Kansas Department of Transportation

TECHNICAL SUMMARY

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

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Introduction

Most state highway agencies do not perform routine fatigue inspections 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.

Project Description

This study conducted fatigue evaluations 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. If the ratio was close to zero after 45 years or any number of actual service years, the member was expected to have a practically infinite life. If the ratio was close to 1 after the service years, the member was expected to be at the end of its life. This information can help inspectors identify for critical spots that may have developed fatigue cracks that otherwise would be difficult to detect.

Project Results

Two approaches were hypothesized to account for fatigue life deterministically and probabilistically. Fatigue Life Simulator Software (FLSS) was developed to manage hundreds of simulations and determine the fatigue life of all members in a structure in specific areas of Kansas. FLSS is compatible and works simultaneously with STAAD.Pro software and Sign Truss Interface provided by KDOT to generate results. Users apply the results to study the behavior of overhead structures and identify critical spots that should be physically inspected and potentially replaced. Results in Kansas indicated a range of structural fatigue life varying by city. Modifications were made to the output files of Sign Truss Interface to incorporate American Association of State Highway and Transportation Officials (AASHTO) load cases 1 and 2 and simulate wind speed into wind pressure using the effect of the two load cases. The modification also automatically incorporated 45 years' worth of wind speed data into the Sign Truss Interface to simulate and generate structural models to determine corresponding stresses to the wind effect.

Project Information

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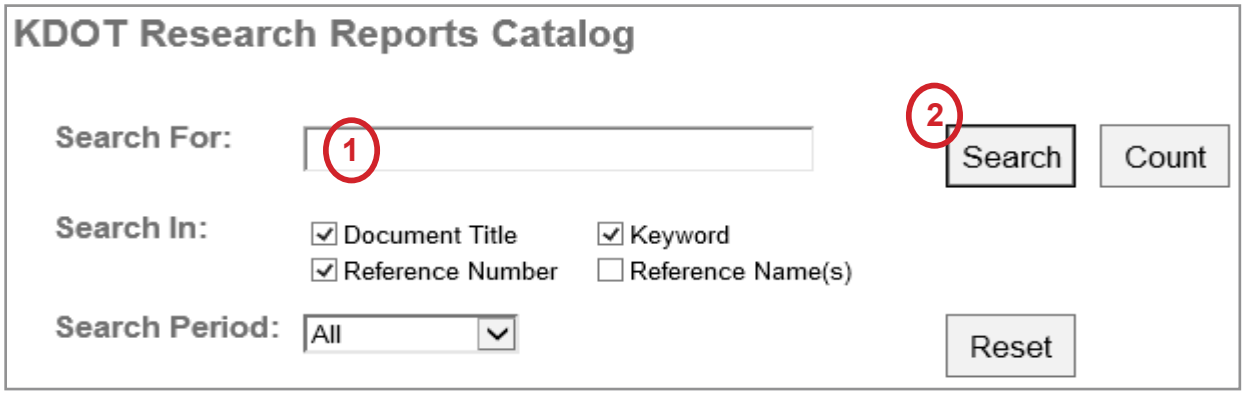

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