

## Exhibit D

### Research Project Submission Template

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

#### **Instrumented Precast Concrete Curbs for Urban Infrastructure Readiness to Autonomous Vehicle Deployment**

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

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

**Principal Investigator(s):** Samer Dessouky

**Project Partners:** N/A

**Research Project Funding:** \$108,500 (\$70,000 Federal and \$38,500 Non-Federal)

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

#### **Project Description:**

Autonomous vehicles (AVs) are increasingly operating in real-world urban transportation networks, creating new demands for targeted infrastructure upgrades. This proposal focuses on infrastructure readiness at the curb level by introducing instrumented precast concrete curbs (curbs embedded with passive identification markers and retroreflective elements) to enhance AV curbside navigation and situational awareness. These curbs enhance navigation reliability in conditions where AV perception is limited by occlusion, low visibility, GPS drift, or indistinct curb geometry. Modular, durable, and scalable, the smart curbs offer a cost-effective retrofit solution for modernizing urban streetscapes. The research will develop prototypes, validate their effectiveness in both controlled and real-world environments, and provide technical guidelines for adoption. This project supports the TRANS-IPIC mission by integrating intelligent infrastructure with emerging mobility systems to advance safer, more adaptive, and resilient transportation networks.

#### **US DOT Priorities:**

Research on instrumented precast concrete curbs to support autonomous vehicle (AV) perception and curbside navigation aligns with multiple strategic priorities of the USDOT and TRANS-IPIC.

- **Safety:** Instrumented curbs provide reliable physical navigation cues in areas where AV sensors are limited by poor lighting, occlusion, or degraded curb conditions. This reduces perception errors and enhances safety in shared curbside spaces near pedestrians and bicyclists.
- **Maintenance and Modernization:** Instrumented precast curbs offer a modular, low-disruption solution for modernizing existing urban streetscapes without full roadway reconstruction.
- **Innovation and Technology:** The integration of passive identification markers and retroreflective elements into standard precast units advances infrastructure-based support for AV, complementing digital and sensor-based navigation systems.
- **Sustainability and Resilience:** Durable precast designs extend infrastructure service life while supporting long-term AV deployment goals and adaptive reuse of roadway corridors.
- **Economic Growth and Mobility:** Improved AV reliability at the curb enables safer, more efficient pickup/drop-off operations and enhances multimodal integration in urban areas, contributing to more connected and accessible transportation systems.

#### **Outputs:**

- **Enhanced AV Curbside Detection:** Testing with AV onboard sensors is expected to demonstrate that curb-embedded passive identification markers and retroreflective elements

significantly improve AV

- detection in conditions with low visibility, degraded GPS, or worn curb geometry.
- **Structural Integrity and Durability Validation:** Mechanical and environmental testing will demonstrate that the embedded technologies do not compromise curb strength or service life, even under simulated wear and exposure conditions.
- **Sensor Compatibility Matrix:** The project will deliver a validated matrix linking curb-embedded marker configurations with detection performance by various AV sensor types (e.g., camera, LiDAR, RFID reader), supporting technology selection for different urban conditions.
- **Pilot Field Demonstration:** A real-world installation will validate the field performance of smart curbs over time, providing insights into environmental durability, reflective retention, and sensor interaction in dynamic conditions.
- **Deployment Guidelines for Transportation Agencies:** The research will produce technical guidance for integrating smart curbs into existing and new streetscapes, including embedment methods, material selection, spacing, and retrofit strategies.

### **Outcomes/Impacts:**

The project will result in a smart precast concrete curb prototype that integrates embedded wireless sensors and reflective markers for enhanced AV navigation and curbside monitoring. The design will be modular and compatible with standard precast fabrication and installation practices. The key implementable outcomes include:

- **Smart Curb Prototype:** A modular precast concrete curb unit embedded with passive identification markers (e.g., RFID, magnetic strips) and retroreflective elements for detection by AV sensors.
- **Deployment Guidelines:** A technical specification document detailing design parameters, installation methods, marker spacing and layout, AV sensor compatibility strategies, and maintenance considerations for municipal deployment.
- **Pilot Test Results:** Field performance data demonstrating the effectiveness of the smart curb in enhancing AV detection, sensor reliability, and urban curbside management in a real-world environment.
- **Scalable Retrofit Strategy:** A cost-effective and phased implementation model that allows cities to upgrade existing curbs in high-priority AV zones without full roadway reconstruction.
- **Technology Transfer Package:** Materials to support transition from research to practice, including public demonstration results, installation videos, and presentations for DOTs and industry stakeholders.

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