TRAN-SET
QUARTERLY NEWSLETTER

WINTER **2020** • ISSUE **13**

INSIDE THE ISSUE

ABOUT TRAN-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions across five states (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas) and is led by LSU. It 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

Happy Holidays!

I want to wish everyone a safe and relaxing holiday season! I would also like to take this opportunity to personally thank all Tran-SET staff, associate directors, program directors, and principal investigators. Your efforts are much appreciated and are directly responsible for the success and achievements Tran-SET has had throughout 2020. Thank you all.

I am excited to report Tran-SET's continued progress. We are organizing our 2021 Tran-SET Conference to be held in Jonesboro, Arkansas, tentatively on June 3–4, 2021. The conference is co-sponsored by the ASCE Construction Institute and hosted by Arkansas State University. The start date of the conference's "call for papers" will be determined soon. The event is a great opportunity to learn how Tran-SET-sponsored research is solving regional transportation needs and to network, collaborate, and engage with professionals in a wide range of transportation fields. For more information, please visit the **conference website**.

Call for problem statements for our fifth cycle of funding has ended, and Tran-SET received 95 problem statements! This shows the increasing interest in our research program. Tran-SET finalized the review and selection of the fifth-cycle problem statements and sent out requests for proposals accordingly. The deadline for the submission of the proposals is January 31, 2021.

Fourth-cycle projects started on August 1, 2020. Two-page fact sheets describing the problem statement, objective, intended implementation, and other project information have been developed for all awarded projects and are now available on **Tran-SET's website**.

I invite you to read through the Winter 2020 newsletter and learn more about our research, technology transfer, educational, and workforce development activities. If you haven't done so already, follow us on **LinkedIn** and **Twitter**. You may also subscribe to our mailing list **here**.

Enjoy!

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

RESEARCH PROGRAM UPDATES

THIRD-CYCLE PROJECTS' FINAL RESEARCH REPORTS

The technical phase of Tran-SET's third-cycle projects ended in mid-November 2020. The projects' final reports were submitted on November 25, 2020, and the next deliverable is the implementation report due on the last day of the project implementation phase, which is May 15, 2021. Tran-SET will circulate the implementation reports as soon as they are available. Third-cycle research reports and corresponding datasets will be available soon through **LSU Digital Commons**.

FOURTH-CYCLE PROGRESS REPORTS AND TRACKERS

Tran-SET's fourth-cycle projects started August 1, 2020. The first PRC meeting for the awarded fourth-cycle projects was held in September, and their first progress reports and trackers were due on December 1, 2020. Two-page fact sheets describing the problem statement, objective, intended implementation, and other project information have been developed for all awarded projects and are available on **Tran-SET's website**.

PROBLEM STATEMENTS FOR FIFTH-CYCLE PROJECTS

The call for problem statements for Tran-SET's fifth-cycle of funding has ended. In total, Tran-SET received 95 problem statements from 14 different institutions. Nineteen problem statements were collaborative and involved multiple partnering institutions. Problem statements were carefully reviewed and selected, and requests for proposals have been sent to the respective institutions. Please see **our website** for more information.

RESEARCH IN PROGRESS: HIGHLIGHTS

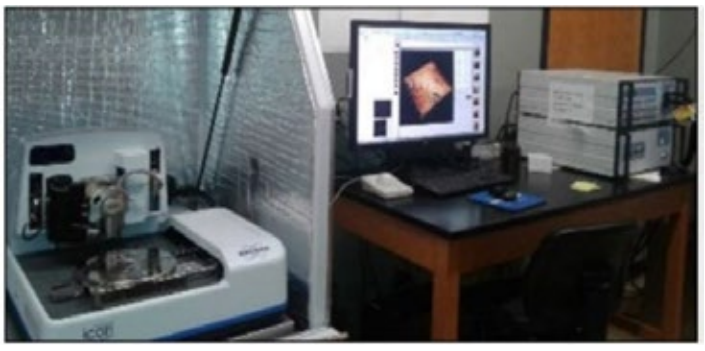
Please see below for a showcase of select, Tran-SET research projects. ***Is our research applicable to your technical area? Beneficial or a potential solution to your local transportation system? Can benefit from your efforts? Interesting?*** *Please contact us for ways to coordinate, be involved, and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

