Damage Assessment of Sign Support Structures
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Objective
The overall objective of this work is to develop a sensing technology to assess the structural soundness of overhead highway sign supports. A portion of the project is devoted to model, by using the method of finite elements, the structural response (stress, deformation) of support structures under the effect of wind loads.

Problem Statement
Overhead and bridge sign support structures can be found along any major highway across the United States. These structures support signage that helps commuters navigate their way. Similarly, variable message sign (VMS) are used to control, inform, and warn the commuters through the display of a number of messages that may be changed or switched on or off as required.

During the past two decades, these simple structures have shown underlying problems associated with their reduced fatigue performance. Defective welds, aging material, and harsh environmental conditions have exacerbated these problems. In general, highway sign supports must withstand in-service dynamic loads. Sources of these loads include natural winds, seismic events (in seismic areas), artificial gusts created by passing vehicles, and vibrations induced into bridges by passing vehicles (sign supports mounted on a bridge). Most of the underlying problems involve cracks induced into welds by fatigue loading. Generally, cracks are found propagating within the leg of a fillet weld or at the toe. Depending upon the amount of time the crack has had to grow, these cracks can propagate into the main supporting member (e.g., the chord of a truss).

While identifying cracks in these structures is the first step in addressing the problem, determining the residual lifetime will lead to an optimal cost solution (repair, retrofit, or replacement), especially if the crack is identified at an early stage before it has propagated into the supporting member.

Work in Progress
An ANSYS finite element model is currently under development to determine stress and deformation of sign structures under the action of wind loads. A Matlab program was written to generate the wind load history, which consists of two main components: mean and turbulent component. The values of the mean component are based on data from the National Climactic Data Center. The turbulent component is based on the Kaimal spectrum.

A monitoring method based on the electromechanical – impedance (EMI) method is currently in progress to detect damage in sign structures.

Results
A survey was conducted amongst US and Canadian DOTs to summarize the current technologies and procedures to inspect sign support structures. The analysis of the survey included strength, limitations, and equipment cost of each approach. The EMI method was proven effective to detect the direction of propagation of damage occurring in metallic structures. A research paper stemming from this research is currently under review at the Journal of Intelligent Material Systems and Structures.