# Exhibit D

**Research Project Requirement Template**

**Research project name: Data-Driven Smart Composite Reinforcement for Precast Concrete**

**Recipient/Grant (Contract) Number:** University of IllinoisUrbana-Champaign / Purdue University / Grant Number 69A3552348333

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

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

**Principal Investigator(s):** Chengcheng Tao / Shanyue Guan

**Project Partners:** N/A

**Research Project Funding:** $97,500 ($64,996 Federal and $32,504 Non-Federal)

**Project Start and End Date:** 01/01/2024 – 12/31/2024

**Project Description:**

The proposed research aims to develop a smart composite reinforcement in precast concrete for real-time health condition monitoring using embedded sensors on the composite. The monitoring system can provide the health condition and risk information of the composite reinforcement and investigate the load transfer effectiveness between layers of the reinforcement and the precast concrete. The self-sensed composite reinforcement health and environmental data such as stress, strain, and temperatures will be paired with mechanical models of composite-concrete system and data-driven machine learning algorithms to predict the risk of the composite reinforcement for a better reinforced precast concrete system. Specific research objectives include: 1) develop embedded distributed sensors for self-sensing composite reinforcement; 2) conduct multi-scale multi-physics modeling with finite element analysis for the composite reinforcement mechanical and bonding performance using the sensor data; 3) integrate the data-driven machine learning algorithms to predict the risk of different composite reinforcement.

**US DOT Priorities:**

The proposed project innovatively integrates sensing technology, computational mechanics of materials, and data-driven machine learning algorithms to detect the structural and materials failure and anomaly mechanism and predict the associated risk in more general cases. The project aligns well with TRANS-IPIC’s mission of improving durability and extending the life of composite reinforcement for PC transportation infrastructure. The research outcomes will efficiently provide real-time health conditions and risks of the composite reinforcement for PC components, and guide the future structural and materials design with enhanced durability, sustainability, safety, and economic value for the PC infrastructure industry.

**Outputs:**

Upon the completion of this project, our team will achieve a self-sensing and risk-aware system for the composite reinforced precast concrete. Currently, the precast concrete industry lacks an automated method that can detect material failure and anomalies and predict the associated risks. The proposed research will address the technology gap and provide a transformative data-driven smart composite reinforced PC system. The outcomes will improve the durability and safety of the precast concrete infrastructure, which is well aligned with the strategic goal of TRANS-IPIC to develop advanced materials for PC components and incorporate “built-in” quality control and repair mechanisms in PC components.

**Outcomes/Impacts:**

The proposed outcome is self-sensing and risk-aware enabled by embedding sensors along the fabric of the liner to monitor its health condition during installation and service and to support the integrity management of the PC infrastructure by developing a corresponding data-drive risk index. Stakeholders in the PC industry will be able to efficiently and accurately detect the anomalies and determine the risk level of the PC infrastructure.

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