MPC-408
October 1, 2012-December 31, 2012

Project Title:
Exploring Unique Plastic-Reinforced Bridge Decks: Phase I

University:
Colorado State University

Principal Investigators:
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Research Needs:
Concrete bridge reinforcement has historically been steel reinforcing bars. Unfortunately steel reinforcement is susceptible to corrosion, particularly in areas of the country such as the Mountain Plains region where deicing agents are frequently applied during winter months. Fiber reinforced polymer (FRP) bars are one alternative that is not used frequently due to cost. While FRP in a traditional round bar has worked successfully for many years, it is hypothesized here that tubular (and other) shapes may provide superior performance. The ability to extrude plastics and fiber reinforced plastics (FRP) into virtually any shape makes small-scale experimental exploration of this concept possible. If the improved performance that is anticipated can be demonstrated it is envisioned that this would have applications not only in bridge decks but in bridge beams, columns, and virtually any reinforced concrete component used in structural design.

Research Objectives:
The research objective of this project is to (1) demonstrate experimentally that shapes other than typical round reinforcing bar can enable better bridge deck performance, and (2) develop a solid model of the most promising shapes that can be used for further investigation in later phases of the work.

Research Methods:
This study will be based on both experimental methods at small scale and numerical modeling. The numerical model will be calibrated/validated based on the experimental test results..

Expected Outcomes:
It is anticipated that (1) several reinforcement shapes will be identified that provide superior performance to typical reinforcing bar; (2) a numerical model capable of predicting the performance of the specimens will be developed; and (3) a proof of concept result substantial enough to enable a Phase II proposal will be demonstrated.

Relevance to Strategic Goals:
This research will directly address two critical issues related to Safety, Economic Competiveness and livable communities such as: *1) Infrastructure longevity; 2) Improved infrastructure design.*

Educational Benefits:
A graduate student will write his MS thesis based directly on this project.

Work Plan:

The proposed study will include following tasks:

Task 1. Literature review (Month 1)
This task is already underway as part of the process of identifying the research problem. However, a more comprehensive literature review to identify all relevant studies on this topic will be conducted in month 1 of the project.

Task 2. Small-scale experiments (Month 2-6)
In this task three different types of small-scale experiments will be constructed in the structures lab at Colorado State University. Between three and five different plastic reinforcing bar designs will be tested under bending, shear, and in pullout for a simple cross-sectional rectangular section. The exact size of the specimens will be determined as part of this Task but it is anticipated that the specimens will be ¼ scale.

Task 3. Analytical model development (Month 4-9)
The numerical model will be developed partially in parallel with the end of the small-scale experiments. The numerical model will consist of a 3-D finite element model with behavior of the concrete and reinforcing bar interaction modeled either phenomenologically using springs, or (as preferred) using constitutive laws.

Task 4. Dissemination and phase II proposal
This Task will consist of dissemination either at the Annual Meeting of the Transportation Research Board (TRB), *Journal of Structural Engineering*, *Journal of Structural Mechanics*, or another archival publication. In addition, a final report and an MS thesis based directly on this work will be written and made available to the public.

Project Cost:
Total Project Costs: $44,000
MPC Funds Requested: $22,000
Matching Funds: $22,000 Source of Matching Funds: CSU

TRB Keywords: Bridges; concrete; FRP