



## Transportation Consortium of South Central States

*Solving Emerging Transportation Resiliency, Sustainability, and Economic Challenges through the Use of Innovation Materials and Construction Methods: From Research to Implementation*

### Program Progress Performance Report (PPPR) #2

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# 1. Accomplishments

## Major Goals and Objectives of the Program

The **Vision** of Tran-SET is to “address the accelerated deterioration of the transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes”.

The **Mission** of Tran-SET is to “conduct all phases of research, technology transfer, education, workforce development, and outreach activities as to solve transportation challenges in Region 6 and support implementation”.

The following fourteen objectives are at the heart of *all* Tran-SET activities<sup>1</sup>:

Table 1. Major Objectives of Tran-SET

ID <sup>1</sup>	Objective
<b>Research</b>	
R1	Improve the durability and extend the service life of transportation infrastructure [IF2, IN1]
R2	Preserve the environment [IF1, IN1]
R3	Preserve the existing transportation system [IF2, IN1]
R4	Address immediate transportation priorities in Region 6 [S1, IF2, IF3, IF4, IN1]
<b>Technology Transfer</b>	
TT1	Ensure that scientific and technological developments are accessible, disseminated, and transferred to a wide range of users including state agencies, universities, and industries [IN2]
TT2	Ensure that scientific and technological developments have a long-term research value and significant impact to the transportation industry by direct collaboration with all levels of government and not-for-profit institutions [IN2]
<b>Education</b>	
E1	Improve and support existing academic programs at Tran-SET’s partnering institutions [IF4, A2]
E2	Improve and support transportation non-degree programs at Tran-SET’s partnering institutions (architectural, business, mechanical, electrical, industrial engineering, etc.) [IF4, A2]
<b>Workforce Development</b>	
WF1	Ensure research outcomes are disseminated through educational and workforce development activities by supporting the development of seminars, workshops, and training courses [IF4, A2]
<b>Emphasis Areas</b>	
EL1	Develop the next generation of leaders and graduate students of the transportation field by supporting mentoring, networking, training, and other development activities [IF4, A2]
EL2	Provide leadership to regional stakeholders and communities (state agencies, universities, and industries) and provide national leadership to applicable research communities [IN1, IN2]
EC1	Encourage and foster collaboration between partnering institutions and external stakeholders as to: (1) maximize sharing of human expertise and facilities among partners and stakeholders, (2) tackle transportation challenges only solvable by multi-disciplinary teams, (3) facilitate knowledge transfer among the team institutions and stakeholders, and (4) minimize duplicative research to optimize the use of available funds [IN2, A2]
ED1	Integrate diversity-related activities into Tran-SET’s efforts as to increase participation of underrepresented students in STEM fields, particularly the transportation field [IF4, A2]
<b>Management</b>	
M1	Operate and manage Tran-SET as to ensure the highest degree of accountability, cost-efficiency, and the optimum use of available funds, facilities, and capabilities [A2]

<sup>1</sup>All activities/accomplishments will be categorized under these fourteen objectives; Tran-SET objectives in blue.

<sup>2</sup>All Tran-SET objectives, activities/accomplishments, and impacts will also be categorized under the objectives of the US DOT Strategic Plan for FY2018. Regarding ID abbreviations: S refers to Safety, IF refers to Infrastructure, IN refers to Innovation, and A refers to Accountability objectives, respectively; US DOT objectives in green.

## Accomplishments (during this Reporting Period)

### Research

**Project Review Committees:** Project review committees (PRCs) have been established for each of the 33 first cycle projects (Jul. 2017). PRCs are made up of three officials, typically from state government agencies and academic institutions. PRCs review quarterly project reports and provide technical guidance to the project teams. [R1, R2, R3, R4, IN2]

**Second Cycle:** Tran-SET issued a call for problem statements (Sept. 2017) for the second cycle of research projects. A total of 66 problem statements were received from 15 institutions. Problem statements were ranked and request for proposals solicited for 38 projects (Nov. 2017). Thirty-eight proposals were received (Dec. 2017) and reviewed by national subject matter experts (Feb. 2018). Ultimately, **37** projects were selected for award and started on **Mar. 15, 2018**. Figures 1a and 1b show the distribution of projects by research objectives and topical areas, respectively. Detailed information can be found in Appendix A. [R1, R2, R3, R4, S1, IF2, IF3, IF4, IN1]

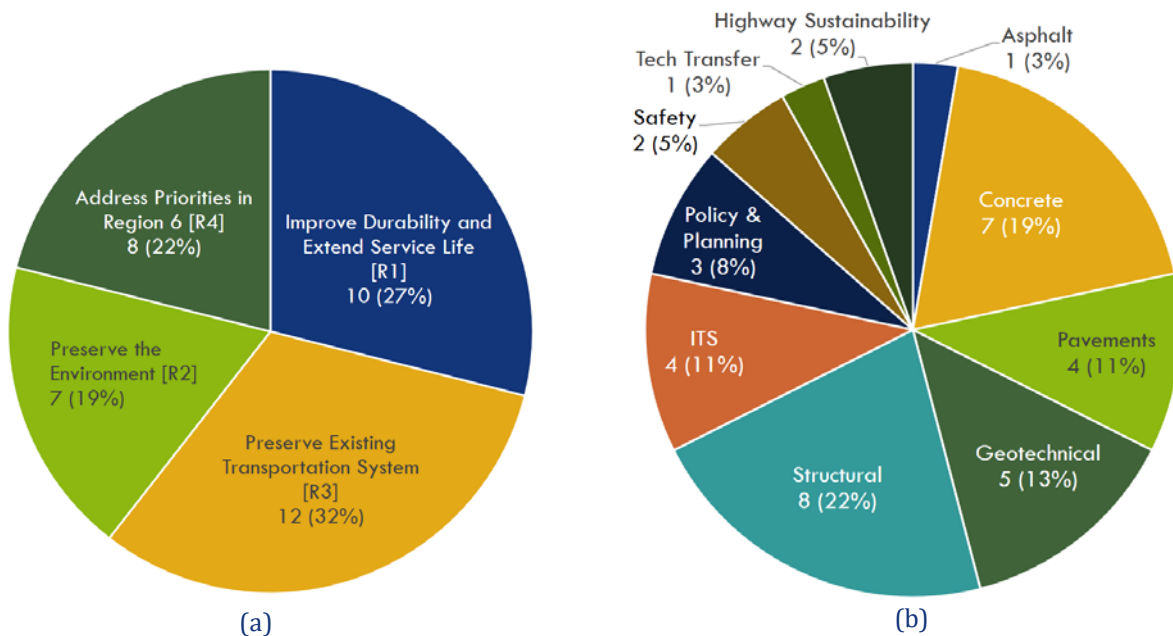


Figure 1. Distribution of Second Cycle Projects by (a) Research Objective and (b) Transportation Area

Projects are also categorized according to the regional challenges they address, see Table 2.

