tips for understanding exam format, topics covered, and useful study materials and guides are essential to making the process easier. Learning from others' experiences can eliminate a lot of misunderstanding. With the construction section being relatively new, not a lot of materials are available to study to prepare for the test.

#### Value Engineering for Goose Creek Channel Improvements

Gary Zika PE, Brian Manning PE, James Hornsby PE

The Harris County Flood Control District (HCFCD) required improvements to 0.9 miles of Goose Creek in Baytown, Texas, including approximately 2,000 lf of U-

shaped channel walls and a 210-foot-wide control structure. Sheet pile designs for the channel walls and control structure were developed and advertised for construction. The successful bidder, Texas Sterling Construction, performed value engineering and recommended to HCFCD that cast-in-place concrete designs be developed, which made use of slip-formed channel walls with welded wire reinforcement and a cast-in-place control structure founded on prestressed concrete piles. The redesign, performed by Brown & Gay Engineers, Inc., saved HCFCD \$400,000.

#### How Software Enhances Collaboration Inside and Outside of Your Company

Patrick Prothe and Andrew Karr

Do you ever have difficulty sharing information between your company, contractors and the project teams? Does it seem like not everyone speaks the same language? Learn how modern software packages facilitate collaboration with everyone involved on projects and help bring projects in on time and on budget. One such software system (Viewpoint Construction) will be covered to demonstrate how one can save time, increase performance and reduce friction by automating documents sharing.

#### Sam Houston Tollway Thin Bonded Permeable Friction Course Overlay

Anil Mirmira PE, Quinton Alberto PE, R. Matthew Estes PE

PFCs are among a new generation of asphalt pavements that are both highly porous and highly permeable. These characteristics result in improved surface drainage and reduced roadway noise. The Harris County Toll Road Authority recently applied a thin bonded PFC overlay to a 3.1 mile section of the Sam Houston Tollway, selected because of its high wet-weather accident rate and growing noise complaints due to recent widening of the facility. This paper documents the processes of selecting the overlay material and method, handling of the bridge joints, development of the PS&E, field experience gained during construction, and initial project results.

#### Delay Claims from the Owner and Contractor's Perspectives

Dennis M. Mac Bride PE

When a project is delayed due to an owner's actions, a contractor may incur unanticipated costs and seek compensation for those losses. On the other hand, when a project is delayed by a contractor's actions, the owner may seek compensation in the form of liquidated or actual damages. In either case, it is important for both parties to understand the basics of delay claims. This presentation will address contract language related to delay, types of delays, types of damages, the requirements for a successful claim, the submission and defense of delay claims, and dispute resolution.

#### Urban Pipelining

Dale Kornegay and Bret Gowers

Constructing pipelines through urban areas presents unique constructability constraints. Limited utility easements, public safety, existing utilities, city streets, rail-

roads, flood control ditches, and DOT ROW are common obstacles. The willingness of the owner, engineer, contractor and ROW owners to continually cooperate in overcoming obstacles determines the overall success of an urban pipelining project. The presenter will discuss the construction methods utilized and problems overcome during the construction of a 6-mile polyethylene pipeline from the McCarty Road Landfill to the Anheuser-Busch brewery located in Houston, Texas. 100% of the project was completed by using trenchless technology methods, primarily horizontal directional drilling.

#### Change Orders: The Good, The Bad, and The Ugly

Charlie Beyer

Change orders are a part of business whether you like them or not. Historically, change orders are perceived as a mechanism for contractors to take advantage of unsuspecting owners. To alter this perception, the different conditions responsible for change orders need to be understood. These conditions include: changes in scope, site conditions, proposal errors, governmental regulations, utility conflicts, subsurface conditions, force majeure, and value engineering. The contractor has no control over most of these conditions; therefore a coordinated effort to enhance communication between owner, engineer, and contractor through all phases of construction will minimize change orders and their cost.

### Materials

#### Coatings, Grouts and Pipe Joints Testing at CIGMAT-University of Houston

C. Vipulanandan PhD PE

Under the USEPA/Environmental Testing and Verification (ETV) controlled testing program, performance of different coating/lining and grouting materials used in the rehabilitation of wastewater facilities are being investigated. For the coating/lining project, special testing chambers have been designed and built to verify the applicability of various coating materials to 36" concrete pipe under a hydrostatic pressure of 15 psi. To quantify the bonding strength between the coatings and substrates (concrete and clay bricks) several ASTM/CIGMAT test methods are being used. These controlled verification programs at CIGMAT, sponsored by EPA/ETV program will be of assistance to manufactures, suppliers, engineers and owners.

#### Designing and Characterizing the LEED Concrete

C. Vipulanandan PhD PE and Emrah Demircan

In order to meet Leadership in Energy and Environmental Design (LEED) guidelines, research is underway to produce concrete (LEED concrete) with alternative binders. In this study, a LEED concrete mix was designed and tested with 70% Class C fly ash as replacement for cement, with appropriate chemical admixture. The LEED concrete reached similar strength as Portland cement concrete with time, but several other

properties were comparable or even better than the conventional Portland cement concrete. By using appropriate chemical admixture, highly workable LEED concrete with up to 200 mm slump was developed for various applications.