EFFECTIVENESS OF SOFTENING AGENTS FOR ENHANCING PROPERTIES OF ASPHALT MIXES WITH HIGH-RAP CONTENTS

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

Reclaimed asphalt pavement (RAP) use in hot-mix asphalt (HMA) has increased in recent years due to the rising costs and demand for crude oils and aggregates. However, using high RAP in new mixes may have performance issues such as low-resistance due to fatigue cracking. This is due to the excessive oxidative aging RAP used in the mix, and it becomes an issue when high RAP is used. To fix this problem, mixes with RAP usually require the use of a softer binder (e.g., PG 58-22) or a softening agent. However, the use of a softer binder puts the contractor in a non-compliance situation, as it is not often an approved Performance Grade (PG) binder (e.g., PG 58-28). The Arkansas Department of Transportation (ArDOT) allows only PG 64-22, PG 70-22, and PG 76-22 on highways. Furthermore, a PG 58-28 binder is more costly than the base binder (PG 64- 22). The second solution of using a softening agent appears to enhance the performance of high-RAP mixes, as it allows contractors to use ArDOT-approved binders without increasing the cost of materials significantly.

The aim of the proposed study is to determine the effectiveness of different rejuvenators on blended binders' rheological and mechanistic properties by means of traditional test methods (e.g., Superpave) and non-traditional techniques, such as the atomic force microscopy (AFM). Binders from two RAP samples will be recovered, and they will be blended with two base binders, as the softening agents, a commercial rejuvenator and two waste products, namely waste cooking oil (WCO) and engine bottom oil (EBO), will be investigated in this study.



AFM tool available in the PI's laboratory.

EFFICIENT, LOW-COST, BRIDGE-CRACKING DETECTION AND QUANTIFICATION USING DEEP LEARNING AND UAV IMAGES

Dr. Chao Sun – University of Texas at San Antonio

Many bridges in Louisiana and the United States are working under severe degradation conditions where cracking can occur. To ensure structural integrity and public security, bridges in the United States are inspected and rated every two years. Currently, this biannual assessment is mainly implemented with inefficient manual visual inspection methods. Furthermore, it is hard to detect cracks in out-of-reach parts of bridges. It is possible there are unseen cracks during inspection that can collapse bridges when the damage on load-bearing members becomes too high. As unmanned aerial vehicles (UAVs) have become popular, researchers have started to use them to collect visual data from unreachable places. Thus, it is promising to integrate this deep learning method with UAV images to develop an automatic crack damage identification method.

The goal of the study is to develop an efficient deep learning-based groundwork to detect and quantify cracks on bridges using computer vision-based technique. The Convolutional Neural Networks' (CNN) deep learning method is powerful in extracting and learning image features and will be used to identify cracks in images. Specific activities include extensive collection of images from the Internet with subsequent categorization into classes (intact surfaces, cracks, multiple joints and edges, single joint or edge, etc.); collection of images of target structures with a UAV (example shown below); development of a deep CNN model using collected images and their augmentation; and identification of cracks using the learned deep learning model. The outcomes of this project will allow automatic crack damage detection and economical quantification of bridge key components.

The Phantom 4 DJ drone in the PI's lab.

RESEARCH IN PROGRESS: HIGHLIGHTS

DEVELOPMENT OF DECISION TREES FOR THE SELECTION OF PAVEMENT MAINTENANCE AND REHABILITATION ACTIVITIES IN SOUTH-CENTRAL UNITED STATES

Dr. Momen Mousa, Dr. Marwa Hassan – LSU

Over time, pavements deteriorate due to both traffic loading and the environment. Maintenance and rehabilitation activities slow down or reset the rate of pavement deterioration. Rehabilitation activities are those activities that repair portions of existing pavements to reset the deterioration rate. They are defined by the American Association of State Highway and Transportation Officials (AASHTO) as "structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capacity." Transportation agencies use maintenance activities to reduce the deterioration rate of pavements by identifying and addressing specific pavement deficiencies. Maintenance activities are widely included in pavement preservation programs, which are defined by the Federal Highway Administration (FHWA) as "a program of activities aimed at preserving investment in the nation's highway system, providing and managing usable roadways, extending pavement life, enhancing pavement performance, reducing costs, and reducing user delays".