Table 2. Regional Challenges Addressed by Second Cycle Projects

Regional Challenge	No. of Projects
Metropolitan growth and congestion	6
Future transportation challenges	11
Declining public revenues	7
Underserved/underinvested communities	1
Safety	4

In total, \$581,395 external matching funds were received; three projects received external matching from industrial firms and nine received external matching from local and state government agencies. Seven projects involved multiple partnering institutions, which support collaboration between institutions of the Consortium.

## Technology Transfer

**Newsletter:** Tran-SET established a quarterly newsletter highlighting its research, technology transfer, education, and workforce development activities with a Winter 2017 issue (Dec. 2017) and Spring 2018 issue (Mar. 2018). Newsletters are disseminated locally (i.e., to Tran-SET affiliates), regionally (e.g., AR, LA, NM, OK, and TX LTAPs), and nationally (e.g., AASHTO RACs, Turner-Fairbank Highway Research Center, and Volpe National Transportation Systems Center). They are also available on [Tran-SET's website](#). [TT1, IN2]

**Project Highlights:** Tran-SET created two- to three-page fact sheets, or *Project Highlights*, for each of its 33 first cycle projects (Mar. 2018), providing updated progress and preliminary results. They have been a great outreach tool and have been disseminated/advertised on Tran-SET's website, Facebook, and Twitter pages – as well as printed hand-outs at conferences and vendor booths. They are also available on [Tran-SET's website](#). [TT1, IN2]

**2018 Tran-SET Conference:** Tran-SET held its first annual conference on April 3-4, 2018 in New Orleans and business meeting with the Center Advisory Board. Many activities have occurred during this reporting period to make it a success: finalizing a venue (Nov. 2017), developing a registration process and webpage (Dec. 2017), developing and disseminating promotional materials (Dec. 2017), soliciting extended abstracts and lectern presentations (Jan. 2018), soliciting student poster presentations (Jan. 2018), soliciting honorary speakers (Jan. 2018), finalizing program (Mar. 2018), and preparing printed materials, final coordination, etc. (Mar. 2018). The program included 35 lectern presentations – covering all 33 first cycle projects – and seventeen student posters. [TT1, TT2, EL2, IN2]

**2018 WTC:** The Word Transport Convention (WTC) is an international conference held June 18-21, 2018 in Beijing, China – and will offer one to two sessions specifically dedicated to Tran-SET research. Activities during this reporting period include preparing and submitting full papers for consideration by the PIs (Mar. 2018). [TT1, TT2, EL2, IN2]

**ICPIC 2018:** The International Congress of Polymers in Concrete (ICPIC) is an international forum with the objective of following progress in the field of polymers and their use in concrete and construction. The conference has been accepting manuscript submission for peer review (Oct. 2017). Tran-SET is a diamond sponsor of the ICPIC 2018 conference, which has been organized by Dr. Mahmoud Taha (Program Director) from the University of New Mexico. [TT1, TT2, EL2, IN2]

**Performance Metrics:** In addition to the accomplishments above and to better assess the progress of each objective, Table 3 provides Tran-SET's technology transfer-related performance metrics (measured outputs) for this reporting period.

Table 3. Technology Transfer Performance Metrics

Objective	Metric	Value
TT1, IN2	Number of peer-reviewed publications published	3
TT1, IN2	Number of presentations given	57
TT1, IN2	Number of conference presentations/papers	29
TT1, TT2, IN2	Number of webinars presented	0
TT1, IN2	Number of visitors to Tran-SET Website	18,317
TT1, IN2	Number of visits to Tran-SET Website	130,980

## Education

**STEM Events:** Tran-SET and its affiliates sponsored, organized, and participated in several STEM events. Three are highlighted below. [E1, E2, EL1, IF4, A2]

- *Summer Transportation Institute (STI)* – STI is a three-week program at the University of New Mexico for 30 promising 10<sup>th</sup> and 11<sup>th</sup> grade students from AZ, NM, and TX (Jun. 2017). Dr. Mahmoud Taha (Program Director) organized a workshop on materials testing. Dr. Fernando Moreu (PI) developed a workshop on building low-cost accelerometer sensors.
- *XCITE* – XCITE is a high school camp at Louisiana State University (LSU) with hands-on activities to expose and prepare students for college (Jul. 2017). Dr. Osama Osman (PI) presented a lecture on traffic simulation models and demonstrated the driving simulator.
- *Jonesboro High School STEM Academy* – Dr. Zahid Hossain (Associate Director) established a two-day internship program with students from the Jonesboro High School STEM Academy (Jan. 2018). The students were introduced to the civil engineering field, transportation profession, materials characterization, and visited his materials laboratory.

**Navajo Technical University Internship:** Tran-SET has made great progress in establishing a one-month summer internship supporting Navajo Technical University students to participate in Tran-SET research at LSU. \$6,200 of funding (from the College of Engineering, Department of Construction Management, and Tran-SET research) has been secured to support two students (Mar. 2018). Tran-SET is currently selecting student candidates for the summer of 2018. [E1, EL1, EC1, ED1, IF4, A2]

**BRCC Internship:** LSU and Baton Rouge Community College (BRCC) have established a research internship program, where BRCC students interested in careers in transportation have an opportunity to participate in Tran-SET research (Jun. 2017). So far, six students have participated. It is anticipated more student interns will take part in the next reporting period as second cycle projects begin. [E1, EL1, EC1, ED1, IF4, A2]

**Tran-SET Scholarship for Veterans:** Tran-SET has made great progress in establishing a scholarship for US veterans at LSU. Representatives from the LSU Veteran & Military Student Services met with Tran-SET to establish a working relationship (Sept. 2017). \$50,000 of funding has been acquired from the Louisiana Associated General Contractors’ (LAGC’s) Contractors’ Educational Trust Fund (CETF) with \$50,000 matching from Tran-SET research (Oct. 2017). The scholarship opportunity has been promoted and disseminated (Dec. 2017). Financial mechanisms and structures for the scholarship have been finalized at LSU (Mar. 2017). Tran-SET is currently selecting two candidates for the 2018 Fall semester. [E1, EL1, EL2, ED1, IF4, A2]

**Performance Metrics:** Table 4 provides Tran-SET’s education-related performance metrics (measured outputs) for this reporting period.

Table 4. Education Performance Metrics

Objective	Metric	Value
E1, E2, EL1, IF4, A2	Number of students participating in Tran-SET research	
	Undergraduate students	63
	Graduate students	67
E1, E2, EL1, IF4, A2	Number of students supported from Tran-SET research	
	Undergraduate students	43
	Masters students	29
	Doctoral students	27
E1, E2, EL1, ED1, IF4, A2	Number of research opportunities from under-representative groups for	
	Undergraduate students	31
	Graduate students	23
E1, E2, EL1, ED1, IF4, A2	Total budgeted costs for women and minorities	\$299,584
E1, E2, EL1, IF4, A2	Number of new transportation-related educational modules delivered	3

## Workforce Development

**SimCap Louisiana:** Mr. Christopher Melson (Program Manager) co-founded the Louisiana chapter of Simulation and Capacity Analysis Users Group (SimCap) (Feb. 2018). SimCap is a volunteer network of professionals that supports, promotes, and improves best practices in the application of traffic simulation and capacity analysis. SimCap is an active, formal workforce development entity that Tran-SET is working with to identify research topics, promote, and transfer research results in order to address regional needs. [WF1, TT2, EL2, R4, IF3, IF4, A2, IN2]

**Involvement in Professional Societies:** Tran-SET has contributed to and presented at various professional society activities. Three are highlighted below. [WF1, TT1, TT2, EL2, IF4, A2, IN2]

- *ASCE Grand Challenge* – Dr. Samer Dessouky (Associate Director) was an “Innovation Winner” at the ASCE Grand Challenge and presented his Tran-SET research at the award ceremony (Sept. 2017).
- *ASCE Concrete Canoe Competition* – Tran-SET aided the LSU ASCE student chapter with their concrete mix design for the ASCE Concrete Canoe Competition (Feb. 2018). The mix design was based on the methodology developed from Tran-SET research (Project No. 17CLSU05).
- *ASCE LSU Presentation* – Dr. Jose Mila gave a 1-hour presentation for the ASCE local chapter at LSU on self-healing concrete.
- *Deep South ITE* – Mr. Christopher Melson (Program Manager) presented Tran-SET research at the 2018 Deep South ITE Winter Meeting and participated in a young member panel discussion (Mar. 2018).

**Performance Metrics:** Table 5 shows Tran-SET’s workforce development-related performance metrics (measured outputs) for this reporting period.

Table 5. Workforce Development Performance Metrics

Objective	Metric	Value
WF1, E1, EL1, IF4, A2	Number of new or revised transportation-related courses	10
	Number of students attending the offered courses	381
WF1, E1, EL1, IF4, A2	Number of seminars/workshops presented	6

## Management

**Program Manager:** Tran-SET hired a full-time Program Manager – Mr. Christopher Melson, formerly of FHWA (Dec. 2017). [M1, A2]

**Project Management System:** Tran-SET established a project management system, in which PIs report on: the progress of each task, products, expenditures, performance metrics, risks, and delays on a quarterly basis (Jan. 2017). The system is currently Excel-based, but Tran-SET is currently developing a web-based management system anticipated to be operational in the next reporting period. Instructions, procedures, and templates of the current system are available on [Tran-SET's website](#). [M1, A2]

**Performance Assessment System:** Tran-SET established the *Grantee Performance Assessment System (G-PAS)*: a defined set of quantitative and qualitative criteria in which the performance of each project team is evaluated upon (Jan. 2018). It is based on the federal *Contractor Performance Assessment Report System (CPARS)* and includes evaluation of quality, schedule, cost control, and management on a quarterly basis. The aim of *G-PAS* is to encourage high-quality, timely products and to expend public funds as efficiently as possible. Detailed information are available on [Tran-SET's website](#). [M1, A2]

**Tran-SET Mid-Year Meeting:** Tran-SET held its first in-person, mid-year meeting with its Associate and Program Directors (Jan. 2017). Collectively, the strengths, weaknesses, opportunities, and



threats (SWOTs) of Tran-SET were defined – as were current management issues and action items to correct the issues. Meeting notes are available upon request. [M1, all, A2]

## Dissemination of Results

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Please see the above *Technology Transfer* section documenting Tran-SET's main outreach activities. More generally, results have been disseminated via: social media (Tran-SET website, Facebook, and Twitter), newsletters, other promotional documents (i.e., project briefs), conferences, educational material (courses, seminars/workshops), and peer-reviewed publications.

## Activities Planned (for next Reporting Period)

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### Research

- Complete final reports for the research phase of the 33 first cycle projects (May 2018) and submit/disseminate per the reporting requirements for UTCs (Jun. 2018). [TT1, IN2]
- Issue call for problem statements for third cycle projects (Sept. 2018). [R1, R2, R3, R4, S1, IF2, IF3, IF4, IN1]

### Technology Transfer

- Develop short, promotional videos for each first cycle project (Jun. 2018). [TT1, IN2]
- Participate in the Tran-SET presentation sessions at the 2018 WTC (Jun. 2018). [TT1, TT2, EL2, IN2]
- Develop and disseminate Tran-SET newsletter for Summer 2018 (Jun. 2018) and Fall 2018 (Sept. 2018). [TT1, IN2]
- Present and promote Tran-SET research at the 2018 ICPIC (May 2018). [TT1, TT2, EL2, IN2]
- Establish a quarterly, joint webinar series with other UTCs and state government agencies. The first webinar will feature research from Tran-SET, UTC-UTI (Tier 1 UTC), and Virginia DOT regarding novel concrete materials (Jul. 2018). The second webinar will feature research from Tran-SET and UTRC (Region 2 UTC) regarding infrastructure resilience to extreme weather events. [TT1, TT2, EL1, EC1, IF4, IN2, A2]

### Education

- Fully implement the Navajo Technical University internship and hire two interns for Summer 2018 (Jul. 2018). [E1, EL1, EC1, ED1, IF4, A2]
- Award two recipients of the Tran-SET scholarship for veterans starting the 2018 Fall semester (Aug. 2018). [E1, EL1, EL2, ED1, IF4, A2]

### Workforce Development

- Continue participation in professional society activities (on-going). [WF1, TT1, TT2, EL2, IF4, A2, IN2]
- As first cycle projects enter their implementation phase (May 2018), Tran-SET anticipates significantly more training and workforce development activities in the next reporting period as PIs refocus their efforts (on-going). [WF1, WF2, IF4, A2]

### Management

- Solicit surveys to the CAB and PRCs to receive feedback and gauge how well Tran-SET activities are addressing regional needs and impacting state-of-the-practice (May 2018). [M1, all, A2]

## 2. Products

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The 33 projects funded in the first cycle showed promising preliminary results: leading to **two** journal publications, **one** book/other non-periodical publication, **29** other publications/conference papers/presentations, **nine** technologies/techniques, and **thirteen** educational curricula/modules. *Please note: these counts do not include journal papers or books under review (to date: ten and one book chapter, respectively) nor accepted conference presentations that will be delivered beyond the reporting period (to date: 47).*

Please see the selected, product examples below. Once the technical phase of the first cycle projects ends (May 2018), Tran-SET anticipates significantly more dissemination products in the next reporting period.

### Journal Publications

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1. Ozcan, H., Ma, J., Karaman, I., Chumlyakov, Y. I., Santamarta, R., Brown, J., and R.D. Noebe (2018). Microstructural design considerations in Fe-Mn-Al-Ni shape memory alloy wires: Effects of natural aging. *Scripta Materialia*, 142, 153-157. [Published] [Federal support acknowledged] [Accessible [here](#)]
2. Ozdagli, A. I., Liu, B., and F. Moreu (2018). Low-cost, efficient wireless intelligent sensors (LEWIS) measuring real-time reference-free dynamic displacements. *Mechanical Systems and Signal Processing*, 107, 343-356. [Published] [Federal support acknowledged] [Accessible [here](#)]

### Books or other Non-Periodical, One-Time Publications

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1. Ortega, D. (2017) "Optimization of thermal energy harvesting prototype to maximize electric energy from asphalt pavement". PhD dissertation, The University of Texas at San Antonio. [Published] [Federal support acknowledged] [Accessible [here](#)].

### Selected other Publications, Conference Papers, and Presentations

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1. Aguirre M., Hassan, M., Shirzad, S., and S. Cooper. "Evaluation of hollow-fibers encapsulating a rejuvenator in asphalt binder with recycled asphalt shingles." Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
2. Ahsan, M.B. and Z. Hossain. "Study of potential use of rice husk ash (RHA) as a supplementary cementitious material in concrete industry." Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
3. Ahsan, M.B. and Z. Hossain (2017). "Use of Rice Husk Ash (RHA) as a sustainable cementitious material for concrete construction". In *International Congress and Exhibition Sustainable Civil Infrastructures: Innovative Infrastructure Geotechnology*, 197-210, Springer, Cham. [Published] [Federal support acknowledged] [Accessible [here](#)]
4. Arce, G., Noorvand, H., Hassan, M., and T. Rupnow. (2018) "Evaluation of the performance of engineered cementitious composites (ECC) produced from local materials." In *International Congress on Polymers in Concrete*, 181-186, Springer, Cham. [Published] [Federal support acknowledged] [Accessible [here](#)]
5. Chennareddy, R., Riad, A., and M.R. Taha (2018). "Pultruded GFRP reinforcing bars with carbon nanotubes". In *International Congress on Polymers in Concrete*, 645-651, Springer, Cham. [Published] [Federal support acknowledged] [Accessible [here](#)]
6. Chennareddy, R., Riad, A. and M.R. Taha. "Smart pultruded GFRP reinforcing bars incorporating nanomaterials". American Concrete Institute Fall Convention, October 2017, Anaheim, CA. [Federal support acknowledged]



7. Datta, U., Dessouky, S., and A.T. Papagiannakis. "Economic feasibility of thermal energy harvesting from asphalt pavements". Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
8. Goldsberry, Milla, J., McElwee, M., Hassan, M., and H. Castaneda (2018). "Evaluation of microencapsulated corrosion inhibitors in reinforced concrete". In *International Congress on Polymers in Concrete*, 99-105, Springer, Cham. [Published] [Federal support acknowledged] [Accessible [here](#)]
9. Hossain, Z., Rashid, F., and S. Roy. "Multiscale evaluation of rejuvenated asphalt binders with a high RAP content". Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
10. Jafari, N.H., Cadigan, J., Puppala, A.J., and T.V. Bheemasetti. "Predicting the stability of highway embankments". Louisiana Transportation Conference, February 2018, Baton Rouge, LA. [Federal support acknowledged]
11. Karaman, I., Ozcan, H., and J. Ma. "Fe-based shape memory alloys: hidden potential and challenges". International Conference on Martensitic Transformations, July 2017, Chicago, IL. [Federal support acknowledged]
12. Moreu, F. "Augmented reality tools for enhanced structural inspections". Transportation Research Board AFF40 Committee Meeting, January 2018, Washington DC. [Federal support acknowledged]
13. Moreu, F., Bleck, B., Vemuganti, S., Rogers, D., and D. Mascarenas (2017). "Augmented reality tools for enhanced structural inspection". In *Structural Health Monitoring 2017*. [Federal support acknowledged] [Accessible [here](#)]
14. Moreu, F., Garg, P., and E. Ayorinde. "Railroad bridge inspections for maintenance and replacement prioritization using unmanned aerial systems (UAS) with laser capabilities". Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
15. Noorvand, H., Arce, G., Hassan, M., and T. Rupnow. "Performance of engineered cementitious composites utilizing locally available materials in the state of Louisiana." Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
16. Ozcan, H., Ma, J., Brown, J., Noebe, R., Chumlyakov, Y., and I. Karaman. "Effects of nano-precipitates on stress induced martensitic transformation in polycrystalline FeMnAlNi superelastic wires". International Conference on Martensitic Transformations, July 2017, Chicago, IL. [Federal support acknowledged]
17. Shirzad, S., Hassan, M., Aguirre, M., Cooper, S., and I. Negulescu. "Effects of light-activated self-healing polymers on the rheological behaviors of asphalt binder containing recycled asphalt shingles." Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
18. Soleimani, S., Ledet, S.J., and J. Codjoe. "Consolidation factors and incentive programs for closure of grade crossing in the United States: a state-of-the-practice synthesis". Transportation Research Board Annual Meeting, January 2018, Washington, DC. [Federal support acknowledged]
19. Sheahan, E., Davis, A., Mirsayar, M.M. and D. Hartl (2018). "Structural health monitoring for DOT using magnetic shape memory alloy cables in concrete". In *Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation XII*, March 2018, Denver, CO. [Published] [Federal support acknowledged] [Accessible [here](#)]
20. Utpal D., Dessouky S. and A.T. Papagiannakis. "Pavement energy harvesting and cooling (PE-Cool) system". Transportation Research Board ACD60 Committee Meeting, January 2018, Washington, DC. [Federal support acknowledged]

## Selected Websites or other Internet Sites

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The Tran-SET website, Facebook, and Twitter pages are continuously updated and are leveraged to disseminate our research, technology transfer, education, and workforce development activities:

- [Tran-SET website](#);
- [Tran-SET Facebook page](#); and
- [Tran-SET Twitter page](#).

A [project-specific website](#) has been developed to directly disseminate information and progress on Project No. 17STUTA03.