### Construction Quality: Laboratory Compaction Tests are Not the Compaction Standard

*C. Vipulanandan PhD PE, P. Tritico, L. Goldberg*

Laboratory compaction tests are often viewed as the compaction standard for earthen fills. However, laboratory compaction tests are only reference standards for field-specified compaction standards. This situation leads to limited controls in engineering and construction of earthen fills. This is demonstrated in a comprehensive field study, where CL soils were field compacted and several properties (dry density-moisture relationship, maximum dry density, optimum moisture content and air content) were compared to the standard Proctor test. All the properties studied showed notable differences between field compaction and laboratory compaction.

### Construction in Developing Countries: An Overview

*Rajeeb Kumar Rajbhandari and Dr. Enno "Ed" Koehn*

This paper reports the current situation of the construction industry and methodologies used in developing countries such as Nepal. It is known that the state of construction in any country is of great concern for international projects. The specific objectives are to review and investigate the various types of employment relationships that commonly exist in construction, to study the effect of the industry on the economy of a nation, the sectors it affects, and its role in the development of a nation, as well as to compare the methodologies and techniques used in developing and developed countries and analyze the differences.

### Controlling and Monitoring Temperature of Massive Concrete Foundations

*Ramón L. Carrasquillo PhD PE, Oscar R. Antommattei MS PE, Erin R. Guerra, B.S.*

The implementation of temperature controlling and monitoring practices during construction of massive concrete foundations provides the opportunity to ensure the quality and durability of the concrete. Integrating the use of nondestructive technologies into the concrete placements for monitoring during the curing period provides an efficient and economical alternative to prevent early age distress and achieve the required quality of these massive structures. This paper presents concrete fundamentals, application of technology, and lessons learned from successful experiences using temperature data loggers as a tool to monitor and control concrete temperature during the construction of projects in Houston, Texas.

### Electrical Properties of Carbon Nanofiber Concrete

*Di Gao, Mariel Sturm, Y. L. Mo*

Concrete is the most widely used construction material, and carbon nanofiber has many advantages in both mechanical and electrical properties such as high strength, high Young's modulus and high conductivity. In this paper, the electrical properties of

concrete containing carbon nanofiber (CNF) is experimentally studied by conducting a compression test, split tensile test and four-point bending test. The test results indicate that the compressive strength of concrete containing CNF are much greater than those of plain concrete and the percent reduction or increment in electrical resistance is also much greater than those of plain concrete.

### Precast Polymer Concrete Prevents Sewer Gas Corrosion in Large Manholes

*Eric H. Davidson*

Municipal wastewater collection systems are constantly exposed to sulfuric acid that is created by hydrogen sulfide out gassing. This exposure to a low pH environment causes the Portland cement in the concrete to be compromised. The standard means of protecting Portland cement concrete structures is using a coating or lining. Polymer concrete does not require any coatings or linings to protect it from this corrosion. This paper will demonstrate how a noncorrosive polymer concrete was utilized on a project to prevent the corrosion of three ten-foot diameter precast structures that are each approximately 110' (33.52 m) deep.

## Environmental & Water Resources Institute *Environmental*

### Developing Sustainability Awareness in a Consulting Civil Engineering Environment

*Les Pittman PE LEED AP RPLS*

Civil engineers deal with sustainable practices every day. We always have. But we have difficulty communicating sustainability to our staffs, clients, elected officials, and the public. It takes planning, commitment, collaboration and strong firm leadership to successfully create an awareness of, and then implement, an internal and external sustainability program within a civil engineering organization. Sustainability is real. It is here to stay. Failing to be out front can leave your firm at a competitive disadvantage. It can affect perception of your firm, ability to win projects, financial performance, employee retention and targeted employee recruiting. Are you prepared?

### Remediation of PCE Contaminated Soil Using Nanoparticles

*C. Vipulanandan PhD PE and S.Harendra*

Contamination of soils by dense nonaqueous phase liquids (DNAPLs) such as chlorinated hydrocarbons is an environmental concern in industrial and hazardous waste sites. The purpose of this study was to evaluate the effect of different solvents and surfactants to extract tetrachloroethylene (PCE) from contaminated soils and then degrade the solubilized PCE using fine metallic nano-size particles. Solvents such as water, methanol, isopropyl alcohol, anionic surfactant (sodium dodecyl sulfate (SDS), cationic surfactant and UH biosurfactant were used to extract PCE from 200,000 mg/Kg contaminated soils. Fe/Ni nano-bimetallic particles were used to degrade the extracted PCE in batch reactors.

### City of Bryan's Sustainable Capital Improvement Program for Community Based Results

*Linda Huff PE, Paul Kaspar PE, Kevin Johnson PE, Stafford Gunning PE*

Development of a sustainable process for the City of Bryan Capital Improvement Program (CIP) has provided community-based results with more efficiency. The process is a tool to assist with identification, management, and implementation of projects. The project evaluation criteria, derived from community responses, City staff, and the City Council, enable the City to compare cross-departmental projects that compete for funding. The subjectivity of comparing projects is reduced and more reliance is placed on the weighted criteria developed using the City Council's strategic initiatives, citizen input, and effectiveness of the project.

