TRAN-SET
QUARTERLY NEWSLETTER

Summer **2021** • ISSUE **15**

INSIDE THE ISSUE

ABOUT TRAN-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across five states (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas). Tran-SET is led by LSU and was established in late-November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes."

LETTER FROM THE DIRECTOR

Wishing You a Warm and Exciting Summer!

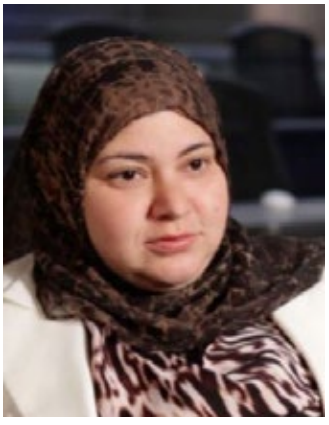
Summer seemed to come so fast this year! As you all know, due to the current COVID-19 situation nationwide, the 2021 Tran-SET conference was held virtually on June 3-4, 2021. The event was co-sponsored by the Judd Hill Foundation and e-hosted by Arkansas State University (A-State). The conference included 45 interesting presentations and 16 student posters, which will be uploaded on our YouTube channel soon. During the conference, Tran-SET also conducted its business meeting with our Center Advisory Board (CAB) members, associate directors, and program directors to solicit feedback/guidance. I would like to take this opportunity to personally thank all Tran-SET staff, associate directors, program directors, and principal investigators whose efforts are much appreciated and are directly responsible for making the Tran-SET conference a big success.

I am always delighted to report Tran-SET's progress. Tran-SET has finalized selection and award of its fifth-cycle projects. In total, 36 research projects will be awarded and will begin on August 1, 2021. If you are interested in learning more about them, two-page fact sheets will be developed for each project and will be available on Tran-SET's website shortly.

Tran-SET is currently soliciting research problem statements for its sixth cycle of funding. Principal investigators/researchers, CAB members, and other community/agency leaders are encouraged to participate. Problem statements for the sixth cycle of funding are due by August 1, 2021. For more information, please visit Tran-SET's **website**.

If you haven't done so already, I highly encourage everyone to follow us on **LinkedIn** and **Twitter**. You may also subscribe to our **mailing list**.

I invite you to read through our Summer 2021 newsletter and learn more about our research, technology transfer, educational, and workforce development activities.



Enjoy!

Marwa Hassan, PhD, PE, F.ASCE
CETF Distinguished Professor
College of Engineering, LSU

RESEARCH PROGRAM UPDATES

CALL FOR SIXTH-CYCLE PROBLEM STATEMENTS NOW OPEN!

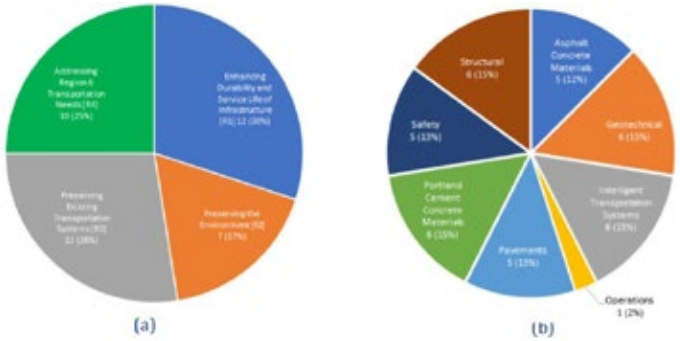
Tran-SET is currently soliciting research problem statements for its sixth cycle of funding. Any and all principal investigators/ researchers are welcomed to submit problem statements, including those not part of Tran-SET or located within Region 6. However, problem statements selected after review/ranking that were submitted by institutions not part of Tran-SET (including those in Region 6), will move forward as an open request for proposal (RFP). Only institutions within Region 6 (including those not part of Tran-SET) will be able to apply to an open RFP. Any and all Center Advisory Board (CAB) members and other community/agency leaders are also welcomed to submit problem statements. Problem statements for the sixth cycle of funding are due by August 1, 2021. For more information, please visit Tran-SET's website.

