Exhibit D

Research Project Submission Template

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

Optimizing Maintenance Decisions for Precast Concrete Bridges

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

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

Principal Investigator(s): Khaled El-Rayes (PI) / Ernesto-John Ignacio (Co-PI)

Project Partners: N/A

Research Project Funding: $115,852 ($65,000 Federal and $115,852 Non-Federal)

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

Project Description:

A large number of US bridges are constructed using Precast Concrete (PC) due to its ability to enhance quality, improve durability, and reduce onsite construction time. Prioritizing and optimizing maintenance decisions for these PC bridges is essential to maximize their structural performance while minimizing their maintenance and life-cycle costs. To advance these goals, this research project focuses on (1) developing novel multi-objective optimization models that enable maximizing durability and safety while minimizing maintenance and life cycle costs of PC bridges; and (2) creating a user-friendly Decision Support Tool (DST) with a graphical interface for streamlined data entry and interactive visualization of optimal maintenance decisions to facilitate its use and adaption by State DOTs. These outcomes are expected to advance TRANS-IPIC's mission of “providing gains in durability, safety, and economy as well as reducing environmental impact and resources required for repair and replacement”.

US DOT Priorities:

The American Society of Civil Engineers (ASCE) reports that approximately 56% of the nation's 623,000 bridges are in fair or poor condition that caused substantial safety risks and traffic delays for millions of daily users. This has been caused by the lack of funding for the rehabilitation and reconstruction of aging bridges which created a $191.3 billion rehabilitation backlog and a $373 billion funding gap over the next decade (ASCE, 2025; FHWA, 2025). To address this pressing challenge, federal and state departments of transportation (DOT) need to optimize the use of limited funding and budgets for the rehabilitation of aging bridges to maximize their overall performance and durability. This presents federal and state DOTs with several challenges, including how to (1) optimize maintenance and repair decisions for precast concrete bridges; (2) maximize bridge safety and load capacity; (3) maximize durability of precast concrete bridges; (4) minimize bridge maintenance and life-cycle costs; and (5) generate and analyze trade-offs among these bridge optimization objectives.

To address these challenges, the proposed research will develop robust multi-objective models and a user-friendly decision support tool for optimizing maintenance decisions for precast concrete bridges. This perfectly aligns with the TRANS/IPIC mission of “providing gains in durability, safety, and economy as well as reducing environmental impact and resources required for repair and replacement” (TRANS-IPIC, 2025).

Outputs:

The anticipated research results include the development of novel multi-objective optimization models and a practical decision-support tool (DST) specifically designed to precast concrete bridges, enabling State DOTs and bridge planners to prioritize and optimize maintenance and repair decisions. The key

deliverables include: (1) validated optimization models that integrate objectives such as maximizing bridge safety and durability while minimizing maintenance and life cycle costs; and (2) a user-friendly DST featuring a graphical user interface for seamless data input and interactive visualizations of optimal maintenance actions and trade-off analyses. These outcomes directly advance TRANS-IPIC's goal of "providing gains in durability, safety, and economy as well as reducing environmental impact and resources required for repair and replacement".

Outcomes/Impacts:

The primary implementable technology from this research is a user-friendly decision support tool (DST) that can be used by State DOTs to optimize the maintenance decisions of precast concrete bridges. The DST will be designed to generate actionable outputs, including prioritized maintenance schedules, tradeoff visualizations and performance forecasts to support the optimization of precast concrete bridge maintenance decisions over a specified planning horizon. These novel capabilities of the proposed DST are expected to advance the TRANS-IPIC mission of "providing gains in durability, safety, and economy as well as reducing environmental impact and resources required for repair and replacement".

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