### Simultaneous Removal of Industrial Pollutants Utilizing Constructed Passive Anaerobic Reactor

*Jim T. Yu PhD and Dana Smith*

Industrial wastewaters are of concern due to the presence of such pollutants as heavy metals and organics, as well as abnormal conditions (i.e., extreme pH). Various methods have been used for remediation but were not cost effective and often generated additional waste. This paper presents the construction process, concerns, and results of removing metals from high-strength (i.e., alkaline conditions with multiple metals of concern) alumina production wastewater using passive anaerobic submerged bioreactors which utilize sulfate-reducing bacteria. These have demonstrated success in simultaneously removing inorganic ions (e.g., sulfate) and selected metals (e.g., arsenic and vanadium), while buffering the pH for suitable discharge.

### The Trinity Corridor Project: Advancing the State-of-the-Art in Green Infrastructure

*Ignacio F. Bunster-Ossa ASLA LEED AP*

Functioning simultaneously as a floodway, transportation corridor, ecological resource and urban park, the Trinity River Corridor Project is poised to showcase green infrastructure as a catalyst for sustainable development. The City of Dallas intends to reorient growth back to its downtown and adjacent communities, potentially attracting thousands of residents to new transit, pedestrian, and recreation-oriented developments. As the project's lead designer, the author will present the history behind this ambitious effort, its contentious civic and political path, and the key design measures aimed at transforming more than 2,000 acres of forgotten land into a defining and "green" urban amenity.

### Post-Construction SWQ BMPs for Roadway Projects in Harris County, Texas

*Pratistha Pradhan PhD CFM*

Linearity of roadway projects results in crossing multiple drainage areas, making the use of a single centralized BMP to tackle the stormwater quality problems almost impossible. Stormwater quality requirements, site conditions, ROW limitations, constructability, maintenance, cost, and public safety issues make the implementation of roadway BMPs more challenging. This paper discusses the major pollutants in roadway runoff,

applicable post-construction structural and non-structural BMPs, their effectiveness and cost, Harris County stormwater quality requirements, and practical problems in the implementation of BMPs for roadway projects. An application case study of roadway BMP in Harris County is also included.

### Settling Velocities of Cohesive and Non-cohesive Sediment Particles

*Remya Kumar and Kyle Strom*

The evolution of particle size distributions and fall velocities are fundamental components in the transport and deposition processes of fine sediments in estuaries, lakes, and oceans. Data for these processes can be difficult to obtain because fine sediment flocs are fragile and dynamic. This paper discusses the development and use of a digital floc camera for nonintrusive measurement of flocs and fine sand in the water column. The camera system was tested for accuracy and used to measure the particle size distribution and settling velocity of sand and clay. The experimental data is compared with theoretical equations and previous studies.

### Hydraulics and Water Resources

#### Combined Surface–Sewer Impact Evaluation

*Fergus M. Graham PE and Michael A. Collins PE*

This paper outlines improvements and expansion to the storm sewer system within the 301-acre Shepherd Drive drainage basin in Houston. Design of the upgrades incorporated use of SWMM (Storm Water Management Model) modeling to refine the preliminary design for the upgrade. Surface flow during storm events was also evaluated using a special SWMM feature that allows flow prediction along interconnected streets with actual LiDAR-based topography for the entire drainage area. Using model-predicted time-varying street flooding predictions, refinements to the sewer system design are accomplished to bring maximum depth flooding to within acceptable limits.

#### New and Expanded WRAP Modeling Capabilities

*Ralph Wurbs*

The Water Rights Analysis Package (WRAP) is routinely applied with the TCEQ Water Availability Modeling (WAM) system in regional and statewide planning studies, as well as for administration of the water rights permit process to assess water availability and reliability for municipal, industrial, and agricultural water supply, environmental instream flow, hydroelectric power generation, and reservoir storage. New and expanded WRAP modeling capabilities that will become operational during 2009 include daily time step forecasting, routing, flow disaggregation, flood control reservoir operations, short-term conditional reliability modeling, salinity simulation, methods for extending the hydrologic period-of-analysis, and methods for condensing datasets.

#### Dynamic Modeling as a Public Involvement Tool

*Scott Berman PE CFM, Scott Hubley EIT CFM, Justin Oswald EIT*

With the advent of dynamic storm water modeling techniques, the opportunity has arisen to utilize dynamic modeling results as a tool to better

inform the general public. In addition to being utilized for detailed hydrologic and hydraulic study, many of the latest 1-D and 2-D modeling software packages have the capability of producing graphics and animation to dynamically illustrate storm water flow through storm drain systems and overland. This paper discusses how these graphics and animations may be utilized to inform the general public about existing flood-prone areas and for proposed storm water design improvements.

#### Benefit-Cost Evaluation with Repetitive Flood Losses

*Michael A. Collins PE, Fergus M. Graham PE, Jorge E. Gutierrez EIT*

The 155 square-mile Chocolate Bayou Watershed, located in Brazoria County, Texas, suffers from significant flooding with repetitive widespread flood losses. Under a grant from the Texas Water Development Board, Brazoria County has identified potential flood-control projects to lessen flooding and repetitive losses. GIS-based and statistical procedures are described, by which limited and incomplete repetitive loss information is utilized to determine estimated total number of losses from of various types and converted to net monetary benefits for the proposed projects. Benefits and costs are determined and used to assess benefit-cost ratios for various projects to assist in prioritizing projects for implementation.

#### Back-to-Back, Again:

##### A Frequency Analysis of Gustav and Ike

*Zachary Toups PE PMP CFM and Guillermo Simon PE CFM*

After the historic 2005 hurricane season, FEMA developed surge stage-frequency curves for locations across the Texas coastline. The surge analysis defined stillwater elevations, which served as a parameter that mapping partners used to determine new base flood elevations for FEMA FIRMs. After two quiet years, the 2008 hurricane season saw two powerful hurricanes, Gustav and Ike, hit Texas and Louisiana only weeks apart from each other, yet again. The authors researched gage and high water mark data throughout the state and applied the FEMA stage-frequency results as a measuring tool to determine the frequency of hurricanes Gustav and Ike.

#### Designing a Wetland Using Hydrologic and Hydraulic Modeling

*Kristen White PE CFM and Saleh Satti EIT*

This paper discusses the design of a functioning wetland nature park along Buffalo Bayou in Harris County, Texas. The design was developed using hydrologic (HEC-HMS) and hydraulic (XP-SWMM) models to size a wetland that functions by retaining water year-round and sustains a minimum water surface elevation of 1.5 feet. This analysis was completed assuming that the wetland was fed only by rainwater, with no external water source. In designing the wetland, a year's worth of rainfall data was used to develop a runoff hydrograph in HEC-HMS to input into XP-SWMM for calculation of the wetland's continuous water surface elevations.

#### Modeling Dam Breach and Flood Inundation Mapping

*Michael Crenshaw PE CFM, Anthony Henry BEng, Ben Gouldby BS*

What happens if the dam fails? Who will be flooded? How much time will they have to

respond? With so many questions and few answers related to breach analysis and downstream inundation, emergency managers are feeling the pressure to answer these questions and prepare EAP's based on reliable data. This presentation will discuss recent research involving an international assembly of scientists that serves as the basis for tools within Wallingford Software's InfoWorks RS (River Modeling) to model dam breaches and provide one-dimensional and two-dimensional hydraulics of the downstream propagation of the flood wave.

#### Chocolate Bayou Watershed Flood Mitigation

*Michael A. Collins PE, Fergus M. Graham PE, Jose de la Pena PE, Gerald Roberts PE, Gary L. Struzick PE, Jorge E. Gutierrez EIT*

The 155 square-mile Chocolate Bayou Watershed, located in Brazoria County, Texas, suffers from significant flooding with repetitive widespread flood losses. Brazoria County, with assistance from a grant from the Texas Water Development Board, has undertaken a watershed-wide study for identifying and evaluating potential flood control projects that will significantly reduce flooding. Large and small detention facilities, tributary channel conveyance improvements, capacity improvement of key hydraulic structures, and major diversions to new channels are evaluated. Changes in floodplain extent are modeled and reductions in structural losses are identified for various levels of storm events.

#### Wireless Motion Sensors for Bridge Scour Monitoring

*Colin Darby, Congpu Yao, Stefan Hurllebaus, Jerry Price, Beatrice E. Hunt, Ok-Youn Yu, Kuang-An Chang, Jean-Louis Briaud*

Scour is a major cause of bridge failure. Instrumenting bridges to monitor behavior during flood events reduces public risk exposure. Research on motion sensors (accelerometers) at Texas A&M University shows a link between scour hole development and decrease of the bridge pier's natural frequency. Motion sensors therefore represent cheap, reliable alternatives to down-hole or below-waterline instruments. Integrating wireless motion sensors and cellular modems allows remote data collection and near-instantaneous online data sharing. Results from Texas A&M's large-scale experiments are examined, and a field implementation case study of the US 59 Guadalupe River bridge south of Victoria, Texas is presented.

#### Importance of Geomorphologic Assessments in Stream Stabilization Projects

*Biswajit Mukhopadhyay PhD PE D. WRE and Paul Dornisfe*

Channels migrate, banks fail, and beds degrade. Their effects cause adversity to the ambience, requiring engineering measures for their stabilization. Unlike flood control project designs that mitigate measures typically preceded by hydrologic and hydraulic investigations, typical bank protections, channel realignments, cross sectional changes, and grade controls are placed empirically without proper understanding of the dynamics of the fluvial systems. These often lead the measures to become unsustainable, and the situations further deteriorate with time. In this paper, arguments (with case studies) are presented for

conducting geomorphologic assessments as prerequisites for proper design of stream stabilizations or channel improvements.

## Structural Institute

### Residential Structural and Utility Damages after Hurricane IKE

*C. Vipulanandan PhD PE and M. Liu*

Hurricane history shows that the Texas coast has experienced over 40 hurricanes in the past 100 years. Based on history, the frequency of hurricanes along the Texas coast was represented by a Poisson distribution. After category-2 Hurricane Ike in September 2009, one of the worst hurricanes based on loss of property and deaths, a survey was undertaken by the Texas Hurricane Center for Innovative Technology (THC-IT) to determine the damages to residential structures and utilities in the region. The response to the survey has been very good and the damages are correlated to the reported maximum wind speeds.

