Exhibit D

Research Project Requirement Template

Advanced Environment-Friendly Concrete Materials for Rapid Infrastructure Repair and Rehabilitation

Recipient/Grant (Contract) Number: 69A3552348306 (CY1-UARK-LSU-01)

Center Name: Southern Plains Transportation Center (SPTC)

Research Priority: Improving the Durability and Extending the Life of Transportation

Principal Investigator(s): Cameron Murray, University of Arkansas; Hassan Noorvand, Louisiana State University

Project Partners: University of Arkansas and Louisiana State University

Research Project Funding: University of Arkansas: $57,422 (Federal) and $57,424 (Match); Louisiana State University: $50,000 (Federal) and $50,000 (Match)

Proposed Start and End Date: 10/01/2023 to 09/30/2024

Project Description: The United States has many infrastructure challenges in terms of maintaining and repairing an extensive network of aging roads and bridges. Additionally, an increased focus on environmentally friendly processes and materials means that there is an urgent need to develop and evaluate alternative cementitious materials and novel portland cement-based solutions to infrastructure maintenance issues. One promising technology is the utilization of calcium sulfoaluminate (CSA) cements in the production of concrete materials. CSA cements offer several advantages, including lower carbon intensity (compared to portland cement), rapid setting, and low shrinkage. These properties make them an ideal candidate for rapidly replacing or repairing critical transportation infrastructure. In addition, Engineered Cementitious Composites (ECCs) with superior ductility and mechanical strength have been proposed as a promising material alternative to extend the durability and service life of infrastructure. However, ECC typically requires a high cement content, leading to challenges such as increased hydration heat, autogenous shrinkage, and higher carbon dioxide emissions. To address these challenges, this project aims to investigate the feasibility of using CSA as a partial or complete replacement for cement in ECC without sacrificing its mechanical properties, specifically tensile ductility. The addition of CSA in concrete and ECC materials will be tested separately at the participating institutions. The PIs have planned activities to enhance collaborations between the University of Arkansas and Louisiana State University by sharing research findings, which include pursuing future collaborations and strengthening the connections between the researchers.

The objectives of this study will be met through two primary tasks, one at UARK and one at LSU. The UARK researchers will examine the durability properties of belitic calcium sulfoaluminate (BCSA) cement through the following sub-tasks: (1) reviewing existing literature and preparing a test matrix including mixture designs, cement types, and curing conditions; (2) conducting experimental testing to determine carbonation and chloride penetration depths; and (3) analyzing results and preparing the final report. The LSU researchers will investigate the mechanical properties of CSA-based ECC through the following sub-tasks: (1) characterizing CSA cement to determine chemical composition, surface condition, and particle size distribution and then using that information to develop ECC mix designs; (2) investigating compression and tension behavior of developed mix designs; (3) examining

adaptation of developed ECC mixes for 3D concrete printing; and (4) working with UARK to develop the final project report.

US DOT Priorities: This project aligns well with the SPTC priorities that seek to enhance infrastructure durability, longevity, and sustainability. Also, this project addresses the USDOT strategic goals of "Climate and Sustainability" and "Economic Strength and Global Competitiveness." Through rigorous research and community outreach, this project aims to foster inclusivity and empowerment in historically underserved communities, while significantly contributing to the nation's infrastructure revitalization with environmentally conscious solutions.

Outputs: This study will produce critical data on the corrosion performance of CSA cement concrete and insights into the mechanical and microstructural properties of ECC materials incorporating CSA as a replacement for portland cement. Deliverables include the following: (1) Comprehensive reports documenting the corrosion performance of CSA cement concrete; (2) Prototypes demonstrating the effectiveness of CSA-based ECC in infrastructure repair.

Outcomes/Impacts: The following outcomes are expected from the proposed study: (1) Quick transition to implementation for rapid repair/rehabilitation of concrete structures using CSA cement concrete by understanding corrosion mitigation strategies; (2) The outcome of this research project will be several successful CSA-based ECC mix designs that will be readily available to the state DOTs for implementation in the transportation infrastructure as well as for further evaluation in future research projects.

In terms of impacts, throughout this project, the research teams aspire to induce accelerated and durable repair/rehabilitation of concrete structures in extreme environments. These technologies are expected to improve the longevity, performance, and cost-effectiveness of transportation repairs and rehabilitation. Recruiting underrepresented groups to transportation-related research and jobs is a priority of the research teams.

Final Research Report: