MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

RESEARCH SUMMARY

THE CALIBRATION OF THE AASHTO ASD AND LRFD FOR MARYLAND SIGN AND HIGH MAST LIGHTING STRUCTURE DESIGN

WHAT WAS THE NEED?

The American Association of State Highway and Transportation Officials' (AASHTO) Specifications for Structure Support for Highway Signs have changed significantly (from LTS-4 to LTS-6, then to LRFD LTS-1) over the past two decades. Federal Highway Administration (FHWA) regulation (NPRM -23 CFR part 625) mandates state transportation - to adopt AASHTO STD LTS-6 (ASD) for sign and signal structure designs. FHWA also published the Load and Resistance Factor Design (LRFD) design edition in 2015 – *Load and Resistance Factor Design For Highway Bridge Superstructures - Reference Manual* – which it may require states to adopt in the future.

WHAT WAS THE GOAL?

In preparation to adopt AASHTO STD LTS-6 and the future LRFD LTS-1 for sign and signal structure, the Maryland Department of Transportation State Highway Administration's (MDOT SHA), Office of Traffic and Safety, worked with the Bridge Engineering Software and Technology (BEST) Center, University of Maryland, to develop new signal standards.

WHAT DID THE RESEARCH TEAM DO?

To develop the new sign standards, this research was divided into six sections. First, the research team had to complete design parameters of MD-specific sign and light structures. A previous extensive study completed by the research team and published in 2017, determined design parameters for MD-specific signal structures. A similar approach was used in this project to identify the MD-specific Fatigue Category of

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PRINCIPAL INVESTIGATOR:
Dr. Chung C. Fu, P. E.
University of Maryland,
College Park
BEST Center
ccfu@umd.edu

Importance Factor (I, II or III) for sign and high mast light structure designs. Second, the team defined MD wind pressure in LRFD for sign structure design. Next was the calibration of LRFD Designs by adopting fatigue design. That was followed by the LRFD Foundation Design. