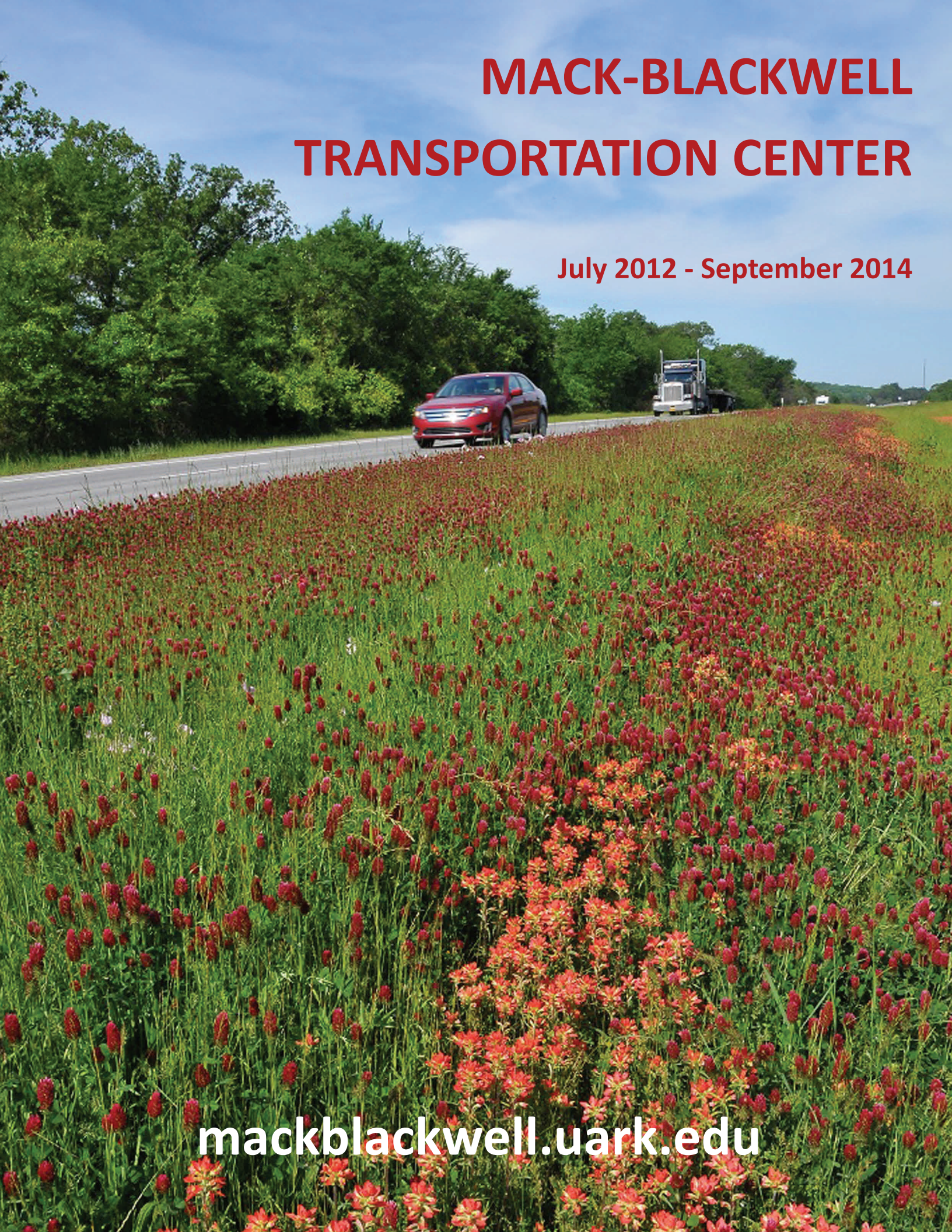

MACK-BLACKWELL TRANSPORTATION CENTER

July 2012 - September 2014

mackblackwell.uark.edu

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UNIVERSITY OF ARKANSAS

MBTC ADVISORY BOARD

Cover photo courtesy of AHTD

MESSAGE FROM THE EXECUTIVE DIRECTOR

These are certainly exciting times for the Mack-Blackwell Transportation Center (MBTC)! Our Tier 1 University Transportation Center (UTC), MarTREC (Maritime Transportation Research and Education Center) is thriving; our partnership with the Region 6 UTC, Southern Plains Transportation Center (SPTC) based out of the University of Oklahoma, is taking off with the awarding of our first projects; and our Center for Training Transportation Professionals (CTTP) continues to grow – particularly in the role of delivering technology transfer in partnership with the Arkansas State Highway and Transportation Department (AHTD). While our programs and products continue to be of highest quality, the secret to our success lies with the many, many talented faculty, staff, and students working with MBTC. As a dear friend, Dr. Kim Needy (Dean of the UA Graduate School), eloquently and succinctly stated in a recent speech: "People matter!". I am continually amazed by the people at MBTC – from our Director, Dr. Heather Nachtmann, through the hourly student cleaning asphalt pans, the good folks working for Mack-Blackwell are singularly focused on delivering quality. It is indeed an honor and privilege to work with such a talented and dedicated group. As you read through MBTC publications, I encourage you to *see* the people involved – these are not only current leaders in transportation, but future leaders as well. Based on what I see here, the future is indeed bright.

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MBTC RESEARCH PROJECTS

PERFORMANCE OF PRESTRESSED GIRDERS CAST WITH LIGHTWEIGHT SELF-CONSOLIDATING CONCRETE – PHASE I

Micah Hale, Ph.D., P.E.
University of Arkansas

This project investigated the bond of 0.6 in. (15.2 mm) pre-stressing strands cast in lightweight self-consolidating concrete (LWSCC). The factors used to characterize this bond behavior include transfer length and development length. Transfer length was determined using both concrete surface strain and strand end slip. Development length was determined using iterative flexural testing with varied embedment lengths. The measured transfer and development lengths of the LWSCC specimens were compared to those measured for the normal weight self-consolidating concrete (NWSCC) specimens as well as to the predictions made by the accepted American Concrete Institute/American Association of State Highway and Transportation Officials (ACI/AASHTO) code equations and equations developed by previous researchers.

PERFORMANCE OF PRESTRESSED GIRDERS CAST WITH LIGHTWEIGHT SELF-CONSOLIDATING CONCRETE - PHASE II

Micah Hale, Ph.D., P.E.
University of Arkansas

The goal of this project was to analyze the current AASHTO pre-stress loss equations and determine their applicability for use in LWSCC. Another purpose was to determine how individual components of the equations compared to those measured. The AASHTO method of predicting modulus of elasticity gave acceptable estimates. Less shrinkage occurred in the LWSCC which utilized soaked coarse light-weight aggregate than the NWSCC made with limestone aggregate. This corresponds to a pre-stress loss of 8.6 ksi due to shrinkage in the limestone mix that did not occur in the lightweight mixes. For the materials and mixture proportions used in this study, the AASHTO load resistance factored design (LRFD) 2010 Bridge Design Specifications approximate method gave better results for the prediction of total pre-stress loss than the refined method. The AASHTO refined method is sensitive to one day compressive strengths. For low strengths, the AASHTO refined method overestimates pre-stress losses. The AASHTO refined method should not be used to estimate pre-stress losses in LWSCC. Using the AASHTO approximate method to estimate pre-stress losses in LWSCC should be acceptable, especially for preliminary design.