THIRD-CYCLE PROJECT CLOSEOUT

In spite of COVID-19 and LSU's subsequent shutdown (March 2020- July 2020), Tran-SET worked closely with principal investigators to deliver projects on time. Out of the 33 third-cycle projects, 14 ended their implementation phase, submitted their implementation reports, and were successfully completed and closed out (February 2021). For the remaining 19 projects, Tran-SET staff conducted an initial review of submitted final reports and datasets (December 2020), requested revisions (February 2021), and received revisions (March 2021). The finalized reports and datasets were archived and disseminated per UTC reporting requirements (April 2021).

FOURTH-CYCLE PROJECTS IN PROGRESS

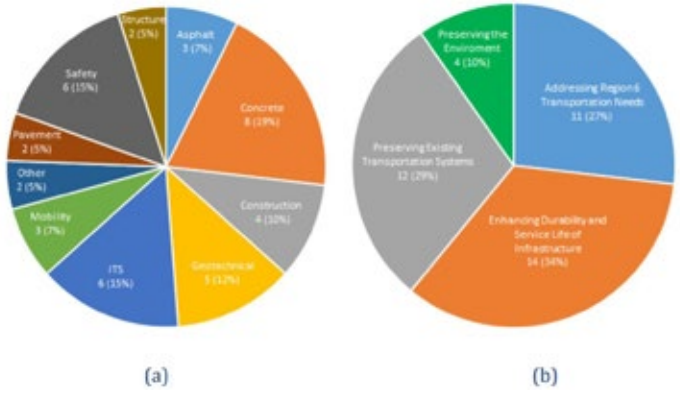
Tran-SET's fourth-cycle projects are in progress and their second progress reports and trackers were submitted on April 2021. The technical phase of Tran-SET's fourth-cycle projects will end on August 1, 2021. Please "stay tuned" as Tran-SET will disseminate the final reports of these projects when available. Don't miss a report by subscribing to our **mailing list here**!



Fourth-cycle projects categorized by (a) research objective and (b) transportation area.

UPDATE ON FIFTH-CYCLE PROPOSALS

Tran-SET issued a call for problem statements in June 2020 for its fifth cycle of research projects. A total of 95 were received (September 2020) and reviewed and ranked by regional leaders (October 2020). Requests for proposals were solicited for 41 projects (November 2020), and 36 project proposals were received (February 2021). Proposals were reviewed by subject matter experts (April 2021) and revised accordingly by the submitted research teams (May 2021). Tran-SET is currently in the process of making award decisions and finalizing the fifth-cycle funding program. **All fifth-cycle projects will start on August, 2021.**



Fifth-cycle proposals categorized by (a) research objective and (b) transportation area.