Decision trees (or decision metrices) need to be developed to select maintenance and rehabilitation procedures for asphalt pavements in Louisiana. This will aid transportation agencies in justifying their maintenance and rehabilitation decisions. The proposed decision trees would consider variables impacting treatment performance, including pavement age, pavement type (asphalt or composite), traffic level, and maintenance history to ensure that an efficient, economical treatment is selected.

Costs of pavement preventive maintenance versus rehabilitation.

SAFETY OF VULNERABLE ROAD USERS (VRU'S) IN LIGHT RAIL TRANSIT (LRT) ENVIRONMENT

Dr. Samir A. Ahmed, Dr. Rifat Bulut – Oklahoma State University

Light rail transit (LRT), which includes modern streetcars, trolleys, and heritage trolleys, is one of the fastest growing modes of public transportation in the United States. Urban and suburban areas across America are switching to LRT to solve issues surrounding traffic congestion, air quality, mobility, and economic growth. The rise of LRT systems has been aided partly by the Federal Transit Administration's (FTA) fixed guideway capital investment program, known as "New Starts." A major reason behind the demand of LRT systems is how easily they are worked into existing urban and suburban corridors where they can operate in shared rights-of-way or semi-exclusive rights-of-way. To lower their cost and complexity, most LRT systems have their tracks placed on city streets, in medians, or in separate at-grade rights-of-way with at-grade crossings. Operating light rail vehicles (LRVs) along these alignments introduces new problems and increases collision risk with vulnerable road users (pedestrians, cyclists, and electric scooter users). Although LRT systems have an outstanding overall safety record compared to other methods of surface transportation, collisions involving LRVs and vulnerable road users (VRUs) occur, resulting in death and/or major injuries. These accidents hurt the image of the safety of LRT systems and the reputation of transit agencies. The goal of this study is to provide transit agencies, state DOTs, and local governments with a resource guide detailing the best practices applicable to improve the safety of VRUs in LRT environments.

A light rail embedded into a city..

RESEARCH IN PROGRESS: HIGHLIGHTS

AUTONOMOUS VEHICLE COMMUNICATION STRATEGIES MODELED IN VIRTUAL REALITY

Dr. Nicholas Ferenchak – University of New Mexico

Autonomous vehicles (AVs) can help improve transportation efficiency, safety, equity, and environmental impacts. However, for these benefits to be feasible, the technology must be properly adopted. For some generations, there will be a transition period in which both human-driven vehicles and AVs share the road. Along with human drivers, pedestrians and bicyclists will share street space with AVs. How will AVs and human users of the road interact and communicate, and how will this impact perception and behavior outcomes? Human perceptions of AVs are important because trusting new technologies is integral to their successful incorporation into the transportation infrastructure. Recent research shows that many people are apprehensive about sharing roads with AVs. However, better AV communication has been linked with increased trust and acceptance. Understanding behavior in the interaction of humans and AVs is important for two types of outcomes—safety and operations. Because approximately 94% of motor vehicle crashes can be attributed to human error, this can be an incredible opportunity to improve traffic safety outcomes.

The objective of this research is to create and assess strategies for AV communication with human road users (drivers and pedestrians). Testing will occur in a three-dimensional VR environment in which participants encounter AVs in a typical urban intersection. The AVs will use various external communication interfaces, including a variety of lighting, color, sequence, text, and noise interfaces. User perceptions will be gathered through a post-experiment survey asking users whether they understood the AV's intentions, how long it took them to do so, and whether or not they trusted the AVs. VR headset sensors will read users' body and eye movements to better understand human users' interaction time and visual focus in interacting with AVs.

