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Research Results

In-Service Structural Evaluation of Box Beam Overhead Sign Structures

Conduct research to predict the remaining strength of in-service box-beam overhead sign structures using field inspection results.

Geotechnical / Structures

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Project Title: In-Service Structural Evaluation of Box Beam Overhead Sign Structures

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WHAT WAS THE NEED?

Approximately 670 box-beam overhead sign structures are currently in service on California Department of Transportation (Caltrans) right-of-way. Most were installed in the late 1960s and early 1970s and are now approximately 50 years old. Many of these structures have experienced corrosion-related deterioration over time, particularly at the connections of the ribbed sheet-steel vertical diaphragms. This deterioration presents challenges for both Structures Maintenance and the Office of Design and Technical Services because no established guidelines exist for interpreting inspection findings or estimating the remaining structural capacity of these aging structures. The lack of consistent assessment criteria has implications for public safety and hinders effective asset management.

This research aims to develop practical guidelines that enable engineers to use field inspection data to estimate the remaining strength of box-beam overhead sign structures. The resulting guidance will support informed, consistent, and safety-focused decisions regarding inspection, maintenance, repair, and replacement.

WHAT WAS OUR GOAL?

The primary goal of this project is to develop guidelines for interpreting field inspection results of deteriorated box-beam overhead sign structures, enabling engineers to assess their remaining structural strength..

WHAT DID WE DO?

Through the Pacific Earthquake Engineering Research Center (PEER) Bridge Program, Caltrans partnered with the University

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of California, Berkeley to evaluate the structural condition of in-service box-beam overhead sign structures. The research program included both experimental testing and numerical modeling of representative box-beam components and full-scale sign structures designed in accordance with Caltrans Standard Specifications and Standard Plans.

Parametric studies were conducted on representative configurations subjected to a range of loading, environmental, and deterioration conditions. The analytical results were correlated with field observations from existing in-service structures to validate the findings and assess their practical applicability.

Based on the combined experimental, analytical, and field data, the project developed guidance to help engineers translate inspection findings into reliable estimates of the remaining structural capacity of box-beam overhead sign structures. This guidance supports more consistent, informed, and safety-focused decisions regarding inspection, maintenance, repair, and replacement.

WHAT WAS THE OUTCOME?

Detailed computer models of the sign structure were created and refined using optimization methods and lab test data to accurately match real structural behavior. High-resolution images were processed for corrosion-detection system, and the detected corrosion patterns were automatically integrated into the model. Laboratory tests comparing corroded and non-corroded specimens showed that while stiffness and natural frequencies were mostly unaffected, corrosion significantly reduced strength, energy dissipation, and changed how damage occurred. A large set of simulated corrosion scenarios was then analyzed using a new stress-based Corrosion Index, which proved effective in predicting strength loss. Finally, a simplified, field-friendly corrosion index was developed, allowing inspectors to estimate remaining structural capacity directly from visual observations without running complex simulations.

WHAT IS THE BENEFIT?

Bridges and related structural assets are critical components of California's transportation system, supporting statewide mobility and economic activity. However, engineers currently lack analytical tools that can reliably translate field inspection findings of box-beam overhead sign structures into estimates of their remaining structural capacity. This capability is essential for making informed maintenance decisions, including repair, rehabilitation, or replacement, and for determining whether existing structures can safely support additional loads from new sign panels or attachments.

This research addresses that need by developing methods to predict the remaining strength of aging box-beam overhead sign structures based on observed field conditions. The resulting guidance will enable more accurate condition assessments, support risk-informed maintenance decisions, and improve the safety, reliability, and long-term performance of these structures throughout California's transportation network.

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