NANOTECHNOLOGY-BASED IMPROVEMENTS FOR PORTLAND CEMENT CONCRETE

R. Panneer Selvam, Ph.D., P.E.
Kevin D. Hall, Ph.D., P.E.
University of Arkansas

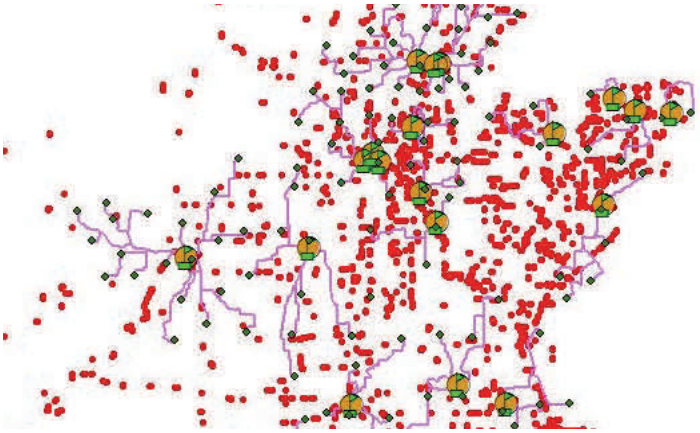
A fundamental understanding of the nano-structure of Portland Cement Concrete (PCC) is the key to realizing significant breakthroughs regarding high performance and sustainability. This project studied a discrete element method (DEM) for considering the calcium silicate hydrate (CSH) gel structure. Using this approach, the CSH structure was manipulated to better model high and low density CSH and provided new insight on the impact of the CSH structure on PCC mechanical properties. The importance of using DEM for nano science study of cement and concrete is discussed in the final project report. The difficulty in using molecular dynamics to study the structure of CSH is also discussed. The current status of DEM application in understanding concrete is reviewed. Existing freeware and commercial codes based on

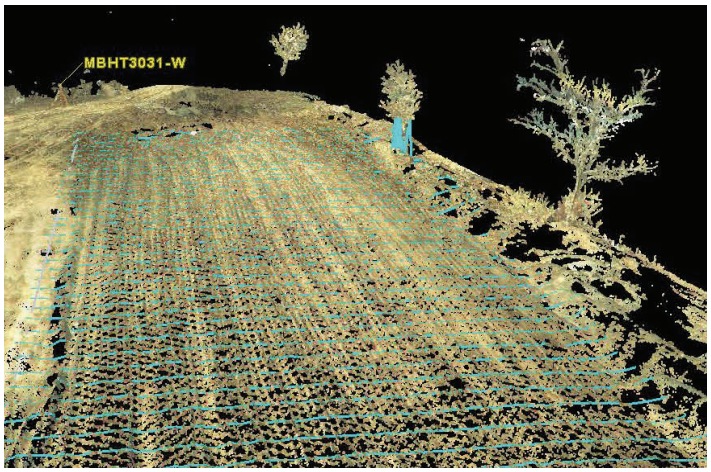
DEM are reviewed. Different DEM codes that are available for this research and the difficulty in using those codes are also discussed.

MODELS FOR DISASTER RELIEF SHELTER LOCATION AND SUPPLY ROUTING

Ashlea Bennett Milburn, Ph.D.
Chase Rainwater, Ph.D.
University of Arkansas

The work on this project focused specifically on the post-disaster delivery of relief across a region devastated by a New Madrid Seismic Zone (NMSZ) catastrophic event. Providing disaster relief in an efficient manner is extraordinarily challenging since much of the relief need and documented damage is not available to the user in the critical hours following the event. Stated simply, critical decisions regarding location of relief distribution points is not strategic and must be done with very little real information. For that reason, much of our study emphasized the ability to make real-time solutions in a fashion consistent with what responders are faced with. Of course, judging the quality of a real-time solution is challenging, unless compared against a describable metric. In our case, we utilized the best known offline solution to establish a bound on how effectively relief demand can be satisfied over a seven-day recovery period. When exploring the impact of varying the barriers used to represent a disrupted road network, this change had minimal impact on the overall amount of demand satisfied. However, it did result in changes in the points of distribution located to satisfy that level of demand.





IDENTIFICATION OF EXPANSIVE SOILS USING REMOTE SENSING AND IN-SITU FIELD MEASUREMENTS

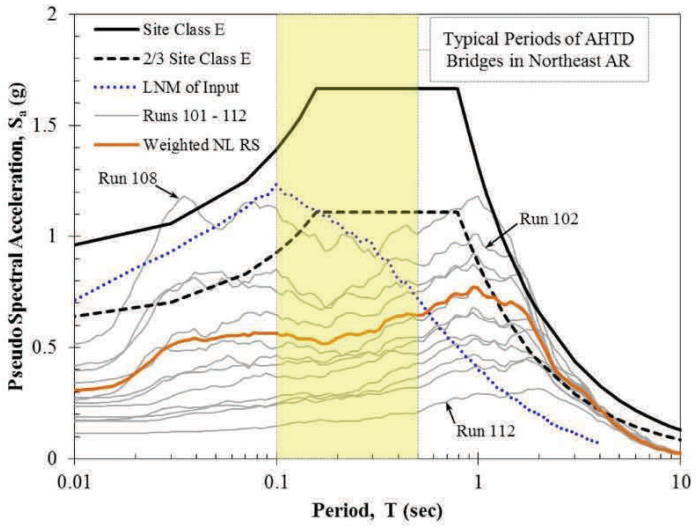
Richard A. Coffman, Ph.D., P.E.
University of Arkansas

The volume change characteristic of clay soils from Northwest Arkansas (with and without bentonite amendment) was determined by combining knowledge gathered from emerging ground based remote sensing platforms (visible, infrared, and microwave spectra), and geotechnical field investigations (volumetric moisture content, soil temperature, soil suction, infiltration, evaporation). The work sought to demonstrate and test the efficacy of remote sensing (specifically using ground based radar) as a new approach for in-situ classification, characterization, and heave prediction of expansive soils. The research findings include the validation of light detection and arranging (LIDAR) remote sensing to identify and characterize the presence of expansive clay induced ground movement. However, improved processing techniques are required to fully utilize the potential of this technology. With respect to the tensiometers, it was difficult to install the probes with an adequate seal and to prevent the growth of algae in the fluid reservoir. Additionally, the suction measurements were found to be highly influenced by diurnal cycles. It is unsure if the suction variation between day and night represent accurate or false results. Despite the difficulties encountered with the installation of the Time-domain reflectometer (TDR) probes, it appears that the TDR system is capable of providing real time measurement of the volumetric water content.

SITE-SPECIFIC GROUND MOTION ANALYSES FOR TRANSPORTATION INFRASTRUCTURE IN THE NEW MADRID SEISMIC ZONE

Brady Cox, Ph.D., P.E.
Now at University of Texas at Austin

This study demonstrates the feasibility of conducting site-specific ground motion response analyses for the seismic design of transportation infrastructure in Northeast Arkansas as a means to reduce short-period design ground motions. Located in the New Madrid Seismic Zone, this region is underlain by incredibly thick layers of soft sediments that are subject to significant seismic hazards. Generic, code-based designs are not capable of accounting for this unique geologic setting. In particular, code-based designs cannot account for the anticipated short-period attenuation and long-period amplification of earthquake ground motions. As a result, short-period structures may be over-designed at a significant cost, and long-period structures may be under-designed at a significant risk. Results from this study show that, had the site-specific ground motion response analyses been conducted prior to design, seismic design loads for the example bridge could have been reduced by 33%. For long-period structures, site-specific analyses may predict amplification exceeding the provisions in the AASHTO specifications. These alternative cases, while not cost-saving, are perhaps the more compelling argument for site-specific ground motion response analyses.



EXPLORING DIFFERENT FORMS OF BASE-STABILIZATION

Andrew Braham, Ph.D., P.E.
University of Arkansas

Over time, the structural capacity of low-volume roads becomes inadequate. A relatively quick and sustainable solution to increase the structural capacity is to perform a base stabilization rehabilitation including cement, asphalt emulsion, and asphalt foam. This project synthesized existing literature and compiled full mix design procedures for these base stabilization technologies. A compression test was performed on multiple asphalt binder contents and water contents. Overall, higher water contents and higher binder contents produced higher compressive strengths.

BIODIESEL WASTE PRODUCTS AS SOIL AMENDMENTS - FIELD STUDY AND RUNOFF IMPACTS

Thomas S. Soerens, Ph.D., P.E.
Now at Messiah College in Pennsylvania

In biodiesel production, the waste product glycerol, commonly called glycerin, is produced and must be disposed. Application of glycerin to soil for dust control or as a beneficial soil amendment in transportation projects is a disposal alternative that has possible advantages. The project results show that a moderate and measured application of glycerol as a soil amendment has no negative effect on soil microbiology, some benefit for plant germination and growth, and no significant increase of total organic carbon from glycerol treated grass plots. High

concentrations of glycerol can have a negative effect on plant germination and growth. The results suggest that glycerol is not toxic to soil microbial communities. In the respirometer testing, the presence of glycerol in a wide range of concentrations in soil showed no inhibition in oxygen uptake. One test with a low concentration of glycerol may have shown a slight inhibition in oxygen uptake relative to the control, but all tests with glycerin showed oxygen uptake.

ECONOMIC EVALUATION OF ARKANSAS INLAND WATERWAYS AND POTENTIAL DISRUPTION IMPACTS

Heather Nachtmann, Ph.D.
University of Arkansas

Arkansas is one of twenty-four states with an inland waterway transportation system. Over one thousand miles of Arkansas navigable waterways have the potential to attract industries by offering low-cost transportation in a strategic location with links to domestic markets including Chicago, Houston, and Pittsburgh and coastal ports in the Gulf of Mexico. A decade ago, prior research indicated that Arkansas ports directly and indirectly contributed to the economic growth of this state including economic value, earnings, and employment. There is a need for current information on the economic impacts of Arkansas' inland waterway transportation system and what impact disruptions to this system may have. The results of this project may spur investment in port development, which can in turn increase Arkansas' competitive advantage over neighboring states while continuing to offer social and environmental transportation benefits.

MODEL FOR MITIGATING DYNAMIC RISK IN MULTI-MODAL PERISHABLE COMMODITY SUPPLY CHAIN NETWORKS

Edward A. Pohl, Ph.D.
Ashlea Bennett Milburn, Ph.D.
Chase Rainwater, Ph.D.
University of Arkansas

This project explored modeling paradigms for developing decision support tools capable of assisting homeland security and inland waterway infrastructure managers with allocating scarce resources to mitigate risks across inland waterway infrastructure in order to reduce the risk of supply chain disruptions in the inland waterways. The models formulated as part of this effort each present a unique set of challenges when it comes to solution approaches for problems of reasonable sizes. While these are strategic decisions and would only need to be made annually or at most quarterly, the complexity of the current model formulations make that a challenge for even reasonably sized problems. Future research is needed to explore solution methods that will enable us to deal with the non-linearity's associated with the perishability issues, the stochastic elements associated with the probabilistic variables and extensive set of possible scenarios, and the complexity that arises in a bi-level modeling framework. Future efforts will focus on exploring reasonable solution approaches for this class of models.

The University of Oklahoma is leading the Southern Plains Transportation Center (SPTC), a Regional University Transportation Center (UTC) that has been funded by a $5.2 million grant awarded by the U.S. Department of Transportation. In addition to OU, the Southern Plains Transportation Center consortium includes Oklahoma State University, Langston University, **University of Arkansas**, the University of New Mexico, Louisiana Tech University, the University of Texas at El Paso, and Texas Tech University. Regional transportation centers differ from other U.S. Department of Transportation funded centers in that consortium members must be located in the region they serve and address regional needs.

The funding helps advance U.S. technology and expertise in transportation through education, research, technology transfer, and workforce development at university-based centers of excellence. The four-year grant awards each regional UTC $2.6 million annually for the first two years, with eligibility to renew for multiple subsequent years.

Extreme summer temperatures, flash floods, and large numbers of freeze-thaw cycles coupled with poor soils create enormous challenges to the region's transportation infrastructure and public safety. According to OU Civil Engineering Professor and Southern Plains Transportation Center Director Musharraf Zaman, "Considering only recent severe droughts, economic losses are estimated at almost $9 billion annually to managed systems in Oklahoma and Texas alone, including transportation infrastructure."

SPTC RESEARCH PROJECTS

EVALUATION OF SURFACE TREATMENTS TO MITIGATE ALKALI-SILICA REACTION

Micah Hale, Ph.D., P.E.
University of Arkansas

Alkali-silica reaction (ASR) is an expansive reaction between the alkalis in the cement and reactive silica in the aggregates. Arkansas is currently witnessing the detrimental effects of ASR at various locations in Arkansas. This project examines methods to slow or stop ASR once it has occurred in concrete structures. Research at the University of Arkansas has shown that concrete expansion due to ASR may be exacerbated by the extreme weather changes that Arkansas has experienced during the recent winter. This weather change has resulted in additional freezing and thawing cycles in ASR infected structures and has caused further deterioration. Concrete cracking due to freezing and thawing has allowed additional water into the structures which accelerates ASR. The research will examine the effectiveness of silane when freezing and thawing cycles are common.

IMPACT OF EXTREME SUMMER TEMPERATURES ON BRIDGE STRUCTURES

Micah Hale, Ph.D., P.E.
University of Arkansas
Royce W. Floyd, Ph.D.
University of Oklahoma

This project focuses on investigating the effects of extreme temperatures on pre-stressed concrete bridges. The project includes three parts: (i) a laboratory and experimental investigation, (ii) development of a computer program, and (iii) finite element modeling of the stress distribution due to temperature variations. The research will propose a new thermal gradient model accounting for the effects of extreme temperatures. A computer program will be developed to assist the quantification of the thermal stress distribution within pre-stressed concrete bridge girders. The minimum reinforcement ratio and placement of non-pre-stressed reinforcement will be refined based on the research findings.