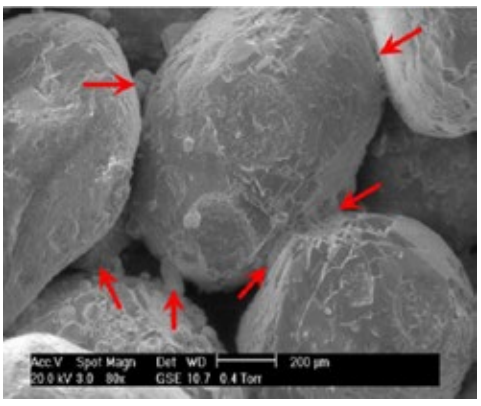
Examples of current lab equipment for pedestrian (left) and driver (center and right) testing. The driver simulator is in storage, so example photos of the equipment have been provided.

RAPID REPAIR OF CRACKS ON THE EMBANKMENT SLOPES USING BIO-CEMENT

Dr. Hai (Thomas) Lin - LSU

Highway embankment slope failures cause road closures, damage public and private property, and cause safety hazards. Restoring highway embankment slope failures is a serious challenge with major impacts on state and federal maintenance budgets. Highway slope failures are common in Region 6. Most of these slope failures happen due to desiccation cracks induced by wetting and drying weather cycles. These desiccation cracks allow water infiltration into the embankment, increasing the moisture content and reducing the soils' shear strength and eventually causing embankment slope failures.

The goal of this project is to explore the use of bio-cement for rapid repair of cracks on the embankment slopes. Slope failures are often caused by surface cracks, which are usually present on the embankment slopes. Most rapid slope failure repair methods (e.g., geosynthetics, soil nails, plastic pins, and lime, etc.) involve major earthwork, special installation machinery, and/or unique construction processes, which may require too much time, disturb the traffic, and be costly. To achieve the goal of the research, the following tasks will be performed: (1) conduct literature review regarding bio-cement and assess the repair methods for embankment slopes; (2) measure the improvement of shear strength of soils after bio-cement treatment using direct shear tests; (3) perform lab-scale embankment slope stability tests treated by bio-cement; (4) assess the effects of bio-cement treatment on the improvement of embankment slope stability using commercial software; and (5) work with Louisiana DOTD to perform a pilot test in the field.



SEM images of MICP-treated sands (arrows show calcite crystals cementing sand particles).

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!*

2020 TRAN-SET CONFERENCE PRESENTATION VIDEOS NOW AVAILABLE!

The 2020 Tran-SET Conference presentation videos are now available on our **YouTube page**. All session presentations were uploaded independently for ease of access. The detailed conference program can be found and downloaded on **Tran-SET's website**. We invite you to go through what was a really successful virtual conference!

2021 TRAN-SET CONFERENCE

The 2021 Tran-SET Conference will be held in Jonesboro, Arkansas, tentatively on June 3-4, 2021. The conference is co-sponsored by the ASCE Construction Institute and hosted by Arkansas State University. The start date of the "call for papers" for the conference will be determined soon. The conference is a great opportunity to learn how Tran-SET-sponsored research is solving regional transportation needs and to network, collaborate, and engage with professionals in a wide range of transportation fields. For more information, please visit the **conference website**.

Accepted papers will be published by ASCE and will provide bibliographic information for each proceeding paper to abstracting and indexing (A&I) services (e.g., Elsevier Engineering Index (EI), National Academies, ExLibris Primo, etc.). For any additional information, please contact **transet2021@astate.edu** with any questions.

JOINT TRAN-SET WEBINAR SERIES: RECORDING NOW AVAILABLE

Tran-SET organized two webinars on October 28 and 29, 2020, on Corrosion Management System of Transportation Infrastructure for Long-Term Durability Reinforced Concrete Structures. Both webinars were jointly hosted by LSU and Texas A&M University. Recordings of these webinars are now available on **Tran-SET's website** or directly on **Tran-SET's YouTube page**.

Webinar: Corrosion Management System of Transportation Infrastructure for Long-Term Durability Reinforced Concrete Structures Part 1.

Webinar: Corrosion Management System of Transportation Infrastructure for Long-Term Durability Reinforced Concrete Structures Part 2.

