Exhibit D

Research Project Submission Template

Recipient/Grant (Contract) Number: University of Illinois Urbana-Champaign / Purdue University / Grant No.: 69A 355 234 8333

Integrating Sensing Technologies, AI, and BIM to Automate the Lifecycle Quality Control of Precast MSE Wall Systems

Center Name: Transportation Infrastructure Precast Innovation Center (TRANS-IPIC)

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

Principal Investigator(s): Hubo Cai (PI), Dulcy Abraham (Co-PI), Phillip Dunston (Co-PI), Jiansong Zhang (Co-PI)

Project Partners: N/A

Research Project Funding: $103,836 ($69,214 Federal and $34,622 Non-Federal)

Project Start and End Date: 01/16/2026 – 01/15/2027

Project Description:

Mechanically Stabilized Earth (MSE) wall panels are manufactured in precast plants to provide desired quality and durability. However, quality deficiencies during any lifecycle phase will offset the expected benefits. Building on the findings from the previous project (PU-23-RP-01: Holistic Quality Management of Precast Concrete Construction for Transportation Infrastructure), we propose to 1) assess the inexpensive pocket LiDAR technology and develop AI algorithms for near real-time dimensional measures (e.g., panel dimensions, rebar spacing, positions of tie strips and anchors during the manufacturing phase; panel alignment, position, and strap layouts during the lifting/installation phase); 2) develop AI algorithms to determine damages such as corner knock-offs and cracks during the transportation phase by comparing before- and after- images of wall panels and installed units; 3) integrate BIM for quality control and accurate 3D as-builts. Project deliverables include technology assessments, AI algorithms, and a BIM-integrated process that will be tested in real project settings.

US DOT Priorities:

Precast Mechanically stabilized earth (MSE) retaining walls have been widely adopted by US Department of Transportation (DOT) agencies in building transportation assets such as embankments of highway and railway and bridge abutments. Over 5 million sq. ft. of MSE walls are constructed annually in the US. MSE wall panels are produced in precast plants under a controlled environment and installed at jobsites to provide desired quality, durability, adaptability, and efficiency for constructing MSE wall systems. However, quality deficiencies during any lifecycle stage (i.e., design, manufacturing, transporting, lifting and installation, and operation and maintenance (O&M)) of PC systems (PCS) can easily offset the expected benefits, leading to premature failures and excessive repair costs. Heavily relying on manual inspections, current practices of quality control (QC) for PC MSE wall systems are time-consuming, prone to missing critical quality problems, and isolated within each lifecycle stage. Therefore, there is a critical need for cost-effective, easy-to-use technologies that can automate inspections and enable holistic quality management of PC MSE wall systems from the lifecycle perspective.

Outputs:

Expected deliverables include 1) technology assessments of inexpensive pocket LiDAR and smartphone cameras regarding their use in collecting quality control data during the in-plant manufacturing and jobsite installation/construction phases and transportation phase, respectively, 2) AI algorithms for processing LiDAR point clouds for near real-time dimensional measures, 3) LLM-based AI algorithms for determining damages occurred during the transportation, 4) a BIM-based integration process to

integrate BIM and sensing technologies for developing accurate 3D as-builts and the lifecycle management and sharing of QC data, and (5) tutorials, demos, technical manuals, and educational modules for education and workforce development. This research contributes to TRANS-IPIC's Strategic Goal 3, Advance the field of building information modeling (BIM) using new technologies.

Outcomes/Impacts:

Expected implementable technology includes: 1) guidance and AI algorithms for the use of pocket LiDAR in dimensional quality measurements during the manufacturing and construction phases, 2) guidance and AI algorithms for using smartphone cameras to detect damages to MSE wall panels during the transportation phase, and 3) a tested BIM framework that automates the quality control of MSE wall systems from a lifecycle perspective.

Final Research Report: URL link to the project's final report will be provided upon the completion of the project.