DEVELOPMENT OF THE MASW METHOD FOR PAVEMENT EVALUATION

Clinton Wood, Ph.D.
University of Arkansas

Infrastructure deterioration is a major issue for transportation infrastructure in the southern plains region and around the nation. Delamination, cracking, and many other failure modes in bridge decks and pavement systems are a daily issue in the constant maintenance of transportation systems. The extreme weather across the nation further exasperates the problem of failing infrastructure by increasing the wear and tear on transportation systems through more frequent freeze-thaw cycles and larger temperature swings. To combat these problems in an economic way, highway departments need non-destructive testing (NDT) methods to determine the condition of infrastructure and the rate of decay to better plan for future repairs and replacement of transportation systems. This project explores Multi-Channel Analysis of Surface Waves as a NDT method developed as an improvement to the Spectral Analysis of Surface Waves method for dynamic characterization of soil for geophysical and geotechnical engineering problems.

Photo courtesy of AHTD

EVALUATION AND REPAIR OF EXISTING BRIDGES IN EXTREME ENVIRONMENTS

Royce Floyd, Ph.D.
University of Oklahoma
Gary Prinz, Ph.D., P.E.
University of Arkansas

The goal of this project is to produce comprehensive strategies for evaluation and resilient repair of prestressed concrete and steel bridge girders subjected to extreme environments in order to increase the longevity of existing structures. The effect of end region steel corrosion on capacity of pre-stressed concrete girders will be examined, with the objective of producing rating procedures related to corrosion level and repair designs incorporating residual strength. Innovative design strategies for corrosion resistant steel bridge fatigue retrofits will also be explored, to protect against environmental extremes and extend bridge fatigue life under increased levels of freight/truck traffic. The PIs are experts in pre-stressed concrete and steel structures respectively and will focus their individual efforts on the specific aspects of the project related to their expertise. They will work together to leverage their expertise into comprehensive recommendations for the common bridge types in Region 6.

Left to Right—Frances Griffith, Diane Allen, Charles Steelman, Stacy Williams, Roselie Conley, and Mary Fleck

Since 1996, the Center for Training Transportation Professionals (CTTP) has provided quality training and testing to transportation technicians working in the state of Arkansas. With new road programs being initiated, the need for these classes has been on the rise. On average, CTTP conducts 30 courses each year with approximately 465 CTTP technical certifications granted annually. Primary courses offered include Basic Aggregates, Concrete Field Testing, Hot Mix Asphalt, Soils, and Concrete Strength Testing. Laboratory certification has displayed steady enrollment, with a total of approximately 100 participating laboratories. CTTP's online training modules have taken a definite step forward with over 600 technicians completing the required Basic Aggregates refresher certification. Another online module, Basic Math for Transportation, was also launched this year. This training is designed specifically for technicians who are familiar with laboratory procedures, but are not as comfortable with the mathematical calculations required for reporting test results. CTTP online training is currently provided at no charge and can be used as a means of preparing for class or simply for reviewing test methods.

CTTP is actively engaged in AHTD's Technology Transfer (T^2) program. CTTP serves as a significant resource for conveying information to cities and counties within the state of Arkansas. Recent T^2 course developments include Asphalt Pavement Maintenance and Storm Water Management, Accelerated Bridge Construction, Safety Countermeasures for Local Roadways, Three-Dimensional Modeling, and Streamlining for Environmental Documentation. The other major addition to the T^2 program is the beginning of the Roads Scholar Program. This program will provide well-deserved recognition to local agency personnel completing a curriculum of courses pertaining to safety, maintenance, and infrastructure. We look forward to congratulating the first group of graduates in the near future!

OUTSTANDING STUDENT OF THE YEAR

The 2012 Mack-Blackwell Transportation Center *Outstanding Student of the Year* was awarded to Cyrus Garner. Cyrus was nominated by Dr. Rick Coffman, who said, "Simply put, numerous hurdles encountered during the project would not have been overcome without Mr. Garner's contribution to this project. Mr. Garner's raw intelligence has allowed him to conduct this pioneering research within Geotechnical Engineering enabling him to make a significant contribution to the profession." Cyrus worked on MBTC DOT 3031, "Identification of Expansive Soils Using Remote Sensing and In-Situ Field Measurements–Phase I."

Cyrus is a doctoral candidate in Civil Engineering. He was born in New York City and raised in Brooklyn, New York and Vinalhaven, Maine. Before continuing his education for a Master's, Cyrus worked as part of the construction management team building correctional facilities in Arizona and Colorado. His master's research focused on the characterization of tunneling induced subsidence, using finite element modeling and closed form solutions, and resulted in three journal publications. Building on his previous work, his current research focuses on ground deformation associated with unsaturated soils (specifically expansive clays). Cyrus uses remote sensing methodologies, utilizing a wide range of the electromagnetic spectrum, to determine soil: color, mineralogy, volumetric moisture content, temperature, and volume change. Above is Cyrus Garner receiving his award from RITA Administrator, Greg Winfree, at the CUTC Awards Banquet.

AR GOOD ROADS SCHOLARSHIPS

From left to right, Kevin Hall; Bill Ramsey, executive director of Arkansas Good Roads Transportation Council; Ross Helliker; Taylor Lindley; Benjamin Whatley; Emmanuel Banks; assistant chief engineer for operations, Arkansas State Highway and Transportation Department; Tanner Clement; Beth Allen and Jack Buffington

Five seniors from the Department of Civil Engineering have received engineering scholarships from the Arkansas Good Roads Transportation Council for the 2014-15 academic year. The Council creates awareness of the many important benefits of improving roads, bridges, and other key transportation infrastructure in Arkansas by researching, evaluating and publicizing data focused on transportation issues. The organization grants scholarships of $5000 for outstanding civil engineering students in their junior year or senior year of college. Recipients of the engineering scholarship commit to work in the transportation field in Arkansas for a minimum of one year after graduation. This year, all five recipients of the scholarship were University of Arkansas students. The recipients were Beth Allen, Tanner Clement, Ross Helliker, Taylor Lindley and Benjamin Whatley. Taylor Lindley is a member of the Honors College.

DAN FLOWERS DISTINGUISHED LECTURE SERIES

Each year MBTC holds its annual "**Evening with the Pros**" to give professional advice to engineering students. Recent participants include Scott Bennett, Director of the Arkansas State Highway and Transportation Department; Nate Bachelor, CEI Engineering; Ross O'Kelley, AECC; and Stuart Nolan, Crisp Engineering.

Dr. John Andrews, the Royal Academy of Engineering and Network Rail Professor of Asset Management from the University of Nottingham Transport Engineering Centre, presented a distinguished lecture on January 14, 2013 entitled: *Controlling the Effects of Engineering Failure*. Dr. Andrew's asset management discussion focused on the development of maintenance strategies for a modern railway system.

On November 14, 2013, **Dr. George Tchobanoglous,** Ph.D., P.E., NAE, Professor Emeritus UC-Davis lectured on *Direct Potable Reuse: A Future Imperative*. Dr. Tchobanoglous discussed how population growth, urbanization, and climate change are stressing public water supplies and offered a viable solution to the problem through direct potable reuse of purified water.

IN THE NEWS

COE FEDERAL DAY

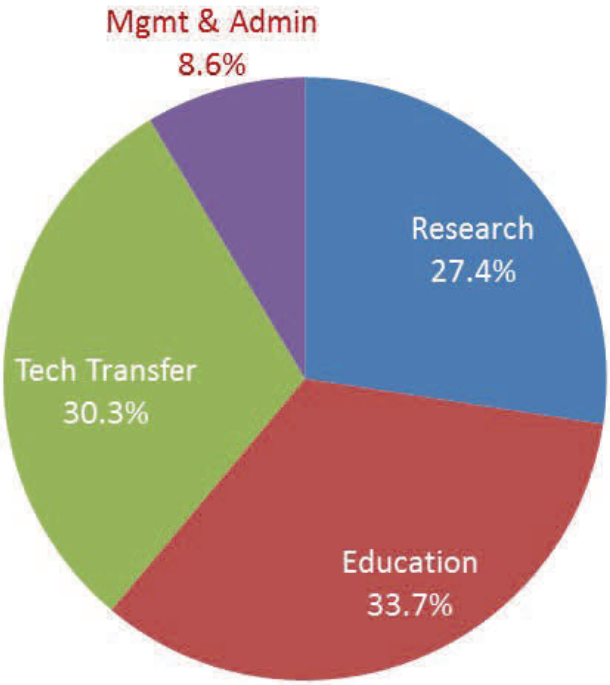
In August 2014, legislative staff members from the offices of Senators John Boozman and Mark Pryor and the offices of Representatives Tom Cotton, Rick Crawford, and Steve Womack toured campus to learn more about engineering research at the University of Arkansas. The guests interacted with faculty researchers, visited engineering research laboratories, and heard from Randy Massanelli, vice chancellor for governmental relations, Provost Sharon Gaber, and John English, dean of the College of Engineering. The staffers toured engineering laboratories and learned about cutting-edge research in the college's five research strength areas: electronics, energy, healthcare, nanoscience, and transportation and logistics. Featured here is a photo of the group listening to Dr. Kevin Hall discuss ongoing research in concrete pavement design.

USCG LANTAREA ACADEMIC SPEAKER SERIES

In January 2013, Dr. Heather Nachtmann of MBTC and Dr. Henry Mayer and Mr. Matthew Campo of the Center for Transportation Safety, Security & Risk at Rutgers University presented "Supporting Secure and Resilient Inland Waterways" to Vice. Adm. Robert Parker along with Coast Guardsman onsite at U.S. Coast Guard (USCG) Atlantic Area headquarters and virtually to the Districts 8 & 9, USCG R & D Center, and the USCG Academy. In addition to Dr. Nachtmann, Dr. Mayer, and Mr. Campo, the Supporting Secure and Resilient Inland Waterways (SSRIW) project team consists of Dr. Justin Chimka and Dr. Edward Pohl at the University of Arkansas and Ms. Jennifer Rovito at Rutgers University. The SSRIW project, funded by the U.S. Department of Homeland Security through the National Transportation Security Center of Excellence, is developing a prototype response and planning tool that provides timely knowledge and awareness of what barge cargoes should be prioritized for offloading in the event of a catastrophic disruption to an inland waterway, and the availability and capacity of nearby ports and land-based freight infrastructure to receive and transport these cargoes.

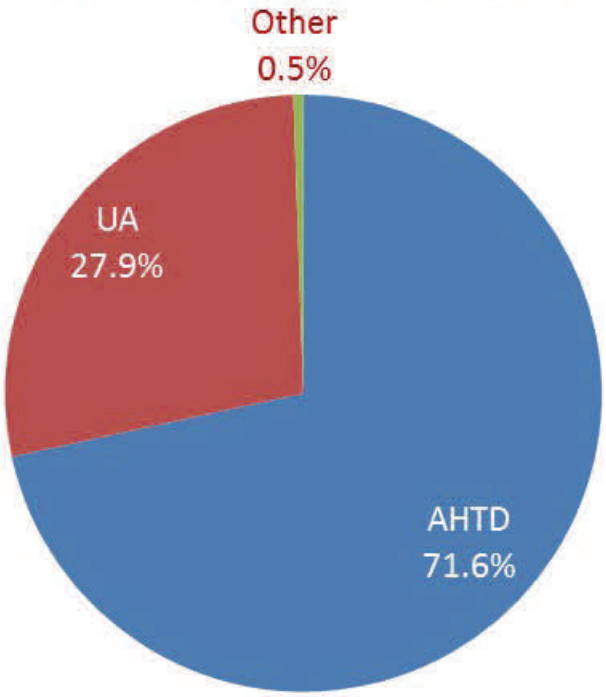
FINANCIAL INFORMATION

MBTC Expenditure Distribution
July 2012 - September 2014



Total Expenditures = $2,478,037

MBTC Match Sources
July 2012 - September 2014



IN THE NEWS

The National Evacuation Conference was held in New Orleans in January 2014 at the Ernest N. Morial Convention Center. The conference planning committee included MarTREC Site Directors Dr. John Renne of UNO and Dr. Brian Wolshon of LSU. “This conference brought together urban planning, disaster mitigation, and resiliency leaders from the University of New Orleans with national and international experts on disaster and evacuation planning, to foster an interdisciplinary exchange of ideas about evacuation issues, in particular mass evacuations prompted by disasters. Topics of discussion included lessons learned from Superstorm Sandy and the Boston Marathon Bombings, as well as evacuation planning around nuclear power plants and for carless and vulnerable populations. Keynote speakers included Tom Ridge, the nation's first secretary of the U.S. Department of Homeland Security and former governor of Pennsylvania, FEMA Deputy Administrator Richard Serino, and retired U.S. Army General Russell Honore, who served as commander of Joint Task Force Katrina responsible for coordinating military relief efforts for Hurricane Katrina-affected areas across the Gulf Coast.” (transportation.uno.edu, 2014)

In July 2014, MarTREC Site Director Dr. John Renne of UNO participated in a roundtable led by the Secretary of the U.S. Department of Transportation Anthony Foxx and New Orleans Mayor Mitch Landrieu to commemorate the 50th anniversary of the Civil Rights Bill. “Transportation in America still has a long way to go in promoting equality,” Dr. Renne said. “We still do a poor job in connecting affordable housing to jobs, shopping and services. We are a car dependent nation, which has disparate impacts to African Americans in many communities. While solving these problems can sometimes be controversial, we owe gratitude to the generations before us that sacrificed so much to enable us to move towards a more inclusive society where we can have an open debate across race, gender and culture.” (transportation.uno.edu, 2014)

MarTREC Director Dr. Heather Nachtmann presented to members of the Mississippi River Commission aboard the MV Mississippi (shown left) in August 2014. The presidentially appointed Commission was conducting an inspection tour of the McClellan-Kerr Arkansas River Navigation System (MKARNS). Dr. Nachtmann presented on a regional economic impact study of the MKARNS that she is conducting with the Arkansas State Highway and Transportation Department, Arkansas Waterways Commission, Oklahoma Department of Transportation, and the University of Arkansas Little Rock. In addition to estimating regional economic impacts, the project is also investigating the ancillary benefits of the MKARNS.

thousands of tourists and travelers from everywhere. Emergency management teams play a huge role in safeguarding the lives of people in endangered areas by evacuating them to safer locations as efficiently as possible. An evacuation plan is an essential component of an emergency plan. This research will study the effect of applying various traffic control plans (TCP) to the Mississippi coast region to provide the most efficient movement of vehicles out of the region during a hurricane evacuation.

