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Project Title

Implementation of Precast Concrete Segments for Electrified Roadway

University

Utah State University

Principal Investigators

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Research Needs

A major impediment to broad public acceptance of electric vehicles is their limited travel range. An exciting potential solution to this problem is In-Motion Electric Wireless Power Transfer. Durability of the Civil-Electrical Infrastructure has been studied in recent research. The next logical step toward adoption is integration in a successful demonstration project.

In order for the future adoption of this technology, roadways will need to be modified to allow the transmission of power to vehicles as they travel. Successful adoption of In-Motion Wireless Power Transfer will require advances in the efficiency of the overall electrical system, improvements in tracking of the actual vehicles, and significant developments in the civil infrastructure.

This proposal will address the constructability of coils in a proposed precast system. The stringent electrical specifications will be monitored while utilized in an actual closed loop working system.

Research Objectives

1. Develop several possible in-pavement wireless power transmission options along with construction alternatives
2. Implement several precast segments of an electrified roadway system into the USU SELECT EV test track

For the system to be successfully implemented, coordination with the power electronics group at SELECT is essential.

Research Methods

This project fits within a larger initiative of developing and demonstrating In-Motion Wireless Power Transfer. From the Civil Infrastructure perspective the process can be divided into 4 parts.

Parts 1, 2, and 3 have been proposed and completed under past research contracts.

1. Conceptual Design of several alternative in-pavement inductive coils. Within this effort includes structural modeling, thermal modeling, and electrical efficiency modeling regarding the strength, shape, and applicability of the magnetic field.
2. Construction and testing of several specimens under laboratory conditions. This testing has and will continue to occur at the Systems, Materials, and Structural Health (SMASH) laboratory located at Utah State University. Several servo-hydraulic cylinders are programmable to execute up to one million cycles on each specimen. It is anticipated to subject the specimen to less than one hundred thousand cycles.
3. Installation of prototype coils in the EV Select Test track for investigations of power transfer efficiency. This cross disciplinary task is also necessary for tracking, and electrical purposes.

Part 4 is being proposed under this project

4. Installation in actual pavement segments on a test section of pavement on the closed loop test track located at the SELECT EV facility. The focus of the installation will be to simulate an actual construction system that will lend itself to rapid, implementable, and cost effective construction.

Expected Outcomes

The expected outcome of this research is several segments of a system implemented into the outdoor, SELECT EV test track facility that can be utilized by vehicles from the operating bus, to medium and small passenger vehicles. These vehicles will be utilized as demonstration vehicles to move forward in the acceptance of in-motion power transfer technologies.

Relevance to Strategic Goals

The aspect of this research that is so universal is that it crosses over many of the strategic goals of the USDOT. This work addresses the durability of pavements, but the main thrust of this work addresses the goals of **environmental sustainability** for the future infrastructure. The concept of an energized roadway that allows for the traveling public to be powered while driving quietly and without carbon emissions addresses the USDOT goal of Environmental Sustainability.

Educational Benefits

This proposed project will involve a graduate student who will utilize the research opportunity as part of a PhD dissertation. In addition, at least one undergraduate student will also work to design and construct the construction system.

In addition to these students, all work related to electric vehicles and wireless power transfer will involve the EV (Electric Vehicle) Club located at Utah State University.

Technology Transfer

The results of this study will be published in a report, a technical journal, a conference paper, and will also be presented in one of the SELECT Center's monthly brownbag webinars. In addition, all research done in this area will be presented as a poster in the annual SELECT Workshop which occurs in the fall of each year.

Work Plan

The results of this research will have a relatively long path to full adoption. However, the problems addressed in this work must be solved prior to wide adoption of the concept of electrified roadways and in-motion wireless power transfer.

The results of this particular phase of this project will answer some of the questions regarding implementation of an actual system that can be used for vehicles to travel around a closed loop.

In order to achieve the objectives outlined earlier in this proposal, the following work plan will be implemented including the explicitly described tasks.

Task 1 (2 months)
Literature Review. Several groups are working on this problem worldwide. Many important lessons have been learned, that will help us to progress to viable designs in the most efficient way possible.

Task 2 (2 months)
Feasibility Study. Conceptual Design of several alternatives for in pavement power unit segments. This task includes a significant effort in: 1. Coordination of precast concrete segments with details that allow for rapid and repeatable electrical connections, 2. Structual design of the segments, including sub-grade requirements, 3. Final design of the system including civil, structural, and electrical drawings to allow for contracting of construction work.

Task 3 (3 months)
Construction. Placement of several segments followed by connections to existing power cabinets.

Task 4 (8 months)
Evaluation of the system over at least a six month period under changing seasons and under

adverse environmental conditions. The system will be evaluated for structural performance as well as efficiency of the system and aspects of durability during operation.

Task 5 (3 months)
Write a report documenting all findings which will aid in future work on this topic.

Project Cost

Total Project Costs:	$133,000
MPC Funds Requested:	$ 66,500
Matching Funds:	$ 66,500
Source of Matching Funds:	Utah State University