Research Project Summary

Remaining fatigue life assessment of bridge decks based upon a numerical-experimental SYSCOM SYStem-COmponent-Material-based approach

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Start-End Dates:
07/01/2024 - 06/30/2027

Abstract
Predicting the fatigue residual life of reinforced concrete (RC) bridge decks is a complex task influenced by various factors such as material properties, reinforcement characteristics, loading conditions, and environmental effects. This process involves three critical steps: selecting appropriate design loads, identifying critical "hot spots," and determining and comparing fatigue stresses. While current design practices address strength and serviceability, there is a significant need for comprehensive guidelines on fatigue life prediction. This study aims to develop a practical, step-by-step methodology using linear finite element analysis (FEM) to accurately predict the fatigue life of RC bridge decks. The proposed Linear FEM-based procedure is distinguished by its calibration against a sophisticated Non-Linear FEM (NL-FEM) model. Validation is achieved through in-situ testing of an actual bridge, component testing of bridge deck hot spots, and material testing, adhering to a System-Component-Material (SYSCOM) approach. This methodology promises to enhance predictive accuracy and efficiency, providing a crucial tool for engineers in the maintenance, repair, and replacement of aging infrastructure.

Deliverables
The project will produce a series of milestone reports, each detailing critical stages of the research process. Additionally, a final PEER report will summarize key research outcomes, the detailed L-FEM procedure, and its application to in-situ tested bridges, alongside interim and final presentations to CALTRANS and the Advisory Board. All collected data, testing results, and developed FEM models will be compiled in a data repository accessible to stakeholders, with at least one technical workshop conducted to train engineers on the L-FEM-based procedure. These deliverables aim to provide a robust framework and practical tools for accurately predicting the fatigue life of reinforced concrete bridge decks, thereby enhancing bridge maintenance and longevity.

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Research Impact

This project has significant potential to advance structural engineering, particularly in predictive modeling for the fatigue life of RC bridge decks. By developing and validating a FEM-based procedure through comprehensive in-situ bridge instrumentation and laboratory testing, the research aims to enhance the precision and efficiency of fatigue life predictions for both concrete and steel reinforcement. The resulting methodology will equip engineers with essential tools for informed decision-making in the maintenance, repair, and replacement of aging infrastructure. The project's outcomes promise to improve structural assessments by introducing a practical, step-by-step methodology that is both reliable and easy to implement. Integrating this new analysis method into industry standards and best practices could lead to significant advancements in fatigue life prediction within the structural engineering field. This shift would also necessitate training and professional development initiatives to ensure engineers can effectively apply the proposed methodology.

Project Image

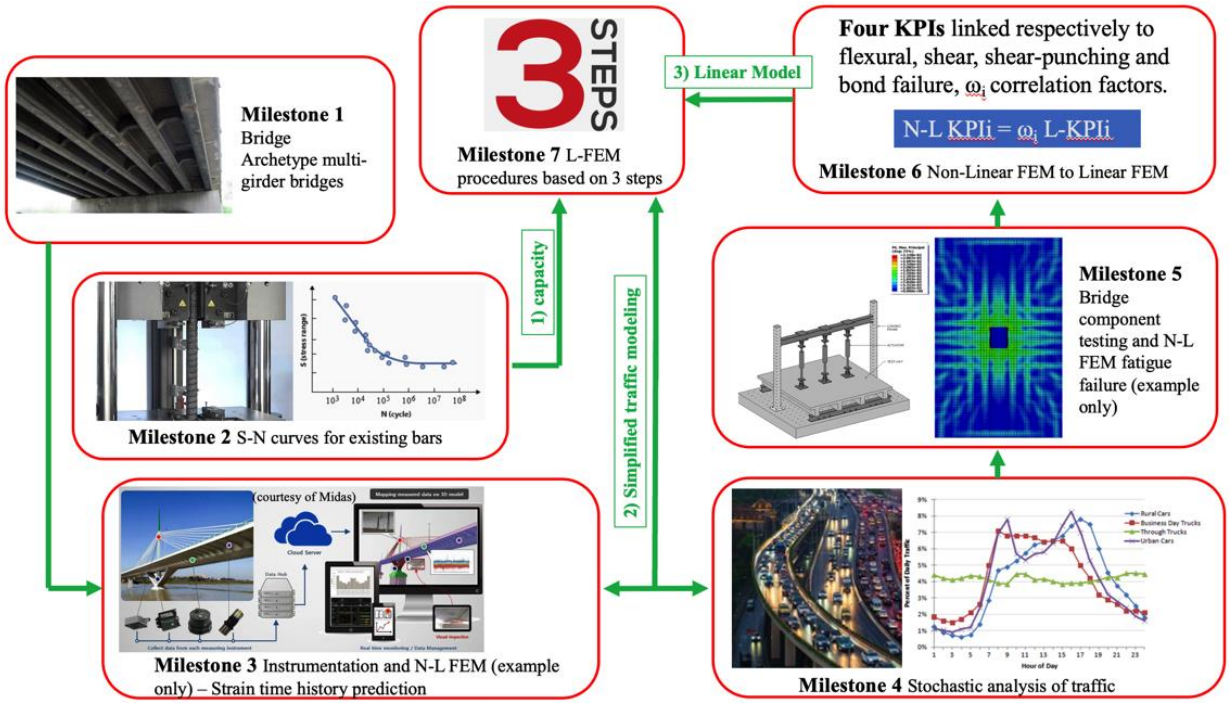

Figure 1 – Flow chart of experimental-numerical residual fatigue life SYSCOM methodology with Milestones' links

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