Kansas Department of Transportation

FACT SHEET

Initial Analytical Investigation of Overhead Sign Trusses with Respect to Remaining Fatigue Life and Predictive Methods for Inspection

PROJECT TITLE

Initial Analytical Investigation of Overhead Sign Trusses with Respect to Remaining Fatigue Life and Predictive Methods for Inspection

STUDY TIMELINE

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FURTHER RESOURCES

Final Report

Technical Summary

Introduction

Most state highway agencies do not perform routine fatigue inspection on highway signs, luminaires, and traffic signals, thereby increasing the potential for unnoticed fatigue cracking. The Kansas Highway System utilizes over 450 sign trusses, most of which have been in service for 30-45 years. In addition to aging support structures, the structural designs of these signs and signals sometimes result in significant cyclical loading due to wind gusts. This study was conducted to investigate the behavior of the structures and develop a software that is capable of estimating the fatigue life based on daily wind speed fluctuation.

Source: Florea et al. (2007). The photo is a courtesy of Professors Dr. Lance Manuel and Dr. Karl Frank at University of Texas at Austin.

Methodology

This study investigated the possibility of estimating the remaining fatigue life for each aluminum element according to AASHTO LRFD wind load combinations. Fatigue Life Simulator Software (FLSS) was developed to work compatibly with STAAD.Pro software and Sign Truss Interface, a program used by KDOT to simulate wind pressure, to determine fatigue life for any model of structural support system in the state of Kansas. Fatigue evaluations were conducted using nominal axial member-specific stress ranges corresponding to a wind speed database for a 45-year period, as well as hundreds of structural analysis simulations. Potential fatigue failure was assessed for each member of the support structure by evaluating the ratio of consumed fatigue cycles to ultimate fatigue cycles using Miner's rule to estimate finite life.

Conclusions

FLSS works compatibly with STAAD.Pro software and Sign Truss Interface to analyze any selected simulated structural model to estimate the amount of deterioration during years of service and determine remaining fatigue life span. Sign Truss Interface simulates wind pressure to generate stresses through wind effects acting on STAAD.Pro software using 45 years' worth of wind speed data. Future research should be conducted on other components of the structures, such as mast arm connections in the case of cantilevered traffic signals.

Potential Impacts and Benefits

Potential benefits include: 1) Prioritization of replacement of sign structures based on condition (field inspection), resulting in a more data-driven replacement program; and 2) a prioritized inspection protocol.