Partnering institutions have also reported on and disseminated Tran-SET-sponsored activities through their own social media outlets. A selected, demonstrative example is shown below:

- University of New Mexico reporting on educational activities (Project No. 17STUNM02):
  - [Article](#) on high school students building sensors;
  - [Article](#) on high school students presenting results of their internship (related to the project);
  - [Article](#) on Dr. Fernando hosting a course for professionals on how to use the developed sensors.

## Selected Technologies or Techniques

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1. Dr. Marwa Hassan developed a procedure (utilizing a wet-spinning line) for the production of sodium-alginate hollow fibers that contain a rejuvenator. The hollow fiber rejuvenator can be used in asphalt mixtures to enhance their durability and self-healing efficiency. The procedure will be documented and disseminated in the final report (Project No. 17BLSU06).
2. Drs. Gabriel Arce, Marwa Hassan, and Tyson Rupnow developed engineered cementitious composites (ECC) with a low fiber content (1.5% volume fraction) and high replacement of fly ash – resulting in a new, more affordable ECC mixture design. The methodology and mixture design will be documented and disseminated in the final report (Project No. 17CLSU05).
3. Drs. Ibrahim Karaman and Darren Hartl developed a series of thermomechanical processing techniques to create high strength FeMnAlNi superelastic wires transforming at room temperature with a high superelastic strain. The following techniques have been developed: (1) thermomechanical processing to produce polycrystalline Fe-based SMA wire with high superelastic strain, (2) method to induce abnormal grain growth by simple cyclic heat treatments, (3) method to control superelastic stress levels by nano-precipitation, (4) atmosphere controlled quartz tube furnace to produce longer wires, (5) wire-braiding test setup, (6) mechanical testing on concrete specimens with embedded SMA wires, and (7) method to model change in detected magnetic field for a length of SMA wire embedded in concrete undergoing a phase transformation. These techniques will be documented and disseminated in the final report (Project No. 17STTAM04).
4. Drs. Homero Castaneda-Lopez, Marwa Hassan, and Miladin Radovic developed a procedure to produce microcapsules of calcium nitrate and triethanolamine. Calcium nitrate microcapsules are activated during a cracking event in the reinforced concrete, while triethanolamine capsules feature a controlled-release mechanism where the corrosion inhibitor is released depending on the pH levels. The procedures will be documented and disseminated in the final report (Project No. 17CLSU08).

## Inventions, Patent Applications, and/or Licenses

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Nothing to report.

## Selected other Products – Educational Aids or Curricula

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Several course curricula have been developed and revised to include methodologies and findings from our first cycle projects, specifically:

1. *New Mexico State University – “CE 579: Ground Improvement”*: revised to include a teaching module on quality control testing of compacted subgrades (Project No. 17STOKS01).
2. *Oklahoma State University – “CIVE 3513: Structural Steel Design”, “CIVE 4041: Senior Seminar”*: revised to include a teaching module on the risk and probability of failure in engineering design (Project No. 17STOKS01).
3. *Oklahoma State University – “CIVE 3633: Transportation Engineering”, “CIVE 4313/5313: Highway Traffic Operations”*: revised to include the latest AASHTO policy, HCM revisions, and addressing traffic congestion through demand management (Project No. 17ITSLSU09).
4. *Oklahoma State University – “CIVE 5403: Advanced Strength of Materials”*: revised to include a teaching module on the effect of fatigue deterioration on bridges (Project No. 17STOKS01).
5. *Texas A&M University – “MSEN 222: Materials Science”*: revised to include infrastructure material topics (Project No. 17STTAM04).
6. *Texas A&M University – “MSEN 440: Material Electrochemistry and Corrosion”*: covers multiscale materials corrosion mechanisms and environmental effects when materials are exposed to different conditions (Project No. 17STLSU03).
7. *University of Texas at Arlington – “CE 5383: Experimental Stress Analysis”*: revised to include techniques for testing models in the area of fluid-structure interaction, incorporating the use of optical measurement methods (Project No. 17STTSA02).

Several other educational modules have been developed as a product of Tran-SET research:

1. A new module on materials informatics was included in the 2017 edition of the “Summer School on Computational Materials Science” held annually at Texas A&M University (Project No. 17STTAM04).
2. A new module designed to show middle school students the effect of dynamic loads (wind and earthquakes) on bridges was developed and will be used annually at Oklahoma State University (Project No. 17STOKS01).
3. A new workshop, “Theory, Experiments, & Applications for Structure Monitoring & Machine Learning – Design, Build, & Analyze Real Data Using Low Cost Sensors”, was developed and held at the IMAC XXXVI Conference and Exposition (Project No. 17STUNM02).

## 3. Participants & Collaborating Organizations

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During this reporting period, Tran-SET partnered with **47** organizations (seven academic institutions, fifteen government agencies, 20 industrial firms, four nonprofits, and one school) to accomplish and oversee its research, technology transfer, education, and workforce development activities, see Table 6 for details.

During this reporting period, Tran-SET collaborated with **20** organizations/individuals (from ten academic institutions, 7 government agencies, one industrial firm, one nonprofit, and one school). As shown in Table 7, these collaborations embody interdisciplinary approaches – with involvement from electrical and computer engineering, chemistry, communication and journalism, art and art history, veteran affairs, and human resources.

## Partners

Table 6. Tran-SET Partners

Organization Name	Type	Location	Description of Contribution
Alliance Safety Council	Nonprofit	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
Arkansas Highway and Transportation Department	State government	Little Rock, AR	Collaborative research (technical guidance for implementation, oversee Tran-SET activities); first and second cycle projects, CAB
Barriere Construction Co.	Industrial firm	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
BNSF Railway	Industrial firm	Fort Worth, TX	Facilities (access to bridges, inspection reports), collaborative research (technical guidance, coordinated outreach); first cycle project
BYK USA, Inc.	Industrial firm	Gonzales, TX	In-kind support (samples of nanoclays), collaborative research (technical guidance and assistance); first cycle project
Canadian National (CN) Railway	Industrial firm	Montreal, Canada	Facilities (access to bridges, inspection reports), collaborative research (technical guidance, coordinated outreach); first cycle project
Capitol Regional Planning Commission	Local government	Baton Rouge, LA	Collaborative research (technical assistance with data collection); first cycle project
Carmeuse Lime and Stone	Industrial firm	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
Charah, Inc.	Industrial firm	Louisville, KY	In-kind support (samples of fly ash, properties data); first cycle project
City of Albuquerque	Local government	Albuquerque, NM	\$6,000 financial support, collaborative research (providing construction cost data); first cycle project
City of Baton Rouge Planning Commission	Local government	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
City of San Antonio	Local government	San Antonio, TX	\$100,000 financial support; \$5,000 in-kind support (expertise, data, and resources); first and second cycle projects
Epoxy Chemicals	Industrial firm	Kirkland, IL	\$50,000 in-kind support (polymer for grout); first cycle project
Ergon, Inc.	Industrial firm	Jackson, MS	\$49,000 in-kind support (supplying, preparing, and testing materials); first cycle projects
Fort Wayne Metals	Industrial firm	Fort Wayne, IN	In-kind support (wires and wire production), collaborative research (technical guidance); first cycle project
Greater Baton Rouge Industry Alliance	Nonprofit	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
HVJ Associates	Industrial firm	Houston, TX	Collaborative research (oversee Tran-SET activities); CAB
Illinois Center for Transportation	Academic institution	Rantoul, IL	In-kind support, facilities (conducting selective tests of asphalt binder); first cycle project
Jonesboro High School STEM Academy	School	Jonesboro, AR	Collaborative research (worked with staff to select students for internship); first cycle projects