RESEARCH IN PROGRESS: HIGHLIGHTS

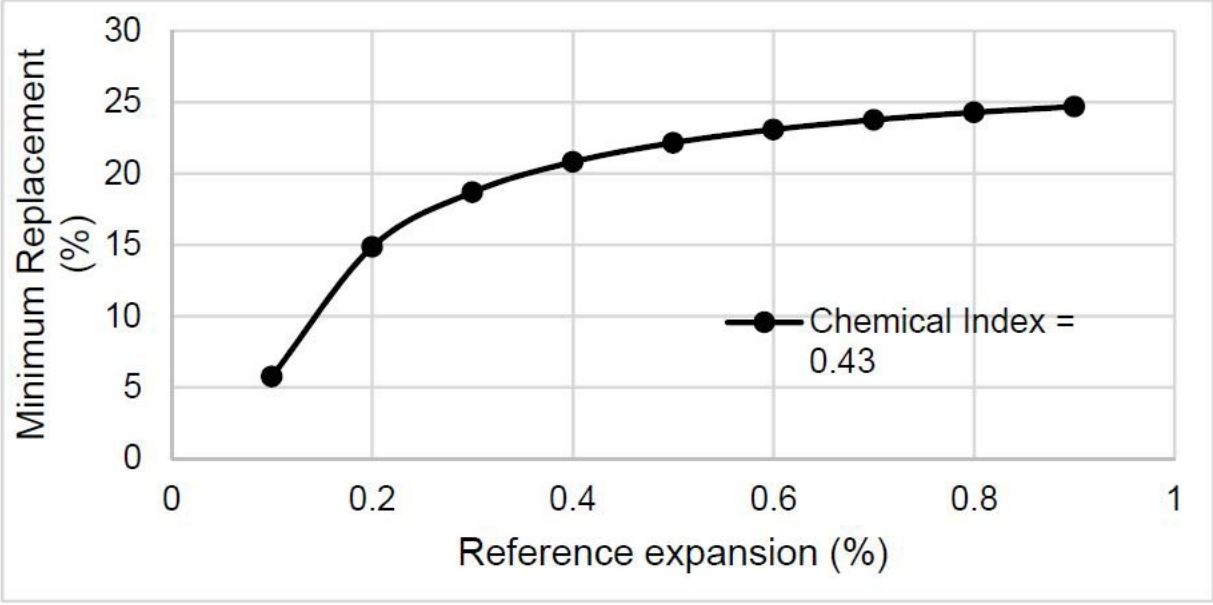
Please see below for a showcase of select, Tran-SET research projects. ***Is our research applicable to your technical area? Beneficial or a potential solution to your local transportation system? Can benefit from your efforts? Interesting?*** *Please contact us for ways to coordinate, be involved, and engaged! To learn more about the following projects (and the rest of our 35 active research projects), please visit* **our website**,

Durability of Concrete Produced With Alternative Supplementary Cementitious Material

Dr. Craig Newtson, Dr. Brad Weldon – New Mexico State University

New Mexico contains several aggregate sources that are very susceptible to alkali-silica reaction (ASR). To moderate ASR, the New Mexico Department of Transportation (NMDOT) requires at least 20% Class F fly ash (by cement mass) in almost all concrete produced in its projects. However, Class F fly ash has become difficult for concrete producers to procure, and future availability is uncertain. Therefore, NMDOT is considering using alternative supplementary cementitious materials (SCMs) that could be used instead. These potential SCMs are to be studied and chemically tested for increased strength and durability.

The purpose of this research project is to assess alternative SCMs being considered for potential acceptance by NMDOT. The SCM under consideration is a natural pozzolan mined from a pumicite deposit near Espanola, New Mexico. Natural pozzolans are a class of siliceous or siliceous and aluminous materials that possess virtually no cementitious value on their own but react chemically with calcium hydroxide and water at ordinary temperatures to form compounds possessing cementitious properties that can improve concrete strength and durability. NMDOT has very little information on mixture proportions and durability properties of concrete produced with this material, so it is not able to fully accept the material for use in concrete produced for its projects, even if Class F fly ash is not available.



Minimum natural pozzolan replacement to mitigate ASR expansion as a function of reference expansion for specimens produced with only cement (no SCM).

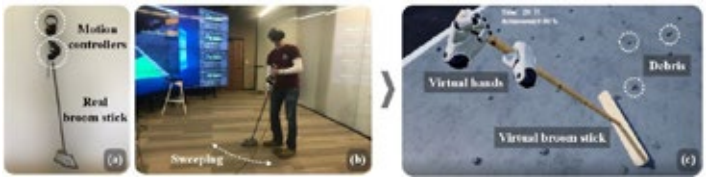
RESEARCH IN PROGRESS: HIGHLIGHTS

Preventing Struck-By Hazards: Defying Risk-Desensitization Via Virtual Accident Simulation

Dr. Changbun "Ryan" Ahn – Texas A&M University

Despite its capability, research into virtual reality (VR) safety training is young. Assessing past studies' performance has relied mostly on indirect measurements (e.g., trainees' perception of the approach's impact) due to the challenges in judging behavioral outcomes. To this end, efforts to rigorously evaluate the effect of VR-based safety trainings will play a critical role in advancing their feasible applications. This project will use behavioral and physiological measurements of habituated behaviors to assess the impact of VR-based safety training in trainees' risk habituation, thus laying an academic groundwork for personalized safety training that adequately stops struck-by deaths in road construction work areas.

