Tran-SET
Transportation Consortium of South-Central States

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Key Points

Project Number:
18STOKS02

Start Date:
03/15/2018

End Date:
09/15/2019

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Funds Requested to UTC:
$70,800

Funding Source(s):
Tran-SET
Oklahoma State University

Total Project Cost:
$141,600

A Comprehensive Framework for Life-Cycle Cost Assessment of Reinforced Concrete Bridge Decks

Brief Project Description

This study focuses on introducing an approach that: (a) characterizes the life-cycle maintenance needs and repair intervals associated with bridge decks constructed using various reinforcement alternatives in FHWA Region-6, (b) develops a systematic methodology for quantifying the impact of bridge maintenance on indirect life-cost including the effect of increased travel time, work zone crashes, operating cost, greenhouse gas emissions, and social losses, and (c) compares different steel reinforcement materials (e.g., regular, epoxy coated, galvanized, stainless steel, etc.) based on their long-term performance and maintenance requirements. The life-cycle cost analysis will integrate a comprehensive sustainability assessment including evaluating the carbon footprint of bridge decks constructed using different reinforcement alternatives.

Problem Statement

Various environmental and mechanical stressors cause deterioration of concrete bridge decks. Normal wear and tear, freeze and thaw cycles, and chloride penetration due to deicing salts can cause aggressive deterioration. These conditions lead to steel reinforcement corrosion, cracking, delamination, and spalling which affect the surface conditions and reduce the safety of the deck. In order to maintain the deck safety above prescribed thresholds, frequent interventions are usually required during the life-cycle of the bridge. These interventions include deck maintenance and repairs as well as bridge deck replacement. The quantification of the life-cycle cost of bridge decks considering maintenance and repair activities represents a significant challenge facing local and state transportation agencies. This study will attempt to fill in the knowledge gaps in quantifying the indirect costs associated with bridge deck maintenance and their impact on the overall bridge life-cycle cost.

Objectives

The main objectives of this study are to:

1. Characterize the use of alternative types of deck reinforcement in Region 6 and identify the life-cycle maintenance and repair activities associated with bridge decks constructed using different reinforcement alternatives. Factors to be investigated include reinforcement type and associated maintenance types, durations, intervals, and costs.
2. Formulate a systematic approach for quantifying the impact of bridge maintenance on indirect life-cost for bridges in FHWA Region 6. Investigated indirect impacts will include the social, economic, and environmental effects associated with increased travel time, work zone crashes and fatalities, operating cost and greenhouse gas emissions, in addition to losses developing due to lost business and taxes.
3. Develop a comprehensive life-cycle analysis approach capable of quantifying the life-cycle cost assessment (LCCA) associated with different steel reinforcement materials (e.g., regular, epoxy coated, galvanized, stainless steel, and MMFX) under uncertainty.

Intended Implementation of Research

Education

The PIs offer several graduate and undergraduate classes related to transportation engineering, structural engineering, and probabilistic life-cycle performance assessment of deteriorating structures. The research results will be used to develop new educational modules to be included these courses. This ensures the smooth transition of the research findings into classroom material and supports the educational and workforce development objectives of Tran-SET.

Outreach

In addition to these activities, Dr. Soliman organizes a poster presentation session during the annual Oklahoma Transportation Research Day that encourages undergraduate and graduate students to participate in transportation-related research and compete on cash prizes based on the quality of their presentations.

Anticipated Impacts/Benefits of Implementation

To support the transition from research to implementation, the research team will prepare a resource guide for bridge engineers to help conducting detailed LCC estimation and identify optimum deck reinforcement to use in new bridge construction or deck replacement based on LCC considerations.

The proposed approach can be implemented by bridge officials to make informed decisions on intervention activities and material selection based on detailed life-cycle cost analysis that consider agency costs, as well as user costs. Implementing the proposed research will lead to improved sustainability, durability and longevity of transportation infrastructure in FHWA Region-6.

Weblinks:

http://transet.lsu.edu/research/research-in-progress/

https://rip.trb.org/View/1505434