TRAN-SET
QUARTERLY NEWSLETTER

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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 All a Wonderful Fall!

As seasons change, I am happy to report Tran-SET's continued progress. Tran-SET has finalized selection and award of its fifth-cycle projects. A total of 36 research projects were awarded, and their start date was set on August 1, 2021. If you are interested in learning more about them, two-page fact sheets are now available on Tran-SET's website. Also, the call for problem statements for our sixth-cycle of funding has ended. Tran-SET received a total of 67 problem statements! Problem statements will be evaluated based on their potential benefits; and funding priority will be given to projects addressing materials, preservation, climate resilience, reconnecting communities following infrastructure reconstruction, broadband in rural areas and its impact on future traffic, impact of carpooling on greenhouse gases, impact of automated vehicles on future traffic, impact of working from home on future traffic, and underserved/underinvested communities.

The last webinar in the Tran-SET Webinar Series was held on September 16, 2021, and was a continuation on the previous webinar, *Advancements in Pedestrian and Bicyclist Safety*. Four transportation experts discussed communication strategies between AVs and pedestrians/bicyclists, as well as pedestrian behavior at signalized intersections captured using LIDAR sensing technology. For more information, visit Tran-SET's **website**. Registration was free!

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

Enjoy!

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

RESEARCH PROGRAM UPDATES

STAFF UPDATE—DR. NOORVAND'S ARRIVAL

Dr. Hassan Noorvand joined Tran-SET in July 2021. He will serve as the Technology Transfer (T2) Coordinator for Tran-SET and will be in charge of further developing Tran-SET's T2 plan and corresponding T2 processes, establishing Tran-SET conferences, and hosting and facilitating PRC meetings.

Welcome to the team, Dr. Noorvand!

Dr. Hassan Noorvand

FOURTH-CYCLE PROJECTS RESEARCH REPORTS

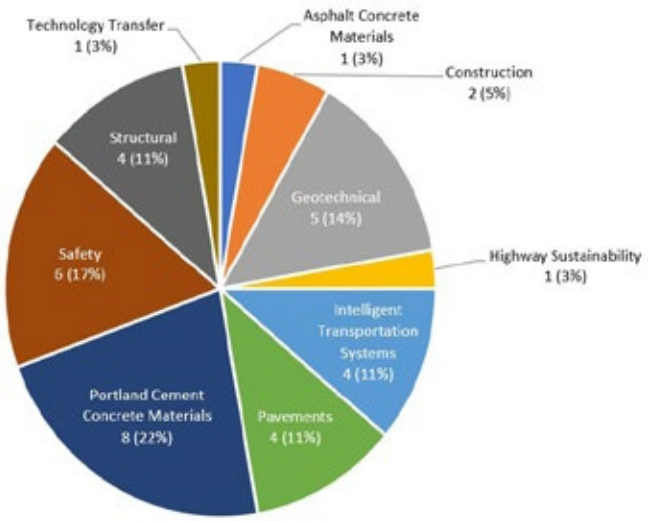
Tran-SET's fourth-cycle projects ended their technical phase on August 2021. The projects' third progress reports and trackers, as well as their final research reports, were submitted in mid-August 2021. Tran-SET will circulate these reports as soon as they are available. Dr. Hassan Noorvand is currently organizing and facilitating TRL assessments for each fourth-cycle project. The process has been a tremendously useful experience: (1) providing an opportunity for the research team to directly communicate to stakeholders, (2) gathering critical feedback from the panel to better inform/improve activities during the implementation (technology transfer) phase, and (3) educating research teams and panel members on the use of the TRL scale and assessment processes.

PROBLEM STATEMENTS FOR SIXTH-CYCLE PROJECTS

The deadline for the submission of problem statements for Tran-SET's sixth cycle of funding was August 15, 2021. A total of 67 problem statements were submitted. They will be ranked by their potential benefits and eventual impacts on workforce development and educational activities that focus on the evaluation and implementation of advanced technologies in the transportation industry. Priority will be given to projects addressing materials, preservation, climate resilience, reconnecting communities following infrastructure reconstruction, broadband in rural areas and its impact on future traffic, impact of carpooling on greenhouse gases, impact of automated vehicles on future traffic, impact of working from home on future traffic, and underserved/underinvested communities.

