



**Project Requirements Form USDOT
CREATE UTC Contract Number 69A3552348330
Center Lead: Texas State University; Texas State University**

Research Project Name: Bio-waste Materials as Supplementary Cementitious Materials for Coastal Concrete Applications	
Improving the Durability and Extending the Life of Transportation Infrastructure	
Principal Investigator: Xijun Shi, xijun.shi@txstate.edu, 512-245-1826, 0000-0003-2858-8603, TXST	
Project Partners: Rio Grande Valley Sugar Growers, Inc; Nest Fresh Eggs	
Research Project Funding:	
Federal: \$104,619	Match: \$52,627 (TXST)
Project Start Date: 09/01/2023	Project End Date: 12/10/2025
Project Description: In the U.S., coal fly ash is by far the most used supplementary cementitious material (SCM). Despite being used every day, the supply of coal fly ash in the U.S. has become a matter of concern because we are blending different coals that produce less amount of Class F fly ash – a type of fly ash that is preferred by the concrete industry. Therefore, it is critical to identify and evaluate alternative SCMs that can offer concrete equivalent or better strength and durability characteristics to Class F fly ash. This is especially critical in coastal areas where concrete durability remains a challenge. One area that is being overlooked by the concrete industry for alternative SCMs is bio-waste materials, which include agricultural waste, eggshells, burnt oyster shell, etc. In this project, the feasibility of using two bio-waste materials, sugarcane bagasse ashes and ground waste eggshells, as alternative SCMs in portland cement concrete for coastal applications is investigated.	
US DOT Priorities: The project carries multifaceted and long-term merits and aligns well with US DOT priority area D and strategic goals. First, these novel bio-waste-based SCMs will extend the life of transportation infrastructure by improving concrete long-term strength and durability. Second, successfully incorporating bio-waste materials in concrete not only reduces the reliance on fly ash or other SCMs that are being phased out, but it also reduces the nuisance caused by these bio-waste materials in terms of required disposal. To facilitate implementation, at the end of the project, detailed guidelines and recommendations will be provided that include 1) bio-waste materials quality control protocols including how to produce, store, and handle the materials, and the chemical composition and size distribution requirements for the materials 2) concrete mix design including optimum biowaste material replacement levels and modifications on design parameters, and 3) how concrete materials properties are modified due to the bio-waste materials addition and how these changes affect design of coastal infrastructures.	
Outputs: The project will produce literature review and lab data to document the use of bio-waste materials as SCM for coastal concrete applications. The expected products include a public database that comprehensively documents the testing results in the project and guidelines and recommendation documents on how to use the bio-waste materials of interest to formulate coastal concrete. The research team has established partnerships with two forward-thinking companies that generate a large quantity of these bio-waste materials. One company is Rio Grande Valley Sugar Growers, Inc, located at Santa Rosa, TX. Being one of the top 10 producers of raw sugar in the United States, the company generates numerous amounts of sugarcane bagasse ashes each year. The other company is NestFresh Eggs, a company based off Denver, CO. The company is looking forward to recycling the waste eggshells.	



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Outcomes/Impacts: The anticipated products include a database assessing the feasibility of the technology and guidelines documents that facilitate implementation. Based on the research outcomes from this project, the research team will talk with owners and regulatory agencies and seek potential practice changes. This research will positively impact transportation systems by offering economical construction materials. In particular, the effort will help overcome the current and impending challenges associated with fly ash shortage in the cement and concrete industry.

The project will also support blue economy career development from at least two aspects: 1) this UTC project will partially fund two Texas State civil engineering graduate students to complete her/his advanced degree. The students are anticipated to contribute to blue economy after graduation. 2) The research outcomes will be openly disseminated to the coastal infrastructure community. The advancement in knowledge of using bio-waste materials in concrete will help engineers and agencies design and build more durable coastal concrete structures.

Final Research Report: <https://rosap.nrl.bts.gov/view/dot/88177>



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Web Links: <https://create.engineering.txst.edu/>

Index Terms (Keywords to describe Project):

Eggshells; sugarcane bagasse ashes; concrete; coastal infrastructure

Subject Areas (Check all that apply, for more details about topic areas see <https://rip.trb.org/>):

Design and Construction: Bridges & other structures; Construction; Design;

Geotechnology;

Hydraulics & Hydrology; Materials; Pavements

Operations and Preservation: Maintenance and Preservation; Operations & Traffic Management;

Securities & Emergencies

Planning and Environment: Economics; Energy; Environment; Planning & Forecasting; Society

Policy & Organization: Administration & Management; Data & Information Technology; Education & Training

Finance; History; Law; Policy; Research; Transportation (general)

Safety, System Components, and Users: Freight Transportation; Passenger Transportation Safety & Human Factors; Terminals & Facilities; Vehicles & Equipment