The proposed project will create a VR training system that allows researchers and practitioners to analyze trainees' risk habituation tendencies based on collected behavioral and physiological response data (i.e., eye movement, vigilance in a simulated environment) and offers interventions that effectively prevent risk habituation by demonstrating the negative consequences of unsafe behaviors. Past injury simulations using a synthetic hand model were effective in promoting situational interest among construction workers; such interventions to curb the development of risk habituation will be used.



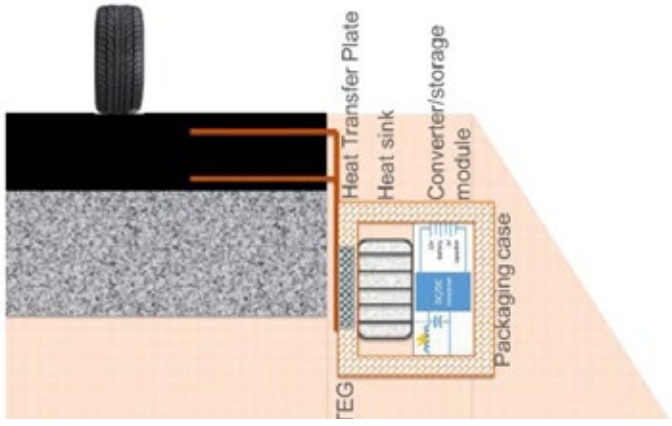
Cyber-physical interactive system for hand-movement synchronization: (a) motion controllers on the real broomstick, (b) sweeping in the real world, (c) debris on the surface in the VR environment.

An Innovative Thermo-Energy Harvesting Module for Asphalt Roadway Pavement

Dr. Samer Dessouky – University of Texas at San Antonio

Energy conservation and using alternative energy resources is more pressing now due to the environmental impact of fossil fuel use. Greenhouse gases disturb the climate, and conventional nonrenewable energy sources are being depleted. Thus, seeking green energy sources is direly necessary. Energy harvesting (scavenging) is a process that recycles unused ambient energy that would otherwise be lost in the form of heat, vibration, stress, or deformation. With growing population and traffic volumes, the demand for safe, sustainable roadways is increasing. Roadways are under several sources of strain energy by vehicle loading and thermal energy gradients by solar heat. These sources can possibly be converted and stored as usable electric power. Using innovative technologies to harvest this green energy may lead to a sustainable transportation network, particularly in remote areas with no power grids.

This project addresses the challenge of rising traffic deaths in rural transportation systems by integrating novel concepts of energy harvesting from asphalt pavements. Said concepts aim to convert waste thermal energy in pavement into low-power lighting and signal warnings. The aim of the study is to draft and implement a novel, robust self-powered Pavement Energy Conversion Module (PECM) to cooling pavement surface and power LED lighting with limited utility power network. The module will absorb pavement heat and turn it into electrical power using thermoelectric generator (TEG) devices to cool the module sites. The harvested power can be used in lighting and sensing applications.



Schematic of thermal energy harvesting prototype.

RESEARCH IN PROGRESS: HIGHLIGHTS

Modeling Crash Severity and Collision Types Using Machine Learning

Dr. Amit Kumar – University of Texas at San Antonio

Traffic crashes are a main source of non-recurrent congestion causing delays to travelers in a transportation network. In 2017, 34,247 fatal motor vehicle crashes were reported in the United States, leading to more than 37,000 deaths. The United States' annual average cost of road crashes is about $230.6 billion or around $820 per person. Crash analyses are complex because human behavior is nearly impossible to model. Traffic safety analysis often contains categorization or classification problems. Literature in the traffic safety domain usually presents two classification systems based on severity and collision type, separately. However, these factors may be connected. Though past studies recognize these correlations and suggest factoring them together in modeling crashes, little has occurred to incorporate it in the modeling process. Modeling separately necessitates more complex model structures to account for cross-model correlations.