Photo courtesy of AHTD

Roadway Sign Recognition During Computer Testing versus Driving Simulator Performance for Stroke and Stroke with Aphasia Groups

Neila Donovan, Ph.D.
Louisiana State University

The literature has shown that stroke may impact pre-requisite skills needed to drive including physical mobility, sensorimotor, cognition, communication, visual perception, and visual processing. No known studies have evaluated the driving performance in a driving simulator of people with stroke+aphasia, or compared their performance to stroke only survivors or healthy controls, we expect the results of this study to add new information to the literature in at least 2 areas: 1) preliminary identification of existing differences among three groups, a control group (CON) a stroke only group (SG) and a stroke+aphasia group (AG) on computer-based road sign recognition tasks; and 2) preliminary identification of existing differences among the same three groups on driving performance variables under different driving conditions in a driving simulator.

National Inventory and Analysis of Transit Oriented Development in Proximity to Coasts and Port Facilities

John L. Renne, Ph.D., AICP
University of New Orleans

There is often a tension between the development of mixed-use transit oriented developments (TODs) and heavy industry near coastal areas, major rivers and near port facilities. This study will quantify and examine the number of jobs and residents in station areas near costal areas, major rivers and near port facilities across the United States. The study will also forecast future development and job potential of underbuilt station areas, which could become TODs over the next several decades. The National TOD Database will be combined with the National Transportation Atlas Database, coastline data from the Census and data on major rivers from ArcGIS. The GIS analysis will isolate all rail stations located within a half-mile, 1-mile and 3-miles of coastlines, major rivers and ports. Once identified, a typology of station areas will be applied based on Renne and Ewing 2013, which outlines a method for determining if a station area is a TOD, Hybrid or Transit Adjacent Development (TAD) (which is a station area that is low-density and automobile focused). The study will identify the number and type of jobs located in all types of stations and compare and contrast by typology. It will also calculate the number of people and households as well provide a snapshot about commuting behavior, vehicle ownership, housing tenure, and socio-economics of residents. The study will also forecast future development potential by looking at several build-out scenarios to turn TADs and Hybrids into TODs.

effective management of highway storm water runoffs will be produced.

LNG Bunkering for Marine Vessels at the Port of New Orleans: Siting and Facility Components

Bethany Stich, Ph.D.
James R. Amdal, Sr.
University of New Orleans

The Port of New Orleans has expressed interest in investigating the physical, operational and safety issues associated with an LNG Bunkering Facility sited within their jurisdiction. The University of New Orleans Transportation Institute (UNOTI) is conducting a best-practices assessment based on the most current research documents and discussions with maritime leaders in the Greater New Orleans area. Reports reviewed include the recently released ABS authored "Bunkering of Liquefied Natural Gas-fueled Marine Vessels in North America" as well an on-going professional journals and related publications including a series of White Papers by FC Gas Intelligence and related resources. UNOTI is also conducting on-site inspections of the Harvey Gulf LNG Bunkering station under construction at Port Fourchon and is planning on interviewing key-decision-makers who participated in the permitting of this facility.

Identifying High-Risk Roadways for Infrastructure Investment Using Naturalistic Driving Data

Brain Wolshon, Ph.D., P.E., P.T.O.E.
Louisiana State University

The goal of this research is to identify high-risk roadway segments for capital investment to mitigate future increases in crash rates. This is achieved by establishing a statistical relationship between surrogate crash measures and roadway segments with historically high crash rates. This research may lead to identifying locations with relatively low crash rates now, but potentially could increase in the future. These findings could potentially reduce the loss of life and property of the traveling public as well as identify roadway segments in need of targeted capital investment to provide a sustainable highway infrastructure for multimodal use.

LIVABILITY AND EMERGENCY MANAGEMENT OF COASTAL AND RIVER VALLEY COMMUNITIES

Development of a Large-Scale Traffic Simulation Model for Hurricane Evacuation of Mississippi Coastal Region

Feng Wang, Ph.D., P.E.
Jackson State University

Hurricanes are one of the most catastrophic events resulting in severe consequences including loss of life and property damage. The magnitude of devastation was evident in the hurricanes Katrina and Rita in the Gulf coast. The Mississippi Gulf coast region generally refers to the Gulfport-Biloxi-Pascagoula Area that consists of the Gulfport-Biloxi Metropolitan Area and the Pascagoula Metropolitan Area, including five counties and a joint population of about 400 thousand residents and 150 thousand families. The casino industry and tourism in the region also attract

Pg. 8-9 river photos courtesy of AHTD

In-Situ Monitoring and Assessment of Post Barge-Bridge Collision Damage for Minimizing Traffic Delay and Detour

Wei Zheng, Ph.D., P.E.,
Jackson State University

Bridges over major navigation waterways often suffer from barge collisions. After collisions, both bridges and navigation waterways are usually closed to traffic for assessing the collision damage of bridge structures, leading to substantial traffic delay or detour. The ultimate goal of this project is to improve the mobility and emergency preparedness for the transportation systems of both highways and navigation waterways through implementing Intelligent Transportation Systems. This research aims to develop an efficient in-situ monitoring and data processing scheme for assisting bridge professionals to reliably assess the barge-bridge collision damage and make prompt and informative decisions related to bridge and navigation operations. The project will explore the efficient sensor deployment that can unitize low-cost acceleration sensors to effectively capture the useful information on collision damages, and effective data processing scheme that integrates Bayesian probabilistic inference and in-situ sensor data to assess collision damages and their uncertainties, and validate their effectiveness through extensive simulated tests.

Exploration of Novel Multifunctional Open Graded Friction Courses for In-situ Highway Runoff Treatment

Yadong Li, Ph.D.
Lin Li, Ph.D.
Jackson State University

This study is aimed at exploring a new material for in-situ treatment of highway storm water runoffs to prevent pollution of water bodies. Storm water runoffs from highways contain both organic and inorganic contaminants of which large portions are eventually conveyed to the nearby water bodies such as rivers and lakes. The U.S. Department of Transportation is subjected to increasing pressures from water quality regulatory agencies for the control and treatment of highway storm water runoffs. There is an urgent need to alleviate the effects of highway runoffs. Copper and zinc have been identified to be the major inorganic contaminants in highway runoffs. The goal of this study is to explore a Multifunctional Open Graded Friction Courses by adding innovative additives to Open Graded Friction Courses to create a new material that has high heavy metal removal capacities. A series of batch experiments will be conducted to optimize the material composition and fabrication process and to determine its adsorption capacities for heavy metal removals. Technical guidance for highway application of this material for

BUILDING RESILIENT AND SUSTAINABLE MULTIMODAL INFRASTRUCTURE

Optimal Dredge Fleet Scheduling within Environmental Work Windows

Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas

The USACE annually dredges hundreds of navigation projects through its fleet of government dredges and individual contracts with private industry. This project seeks to examine the decision of allocating dredge resources to projects system-wide under necessary constraints including environmental restrictions concerning when dredging can take place due to migration patterns of turtles, birds, fish, and other wildlife, dredge equipment resource availability, and varying equipment productivity rates that affect project completion times. Building on previous research with USACE, this project is specifically motivated by the need to apply recently developed scheduling optimization tools to provide comprehensive sensitivity analysis regarding the impact of varying dredge job sizes, available dredge equipment and the size of environmental windows. Beyond sensitivity analysis, this project will expand the previously developed optimization tools to allow for multiple dredge resources to work on a single job, environmental windows to be dredge specific and environmental windows to serve as soft constraints. Finally, while previous work has assumed that the demand for dredging, availability of dredge equipment and length of environmental windows are known with certainty, this research will explore how dredge planning is impacted when these factors are treated as stochastic components. The goal of this research is to offer a robust decision tool that can be used by USACE to determine the appropriate dredge fleet and the optimal operations associated with that fleet for a given set of jobs.

Rapid and Non-Destructive Assessment of Levees for Strength and Liquefaction Resistance

Clinton Wood, Ph.D.
Michelle Bernhardt , Ph.D.
University of Arkansas

In 2013, the American Society of Civil Engineers (ASCE) gave the levee system in the United States an overall rating of D-. This rating is based in part on information from the National Levee Database which is comprised of approximately 14,700 miles of levees operated by the USACE. These levees are more than 55 years old on average and were originally designed to protect farmland from flooding; however, due to urban sprawl and changes in land use, over 14 million people now live or work behind these structures. To prevent failures in these structures, ASCE estimates more than $100 billion is needed to repair and rehabilitate the levee system. However, only a small portion of that money is currently allocated by the federal government. Therefore, the available money must to be used to repair the most critical levees first. The goal of this research is to develop a rapid, non-destructive geophysical testing program and probabilistic framework that can be used to proactively evaluate levees. A series of geophysical field trials will be conducted to determine the most accurate and efficient methods and the best parameters for detecting various features or defects within levees.

Photo courtesy of USACE

extends our earlier work through CPTAP model enhancement, expanded application, and improved solution approach development. The overall research objective is to provide timely knowledge and awareness of what cargoes should be prioritized for offloading during disruption response and what infrastructure exhibits low resiliency in terms of modal capacity to potential attacks or natural disasters against inland waterway transportation systems. Ongoing work has developed a systematic literature review of cargo prioritization methods and factors and an optimization approach to CPTAP to provide decision support for disruption response stakeholders in order to minimize the total value loss of cargo disruptions on the inland waterways.

Multimodal Transport and TransLoad Facilities in Arkansas

Justin R. Chimka, Ph.D.
University of Arkansas

Photo courtesy of Omaha TransLoading

Funded by the Arkansas Economic Development Commission, this project is based on the theory regional and short line railroads are underutilized, and a key to unlocking greater economic value in Arkansas is additional TransLoad Facilities that enable Multimodal Transport. Long term goals related to the project include determining what should be the locations and capabilities of additional facilities, and producing a guidebook for people interested in developing a TransLoad Facility.

Regional Economic Impact Study of the McClellan-Kerr Arkansas River Navigation System

Heather Nachtmann, Ph.D.
University of Arkansas

Forty-one states in the United States are connected via navigable inland waterways. The navigable inland waterways provide a low-cost, reliable, and environmental friendly transportation system. Research shows that the navigable inland waterways system has a significant impact on gross output, gross domestic product, employee earnings, and employment. The McClellan-Kerr Arkansas River Navigation System (MKARNS) contains 440 miles of waterway and is a crucial part of the United States' transportation system. The MKARNS connects strategically the heartland of the United States with the rest of the world. Thus, this project is investigating the economic impacts of the MKARNS to enhance the understanding of its importance and potential outcomes of a disruption. The findings of this study may be valuable for future investment decisions into the MKARNS which can result in sustainable growth in the regional economy.

events. The research objectives are: 1) to develop mathematical models to assess the cost (to distributors using the inland waterway system) of transporting multiple products from origin(s) to destination(s) when the channel depths of all waterway segments are fixed, 2) to develop a static (i.e., not evolving over time) model for selecting dredge projects with the aim of answering the following question: Given resource limitations what we know about current channel depths, which subset of dredge projects should be executed in the present?, and 3) extend the models of the previous objective to schedule dredge projects dynamically over time as new information about hydrologic conditions becomes known.

Economic Impacts of Lock Usage and Unavailability

Justin R. Chimka, Ph.D.
University of Arkansas

Freight statistics should provide an objective baseline for transportation policy decisions, and national economic benefits of maritime transport necessitate improving inland waterways infrastructure. Proposed work includes consolidating and learning from Lock Use, Performance, and Characteristics data collected by the U.S. Army Corps of Engineers (USACE) and published by the Navigation Data Center. The objective is to estimate statistical models of annual tons locked by commodity group and lock, as a function of lock usage and unavailability (1993-2013), to discover knowledge of relationships between system disruption and economic consequences. This research will estimate annual tons locked by commodity group and lock, as a function of lock usage and unavailability (1993-2013). Usage data include average delay and processing time, barges empty and loaded, flotillas and vessels, lockages, and percent vessels delayed. Unavailability data include scheduled and unscheduled lock unavailabilities, and unavailable times. Estimation would require consolidation and statistical models of Lock Use, Performance, and Characteristics published by the USACE Navigation Data Center. Results would include effects of lock usage and unavailability on tons locked by commodity group (coal, petroleum, chemicals, crude materials, primary manufactured goods, food, manufactured equipment, waste material).

Supporting Secure and Resilient Inland Waterways

Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
University of Arkansas

To mitigate inland waterway disruption impacts, we developed the cargo prioritization and terminal allocation problem (CPTAP) to minimize the total value loss of disrupted barge cargoes. CPTAP is formulated as a nonlinear binary integer program, and problems of realistic size can be efficiently and effectively solved with a heuristic approach. The final solution identifies an accessible alternative terminal for each disrupted barge and the prioritized offload turn that each barge takes at its assigned terminal. Implementation of CPTAP results in reduced cargo value loss and response time when compared to a naïve minimize distance approach. This project

MarTREC RESEARCH PROJECTS

MARITIME AND MULTIMODAL LOGISTICS MANAGEMENT

Dynamic Decision Modeling for Inland Waterway Disruptions

Shengfan Zhang, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas

The inland waterway system is a major component of the U.S. transportation system. Disruption on the inland waterway system can have widespread economic and societal impacts, and their consequences can be significant. However, the uncertainty associated with the disruptive events, such as extreme weather conditions, have made it difficult to determine whether it is optimal to stay on the water and wait for the locked traffic to clear, or it is more economical to redirect to rail or freight transportation. In order to facilitate decision making in the event of waterway closure under uncertainty, this research will develop a dynamic multi-criteria decision framework that can be used to find a timely and optimal solution for the greatest overall societal benefits. The overall goal of this research is to facilitate decision making in the event of inland waterway disruptions considering uncertainty associated with the disruptive events. To reach this goal, our research objectives are: 1) to understand the history of disruptive events for inland waterways, their consequences, and current practices in the event of waterway closure, 2) to characterize the risks and uncertainty associated with inland waterway disruptions, 3) to develop a multi-criteria Markov decision process model that incorporates uncertainty and considers objectives from all stakeholders, and 4) to design a user-friendly post disruption decision support tool that can assist decision making for practitioners.