### Nonlinear Analysis of Space Trusses

*Mostafa El-Shami, Ahmed Elshafey, Kamel Kandeel, Boshra Aboul-Anean*

Space structures are economical and aesthetically pleasing in appearance. They provide the right solution for architects and civil engineers to accommodate large areas. They also satisfy the requirements for lightness, economy, beauty, and speedy construction. The general purpose of this paper is to introduce a simplified and computationally efficient finite element model to investi-

gate the nonlinear behavior of space trusses. The ANSYS program was employed to do this model with elasto-plastic analysis. Numerical examples are presented to demonstrate the computational advantage of the proposed model and its ability.

### Shear Behavior of Prestressed FRC Beams

*Padmanabha Rao Tadepalli, Hemant B. Dhonde, Arghadeep Laskar, Y.L. Mo, Thomas T.C. Hsu*

Three prestressed concrete (PC) I-beams were tested to study the effects of steel fibers on the increase in shear strength and ductility of beams. After fabrication of the beams, they were subjected to concentrated vertical loads up to their maximum shear or moment capacity using four MTS actuators. From the load tests, it was observed that the shear capacities of the beams were observed to significantly increase due to the addition of steel fibers in concrete. Replacement of shear reinforcing bars with steel fibers also increased the ductility and energy dissipation capacity of the structure.

### A 3-D Finite Element Model for RC Members Subjected to Combined Bending and Torsion

*Ashraf Ayoub PhD and T. Ravi S. Mullapudi*

This paper presents a new reinforced concrete (RC) frame element model to solve combined loading problems, including torsion. The proposed model is formulated to address interaction between the axial force, biaxial shear, biaxial bending, and torsion. The shear mechanism along the beam is modeled by using Timoshenko beam approach with curved three-dimensional

frame elements with arbitrary cross-section geometry. The validity of the model is established by correlation of analytical results with experimental tests of RC specimens. The result shows that the flexural capacity and ductility of the RC members decreased significantly under combined bending and torsion.

### Behavior of a Finite Beam on a Two-Parameter Foundation Subjected to Dynamic Loading

*Ashraf Ayoub PhD and T. Ravi S. Mullapudi*

The nonlinear dynamics of an inelastic beam resting on a nonlinear soil bed is analyzed with the development of fiber beam element. The Winkler approach models the soil as a single layer, and assumes that the foundation reaction at a particular point is proportional to the soil displacement. In this paper a new finite element formulation was developed to simulate the dynamic performance in which the soil can be viewed as a semi-infinite inelastic element that can resist bending, in addition to the well-known Winkler effect. The presented solutions and applications show the superiority of the element in simulating the complex response of foundation structures.

### Parametric Studies of Reinforce Concrete Shear Walls

*Ashraf Ayoub PhD, T. Ravi S. Mullapudi, Parnak Charkhchi*

This paper investigates the effect of different parameters like the slenderness ratio, the concrete strength, the reinforcement ratio, the axial force and different boundary conditions. An analytical model that couples the axial shear and

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banding is proposed. The concrete constitutive law is based on the recently developed softening membrane model. The finite element model was validated through a correlation study with an experimentally tested reinforced concrete wall. These studies resulted in several conclusions regarding the global and local behavior of the wall system.

### Evaluation of Constitutive Behavior of RC Elements under Tri-Directional Shear

*Ashraf Ayoub PhD, Moheb Labib, Yashar Moslehy*

The two-dimensional design and behavior of typical reinforced concrete (RC) structures have been extensively studied. Such design requires knowledge of the constitutive behavior of reinforced concrete elements subjected to a biaxial state of stress. The true behavior of many large complex structures requires knowledge of the constitutive laws of RC elements subjected to a triaxial state of stress. The goal of the proposed work is to develop new constitutive relations for RC elements subjected to a triaxial state of stress. This paper presents details regarding the mounting and installation of additional hydraulic cylinders on the universal panel tester, and preliminary results of large-scale tests of a series of RC panels subjected to three-dimensional shear loads.

### Evaluation of Constitutive Behavior of FRP Shear-Strengthened Reinforced Concrete Elements

*Ashraf Ayoub PhD, Yashar Moslehy, Moheb L. Labib*

The use of fiber-reinforced polymer (FRP) materials as an economical alternative to traditional methods for strengthening deficient reinforced concrete elements dates back to the 1970s. While research related to the flexural behavior of FRP-strengthened elements has reached a mature phase, studies related to FRP shear strengthening is still in a less advanced stage. Several analytical models were recently proposed to predict the gain in shear capacity due to FRP strengthening. The intellectual merit of the proposed work is the development of new constitutive relations for FRP-strengthened reinforced concrete elements subjected to pure shear. The proposed research is expected to result in breakthrough understanding of the complex shear phenomenon of FRP-strengthened elements.

### Effect of Fiber Factor on the Softening Characteristics of Prestressed Steel Fiber Concrete

*N. Hoffman, Thomas T.C. Hsu, Y.L. Mo*

The results of five prestressed steel fiber concrete panel tests were used to determine a relationship between fiber factor and softening coefficient for steel fiber concrete. The researchers utilized the universal element testing (UET) machine at the University of Houston to test five full-scale panels in sequential loading. Longitudinally prestressed steel fiber concrete panels were placed in the machine and loaded first in longitudinal (horizontal) tension. Understanding the softening characteristics of prestressed steel fiber concrete elements is necessary to accurately predict behavior of prestressed steel fiber concrete structures using the Softened Membrane Model (SMM).

