MPC-381

January 1, 2012 – December 31, 2012

Project Title:
Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic

University:
Colorado State University

Principal Investigators:
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Research Needs:
An expansion joint in a poor condition typically will not be able to resist corrosion and prevent water or chemicals from penetrating into bridge bearings and piers, which will greatly expedite the deterioration process of the bridge structure. In addition to threatening the integrity of bridge structures, a damaged expansion joint may also cause serious risks of traffic accidents when vehicles pass in high speeds. According to FHWA, over 60% of the joints were leaking water and 40% were experiencing problems that would shorten their service lives. According to the existing studies, the actual damage scenarios of expansion joints for a particular bridge can be pretty complicated. One critical challenge lies on the failure of rationally considering the interactions of bridge joints and vehicles, especially considering the deteriorating process of the joints. For example, traffic loads induce more dynamic impacts on the joints which cause damages. More damages, such as unevenness will cause more dynamic interactions with passing vehicles, which in turn cause more impacts loads on the joints from the vehicles. Such a process continues which will accelerate the deterioration process of the joints.

Research Objectives:
As an important step toward tackling the accelerating damage problem of expansion joints, the objective of this study would be to characterize the basic interactions between the passing traffic and the deteriorating joints by developing a rational model. As a result, better understanding of the lifetime performance of the joints can be achieved.

Research Methods:
This study will primarily develop the FEM-based simulation model. The study will focus on characterizing the interactions between joints and passing traffic through FEM modeling (Task 2), developing the prediction model of joint damage (Task 3), and finally develop the performance-based assessment and prevention startegy.

Expected Outcomes:
Accelerating damage and the resulting costly repair or replacement of expansion joints have become a serious problem in the nation. Due to the complexness of various possible causes, it is important to have such a powerful tool to predict the performance and therefore propose any efficient and effective way for the prevention. With the improved joints, traffic passing through these bridges will also have safer driving experience.

Through communicating with some stakeholders, the PI believes the proposed model, once developed, has potential to be incorporated into some local DOT applications to further investigate the site-specific performance of the bridges in the region.

Relevance to Strategic Goals:
This research will directly address several critical issues related to Safety, Economic Competiveness and livable communities such as: *1) Infrastructure longevity; 2) Heavy vehicles and commercial trucks; 3) Improved infrastructure design*.

Educational Benefits:
Graduate students and undergraduate will be involved into this project by serving as research assistants.

Work Plan:
The proposed study will include following tasks:

Task 1. Literature review (Month 1-Month 3)
Extensive literature review will be conducted on the related studies. Particular attention will be paid to existing studies in mountainous states. Some problems and conclusions already made in the existing studies will be gathered for the present study.

Task 2. Develop FEM-based model to consider dynamic impact loads of traffic through interaction with joints (Month 4-Month 10)
Based on the findings in Task 1, the FEM-based model which can model the dynamic interactions between the vehicles and the joints are developed.

Task 3. Predict the damage development of joints under stochastic traffic (Month 8-Month 15)
For the prototype bridge, time-progressive analysis will be conducted to predict the damage with the daily stochastic traffic.

Task 4. A performance-based framework which can provide some prevention strategies will be developed depending on the respective performance criterion. (Month 14-Month 24)

Project Cost:
Total Project Costs: $84,000
MPC Funds Requested: $42,000
Matching Funds: $42,000 Source of Matching Funds: University, CSP research grant

TRB Keywords: Bridges; expansion joints; vehicles; interaction; damage

References: NA