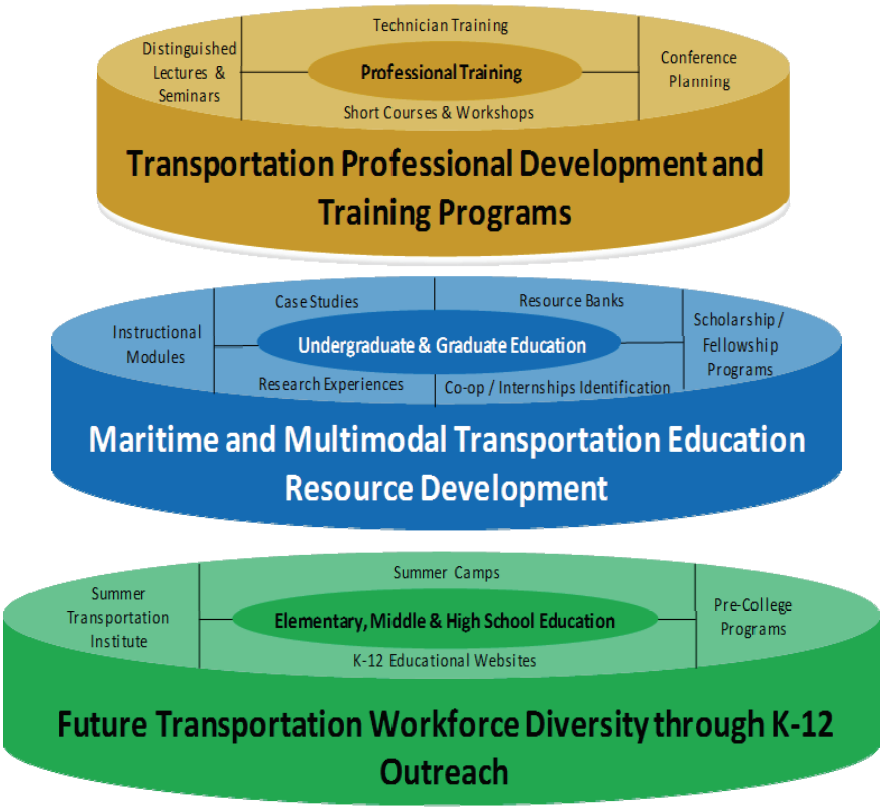
Efficient Dredging Strategies for Improving Transportation Infrastructure Resilience

Kelly Sullivan, Ph.D.
University of Arkansas

The viability of the marine highway system as efficient means of transportation is highly dependent upon weather patterns, which vary widely from year to year. Droughts can render waterways impassable to large ships, forcing distributors to either rely on other, more expensive, transportation modes to satisfy their transportation needs, or take action to restore waterway navigability. One way to accomplish this is by dredging, or excavating, certain stretches of waterways. This project will develop mathematical modeling approaches to explore cost efficient dredging strategies for hardening inland waterway infrastructure against the possible impacts of drought

EDUCATION & WORKFORCE DEVELOPMENT

MarTREC is dedicated to transportation education and workforce development through the conduct of educational activities in Multimodal and Multidisciplinary Transportation Educational Resource Development, Transportation Professional Development and Training Programs, and Future Transportation Workforce Diversity through K-12 Outreach which build upon existing programs at the MarTREC consortium institutions.



The MarTREC consortium is extensively networked through existing collaborative partnerships. These established partnerships will support MarTREC's technology transfer activities in Research Dissemination, Educational and Workforce Outreach, Information Exchange Mechanisms, and Technology Innovation. MarTREC is committed to broadening participation and increasing diversity in transportation. Due to dedicated leadership, institutional demographics, and existing programs, MarTREC is ideally situated to support this cause. It is anticipated that transportation agencies and private industry will be increasingly challenged to find highly-qualified and technically-trained employees in the coming years due to increased retirement rates, fewer entrants into the transportation field, and increased competition for skilled labor, engineers, and planners. The USDOT-funded 21st Century Workforce Development Summit expressed concern that transportation agencies could face a workforce loss up to 50% by 2020. MarTREC is dedicated to transportation education and workforce development.

MarTREC

Maritime Transportation Research & Education Center

CONSORTIUM

Competitively funded in September 2013 through Map-21, the University of Arkansas, located in Fayetteville, AR, was awarded a Tier 1 Center entitled the Maritime Transportation Research & Education Center that focuses on building Economic Competitiveness. Our consortium consists of the University of Arkansas, Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University, Baton Rouge, LA; and University of New Orleans, New Orleans, LA. JSU is a Minority Serving Institution and AR, LA, and MS are EPSCOR States collaborating to meet the EPSCOR goal of stimulating competitive research.

VISION

MarTREC's theme is building economic competitiveness through efficient, resilient, and sustainable maritime and multimodal transportation systems. Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education. Our MarTREC consortium was formed based on nationally-renowned expertise supporting the MarTREC theme, strategic location along a major navigable river or in a coastal area, and dedication to transferrable research and inclusive education and workforce development.

RESEARCH

MarTREC will conduct research activities in three research domains: 1) Maritime and Multimodal Logistics Management, 2) Building Resilient and Sustainable Multimodal Infrastructure, and 3) Livability and Emergency Management of Coastal and River Valley Communities.

MESSAGE FROM THE DIRECTOR

MarTREC's vision is to be recognized as the nation's premier source for expertise on maritime and multimodal transportation research and education. We are thrilled that Rear Admiral Kevin Cook, Commander of the U.S. Coast Guard's Eighth District; Mr. Jeff Lillycrop, Technical Director of USACE ERDC Civil Works; Dr. Kenneth Ned Mitchell, Research Civil Engineer of the USACE ERDC's Coastal and Hydraulics Laboratory; Dr. Craig Philip, CEO - Retired of Ingram Barge Company, and Ms. Shannon Samples Newton, President of the Arkansas Trucking Association have joined our Advisory Board to help us achieve that vision. MarTREC leaders and researchers are working to maximize the effectiveness and efficiency of the maritime and multimodal transportation system by conducting translational research to benefit the economic, reliability, safety, and environmental aspects of the system. I hope you enjoy your first look into the valuable contributions being made at the University of Arkansas and our partners at Jackson State University, Louisiana State University, and the University of New Orleans.

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MarTREC

Maritime Transportation Research & Education Center

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