Research Project Highlight

Refined Bridge Deck Design and Analysis

PEER-Bridge TO2

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Abstract

Since the 1960's, bridge live loads (design axle loads) and truck volume have been continuously increasing. The truck loads and wheel configurations that the bridge decks are designed for according to the AASHTO LRFD Bridge Design Specifications no longer reflect the modern trucks, not mentioning the use of larger permit vehicles (e.g., P-15) and new vehicle configurations mandated or allowed by federal or state programs such as special hauling vehicles (SHV) and emergency vehicles (EV) in the design. The approximate analysis method in the AASHTO LRFD specification that the current bridge deck design procedure is based on was initially developed in the 1930's and the accuracy is of concern due to simplified assumptions and approximations in the procedure. In addition, the California Amendments to AASHTO does not permit the empirical design of reinforced concrete decks and overhangs due to concerns associated with durability of such members under high average daily truck traffic applications. Laboratory and in-situ testing of concrete bridge decks designed by the empirical method have also demonstrated concrete cracking and potential reinforcement corrosion in such members, as well as insufficiency in the empirical reinforcement to resist shrinkage stresses. Therefore, a more accurate, safe and reliable bridge deck design procedure needs to be developed that considers all the impacts in order to ensure the safety and adequate load-carrying capacity of the bridge to meet the growing traffic demand. The *objective* of this research is to develop an updated LRFD-based bridge deck design procedure based on refined analysis methods that consider modern vehicle configurations, dynamic loads, flexural and shear demands, and fatigue of concrete and steel reinforcements. The developed procedure will feature two design tiers: (1) a rigorous and refined analysis incorporating the use of a computer code; and (2) a streamlined chart-based procedure suitable for production design.

Deliverables

A PEER report and several conference and journal papers describing the refined analysis, updated design methodology and a simplified design procedure.

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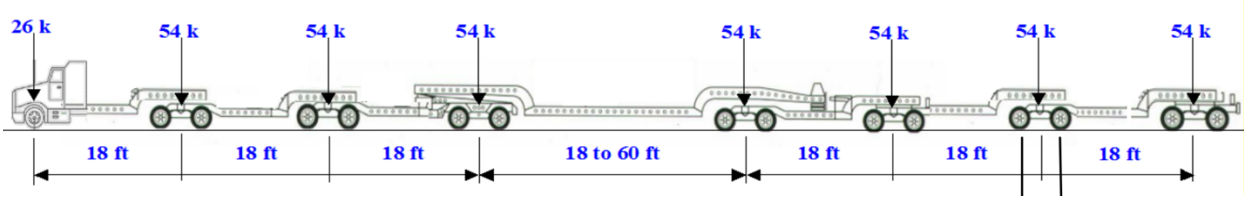
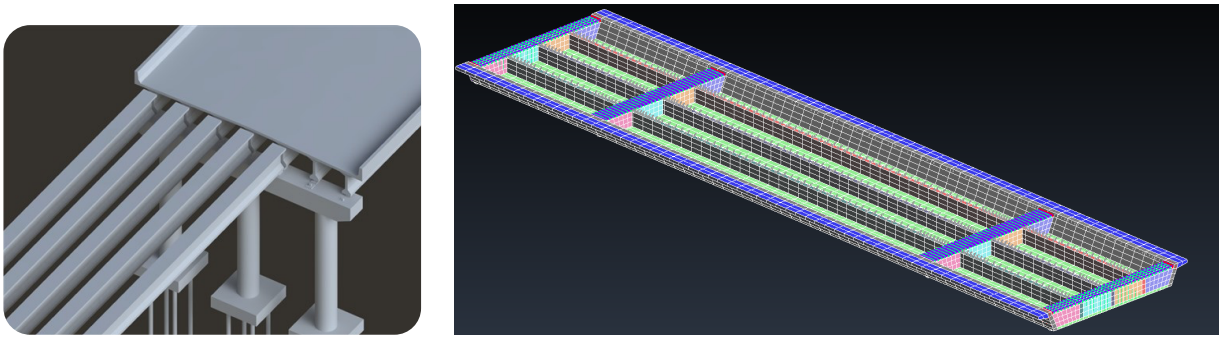
Research Impact

The work in this research will provide an updated LRFD-based bridge deck design procedure based on refined analysis that considers the modern vehicle configurations, dynamic (rolling) loads, flexural and shear demands, and concrete fatigue. The potential broad impacts of this work in the engineering design and evaluation of our nation's infrastructure include: (1) Increased cost savings by going beyond use of approximate, simplistic and conservative design methods in the existing specs; (2) Improved structural safety by more rigorous assessment of required modern loads and accurate modeling of system/local behavior; (3) Enhanced safety evaluation by full consideration of deck flexural, shear, torsion and fatigue; (4) Accomplishing sustainability by more frequent salvaging of existing infrastructures; and (5) Promoting a fundamental change in the practice of bridge engineering and industry from use of simplistic design formulae to achieve more optimal design solutions via innovation development. Therefore, the final product of this work is of particular interest to industry, Caltrans and other State DOT design engineers, bridge maintenance personnel, contractors, and specialty subcontractors such as inspection and repair crews.

Project Image



(a) Modern vehicle configurations (e.g., CA P-15 truck, CA Amendments 2014)



(b) Model details

Figure 1 Refined bridge deck analysis

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