This research is motivated to bridge this literature gap and aims to model collision type and crash severity simultaneously by studying past literature to understand the latest practice of crash classification and using past crash data from Texas cities for both crash and numerical analysis. It proposes analyzing crash data using multi-label classification machine-learning tools, which have not previously been used for traffic safety problems. Consequently, this project can be a model for future research in traffic safety.

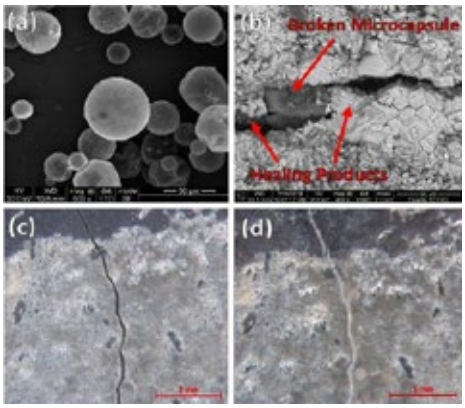
Study area in Texas.

Determination of the Optimal Parameters for Self-Healing Efficiency of Encapsulated Bacteria in Concrete in a Simulated Subtropical Climate

Dr. Momen Mousa, Dr. Marwa Hassan, Dr. Gabriel Arce – LSU

Reinforced concrete's susceptibility to cracking greatly reduces the infrastructure durability via corrosion. Currently, patching materials and waterproofing membranes are commonly used for crack-sealing. Yet, due to funding limitations, it is difficult to afford the costly and labor-intensive evaluation, maintenance, and repair needed for the service life of structures. To address this problem efficiently, researchers propose self-healing concrete materials. Bacterial concrete has become one of the most promising self-healing alternatives because it can autonomously heal large cracks.

This project aims to optimize self-healing methods of encapsulated bacteria in concrete and assess whether a higher bacteria cell concentration, better nutrient selection, or an alternative encapsulation method is needed. These parameters will be first tested in mortar beams with respect to self-healing efficiency, and depending on the results, further testing will be done in concrete specimens. The proposed bio-concrete's efficiency will be tested to evaluate the bacteria's effect on concrete's inherent properties, like compressive strength and static modulus of elasticity, and its self-healing efficiency through crack repair will be monitored through 28 wet-dry cycles (consisting of eight hours of water immersion and 16 hours of drying). If successful, this project will move field-testing to Region 6, where it can help improve the performance of the concrete transportation infrastructure.



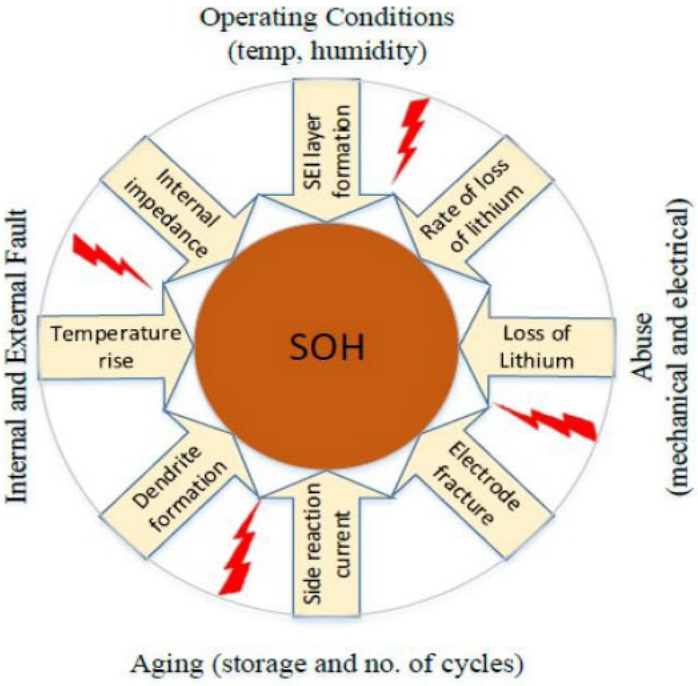
(a)Secondary electron (SE) image of microcapsules, (b) backscattered electron (BSE) image of a broken microcapsule intersecting a crack in cement mortar, (c) cracked cement mortar, and (d) autonomously-healed crack in cement mortar with microcapsules after seven wet/dry cycles.

