MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

RESEARCH SUMMARY

STRUCTURAL ASSESSMENT FOR MD SIGN STRUCTURES PROJECT BASED ON AASHTO LTS-6 STRENGTH AND FATIGUE CRITERIA

WHAT WAS THE NEED?

Road-side infrastructures are part of the highway plan, and their safety is essential for maintaining traffic flow and traffic safety. The AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals have gone through several evolutional/revolutionary changes since the year 2001 (LTS-4) and the latest editions are 2013 (LTS-6) and 2015 (LTS-LRFD) editions with their respective interims. The LTS-LRFD specifications adopted the ASCE/SEI 7-10 wind loads and considered wind as an extreme limit state, unified with the most used U.S. Standards. The LTS-LRFD specifications raised the wind load to stronger storms with lower Mean Recurrence Intervals (MRI) which requires new structural analyses of the old structures under the current wind loads.

WHAT WAS THE GOAL?

The Maryland Department of Transportation State Highway Administration (MDOT SHA) is conducting this research to develop a sign structure assessment approach in collaboration with the Bridge Engineering Software and Technology (BEST) Center, University of Maryland to understand the influence of the new wind loads on types of structures and if they should be categorized as at risk, marginal, or can remain in service. This research included six tasks.

WHAT DID THE RESEARCH TEAM DO?

The data of sign structures in MD was collected and grouped. The MDOT SHA Traffic Structure Inventory Inspection Management (TSIIM) database was provided and permitted for the use for analytical purposes. Also, the Excel format file was extracted and downloaded for analysis.

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Types of sign structures, the years they were built, AASHTO versions adopted, material, dimensions, inspection record (if exists), were collected through the database. For more detailed information, GPS locations, roads, and traffic conditions (interstate, non-interstate, ADT/ADTT, etc.) were collected from the MDOT SHA Traffic Monitoring System (TMS). All Maryland sign structures were summarized and then categorized based on 5 major categories (cantilever type, butterfly type, span-cantilever type, double type, and overhead type). Based on the team's research, galloping was the most critical fatigue load of the three types specified by AASHTO (galloping, natural wind gust and truck gust). Then, 5 out of 19 types for a total of 736 galloping-influenced structures were left for consideration. Valid sampling techniques were adopted to determine the sign bridge sampling sizes for numerical modeling and evaluation. Sample models were established and run in Sign Bridge Analysis and Evaluation System (SABRE) software from 5 major categories for a total sample sign structure population. Their fatigue details were carefully calculated, summarized and checked against the code or documents. Next, sample sign structures were evaluated based on AASHTO LTS-6 with fatigue consideration for maximum fatigue life expectation. Although the LRFD criteria is not adopted for this study, the AASHTO LRFD-based development for wind and traffic volume (AADT) is considered in the risk analysis. The locations of the 736 sign structures, which are influenced by wind galloping, within different ranges of AADT were observed and studied from the Arc-GIS map. Tentative factors considered in ranking and prioritizing were tabulated.

WHAT WAS THE OUTCOME?

A semi-qualitative risk ranking approach and a reliability analysis approach were developed for the assessment of MD sign structures. In the sign structure rank system, four relevant factors, including structure analysis result, number of anchor bolts, average annual daily traffic volume (AADT), and sign structure age, were considered in the evaluation. The rank in each factor is assigned to a certain weight to obtain the final rank score. For the structure analysis portion, certain types of sign structures were summarized into groups according to the distribution of span lengths and post sizes. Subsequently, these samples were modeled and analyzed by the SABRE program. Their Combined Stress Ratio (CSR) of posts and arms, as well as their fatigue stress ranges, were obtained. When evaluating a structure based on one factor, a risk rank was given according to its condition data. Eventually, the ranking of all existing sign structures is generated to prioritize the structural replacement. Finally, an Automated Sign Structure Ranking Program was developed to help maintain and monitor the current sign structure (CN2 and OH6 type). It imported the TSIIM database combined with the traffic information from the MDOT Traffic Monitoring System, then organized and analyzed the inventory condition.

HOW WILL MDOT SHA USE THE RESULTS?

MDOT SHA will use the results to assess the structures prior to performing any field inspections. The analyses provided will help MDOT SHA develop more accurate budgeting programs for targeted inspections and the replacement of sign structures.

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