Organization Name	Type	Location	Description of Contribution
Texas Local Technical Assistance Program	State government	Arlington, TX	Collaborative research (oversee Tran-SET activities); CAB
Los Alamos County	Local government	Los Alamos County, NM	Facilities (offices, construction sites), collaborative research (technical guidance, data sharing, coordinated outreach); first cycle project
Los Alamos National Laboratory	US government	Los Alamos, New Mexico	Collaborative research (assisted in bridge inspections); first cycle project
Louisiana Community and Technical College System	Academic institution	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
Louisiana Economic Development	State government	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
Louisiana Tech University	Academic institution	Ruston, LA	\$34,000 in-kind support; first cycle project
Louisiana Transportation Research Center	State government	Baton Rouge, LA	\$651,493 financial support, in-kind support, facilities, collaborative research; first and second cycle projects, CAB
Louisiana Workforce Commission	State government	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
NEAR Ready Mix Concrete	Industrial firm	Brookland, AR	\$12,000 in-kind support (testing materials); second cycle project
New Mexico Department of Transportation	State government	Albuquerque, NM	\$94,000 financial support, \$70,000 in-kind support (data collection) collaborative research (sharing of data, technical guidance for implementation, oversee Tran-SET activities); first and second cycle projects, CAB
Norchem, Inc.	Industrial firm	Hauppauge, NY	In-kind support (samples of fly ash, properties data); first cycle project
Oklahoma Department of Transportation	State government	Oklahoma City, OK	Collaborative research (oversee Tran-SET activities); CAB
Paragon Technical Services, Inc.	Industrial firm	Richland, MS	\$40,000 in-kind support (supply, prepare, and test materials), facilities; second cycle project
Ports Association of Louisiana	Nonprofit	Baton Rouge, LA	Collaborative research (oversee Tran-SET activities); CAB
PPG Industries, Inc.	Industrial firm	Cheswick, PA	In-kind support (glass fiber spools); first cycle project
Riceland Foods	Industrial firm	Stuttgart, AR	In-kind support (rice haul ash samples, properties data); first cycle project
Sewer Shield Composites	Industrial firm	Mesa, AZ	\$50,000 in-kind support (glass fiber reinforced polymer pipes); first cycle project
Technology Center, Inc.	Nonprofit	Pueblo, CO	Facilities (full-scale railroad laboratory), collaborative research (technical guidance, potential adoption); first cycle project
TenCate Geosynthetics	Industrial firm	Pendergrass, Georgia	Collaborative research (aiding in implementation of field demonstration); first cycle project
Texas Department of Transportation	State government	Austin, TX	Collaborative research (coordinated outreach, oversee Tran-SET activities); first cycle project, CAB

Organization Name	Type	Location	Description of Contribution
Texas Local Technical Assistance Program	State government	Arlington, TX	Collaborative research (oversee Tran-SET activities); CAB
The Culpepper Group, LLC	Industrial firm	New Orleans, LA	Collaborative research (consultation); first cycle project
Transpo Industries, Inc.	Industrial firm	New Rochelle, NY	\$50,000 in-kind support (materials); first cycle project
Transplace, Inc.	Industrial firm	Frisco, TX	In-kind support (freight movement data); first cycle project
Tulane University	Academic institution	New Orleans, LA	\$37,3779 in-kind support; first cycle project
University of New Orleans	Academic institution	New Orleans, LA	\$6,000 in-kind support; first cycle project
University of Louisiana at Lafayette	Academic institution	Lafayette, LA	\$293,937 in-kind support; first and second cycle projects
University of Texas at Tyler	Academic institution	Tyler, TX	\$40,054 in-kind support; first cycle project

## Collaborators

Table 7. Tran-SET Collaborators

Organization/Name	Type	Description of Collaboration
Arkansas Highway and Transportation Department Human Resources Division	State government	Interviewed, supplying workforce data at transportation agencies; first cycle project
CINVESTAV Mexico City, Mexico	Academic institution	Providing critical guidance on corrosion damage monitoring; first cycle project
Chinese Earthquake Administration Institute of Engineering Mechanics Beijing, China	Government	Aiding with testing procedures, facilities for infrastructure inspection; first cycle project
Institute of Disaster Prevention Yanjia, Hefei, China	Academic institution	Aiding with testing procedures, facilities for infrastructure inspection; first cycle project
Louisiana Department of Transportation and Development Human Resources Division	State government	Interviewed, supplying workforce data at transportation agencies; first cycle project
Louisiana State University Department of Chemistry Dr. Ioan Negulescu (Professor)	Academic institution	Providing critical expertise on self-healing materials and process; first cycle projects
Louisiana State University Department of Chemistry Dr. William Daly (Emeritus Profess), Dr. Sreelatha Balamurugan (Postdoctoral Research)	Academic institution	Providing critical expertise on microencapsulation procedures for concrete aggregates; first cycle project
Louisiana State University Department of Veterans Affairs	Academic institution	Advocate, aiding Tran-SET in establishing scholarship program for US veterans
New Mexico Department of Transportation Human Resources Division	State government	Interviewed, supplying workforce data at transportation agencies; first cycle project
Oklahoma Department of Transportation Human Resources Division	State government	Interviewed, supplying workforce data at transportation agencies; first cycle project