RESEARCH IN PROGRESS: HIGHLIGHTS

Smart Battery Management System for Electric Vehicles: Self-Learning Algorithms for Simultaneous State and Parameter Estimation and Stress Detection

Dr. Avimanyu Sahoo, Dr. Samir Ahmed – Oklahoma State University

The recent additions of lithium-ion (Li-ion) batteries in the high-end, plug-in electric vehicle (EV) categories offer approximately 300 miles on a single charge. It is expected that the Li-ion battery market will also reach $92 billion by 2024. However, the volatility of internal constituents, flammability, and toxicity of the electrolyte, which are the adverse sides of the high-energy density of Li-ion batteries, make the cells thermally unstable at high temperatures and reduces life when operating at low temperatures. EVs are without a doubt the future of transportation systems due to their cost-effective, eco-friendly nature. The rapid growth in energy storage technologies, such as Li-ion batteries with high-energy density has accelerated the acceptance of EVs in recent years. Efficient operation of Li-ion batteries in EVs requires an intelligent and smart battery management system (BMS) capable of learning the health degradation to accurately estimate the state-of-charge (SOC) and the state-of-health (SOH). This will add autonomy to the BMS in health-conscious decision making, such as fast charging, discharging, cell balancing, and optimal power and energy management. The design of smart BMSs requires the developing of enhanced SOC- and SOH-dependent, parameter-varying dynamical models of Li-ion battery and real-time learning algorithms to learn the parameter-varying model. This project aims to create enhanced electric circuit models (ECM) of the Li-ion battery by incorporating SOH indicators, such as capacity loss and power loss, both under normal and accelerated degradation conditions, which can detect internal faults and stress.



Effects of stress and operating conditions on battery internal constituents leading to health degradation.

TECHNOLOGY TRANSFER ACTIVITIES

Tran-SET has two objectives that guide its technology transfer (T2) activities: to ensure that scientific and technological developments are: (1) accessible, disseminated, and transferred to a wide range of users including state agencies, universities, and industries and (2) have long-term research value and significant impact to the transportation industry. Please see below for a showcase of select, T2 activities sponsored by or involving Tran-SET. Please stay up-to-date with our activities by following us on ***LinkedIn*** *and* ***Twitter****, visiting our* ***website****, and subscribing to our* ***mailing list****!*

2021 Tran-SET Conference Was a Complete Success!

Due to COVID-19, Tran-SET held its 2021 conference virtually on June 3–4, 2021. The event was e-hosted by Arkansas State University and co-sponsored by the Judd Hill Foundation. The event included 45 interesting presentations, which will be uploaded on our YouTube channel soon. During the conference, Tran-SET also conducted its business meeting with its Center Advisory Board (CAB) members, associate directors, and program directors to solicit feedback/guidance from the CAB. Thank you to all Tran-SET staff, associate directors, CAB members, and program directors for their efforts in these unprecedented times and for making the Tran-SET conference a big success.

TRB's Standing Committee on Bicycle Transportation ACH20

Dr. Nick Ferenchak (Tran-SET principal investigator) was invited to become a member of the Transportation Research Board's Standing Committee on Bicycle Transportation (ACH20). The committee is concerned with all aspects of bicycling, bicyclists, behaviors of other road users interacting with bicyclists, as well as policies and criteria for facilities to assure safe, secure, comfortable, convenient, and efficient travel for bicyclists. The committee aims to integrate bicycling into multimodal transportation systems and broader transportation and land-use planning, policy, and engineering. Dr. Ferenchak has assisted the committee with the development of research needs statements and its website. For more information, we invite you to visit the following **website**.

Recording of Webinar on Advancements in Pedestrian and Bicyclist Safety Now Available

The recording of Tran-SET's Joint Webinar Series on "Advancements in Pedestrian and Bicyclist Safety" is now available online. In this Webinar, Dr. Hatim Sharif (University of Texas at San Antonio), Dr. Patrick Singleton (Utah State University), and Dr. Shan Bao (University of Michigan-Dearborn) talk about crash-associated risk factors involving cyclists/pedestrians and how they can be modeled to help improve the existing interaction with vehicles.

We invite you to view the recording of the webinar on **Tran-SET's website** or directly on **Tran-SET's YouTube page**.

Tran-SET would like to sincerely thank the webinar presenters (please see below):

TECHNOLOGY TRANSFER ACTIVITIES

Brutus the Robot, Helping Identify Rockfall Risk

Dr. John Stormont, Dr. Fernando Moreu (Tran-SET principal investigator), and their research team at the University of New Mexico are working on an automated method for identifying the risk of rockfall using sound data collected by a robot. The team has developed Brutus, a wireless robot that is equipped with sensors and a hammer. By remote control, Brutus can approach the surface of interest, tap it, and collect the hammer taps' sound using an attached microphone. The sound data are post-processed with machine-learning algorithms to classify and recognize the rocks that are more prone to fall by using the sound generated by a repetitive hammer actuated by the robot inspector wirelessly. Their preliminary rock classification results with limestone from the Geomechanics Laboratory were presented at the 2021 Tran-SET conference.

AASHTO 2021 High-Value Research Winner

We would like to congratulate Dr. Mahmoud Reda Taha (Tran-SET principal investigator) and his research team at the University of New Mexico on their project, "Cost-Effective Methods to Retrofit Metal Culverts Using Glass Fiber-Reinforced Polymer Composites," for being selected as 2021 High-Value Research Winner by the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee. The group has also been invited to present its findings at the upcoming TRB conference. For more information, visit the following website.

EDUCATIONAL & WORKFORCE DEVELOPMENT

Tran-SET has a firm initiative to advance the transportation workforce and develop its next generation of leaders by: (1) attracting and supporting diverse, promising individuals to the transportation field through internships/research assistantships; (2) providing experiences through education and cutting-edge research to more properly prepare these individuals as they enter the workforce; and (3) incorporating and disseminating knowledge generated from sponsored research into educational and training products/activities. The following is a showcase of select, educational and workforce development activities sponsored by or involving Tran-SET:

Annual Safety Training

Dr. Zahid Hossain (Tran-SET principal investigator) hosted an annual safety training for a local ready mix concrete company. About 50 staff members (plant operators, concrete truck drivers, loaders, and supervisors) of the company participated in a five-hour training session held in Centennial Hall at Arkansas State University's Reng Student Union.

Safety training.

High School Summer Research Program

Tran-SET is participating in the High School Summer Research (HSSR) intern program organized by LSU, which involves high school students in research during Summer 2021. Currently, five Tran-SET principal investigators are mentoring five high school students on transportation-related projects. The students will present their work next month, and the top three students (out of a total of 17) will receive awards.

Students in the HSSR Intern Program.

Champion of Diversity Award

The Champion of Diversity Award was presented to Dr. Zahid Hossain (Tran-SET principal investigator) during the annual recognition program conducted online by the Division of Diversity and Community Engagement. The Diversity Awards program is a recognition of individuals and organizations who have demonstrated the highest commitment to advancing diversity and inclusion on the Arkansas State University campus—as well as in the Jonesboro, Arkansas, community—over the past year.

Dr. Zahid Hossain