AWARD OF FIFTH-CYCLE PROJECTS

Tran-SET has finalized the selection and award of its fifth-cycle projects. A total of 36 projects were awarded, and their start date was set on August 1, 2021. The projects totaled $4.1 million (grant and matching funds) and are categorized below by topic area.



Projects are categorized by topical 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**,

Comparative Analysis of 3D-Printed Bridge Construction in Louisiana

Dr. Amirhosein Jafari, Dr. Ali Kazemian – LSU

Construction 3D printing (C3DP) technology is an emerging revolution in the construction industry with various application domains such as emergency construction and low-income housing. Despite the contribution of this technology to emergency construction and affordable housing, utilizing C3DP for infrastructure development seems to hold great potential as well. This automated and accelerated process is also promising for civil structures, including buildings and bridges, which require extensive labor. If successful, it is expected that 3D structural printing can significantly reduce the construction time and cost. However, unlike applications in other areas, civil structures are typically on a large scale, with length or height spanning hundreds of feet. They are subjected to complex loadings, including gravity, live, wind, seismic, etc. Therefore, it is challenging to develop suitable printing tools and materials. As a result, although there are limited 3D-printed buildings, 3DP of civil structures is still at a primitive stage. C3DP technology has been used for bridge construction in a few demonstration projects in different countries. These are relatively small pedestrian and bicycle bridges. However, these demonstration projects highlight the massive potential of C3DP technology for accelerated bridge construction on different scales. Considering the recent emergence of C3DP technology, as well as the limited number of (demonstration) projects using C3DP for segmental bridge construction, there is minimal experimental and field data on this topic. The main challenges of using C3DP technology in civil infrastructure such as bridges are as follows: (1) automated fabrication is often not suitable for large-scale products and conventional design approaches; (2) the smaller ratio of automated products in comparison with other industries; (3) only limited material can be used by automated machines; (4) expensive automated machines tend to be unfeasible economically; and (5) managerial issues and the increasing pressure towards environmental issues of construction materials. Therefore, there is a gap in terms of investigating the feasibility of using the C3DP technology for segmental bridge construction.

The objective of this research project is to study the feasibility of utilizing the innovative C3DP technology for segmental bridge construction in the state of Louisiana, to analyze different implementation scenarios, and to document the best practices for 3D-printed bridge construction to maximize the advantages of this construction technology. By advancing C3DP technology, this project will take a significant step towards the realization of the potential of this technology to help automated, smart, and resilient infrastructure development in Region 6 and beyond.

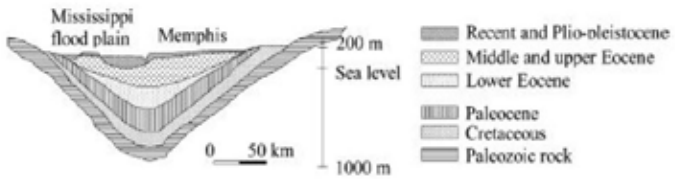
3D-printed bridge in China.

RESEARCH IN PROGRESS: HIGHLIGHTS

Seismic Hazard Analysis for the City of Jonesboro and Surrounding Counties Within Northeast Arkansas (NEA)

Dr. Zahid Hossain, Dr. Ashraf Elsayed – Arkansas State University

Estimation of liquefaction resistance and shear velocities are key elements in the assessment of potential earthquake ground shaking and damage of existing and new construction sites. The Arkansas Department of Transportation (ARDOT) and other agencies in the region need ground motion response analysis (GMRA) data of specific construction sites. As part of recent ARDOT Transportation Research Committee (TRC) Projects 1603 and 1901, researchers have surveyed 35 construction sites in northeast Arkansas in the last five years. However, these sites are not enough to cover the entire region. Since site-specific GMRA analysis is expensive and time-consuming, the proposed study will use the available data from these sites and develop models to predict earthquake-resistance parameters of other locations.



Idealized cross-section of the Mississippi Embayment.