Organization/Name	Type	Description of Collaboration
Sandia Peak Ski & Tramway	Industrial firm	Aided with onsite field demonstration of low-cost sensors; first cycle project
SimCap Louisiana	Nonprofit	Identifying research needs in the area of simulation and capacity analysis, coordinated outreach
South Valley Academy	School	Aided with onsite presentation to middle and high school students; first cycle project
St. Charles Parish Mr. Luis Martinez (GIS Coordinator)	Local government	Providing critical GIS expertise and technical guidance; first cycle project
Texas Department of Transportation Human Resources Division	State government	Interviewed, supplying workforce data at transportation agencies; first cycle project
University of Illinois at Urbana-Champaign Department of Civil and Environmental Engineering Dr. Timothy Stark (Professor)	Academic institution	Providing critical technical guidance, coordinated outreach through ASCE committee; first cycle project
University of New Mexico Department of Art and Art History Dr. Andrea Polli (Professor)	Academic institution	Assisting with and providing critical guidance on social media activities; first cycle project
University of New Mexico Department of Communication and Journalism	Academic institution	Aided with mentoring high school students on engineering and communication; first cycle project
University of New Mexico Department of Electrical and Computer Engineering Dr. Rafael Fierro (Professor)	Academic institution	Aiding with drone testing using low-cost sensors; first cycle project
University of Virginia Department of Civil and Environmental Engineering Dr. Osman Ozbulut (Assistant Professor)	Academic institution	Providing critical expertise on novel structural health monitoring techniques; first cycle project

## 4. Impact

Given that the second cycle projects just began and first cycle projects are still in the preliminary research phase, there are limited *true impacts* to report. The following subsections detail how select products and activities stated above will *likely* impact transportation-related activities.

### Impact on Principle Disciplines

- The developed innovative technique for incorporating hollow fiber rejuvenators in asphalt pavement (Project No. 17BLSU06) offers a new generation of asphalt mixtures with superior service life, lower initial cost, and a more sustainable construction practice. [R1, IF2, IN1]
- The developed engineered cementitious composites (ECC) with a low fiber content and locally sourced ingredients (Project No. 17CLSU05) offers a superior, durable, efficient, and safe construction material that may lead to reduced recurring maintenance and repair of infrastructure. [R1, IF2, IN1]
- The developed series of thermomechanical processing techniques to create high strength FeMnAlNi superelastic wires (Project No. 17STTAM04) is the first step in magnetic damage detection – allowing the detection of inner damage of concrete structures which cannot be

seen from the exterior. This capability is extremely useful in determining the lifespan, durability, and safety of concrete transportation infrastructure. [R1, IF2, IN1]

- The developed procedure of using microcapsules of calcium nitrate and triethanolamine as corrosion inhibitors (Project No. 17CLSU08) offers the potential for reinforced concrete structures that are more resistant to corrosion damage – leading to reduced maintenance and repair of these structures. [R1, IF2, IN1]

### Impact on Other Disciplines

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- The microcapsules developed for asphalt (Project No. 17BLSU06) and reinforced concrete (Project No. 17CLSU08) required interdisciplinary expertise from chemistry, materials science, and civil engineering fields. The encapsulation procedures will be especially beneficial to the field of chemistry, increasing the knowledge base in this area. [R1, E2, IF2, IN1]

### Impact on Transportation Workforce Development

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- Sponsorship, organization, and participation in STEM events exposes and attracts a potential pool of smart, talented, and enthusiastic students to the transportation field at a young, influential age. [E1, E2, EL1, WF1, IF4, A2]
- Tran-SET research has supported a high number of students, especially those from under-representative groups (Table 4) – educating and training the future workforce with the needed skills and capabilities to meet the current and future needs of the transportation industry. [E1, E2, EL1, ED1, WF1, IF4, A2]
- The Navajo Technical University internship, BRCC internship, and scholarship for veterans, specifically target under-representative groups with the aim of exposing and attracting them to the transportation field and providing the necessary education and training to enter the workforce. [E1, E2, EL1, ED1, WF1, IF4, A2]
- The developed educational modules (Table 4), revised transportation-related courses (Table 5), and provided seminars/workshops (Table 5) have educated and trained the current and future workforce on emerging innovations – supplementing its capabilities and increasing its competitiveness. [E1, E2, EL1, WF1, IF4, A2]

### Impact on Physical, Institutional, and Information Resources

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- New testing laboratory setups have been developed for direct tensile tests of engineered cementitious composites (ECC) dog-bone shape specimens and flowability tests (Project No. 17CLSU05). These setups will be available and utilized in future research at LSU and in the Consortium. [E1, IF4, A2]
- A new shake table has been repaired and setup for large-scale testing in the Smart Management of Infrastructure Laboratory at the University of New Mexico (Project No. 17STUNM02). The instrument and setup will be used in future research. [E1, IF4, A2]
- The developed course material (Table 5) has increased institutional knowledge and resources at its respective institutions – and are available for future teachings of the courses. [E1, IF4, A2]
- The establishment of *SimCap Louisiana* will improve the state-of-the-practice in the application of traffic simulation and capacity analysis tools throughout the state of Louisiana. [E1, IF4, A2]

## Impact on Technology Transfer (T2)

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- Tran-SET is committed to ensuring that project findings have a long-term research value and significantly impact the transportation industry. All first and second cycle projects have allocated at least 10% of their funding for a dedicated six-month implementation phase. Tran-SET established the appropriate mechanisms, partners, and collaborators for successful technology transfer – once the first cycle projects are complete and have developed suitable technologies.

## Impact on Society beyond Science and Technology

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- The developed technologies and techniques specified above (Project Nos. 17BLSU06, 17CLSU05, 17STTAM04, 17CLSU08) all offer superior infrastructure materials capable of profound social and economic impacts. Improving the durability and extending the life of infrastructure can lead to significant savings in maintenance and repairs (monetary and societal: less delay due to work zones, more resilient infrastructure in extreme weather events, increase in economic competitiveness, other benefits from a state of good repair, etc.). [R1, EL2, IF2, IF4, IN1, IN2]

## 5. Changes/Problems

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### Changes in Approach

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Nothing to report.

### Actual or Anticipated Problems/Delays

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Nothing to report.

### Changes Impacting Expenditures

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Nothing to report.

### Changes in Study Protocol

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Nothing to report.

### Changes in Primary Performance Site Location

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Nothing to report.

## 6. Special Reporting Requirements

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Not applicable.

## Appendix A

Table 8. Awarded Second Cycle Projects

Project No.	Title	Total Cost	Leading Institution	Research Objective	Topical Area
18BASU02 <sup>1</sup>	Elimination of Empirical, Ineffective and Expensive PG Plus Tests to Characterize Modified Binders	\$100,331	A-State	R1, IF1, IF2, IN1	Asphalt
18CASU03 <sup>1</sup>	Use of Rice Husk Ash (RHA) in Flowable Fill Concrete Mix Material	\$79,010	A-State	R2, IF2, IN1	Concrete
18CLSU01 <sup>2,3</sup>	Application of Engineered Cementitious Composites (ECC) for Jointless Ultrathin White-topping Overlay	\$610,480	LSU	R1, IF2, IN1	Concrete
18CLSU02 <sup>2</sup>	Self-healing Concrete through Microencapsulated Bacterial Spores in a Simulated Hot Subtropical Climate	\$122,816	LSU	R1, IF2, IN1	Concrete
18CLSU03 <sup>2</sup>	Use of Bagasse Ash as a Concrete Additive for Road Pavement Applications	\$120,002	LSU	R2, IF2, IN1	Concrete
18CLSU14 <sup>2</sup>	Investigation of Physical and Dynamic Properties of High Porous Concrete	\$40,100	BRCC	R1, IF2, IN1	Concrete
18CNMS01	UHPC Shear Keys in Concrete Bridge Superstructures	\$180,000	NMSU	R1, IF2, IN1	Concrete
18CTAM03 <sup>3</sup>	Development of Geopolymers Based Cement and Soil Stabilizers for Transportation Infrastructure	\$248,000	TAMU	R1, IF2, IN1	Concrete
18GTASU01	Development of Metals Corrosion Maps of Arkansas and Maintenance of Cross-drains	\$100,271	A-State	R3, IF2	Geotech
18GTLSU06 <sup>3</sup>	Integrated Field Instrumentation, Full-Scale Physical Experiments, and Numerical Modeling of the Performance and Rehabilitation of Highway Embankments	\$210,000	LSU	R3, IF2, IN1	Geotech
18GTLSU10	Soil-Recycled Aggregate-Geopolymer Road Base/Subbase System- Step Towards Sustainability	\$89,148	ULL	R2, IF2, IN1	Geotech
18GTTSA02	Performance of Drilled Shaft under Combination of Complicated Loads under Hurricane Event	\$100,000	UTSA	R3, IF2, IN1	Geotech
18GTUNM01 <sup>2</sup>	Karst Sinkhole Detecting and Mapping Using Airborne LiDAR	\$140,000	UNM	R3, IF2, IN1	Geotech
18HSTSA01 <sup>2</sup>	Evaluation and Enhancement of Carbon Sequestration Potential, Bioenergy Production and Ecosystem Services of Existing Vegetation along Roadsides	\$100,000	UTSA	R2, IF2, IN1	Highway Sustain.

Project No.	Title	Total Cost	Leading Institution	Research Objective	Topical Area
18HSTSA02 <sup>2,3</sup>	Assessing the Impacts of Super Storm Flooding in the Transportation Infrastructure - Case Study: San Antonio, Texas	\$140,000	UTSA	R2, IF2, IN1	Highway Sustain.
18ITLSLU07 <sup>2</sup>	Investigating and Analyzing Factors Affecting Lane-Capacity Variations in the Roadway Network in Baton Rouge, LA: Measures for Mitigating Traffic Congestion	\$90,001	LSU	R4, IF3	ITS
18ITLSLU09	Combining Virtual Reality and Machine Learning for Intelligent Sustainable Traffic Management	\$60,000	LSU	R4, IF3, IN1	ITS
18ITSOKS01	Vehicle Sensing and Communications using LED Headlights to Enhance the Performance of Intelligent Transportation Systems: Proof of Concept, Implementation, and Applications	\$141,400	OKS	R4, IF3, IN1	ITS
18ITSTSA03 <sup>3</sup>	Smart Charging of Future Electric Vehicles Using Roadway Infrastructure	\$130,001	UTSA	R2, IF3, IN1	ITS
18PLSU08 <sup>3</sup>	Decision-Making Tool for Road Preventive Maintenance Using Vehicle Vibration Data	\$70,003	TAMU	R3, IF2, IN2	Pavement
18PLSU13	Mitigating Pavement Reflective Cracking Using A Ductile Concrete Interlayer	\$89,748	ULL	R3, IF2, IN1	Pavement
18POKS03	Developing Implementable Climatic Input Data and Moisture Boundary Conditions for Pavement Analysis and Design	\$57,000	OKS	R3, IF2, IN1	Pavement
18PPLSU04 <sup>3</sup>	Strategies for Prioritizing Needs for Accelerated Construction after Hazard Events	\$160,000	UNM	R4, IF2, IN2	Policy & Planning
18PPPVU01	Lifecycle Environmental Impact of High-Speed Rail System in the I-45 Corridor	\$47,000	PVAMU	R2, IF2, IF3	Policy & Planning
18PPUNM02	Evaluating how the Quality of Pedestrian Infrastructure Affects the Choice to Walk	\$100,000	UNM	R4, IF1	Policy & Planning
18PUTA02	The Impact of Hurricane Harvey on Pavement Structures in the South East Texas and South West Louisiana	\$157,999	UTA	R3, IF2	Pavement
18SALSU05 <sup>2</sup>	Truck Crash Causation in Louisiana	\$50,318	LSU	R4, S1	Safety
18SATSA05	Portable Roadway High Water Detection System for Driver Safety and Infrastructure Assessment	\$78,000	UTSA	R4, S1, IN1	Safety
18STLSU11	FRP Composite Decks for Movable Bridges	\$88,566	ULL	R1, IF2, IN1	Structural

Project No.	Title	Total Cost	Leading Institution	Research Objective	Topical Area
18STLSU12	Exterior Bridge Girder Fender System for Over-height Vehicle Impact Protection	\$132,536	ULL	R3, IF2, IN1	Structural
18STOKS02	A Comprehensive Framework for Life-cycle Cost Assessment of Reinforced Concrete Bridge Decks	\$141,600	OKS	R3, IF2, IN2	Structural
18STTAM01	Reduction of Structural Damage from the Thermal Expansion of Concrete using Multifunctional Materials	\$70,000	TAMU	R1, IF2, IN1	Structural
18STTAM02 <sup>1</sup>	Disaster-Resilient and Self-Assessing Multifunctional Transportation Structures	\$170,000	TAMU	R1, IF2, IN1	Structural
18STTSA04	Structural Vulnerability of Coastal Bridges under Extreme Hurricane Conditions	\$100,000	UTSA	R3, IF2, IN1	Structural
18STUNM03	Augmented Reality Enhancing the Inspections of Transportation Infrastructure: Research, Education, and Industry Implementation	\$100,000	UNM	R3, IF2, IN2	Structural
18STUTA01	Toward Corrosion-Free and Highly Sustainable Structural Members by using Emerging Ultra-High-Performance Materials for Transportation Infrastructure	\$140,000	UTA	R1, IF2, IN1	Structural
18TTNMS02	Workforce Development Symposiums for UHPC	\$52,000	NMSU	R4, IF4, IN2	Tech Transfer

<sup>1</sup>Industrial firm providing matching funds; public-private partnership.

<sup>2</sup>Government agency providing matching funds; public-public partnership.

<sup>3</sup>Multi-institution project.