## Transportation & Development Institute

### Design and Construction Practices in Environmentally-Challenged Transportation Right-of-Ways

*Mark K. Boyd PhD PE and Y. Lynn Clark PG*

Toxic plumes, closed MSW landfills, lead-contaminated soil, abandoned underground tanks, and numerous other challenges have been addressed and cost effectively resolved for TxDOT, toll authorities and municipalities. Lessons learned by the authors are combined with research to guide engineers toward optimum pipe and backfill material selection for utility installations and general best management practices for roadway design and construction in environmentally compromised projects.

### Bond Strengths of Tack Coats to Aged Concrete Pavements

*C. Vijulanandan PhD PE and A. Parihar*

Tack coats are being used to enhance the bonding strength of asphalt concrete to aged cement concrete pavements. In this study, tensile and shear bonding strengths of tack coats to 20-year-old concrete pavement were investigated. Bonding study of three tack coats, RMA, PG 64-22 and PG 58-28, to cement concrete surface under accelerated thermal aging conditions revealed that the direct tensile bond strength of RMA, PG 64-22 and PG 58-28 remained unaffected in up to 20 freeze-thaw cycles. However, the tensile strength of the some of the tack coats decreased with the increasing freeze-thaw cycles.

### Conveying Access Management Techniques to the Public

*P.K. Okyere PE and Praveen Pasumarthy PE*

Research has found that access management techniques, such as raised medians and low access point densities, improve safety and mobility. However, one of the challenges is getting buy-in from property owners and the general public. The Corpus Christi District of TxDOT initiated development of an access management plan for two-mile sections of SH 357 and FM 2444. This paper presents the techniques employed for successful completion of these projects. A detailed public involvement plan was developed to build consensus, and design concepts and recommendations were effectively conveyed to the public using 3-D visualization software (VISSIM).

### Access Management Standards and Traffic Impact Analysis Guidelines for the City of Houston

*Charles R. Stevens Jr. PE PTOE LEED®AP, Raymond Chong PE PTOE*

In March 2007 the City of Houston began the process of developing access management standards and traffic impact analysis guidelines to be included in Chapter 15 (Traffic and Signal Design Requirements) of the *Infrastructure Design Manual*. Multiple drafts were prepared based on stakeholder input and findings from research. The finalized versions were published approximately two years

later on July 1, 2009. With these documents now being part of the *Infrastructure Design Manual*, this paper documents the development and current implementation efforts, as well as important lessons learned from the process.

### Modeling FAA Surfaces for Airspace Analysis Using Geopak

*Katie Helmsberger PE and Lane Wheatley EIT*

This paper discusses the required FAA approach/departure airspace surfaces and an innovative approach to modeling those airspace surfaces for evaluation of airspace obstructions using Geopak. The modeling technique uses Geopak Site grading software in an unconventional way to produce extremely accurate elevations of the FAA surfaces at any point or along any path. The benefits of this approach are that it is relatively simple; necessary information is usually available to the public; it is cost-effective due to the lack of expensive equipment or software; and it is nondisruptive to airfield operations. This modeling technique was recently used at DFW International Airport and has been approved for use by the FAA.

### Modern Streetcar Design in Texas—Climbing the Learning Curve

*David Recht PE, Jay Kline AICP, Kenneth J. Hughes PE*

Many municipalities are considering implementing modern streetcar systems to enhance public transportation and assist in generating transit-oriented development opportunities. Though several agencies have already started modern streetcar design, this is the first in Texas and will be the first leg of the "Downtown Dallas Circulator." The purpose of this paper is to share the authors' experience in designing a 3,300 linear foot guideway segment for a modern streetcar operation. Topics to be addressed include project mission, track slab considerations, existing utility impacts, paving requirements and considerations, drainage interfaces, and stakeholder coordination.

### SPUI Design Considerations for the Grand Parkway in Harris County

*Doug Emery PE, Matt Brannen PE, Federico Mendoza PE PTOE*

The Harris County Toll Road Authority (HCTRA) is developing Segment E (IH 10 to US 290) of the Grand Parkway as a toll road, typically without frontage roads. HCTRA and Brown & Gay Engineers, Inc. analyzed alternative interchange designs (diamonds and SPUIs), considering intersection capacities, planned land use, and thoroughfare continuity. Five of six candidate interchanges are being designed as SPUIs and require unique geometric (rural vs. urban, simple vs. compound curvature), operational (signal head locations, illumination, pedestrians), and structural (one-span vs. three-span) design analyses. These SPUI designs will result in more efficient access onto the toll road without sacrificing safety or increasing costs.

### Reducing Delays on US 281 via the Signalized Superstreet Configuration

*Gilmer D. Gaston PE PTOE*

Conventional intersections are inefficient at handling high volumes of traffic. The superstreet is a simple alternative for improving traffic flow along

certain arterial roadways. The superstreet provides high traffic throughput by harnessing efficient traffic signal operations and separation of conflicting traffic movements both in time and space. Through detailed traffic simulations, the superstreet has been found to provide a simple cost-effective solution that improves safety, reduces delays, increases north-south throughput, maintains existing commercial access, and meets Federal environmental clearance criteria. The FHWA will soon release design guidance for the superstreet as an alternative intersection strategy for handling congestion.

