# Exhibit D

**Research project name: Evaluating Prestressed Concrete Beams with Cracks using Machine Learning**

**Recipient/Grant (Contract) Number:** University of IllinoisUrbana-Champaign / University at Buffalo / 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):** Dr. Pinar Okumus and Dr. Negar Elhami Khorasani

**Project Partners:** Potential partners are State DOTs and private engineering firms.

**Research Project Funding:** Federal (UTC): **$**120,000 ($80,000 Federal and $40,000 Non-Federal)

**Project Start and End Date:** 09/01/2023 - 08/31/2024

**Project Description:**

Bridge owners face difficult decisions on whether a bridge should be posted, repaired or replaced when prestressed concrete members have shear related cracks due to overloading. The decisions are currently made based on engineering judgment, costly load-testing or time consuming modeling. Guidance is needed to interpret cracks and their impact on shear capacity to avoid overly conservative load ratings and to keep bridges operational, without compromising safety and economy. This project will develop a tool through machine learning to relate cracking to load history of bridge members. Algorithms will be trained using shear test data from the literature, considering material and geometric properties in addition to crack width as an indicator for distress. The outcome will be the advancement of knowledge on shear evaluation and load rating of in-service precast prestressed concrete bridges with visual signs of distress and guidance for repair actions for bridge owners.

**US DOT Priorities:**

This research aligns with *“advanced asset management”* *research priority* that corresponds to *“economic strength and global competitiveness” strategic goal* of the US DOT. This priority and goal are supported because the research will lead to “early identification of structural deficiencies” as well as development of approaches that can “extend the life of assets”. The project also supports the *UTC focus area on “improving the durability and extending the life of transportation infrastructure.”* These will be accomplished by creating a tool that can inform how crack sizes in concrete observed in the field relate to the remaining capacity of prestressed concrete bridge elements. This interpretation will allow bridge owners and engineers to make timely repair and maintenance decisions that can improve safety and extend service life of bridges. An automated tool is particularly beneficial since large inventories and limited assets dictate efficient evaluation tools. Since the tool to be developed is based on data and machine learning, the *US DOT “transformation” strategic goal* and *“data-driven insight” research priorities* are also supported.

Existing assessment methods for prestressed concrete bridges with cracks rely on costly load testing, time consuming analyses or engineering judgment. The proposed work is transformative because it will add a new machine learning based tool to prestressed concrete bridge assessment. The project cuts across civil engineering and computer science disciplines, and the findings can be applicable to prestressed concrete bridges that carry any mode of transportation.

**Outputs:**

The outcome of this work is a shear condition assessment tool for prestressed concrete bridges with cracks. The end users of this tool are bridge engineers and owners who are responsible for evaluating and maintaining bridges.

**Outcomes/Impacts:**

The bridge condition evaluation tool that will be developed can improve load rating practices and can improve frequency of bridge inspections, by providing an efficient alternate to existing bridge evaluation methods, at a time aging U.S. infrastructure requires regular inspections to ensure safety. Informed decisions on maintenance actions can enhance the safety and reliability of bridges and reduce the cost of maintenance. Because machine learning is at the core of the proposed work, the project will contribute to workforce development by familiarizing civil engineers with artificial intelligence. Students involved in the project will be trained to gain skills in computer science, as well as civil engineering domains. They will gain competencies in bridge engineering, prestressed concrete, machine learning areas as well as the required industry- and sector-wide general competencies.

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