The proposed study aims at analyzing 15 critical sites in northeast Arkansas near the City of Jonesboro. Routine soil test data, such as standard penetration test (SPT) values available from historical, current, and future construction projects, will be used to predict parameters including liquefaction resistance, peak ground acceleration, and spectrum velocity profiles. Afterward, seismic risk and hazard maps will be developed. Existing literature suggests that the Bayesian analysis-based risk assessment can quantify the uncertainty in a more meaningful way; thus, it will be used to develop an alternative decision support tool. Simultaneously, based on uncertainty analysis of GMRA results, standard ground motion prediction equations will be fine-tuned so that they are applicable for regional scales.

Field Evaluation of E-Ticketing Technologies for Efficient Asphalt Delivery Ticket Collection and Quantity Calculation

Dr. Susan Bogus Halter – University of New Mexico

Every year, state departments of transportation (DOTs) collect thousands of paper tickets for delivering hot mix asphalt, warm mix asphalt, concrete, base course, embankment, and other construction materials. Collecting paper load tickets is an antiquated practice that exposes inspectors to substantial risk of death or personal injury by assigning them adjacent to traffic or moving or backing equipment. In addition, paper-based load tickets may be lost, and in some cases, it is difficult to decipher the information on the ticket due to poor printing. Under the current system, paper-based load tickets are taken back to the project office where they are summed and entered into an Excel spreadsheet for reporting and payment purposes, which is time-consuming, labor-intensive, and error-prone. In recent years, new e-ticketing (i.e., electronic-ticketing) technologies have enabled the collection of this information electronically, allowing for safer and more efficient inspection, rapid project delivery and payment, reduced effort for ticket management, and near real-time comparisons of theoretical tonnages and temperatures to actual tonnages and temperatures. This research will conduct field evaluations of an e-ticketing system on several New Mexico Department of Transportation (NMDOT) paving projects throughout the state of New Mexico. This project will also develop a guidebook for the implementation of the tested e-ticketing system to assist NMDOT with workforce development and professional training.

Hand-off of paper load tickets at job site.

RESEARCH IN PROGRESS: HIGHLIGHTS

Intelligent Incipient Fault Detection System for Electric Vehicle Battery: Fault Isolation Schemes and Prototype Development

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

An electric vehicle charge station.

Lithium-ion (Li-ion) batteries are the primary energy storage devices for electric vehicles (EVs) due to their high energy and power density and long life cycle. The recent variants of the high-end, plug-in EV (PEV) with Li-ion battery pack offer a range of approximately 300 miles on a single full charge, which is close to their gasoline counterparts. Further, to bridge the gap between the fueling time of the gas-powered vehicles and the charging time of EVs, high-power chargers have also been introduced, reducing the charging time to less than 30 minutes. However, the volatility of internal constituents, electrolyte's flammability, and toxicity make the cells thermally unstable at high temperatures and reduce life when operating at low temperatures. Further, the low tolerance to abuse (overcharging and discharging) and vulnerability to thermal runaway jeopardize user safety, leading to an explosion, which is a national concern. Moreover, the Li-ion battery packs are operated at their maximum operating limits to deliver EVs' required power. The extreme operating conditions and abusive operations may lead to internal and external faults, such as short circuits, rise in cell internal temperature, lithium plating and loss of lithium, and solid electrolyte interface (SEI) layer formation. These internal faults have a cumulative effect on the battery's health, aggravating the vulnerability to thermal runaway. Various external safety mechanisms are employed in the battery management systems (BMS) to protect the battery from external fault conditions. However, it is still challenging to detect the internal faults from the available measurements, i.e., voltage, current, and surface temperature.

The project's overall objective is to develop, implement, and validate an intelligent fault detection scheme capable of detecting a Li-ion battery's internal faults in its incipient stage. The objective will be attained by developing failure-mode analysis schemes identifying the root causes, developing computationally efficient fault detection algorithms using real-time machine learning, developing Field Programmable Gate Array (FPGA)-based hardware architecture to implement fault detection schemes; and validating the prototype experimentally.