## Geo-Institute

### TCM Method for Soil-Cement Columns Gulfship Project, Gulfport, Mississippi

*Phillip G. King PE, David Cox, Keith Anderson*

The total column mixing method (TCM) for soil-cement columns was utilized at the Gulfship, LLC, shipbuilding facility in Gulfport, Mississippi. The project consisted of 514 72" diameter soil-cement columns to support a new ship launching facility. Standard in-situ methods of soil mixing require each soil stratum be mixed independently with very little intermixing between strata. Each stratum behaves differently with the cement that is injected and a column design has to be based off of the weakest soil strata. The paper will present the geotechnical engineering design, results of several load tests and a discussion of the construction procedure.

### Active Zone and Cracked Retaining Wall

*C. Vipulanandan PhD PE and K. Vembu*

In this study, the causes of distress (crack movement) in the face panels of a 244 m long and 4.6 m high retaining wall were investigated by instrumenting the active zone adjacent to the wall. Based on the measurements, greatest vertical and horizontal displacements were observed in the top two meters of the ground. The tensiometers measured the changes in the matric suction pressures during this period. Highest vertical settlement and swelling in the active zone were in phase with suction pressure measurements. Inclometers were used to measure lateral movement during the monitoring period.

### Behavior of ACIP Piles in Cohesive Soils

*C. Vipulanandan PhD PE, Kalaiarasi Vembu, Tracy Brettmann,*

*K. Tand*

In order to better quantify the performance of ACIP piles in cohesive soils, the load-displacement behavior of an ACIP pile at the University of Houston test site was investigated. A database of ten other full-scale ACIP piles in cohesive soils with diameters ranging from 406 mm to 457 mm and length varying from 9.7 m to 28 m was also used in this investigation. The measured pile capacities varied from 898 kN to 3648 kN (100 tons to 410 tons). A nondimensional hyperbolic relationship was used to verify the nonlinear load-displacement behavior of the ACIP piles in cohesive soils.

### Predicting Soil Suction Profiles Using Prevailing Weather

*Ronald F. Reed PE*

Suction profiles are useful in evaluating many aspects of unsaturated soil behavior, including

strength and prediction of movement. Profiles are typically obtained at a point-in-time of sampling. Evaluating potential change in soil properties with suction requires an understanding of the time variation in the suction profile. Modeling of daily weather patterns using a modified Thornthwaite Index procedure is used to predict the suction profile for three specific geologic settings. Two predicted profiles per geology are compared to historically measured profiles. The procedure reasonably models the observed suction profile using three to five months of prevailing weather.

### Soil Properties of CH Soils in Southeast Texas

*N.Palla, S. Gudavalli, Liang Chao, M. Jao*

This study investigates soil properties of CH soils in the southeast Texas, which can provide a useful database for engineering design. Field and lab test data were collected from the TxDOT Beaumont District. The field tests were conducted in Jefferson County. The laboratory tests included moisture content, unit weight, liquid limit, plastic limit, and soil classification. Variations of the soil properties investigated with depth have been quantified. Regression analyses were performed to obtain correlations between soil properties and depth. This paper presents the newly developed correlations, which can be useful for estimating and interpreting soil properties for future design.

### 2008 Midwest Levee Failures: An Investigation

*Michelle Bernhardt, Dekay Kim, Mathieu Leclair, Francisco*

*Olivera, Jean-Louis Briaud*

Texas A&M University participated in field reconnaissance to gather pertinent, time-sensitive data needed to characterize different levee breach locations after the 2008 Midwest floods. The field investigation consisted of visual characterization of the soils and vegetation present at each levee site along with sample collection. The work presented includes a hydrological investigation, a study of the influence of vegetation on levee erosion, and characterization of the soils at each levee site including: densities, classification of the levee soils using the Unified Soil Classification System (USCS), plasticity, grain size distribution, compaction curves, and erosion testing in the erosion function apparatus.

### Theoretical Foundations of Geotechnical Engineering II: Guidance for Slab Design

*John T. Bryant PhD PG PE*

All of the Post-Tensioning Institute's (PTI) slab-on-grade design manuals have contained the concept of unsaturated soil mechanics and the complex soil-structure interaction equations based upon continuum mechanics. Some question the complexity of the least-squares regression coefficients contained within the structural design equations. Based upon experience, we are in some ways reluctant to embrace the concept of soil suction to predict movement because of its more mathematical and theoretical basis in the geotechnical soil design parameter section. However, one must understand that this is not a simple beam or truss that we are designing that is simply supported. We are dealing with a slab-on-grade that is intimately connected at the soil surface at multitudes of points.

## Forensic Technical Group

### Long-term Vegetation Effects on Lightly Loaded Slabs-on-Ground

*Gerald F. A. Lowe PE M.ASCE*

Long-term behavior of lightly loaded slabs-on-ground built on expansive soils is dependent on several different factors. Current design methods, such as the PTI method, recognize that vegetation may have a significant effect on overall performance of the slab but give no clear method for rationalizing the effect. This effect has been observed on both residential and light commercial slabs. The general results of a number of investigations performed in the last three years are summarized, as well as two illustrative case studies. Recommendations are presented for further investigation of the phenomenon.

