Exhibit D

Research Project Requirement Template

Bond Performance of Advanced Environmentally Friendly Concrete Materials for Rapid Infrastructure Repair and Rehabilitation

Recipient/Grant (Contract) Number: 69A3552348306 (CY1-OU-04)

Center Name: Southern Plains Transportation Center (SPTC)

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

Principal Investigator(s): Royce Floyd, Jeffery Volz, Shreya Vemuganti, University of Oklahoma

Project Partners: University of Oklahoma

Research Project Funding: University of Oklahoma: $49,788 (Match)

Proposed Start and End Date: 10/1/2023 to 09/30/2024

Project Description: Portland cement production results in approximately 2.5 gigatons of direct CO_2 emissions per year, or between 5% and 10% of CO_2 emissions produced by humans. Calcium sulfoaluminate (CSA) cements are a promising alternative to hydraulic cements because of the significant reduction (nearly half) in CO_2 emissions during production and high early strength (rapid setting) or controlled expansion (shrinkage compensating). These properties make CSA cement attractive and effective for transportation infrastructure, including accelerated repair of pavement and/or mitigation of shrinkage cracking. Half of the bridges in the United States already have or will reach their anticipated design life in the next 10 years. Many of these bridges can have their service life safely extended – with reduced environmental impact – by targeted repair and rehabilitation using CSA cement. Using concrete mix designs developed at the University of Oklahoma (OU), the University of Arkansas, and Louisiana State University, the proposed research will evaluate the ability of CSA cement to bond to traditional concrete substrates and the durability of those bonds over time. The objectives of the proposed study are to (1) Evaluate the bond performance of CSA cement concrete for varying substrate conditions; (2) Evaluate the freeze-thaw durability of CSA cement concrete repairs; and (3) Develop and communicate recommendations for CSA cement concrete repairs.

These objectives will be achieved by experimental evaluation of CSA cement concrete mix designs developed at OU and SPTC partner institutions through six specific tasks. Task 1 will involve identifying CSA cement concrete mix designs for use in further testing. Task 2 will examine the bond of the CSA cement concrete repair materials to conventional concrete substrates with different surface preparations, using direct pull-off testing. In Task 3 freeze-thaw resistance of the repair interface will be evaluated using rapid freeze-thaw cycles. Repair interfaces for both newly cast specimens and concrete from in-service bridges will be tested for freeze-thaw resistance. In Task 4 bond and freeze-thaw results will be compared to the results for other advanced concrete materials. Task 5 will involve the construction of a large-scale repair demonstration for DOT officials that will then be used for long-term performance evaluation. Task 6 will include the development of educational materials including a prerecorded training module, live workshop, and demonstration for high school outreach events.

US DOT Priorities: This project will address the USDOT Strategic Goal of Climate and Sustainability, specifically decarbonization, through the development of innovative concrete technology with reduced carbon emissions and potential for extended service life of structures. Advanced repair materials help

address the USDOT Strategic Goal of Economic Strength and Global Competitiveness by improving the performance and life of structures on critical freight corridors. Diversity, Equity, and Inclusion will be addressed for this project by actively recruiting research assistants from under-represented groups, having all project personnel complete DEI training, and having regular collaborative meetings with the research team.

Outputs: This project will provide mix designs and data on the bond behavior of CSA cement-based repair materials to concrete substrates of varying conditions and surface preparations, as well as recommendations for mix designs and surface preparations for CSA cement concrete repairs. This will include a small repair and outreach demonstration. It is anticipated that one journal paper will result directly from this work. The proposed training module will be recorded and archived on the SPTC website, and a 3-5-minute video will summarize the project and be used to solicit potential implementation.

Outcomes/Impacts: Production of CSA cements produces fewer CO_2 emissions than conventional cement and reduces the overall environmental impact of concrete construction. CSA cement concrete for repair of existing transportation structures will allow more rapid repairs/rehabilitations that reduce the impact on the traveling public while extending the life of existing structures. The final mix designs, guidance, and training are expected to be immediately implementable. Recommendations for mix designs and surface preparation can be used to develop and revise construction specifications and special provisions. The research team will work with ODOT, private contractors, and colleagues at the University of Arkansas and Louisiana State University to identify potential implementation projects.

Final Research Report: