ABSTRACT

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Highway sign structures are widely used in the state of Indiana as well as many other states in the US. Due to their high flexibility, wind loading on these sign structures occasionally produces significant stress cycles associated with fatigue damage. Cracking caused by fatigue damage may occur at several critical spots on the sign structures. Cracks in sign structures have been observed in a number of states and several sign structure failures have been reported.

Analytical research was performed to evaluate the fatigue lives of the critical details in sign structures, including double-mastarm cantilever sign structures, box-truss sign structures, monotube sign structures, tri-chord sign structures, and single-mastarm cantilever sign structures. Finite element models of the sign structures were developed based on selected prototype sign structures installed in Indiana. Natural wind gusts was chosen to be the most critical source of load causing fatigue damage on the investigated sign structure types, except for the single-mastarm cantilever sign structure. The wind speed distributions for six locations in Indiana were determined, and a wind load simulation procedure was developed to generate wind load time histories. Dynamic analyses were performed with the generated wind load applied on the finite element models to obtain the stress time histories at several

structural details. A fatigue analysis procedure was defined to predict the fatigue lives based on the stress time history results.

The fatigue lives of the structural details were presented and discussed. The most critical details in the various types of sign structures were identified. It was found that the double-mastarm cantilever sign structure was the most fatigue-susceptible sign structure among the investigated sign structures, excluding the single-mastarm cantilever sign structure, and the post-to-base plate socket weld connection on it was the most critical detail. It was also found that variations in the fatigue life occurred due to differences in the wind environment at various sites.

The method, the frequency, the personnel qualification, and the procedures for sign structure inspection were proposed based on a literature search and communication with inspection engineers. Guidelines for component inspection of sign structures were recommended. Suggestions for future research were presented.