TECHNOLOGY TRANSFER ACTIVITIES

STRUCTURAL EXTREME EVENTS RECONNAISSANCE NETWORK (STEER)

Hurricane Laura made landfall as a Category 4 storm near Cameron, Louisiana, on August 27, 2020, resulting in estimated losses along its path in the range of $4 billion to $12 billion. Laura is one of the most well-documented storm events, and thus, provided novel opportunities to understand the vulnerabilities underpinning losses across a variety of building occupancies and other critical infrastructure. In response, Dr. Sabarethinam Kameshwar, Tran-SET PI, and a team of researchers took part in a reconnaissance mission led by Structural Extreme Events Reconnaissance Network (StEER) to extract data from the impacted area immediately after the event began. For more information on the mission, visit the **Designsafe-CI website**.

FIELD TESTING IN LSU

Dr. Momen R. Mousa, Tran-SET PI, collaborated with Stripe-A-Zone Inc. to apply pavement markings at LSU to serve as a field experiment in Tran-SET Project 20BLSU03. Waterborne paints and thermoplastic markings from different manufacturers were applied in the transverse and longitudinal directions on asphalt and concrete surfaces. The performance of the markings will be monitored for the next 15 months. Thanks to Herbert Bickley, P.E; Quin J. Boylan; Brad Henry; Frank Coghlan; Andrew Birney; Jon Cunningham; Josh Morales; Aaron Harris; and Paul Garland for making this possible. Stay tuned for results!

Area in Cameron, Louisiana, affected by Hurricane Laura.

Pavement marking on LSU road.

EDUCATIONAL & WORKFORCE DEVELOPMENT

Tran-SET has a firm initiative to advance the transportation workforce and to 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. Please see below a showcase of select, educational and workforce development activities sponsored by or involving Tran-SET.

US ARMY ECYBERMISSION

As part of Tran-SET's dedication to enhancing education and workforce development, next year Tran-SET will collaborate with the U.S. Army Educational Outreach Program (AEOP) on its eCYBERMISSION. eCYBERMISSION is a web-based STEM competition for students in grades 6-9. More information about this competition can be found on its website.

Tran-SET's participation will be in the form of recruiting volunteers (faculty members or graduate students) to serve as virtual judges who provide timely feedback, comments, and scores on student mission folders during virtual judging, which takes place March 16-31, 2021.

PEDESTRIAN, BICYCLISTS, AND MOTORISTS' INTERACTION WITH AUTONOMOUS VEHICLES

Dr. Nicholas Ferenchak, Tran-SET PI, is leading a research group in exploring pedestrians, bicyclists, and motorists' behaviors in interacting with autonomous vehicles by implementing virtual reality (VR). His team is also studying how drivers behave at rail crossings through a Federal Rail Administration project. A virtual tour of the VR lab is available at the **following link**.

Virtual lab implementation.

SUMMER TRANSPORTATION INTERNSHIP PROGRAM FOR DIVERSE GROUPS (STIPDG) INTERNSHIP

The Summer Transportation Internship Program for Diverse Groups (STIPDG) is a unique opportunity for undergraduate, graduate, and law students to get hands-on experience in public service while learning more about transportation challenges and advancements in the United States. In partnership with the U.S. Department of Transportation, this program is a critical part of the department's employee recruitment efforts.

If interested in being considered for the STIPDG Intern Program, please fill out a STIPDG application at the following **website** by January 31, 2021. The program runs 10 weeks, from June 7-August 13th, 2021 (tentative).

LAN ENGINEERING WEBINAR: TXDOT PRACTICE ON LEVEL-UP PAVEMENT PATCHING

Dr. Samer Dessouky, Tran-SET associate director, presented a webinar, TxDOT Practice on Level-Up Pavement Patching, hosted by LAN Engineering on September 23, 2020. Level-up patching is an economical, widespread corrective pavement rehabilitation treatment. It differs from the conventional spot-patching of localized pavement problems. Level-up patching involves laying down a thin asphalt layer over an existing pavement structure to correct for rutting, restore cross-slope, and improve ride quality. It is performed mainly through either blade or laydown operations. For more information on this topic, visit the **ASCE library**.

Level-up patching of road at the Concrete Convention and Exposition.