CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6829: Fatigue Resistance and Reliability of High Mast Illumination Poles (HMIPs) with Pre-existing Cracks

Background

High mast illumination poles (HMIPs) are used throughout the U.S. to provide lighting along highways and at interchanges. Texas currently has about 5000 HMIPs, varying in height from 100 to 175 ft. Failures of HMIPs have been reported in several states. These collapses have been attributed to failures at the shaft-to-base plate connection.

No collapses of HMIPs have been reported in Texas. However, recent studies have shown that many galvanized HMIPs in Texas have pre-existing cracks at their shaft-to-base plate connection, most likely caused by the galvanization process before the poles were placed in servive. Previous research has also shown that pre-existing cracks may significantly reduce the fatigue life of galvanized HMIPs.

TxDOT has identified three major issues/concerns with respect to HMIPs with pre-existing cracks. First, there is a lack of reliable experimental data about the fatigue life of pre-cracked HMIP base-connection details. Second, there is significant uncertainty regarding the natural wind response of HMIPs to the various major wind environments in Texas. Much of this uncertainty is related to the lack of measured data from comprehensive field studies. Third, due to this lack of data, the 'safe/serviceable' life of in-service TxDOT HMIPs with pre-existing cracks cannot be reliably predicted.

What the Researchers Did

This project's main goal was to generate data and information to support a probabilistic-based assessment of the remaining life of HMIPs with pre-existing cracks. The following major tasks were undertaken in this project:

1. A survey was conducted to collect data on in-service HMIPs in Texas to determine the HMIP designs of most interest and their locations.

2. Historical wind data was collected in Texas for the HMIP design types and locations of interest identified in the survey and for locations representative of major wind environments in Texas.

3. Extensive laboratory fatigue testing was conducted on test specimens representative of HMIPs with pre-existing cracks. This test program was focused on collecting fatigue life data at low stress ranges representative of wind-induced stresses due to vortex-induced vibrations.

4. Field monitoring of in-service HMIPs was conducted at five sites across Texas to obtain data on fatigue-load history and to characterize wind response of HMIPs. Data was collected for approximately one year at each site.

5. Computational studies were conducted

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to extend the information collected in the laboratory test and the field monitoring programs, and to evaluate the capability of available computational tools to study the fatigue behavior of cracked HMIPs.

6. A weld-repair procedure to extend the fatigue life of cracked HMIPs in-service was developed and tested on a limited number of poles.

7. A reliability-based framework was developed to extend the information collected in the laboratory test and during the field monitoring tasks to assess the safety of in-service HMIPs with pre-existing cracks.

What They Found

The main objective of Project 0-6829 was to develop a probabilistic-based assessment of the remaining life of HMIPs of pre-existing cracks in Texas. It is estimated that there are likely more than 1000 such HMIPs in our state. The results of this study show a wide range in the predicted lives of HMIPs with pre-existing cracks at different locations throughout the state. Based on a probability of failure of 5-percent, the predicted fatigue life at a number of locations analyzed throughout the state showed predicted lives varying from approximately 30 years to over 300 years. The variation in predicted lives is mainly affected by differing wind characteristics at each location.

What This Means

While the predicted fatigue life of HMIPs with pre-existing cracks, based on a 5-percent probability of failure, varied from about 30 years to more than 300 years for various locations around the state, there were a number of locations where the fatigue life was on the order of 30 to 40 years. Considering that a number of poles at these locations have already been in service a number of years, the remaining fatigue life is likely less than 30 to 40 years. The research identified certain TxDOT districts with more severe wind conditions, and therefore shorter predicted fatigue lives for HMIPs with pre-existing cracks. However, within any given district, the wind conditions can vary widely from one location to another. Consequently, HMIPs with rather short predicted fatigue lives can occur in any district. As a result, the research team recommends that TxDOT develop a program of inspection to identify HMIPs with significant cracking at the base, and consider repairing these poles before the cracks extend through the full thickness of the shaft wall. For poles with cracks that extend through the full thickness of the shaft wall, the research team recommends replacement of the poles.

For More Information

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