DRISI
CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
TRANSFORMING IDEAS INTO SOLUTIONS

Research Results

Refined Bridge Deck Design and Analysis

Bridge research to improve bridge deck design procedure and reduce construction and maintenance costs.

Geotechnical/ Structures

February 2026

Project Title: Data Dashboard and Capacity Building for Electric Carsharing in Underserved BIPOC Communities

Task Number: 3668

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WHAT WAS THE NEED?

The current bridge deck design procedure relies on the AASHTO LRFD approximate analysis method, originally developed in the 1930s and refined in the mid-20th century. Its accuracy is limited by inherent simplifications. Additionally, current truck load and wheel configurations do not reflect modern vehicle demands. Federal programs introducing Special Hauling Vehicles (SHV) and Emergency Vehicles (EV) require consideration in design. Existing methods also fail to adequately address high-cycle fatigue, a common cause of deck failure.

WHAT WAS OUR GOAL?

Develop a more accurate and reliable LRFD-based bridge deck design procedure for production use.

WHAT DID WE DO?

Through the PEER-Bridge Program, Caltrans partnered with UC Davis to create an updated LRFD deck design method using refined finite element analysis. The new approach incorporates modern vehicle load configurations and realistic load demands. Both simplified and advanced procedures were developed for designers. The study also assessed the integration of concrete fatigue considerations through literature review and impact analysis.

WHAT WAS THE OUTCOME?

The research produced an updated LRFD-based design procedure that accounts for modern vehicle configurations, dynamic loads, flexural and shear demands, and key design parameters. Fatigue-related issues were thoroughly reviewed, with a framework proposed for future study.

Caltrans

DRISI provides solutions and knowledge that improves California's transportation system.

Extensive finite element analyses validated the simplified Rigid Support Model (RSM) against detailed 3D models. Results informed streamlined charts and an updated CA-A4 design table, aligned with AASHTO formatting. The revised values address negative moment demands for HL-93, SHV, and P-15 vehicles for girder spacings under 13 ft, with special considerations for EV3 and other vehicles beyond that range. This refined procedure improves cost efficiency by reducing reliance on conservative approximations and enhances structural safety through rigorous load assessment and accurate modeling.

WHAT IS THE BENEFIT?

Bridges are vital to California's mobility and economy. Current approximate methods rely on oversimplified assumptions, leading to unnecessary costs and failing to account for modern vehicle loads. These omissions accelerate deck deterioration and increase maintenance and life-cycle costs. By refining design methodology to better estimate load demands and deck capacity, we achieve safer, more efficient, and cost-effective designs that meet growing traffic needs.

LEARN MORE

https://dot.ca.gov/programs/research-innovation-system-information/research-final-reports

IMAGES

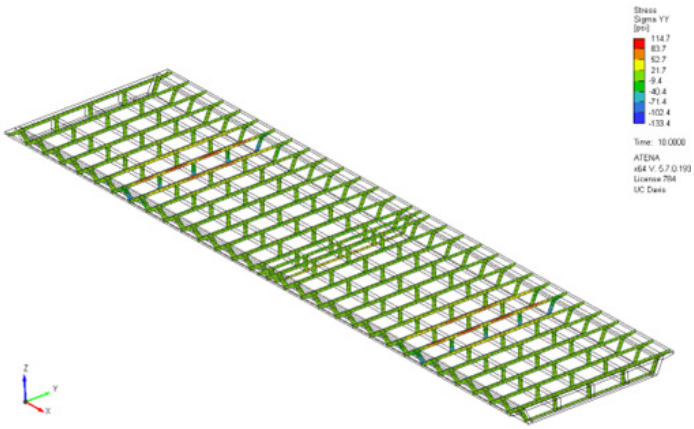
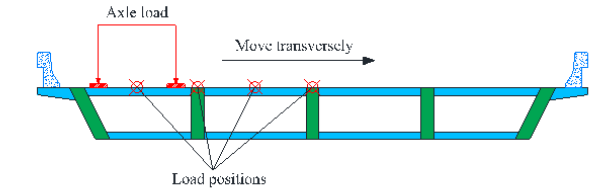


Image 1: Plane cuts of an example bridge model in ATENA



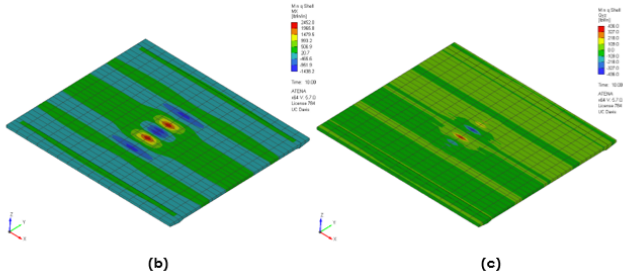


Image 2: (a) Axle Load positions example; (b) Moment intensity; (c) Shear intensity

