MPC-634
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Project Title

Durable and Constructible Materials in Glass Reinforced Concrete to Efficiently Shape Magnetic Fields

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 is a research question with continuing national and regional interest. Laboratory level studies have considered embedding of inductive coils into both rigid and flexible pavement materials.

This project aims to answer questions regarding the durability and efficiency of various configurations of litz wire and ferrite material. This work is in collaboration with power electronics and mechanical engineering colleagues associated with the SELECT center at Utah State University.

Research Objectives

The objective of this research is to develop a suitably efficient embedded coil configuration into pavement that is functionally efficient and durable. This objective will be achieved by producing at least two operating models that can be evaluated electrically at the EVR test track. These models will provide a construction approach of how these panels can be mass constructed as well as demonstrate the durability of long-term use in the test track environment.

Research Methods

Previous studies have focused on the durability of precast concrete panels with embedded coils using finite element analysis methods and some structural testing.

The methods proposed in this study are much more focused on achieving configurations that result in electrical efficiency while providing structural panels that are sufficiently durable and constructible.

Each configuration will be thoroughly analyzed for both thermal stresses as well as applied load induced stresses. These models will incorporate fatigue methods to evaluate the effects of repeated cycles of truck loadings in critical areas.

Two specimens will be constructed of a selected design for construction. These panels will be tested for fatigue in the Systems, Materials, and Structural Health (SMASH) Laboratory and also tested for efficient power transfer following the structural testing

Expected Outcomes

It is expected that at the end of this study, the researchers will narrow down the proposed materials, configuration, and construction methodologies for a first generation deployment of wireless power transfer panels that can be utilized in either a static or a dynamic application within the travel path of vehicles.

Additionally, a final report will outline the steps required for scaled up production of the process to be followed by a contractor.

Relevance to Strategic Goals

This research is so universal is that it crosses over many of the strategic goals of the USDOT. This work addresses the durability of pavements, thru cost-effective maintenance practices for highways. The concept of an energized roadway that allows for the traveling public to be powered while driving quietly and without carbon emissions also addresses the USDOT goal of Environmental Sustainability.

As the transportation system in the US transitions from fossil fuels to an electrified system, the distributed air pollution in population centers will be significantly reduced. This transition opens doors to significantly more sustainable power production methods for transportation.

Educational Benefits

This proposed project will involve a graduate student who will utilize the research opportunity as part of a master's thesis. In addition, at least one undergraduate student will also work on the construction of the specimens.

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 electrified transportation community has several outlets that accelerate technology transfer. These include regular meetings of trade groups and specialty conferences. One outlet for tech

transfer is the Bi-Annual CERV (Conference for Electric Roads and Vehicles) conference held in Park City, Utah.

The results from this research will also be published in a final report, a technical journal article, and at least one conference proceedings.

Work Plan

Each of the described tasks will be performed at faculties at Utah State University using University personnel and students.

Task 1 (2 months). Literature Review.

> There are several groups working to develop dynamic wireless power transfer (WPT). Most of these groups are international. Steps will be taken to learn about the pertinent advances and related work. This task will determine the current state of the art in WPT technologies. The difficult part of a traditional literature review in this field is that many of the latest advances are carefully protected by non-disclosure agreements and intellectual property protection concerns. But with discussions and contacts, information will be collected in order to guide this research.

Task 2 (3 months). Evaluation of materials and electrical configurations for most efficient power transfer.

> This task will evaluate concepts and configurations of the electrical components as well as the materials used in potential specimen.

Task 3 (3 months). Design of specimen and the instrumentation plan design.

> This task includes the actual preparation of construction drawings and the instrumentation plan to be included in the specimen.

Task 4 (3 months). Construct specimens.

> This task includes purchasing all materials and instrumentation, building forms, placing reinforcement, placing instrumentation and placing concrete.

Task 5 (6 months). Evaluation of specimens.

> This task includes the thorough evaluation of the specimens for electrical efficiency as well as structural problems. The pads will be functional and utilized in the operations of the Electrified Vehicle and Roadway (EVR) facility.

Task 6 (4 months). Write Report and journal paper.

> This task includes the writing of a report documenting all findings as well as writing a journal paper for submission.

Project Cost

Total Project Costs:	$127,000
MPC Funds Requested:	$ 63,500
Matching Funds:	$ 63,500
Source of Matching Funds:	Utah State University