### Recommended Guidelines for Design, Construction and Forensic Evaluation of Inground Swimming Pools in Texas

*David A. Eastwood PE*

Many inground swimming pools are built in Texas. The author has observed many of these pools experiencing movements and cracking. The purpose of this paper is to highlight prudent practices and guidelines for design and construction of pools in order to protect the public and pool contractors against faulty pool design and construction. Pool design and construction should always consider the effects of subsoil, groundwater, structural considerations, drainage, trees and slopes. The author will specify recommended geotechnical exploration, design parameters, structural design considerations, and various pool design and construction techniques. The author will also discuss in detail the effects of trees on pools.

### Landscaping for Foundation Performance and Sustainability

*Carolyn J. LaFleur MS PE M.ASCE*

Civil engineers receive training in the physical and mechanical properties of soil as related to design of foundations, retaining walls, and other structures. However, engineers are often not knowledgeable or trained in the biological properties of soils, specifically the microorganisms that inhabit healthy soil. Promoting healthy soil near the perimeter of a structure can effectively mitigate the flux of moisture around the structure that can lead to less than desirable foundation performance. Awareness of these properties and how they can be incorporated into the design process can improve structural performance, conserve water used for irrigation, and count as beneficial "points" in green building projects.

## History and Heritage

### The First Railroad Built in Texas: Crossing the Brazos at Richmond

*Jerry R. Rogers PhD PE D.WRE Dist.M.ASCE*

The first railroad in Texas was begun by General Sidney Sherman. The Texas legislature awarded a charter in 1850 for the Buffalo Bayou, Brazos and Colorado (BBB&C) Railroad. In 1851, John A. Williams from Boston was named locating engineer and he started by surveying the route. The Brazos River became an obstacle to the railroad. This paper

tracks the first railroad in Texas and the Brazos bridges at Richmond from 1856 to 1869. In 1870, the new name of Galveston, Harrisburg and San Antonio Railroad was adopted over the BBB & C.

## Educational

### Constructing Our Future—Creating and Working with a New Generation of Engineers

*Kristin Green PE*

What are the challenges that the engineering profession is facing in the near future? In the next five years, engineering professionals leaving the workforce will outnumber young engineers entering the workforce. Engineering firms will be competing against each other

like never before for entry/mid level engineers. However, the real challenge will be retaining these young engineers who will have a much different approach to their careers than previous generations. In order to sustain our profession, we will undoubtedly have to adapt to this approach as we prepare the next generation of engineers for the challenges that will face them.

### Improvements of Civil Engineering Undergraduates with the Implementation of Program Outcomes

*PT Leelani, J.O. Sai, M.A Faruqi, F. Aquinica, D. Sun, B. M. Bailey*

As specified by the Accreditation Board of Engineering and Technology (ABET) and the ASCE Body-of-Knowledge for the 21st Century, program outcomes

were first developed to compliment the educational objectives and mission of Texas A&M University-Kingsville (TAMUK). The program outcomes were then adopted to become part of the course learning objectives. Using the processes of assessment and evaluation, the program outcomes were achieved with the improvements made based on actual feedback results. This paper describes the developed program outcomes, as well as faculty attention and improvement efforts, which have been given to each curricular component in consistence with the educational objectives of the civil engineering program at TAMUK.

## Posters

### Developing a Vulnerability Composite Map for Harris County, Texas

*Chunling Liu*

The project covered by this poster promotes a broad perspective of vulnerability, which combines both geophysical vulnerability and social vulnerability and presents a more complete measurement of vulnerability for evacuation assistance needs as related to the hurricane hazard in Harris County. The geophysical vulnerability index and social vulnerability index will be developed based on National Hurricane Center data, FEMA maps and census information, and then combined to determine spatial patterns of evacuation assistance needs. Through examining these spatial patterns, this research will provide useful knowledge to emergency planners for developing an effective evacuation strategy.

### ASR Mitigation Techniques: A Field Study in Houston, Texas


*Eric R. Giannini and Anthony F. Bentivegna*

Several years after entering service, columns supporting a flyover near downtown Houston, Texas began to exhibit significant cracking that was attributed to alkali-silica reaction (ASR). From 2006 to 2009, TxDOT and FHWA jointly funded a field study of ASR mitigation techniques involving 12 of the affected columns. These included electrochemical and vacuum impregnation of lithium and several types of silanes and other coatings. After three years of monitoring, it was concluded that the silane treatments had achieved the most success of all the post-treatments in mitigating ASR in the columns.

### Dallas Center for the Performing Arts and Dee and Charles Wylie Theatre

*Peng Zhao PE and Diana O'Connor*

The Dallas Center for the Performing Arts (DCPA), a multiveneue center for music, opera, theater and dance, will celebrate its grand opening this October. The most significant performing arts complex built since the Lincoln Center in New York, the center will provide multiple state-of-the-art facilities surrounded by a ten-acre park. The Dee and Charles Wylie Theatre is a 12-level building that features an unprecedented "stacked" vertically organized facility. The site design, including an 18-foot below grade entrance, presented unique challenges. URS designed innovative solutions to address this complex site, respecting the facility's aesthetic qualities and enhancing the patron experience.



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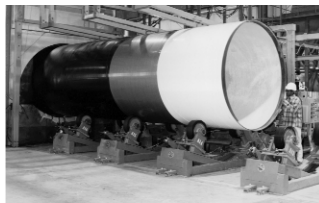
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