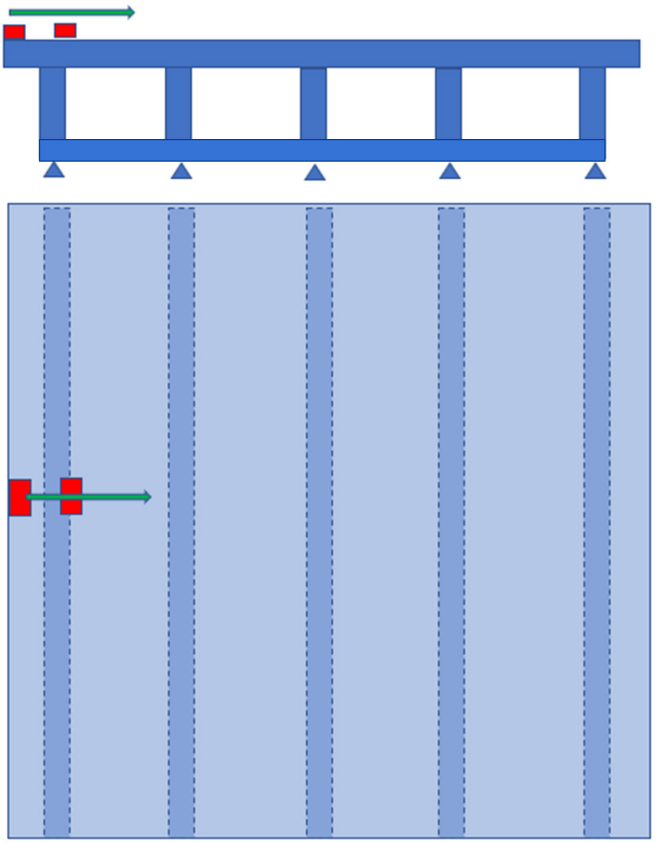


Image 3: Illustration of the Rigid Support Model (RSM)

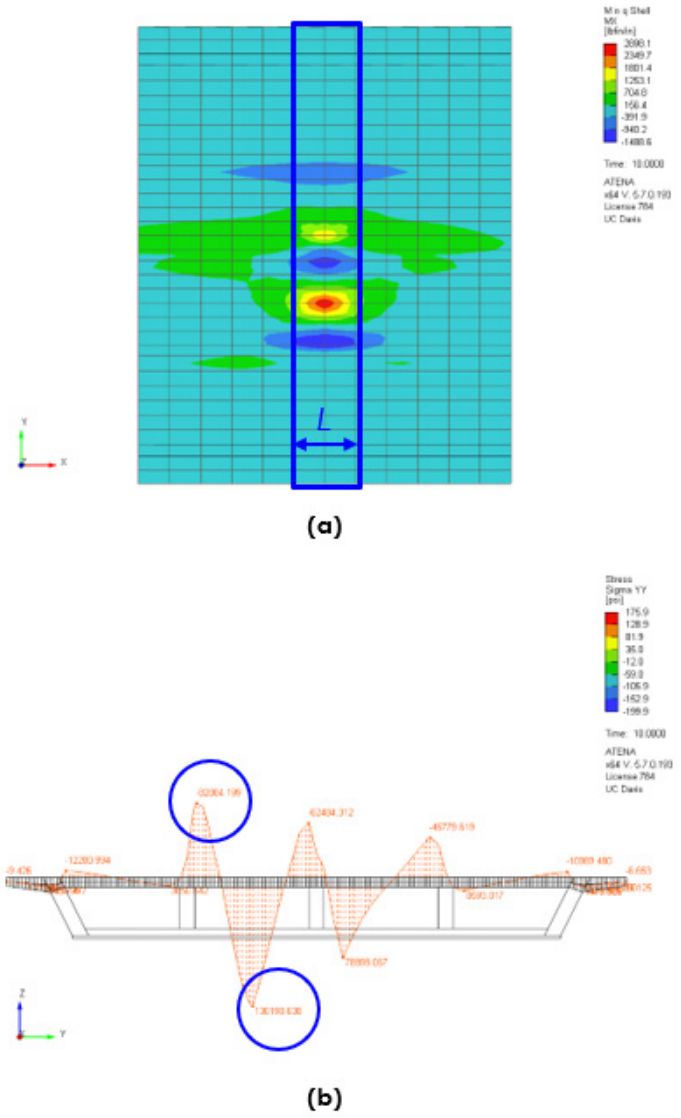


Image 4: (a) Average load demand within influence length, L; (b) Integrated transverse moment distribution