**Exhibit D**

Research Project Requirement Template

# Research project name: Photogrammetry and LiDAR-Based Precast Concrete Railroad Crossties Abrasion Damage Detections

**Recipient/Grant (Contract) Number:** University of Illinois Urbana-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):** PI: Shanyue Guan, Purdue University, Co-PI: Chao Sun, Louisiana State University

**Project Partners:** Vossloh North America

**Research Project Funding:** $86,033 ($53,533 Federal and $32,500 Non-Federal)

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

# Project Description:

Recent derailment accident that happened in East Palestine, Ohio has drawn huge public attention to railroad system safety. While this accident is under investigation, one of the major contributions to many other derailment accidents is the precast concrete crossties abrasion damage. Concrete crossties can lose concrete sections on portions of the tie bottom and sides during service. Identifying the abrasion damage of precast concrete crossties is critical to extend the railroad service life and prevent the potential derailment. The ultimate goal of this research is to develop mitigation measures to reduce concrete railroad tie section loss at the ballast interface based on expected service life for a given track’s loading and environmental conditions. As a first step to achieve this goal, this project proposes to develop a photogrammetry and LiDAR scanning-based precast concrete crossties abrasion damage detection system. The recent development of photogrammetry and LiDAR technologies provides the possibility of measuring the crossties loss to millimeter level.

**US DOT Priorities:**

This project aims to improve the infrastructure safety as one of the US DOT priorities and aligns well with the mission of TRANS-IPIC to develop solutions for precast concrete crossties and revolutionize the development and performance of future railroad infrastructure, providing gains in durability, safety, and resources required for repair and replacement. This project will provide a transformative approach to detect precast concrete crossties abrasion damage with integrated photogrammetry and LiDAR scanning for the railroad industry but also can be applied to precast concrete used for highway systems and bridges, and further enhance infrastructure safety in the US.

**Outputs:**

Upon the completion of this project, our team will achieve a photogrammetry and LiDAR system-based mobile system for detecting railroad precast concrete crossties abrasion damage with high accuracy.

Currently, the railroad industry is lacking an automated method that can detect concrete crossties conditions and improve regular maintenance and repair. Our system will address the technology gap and provide a transformative condition monitoring and remote sensing approach for the railroad industry. The outcome of this project will improve the durability and safety of the precast concrete crossties which is well aligned with the strategic goal of TRANS-IPIC to incorporate “built-in” quality control and repair mechanisms in precast concrete components.

# Outcomes/Impacts:

Our research team would like to provide a practical tool for the railroad industry to improve railroad safety. To achieve this goal, we will collaborate with the railroad companies and deploy our system at some railroad tracks to detect the concrete crossties' abrasion damage conditions. Our team will conduct measurements under different weather conditions (bright sun, partly cloudy, and overcast), at different times of day (morning, noon, and afternoon), and on different days, as well as with different track alignments (tangent/straight and curved). Specifically, the test will consist of inspecting crossties with different conditions (damaged and normal). Based on the system performance and feedback from the railroad company, we will improve the system design correspondingly.

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