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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

In-Service Structural Evaluation of Box Beam Overhead Sign Structures

Bridge research to predict the remaining strength of in-service box beam overhead sign structures from results of field inspections.

Geotechnical /Structures

May 2025

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

Task Number: 3673

Start Date: June 1, 2022

Completion Date: November 30, 2024

Task Manager:
Christian Unanwa
Contract Manager
Christian.Unanwa@dot.ca.gov

WHAT IS THE NEED?

Approximately 670 Box Beam Overhead Sign Structures exist on the California Department of Transportation's (Caltrans) Right-Of-Way. Many of these structures were installed in the late 1960's and early 1970's and so are now about 50 years old. These structures have a history of problems with corrosion damage to connections of the ribbed sheet steel vertical diaphragms (see Image 1). Structures Maintenance and Office of Design and Technical Services have difficulties in assessing the structural condition of these structures due to a lack of guidelines on how to interpret inspection results to predict the remaining strength in the degraded structure. This has safety implications as well as interferes with efficient and effective asset management.

This research will develop user-friendly guidelines for transferring field inspections of box beam overhead sign structures into useful information about the remaining strength of the structures.

WHAT ARE WE DOING?

Through the PEER-Bridge Program, Caltrans is contracting with the University of California, Berkeley (Principal Investigator - PI) to investigate the structural condition of in-service box beam overhead sign structures.

The research will involve experimental testing and numerical simulation of representative box beam sign components and full sign structures designed according to Caltrans Standard Specifications and Standard Plans. Parametric studies on a representative sign structure configuration subjected to various loading, environmental, and degraded conditions will be conducted after which the results will be used to correlate with field observations of in-service box beam sign structures.

Finally, guidelines will be developed for transferring the field inspection results into useful information about the strength of

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in-service box beam sign structures.

WHAT IS OUR GOAL?

The primary goal of this project is to develop guidelines to interpret field inspections of degraded box beam overhead sign structures. This will enable engineers to assess the remaining strength of the structure.

WHAT IS THE BENEFIT?

Bridges play a critical role in California's transportation system by enhancing its mobility and economy. Currently, designers don't have the tools to correlate inspection results of box beam overhead sign structures with the remaining strength of the structure. The capability of predicting the remaining strength of degraded box beam sign structures is required to determine when to replace or repair the sign structure as well as to determine if the sign structure can withstand additional loading if desired to attach additional sign elements to the structure.

The aim of this research is to ensure reliability and structural integrity of aging box beam sign structures within California's transportation network.

WHAT IS THE PROGRESS TO DATE?

A literature review on box beam overhead sign structures as well as a study of the drawings of box beam overhead sign structures of different geometrical configurations previously constructed by Caltrans, have been conducted. This was followed by development of two-post and one-post finite element models of box beam sign structures in the program ABAQUS. These models will subsequently be used to perform iterative analysis and updating for different design parameters such as structural configurations and actual material test data.

Samples of the sheet ribbed steel and top chord of a single-post sign structure was recently collected from an in-service box beam sign structure near Davis, CA for purposes of testing to determine the mechanical properties. Also, vibration data using hammer hits at various locations of the sign structure and the PI's in-house sensors, were obtained during the field visit. The vibration data will subsequently be used to identify the natural period of vibration of the sign structure. Also, the previously developed FE models will subsequently be updated using the experimentally determined material data, natural period of vibration, and the available structural drawings of sign structures.

The PI has also developed a trained deep learning segmentation model for automatic prediction of corroded areas of a sign structure. The model prediction of corroded areas showed a high degree of accuracy when compared to images collected during Caltrans sign structure inspections (see Image 2).

An existing overhead sign structure (SeaCliff) located Highway 1 was taken down and transported to the UCB Richmond. The SeaCliff sign has been tested to failure to obtain the displacement demand for various sign components. Correlation of failure behavior was used to validate finite element analysis of the sign sturcure.

IMAGES

Image 1: Typical corrosion damage of in-service box

beam sign structures.

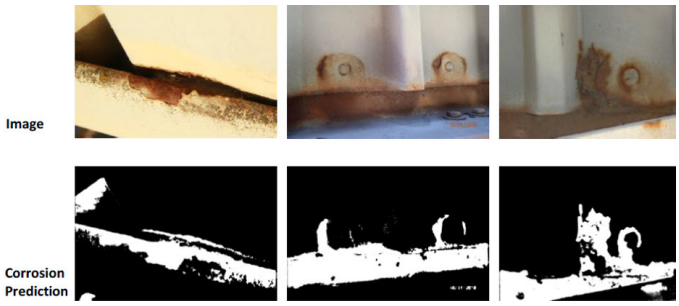

Image 2: Comparison of actual corroded areas with those predicted by segmentation model.