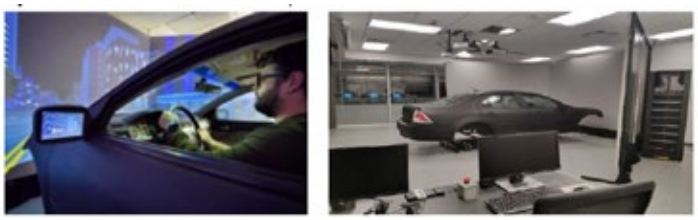
RESEARCH IN PROGRESS: HIGHLIGHTS

Examining Drivers' Behaviors to Connected and Automated Vehicles

Dr. Hany Hassan – LSU

It is envisioned that connected and autonomous vehicles (CAVs) are the future of transportation, as they will assist in minimizing some inefficiencies of current transport systems. CAVs or driverless vehicles are currently being developed in both commercial and research projects across the world and are expected to be publicly available soon. CAVs are expected to provide more accessible mobility options for all road users, especially older adults and people with disabilities. It might also be a safe mobility option during the COVID-19 pandemic. However, it is not clear how drivers of conventional vehicles would interact with other human-driven vehicles and autonomous vehicles in such a mixed traffic environment, especially in complex traffic areas (e.g., merging and diverging areas). Indeed, it is expected that a mixed traffic network (including both CAVs and human-driven vehicles) would impose additional challenges to drivers (especially to older road users), which need to be studied and remedied. Not only does studying the actual drivers' behaviors to other CAVs affect the safety of all road users, it also plays a significant role in acceptance and propagation of CAVs. In this regard, little is known about the acceptance of CAVs among different socio-demographic groups of drivers. Therefore, it is imperative to study the aforesaid issues before CAVs are publicly available and facilitate paving their road to success.

The main objectives of this project are to examine how drivers will interact with other human-driven vehicles and CAVs under different traffic/road/environmental conditions; investigate behaviors of drivers and passengers of autonomous vehicles in different levels of CAVs (semi and full levels of vehicular automation); and explore the changes in the willingness and preferences of road users toward CAVs before and after participating in the driving simulator experiments.



LSU College of Engineering driving simulator.

Alternative Supplementary Cementitious Materials in Ultra-High-Performance Concrete

Dr. Craig Newtson – New Mexico State University

Previous ultra-high-performance concrete (UHPC) research at New Mexico State University (NMSU) has shown that UHPC produced with local materials and supplementary cementitious materials (SCMs), such as silica fume and class F fly ash, can exhibit comparable mechanical and durability properties to proprietary UHPC mixtures. Incorporation of locally available materials can reduce materials cost up to 70% compared to proprietary UHPC. The UHPC mixtures developed at NMSU have recently been specified by the New Mexico Department of Transportation (NMDOT) for use in pre-cast, pre-stressed bridge girders and bridge deck overlays because of their exceptional durability properties and ability to bond with substrate concrete. Unfortunately, class F fly ash production has decreased sharply as the energy industry has moved to renewable energy technologies to produce electricity and coal-burning generating stations have been decommissioned. The New Mexico Department of Transportation (NMDOT) expects that by as early as 2022 the supply of class F fly ash will be insufficient to meet its needs for concrete construction. Alternative SCMs are needed for all concrete mixtures, including the non-proprietary UHPC mixtures.

Four-inch cube specimens for compressive strength test.

This research project will assess the potential of three alternative SCMs that might be used in non-proprietary UHPC. The SCMs to be studied are a natural pozzolan mined from a pumicite deposit near Espanola, New Mexico; a manufactured metakaolin product produced by a local cement manufacturer, and a ground-granulated blast furnace slag (GGBFS) from a neighboring state. The important performance characteristics of new UHPC mixtures produced with the SCMs include workability in the fresh state, compressive strength, flexural strength, and durability-related properties such as rapid chloride permeability, surface resistivity, shrinkage behavior, and frost.

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****!*

KENS TV Interview on the Impact of Recent Flood Events in San Antonio

Dr. Hatim Sharif (Tran-SET principal investigator) was interviewed by KENS about recent flooding in San Antonio and its impact on road safety. He discussed how one of the greatest challenges that big cities face during rain events is urban infrastructure, which does not allow water to infiltrate the soil. He also said that as development continues, cities will experience more water runoff. During the interview, a few potential solutions were suggested like rain gardens, permeable pavements, and rainwater harvesting. For more information on the interview, visit the **KENS website.**

KSAT12 Interview on the Effect of Rainy Weather on Pavement Structures

Dr. Samer Dessouky (Tran-SET principal investigator) was interviewed by KSAT on the subject of potholes. In the interview, he discussed how the prolonged presence of water trapped within a pavement structure, mixed with the ongoing traffic, can accelerate damage on pavements. He mentioned that timely maintenance is key to prevent the damage from expanding to other areas and going further into layers underneath. For more information on the interview, visit the **KSAT website.**

Recording of Webinars on Advancements in Pedestrian and Bicyclist Safety Are Now Available

The recording of Tran-SET's latest webinar on Advancements in Pedestrian and Bicyclist Safety is now available online! It was held on June 17, 2021. Dr. Hatim Sharif (University of Texas at San Antonio), Dr. Patrick Singleton (Utah State University), and Dr. Shan Bao (University of Michigan-Dearborn) discussed the relationship between pedestrian/bicyclist injury severity and crash-associated factors, a systemic safety analysis of pedestrian and bicycle safety in Utah, and the interaction between level 4 autonomous shuttle busses and pedestrians on public roads. 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

Joint Tran-SET Webinar Series

Our last webinar in the Joint Tran-SET Webinar Series was a continuation of the previous one and was held on September 16, 2021, on Part 2 - Advancements in Pedestrian and Bicyclist Safety. In this webinar, Dr. Nick Ferenchak (University of New Mexico), Dr. Pengfei (Taylor) Li (University of Texas at Arlington), Dr. Sirisha Kothuri (Portland State University), and Dr. Fred Feng (University of Michigan-Dearborn) presented the latest research advancements for enhancing pedestrian and bicyclist safety.

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

Reclaimed Fly Ash Concrete Mix Field Demonstration

On August 2, 2021, Dr. Zahid Hossain (Tran-SET principal investigator) and his research team had a field demonstration of reclaimed fly ash and placed 27 cubic yards of concrete on a 50 ft x 12 ft x 5 inch pavement. This test site was constructed in cooperation with Boral Resources, NEAR Ready Mix Co., and Arkansas State University Facilities Management. Four students worked with the construction crews during the pouring operation.

Development of Low-Cost, Efficient Wireless Intelligent Sensors

Dr. Fernando Moreu (Tran-SET principal investigator) and a cross-disciplinary group from the University of New Mexico developed low-cost sensors for flooding information on critical infrastructure as part of a National Science Foundation (NSF) project to promote resilience in Native American communities. This project is funded with support from the National Science Foundation, in partnership with the U.S. Department of Energy and the U.S. Department of Homeland Security, as part of the Civic Innovation Challenge. For more information on this project, visit this **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:

Augmented Reality Enabling New Human-Infrastructure Interfaces Webinar

On July 21, 2021, Dr. Fernando Moreu (Tran-SET principal investigator) was the speaker at the international webinar, Augmented Reality Enabling New Human-Infrastructure Interfaces, hosted by IABMAS. This seminar challenged the traditional conversations about Big Data, the internet of things, smart cities, and infrastructure maintenance decision making by proposing a different paradigm for smart infrastructure management centered in new human-infrastructure interfaces informing new frontiers. The discussion explored the area of human decisions and cognition of the built infrastructure enabling transformations of human tasks interacting with structures.

STEM Festival

Tran-SET is participating in the STEM Festival that will take place on November 25, 2021, at the Pennington Student Activity Center in Hammond, Louisiana. Tran-SET will present on a variety of novel concrete and asphalt materials, including engineered cementitious composites (ECC), engineered geopolymer composites (EGC), bio-concrete, and hot-mix asphalt concrete (HMAC). The STEM Festival is an opportunity for high school students to engage in hands-on activities, view demonstrations, and meet with college representatives to learn more about their undergraduate programming. For more information on the festival, feel free to visit its **website.**

San Antonio Council of International Visitors

On June 28, 2021, Dr. Samer Dessouky and Dr. Hatim Sharif, Tran-SET principal investigators and professors at UTSA, presented at the San Antonio Council of International Visitors (SACIV) to delegations of nine emerging leaders selected by the U.S. State Department and representing a diverse set of African nations and a cross-section of industry/government/NGO organizations. SACIV is a non-profit organization that arranges professional programming for emerging international leaders who have been selected by the U.S. State Department's International Visitor Leadership Program (IVLP) to come to the United States. The organization aims to build international friendships, to facilitate the exchange of ideas, to foster cultural understanding, and to promote San Antonio as an international city.

One of the online presentations from SACIV.