Project Requirements Form USDOT
CREATE UTC Contract Number 69A3552348330
Center Lead: 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(s):
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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**: 12/31/2024

Project Description:
The cement industry releases approximately 8% of world's CO_2 - a significant source that induces climate change. To curb the carbon emissions from the cement and concrete industry, utilization of supplementary cementitious materials (SCMs) to replace a portion of portland cement in concrete is considered one of the most effective approaches. In the U.S., coal fly ash is by far the most used SCM. Despite being used every day, the supply of coal fly ash in the U.S. has lately become a matter of concern due to the promotion of renewable energy sources and blending of 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 supplementary cementitious materials that can offer concrete equivalent or better strength and durability characteristics to Class F fly ash. One area that is being overlooked by the concrete industry for alternative SCMs is bio-waste materials, which include agricultural wastes, eggshells, burnt oyster shell, etc. In this project, the feasibility of using two bio-waste materials, i.e., 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 significantly improving concrete long-term strength and durability. Second, the successful inclusion of 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 environmental nuisance caused by these bio-waste materials along with promoting the circular economy through sustainable handling and disposing of these materials. To facilitate implementation, at the end of the project, detailed guidelines and recommendations on 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, will be established. Ultimately, implementation of bio-waste materials in concrete will help the cement and concrete industry and transportation infrastructure sector make strides towards the carbon-neutrality goal.

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 committed to sustainability and is looking forward to recycling the waste eggshells.

Outcomes/Impacts: The anticipated products include the 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 eco-friendly, 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 and sustainable coastal concrete structures.

Final Research Report: URL to final Report will be provided upon completion.

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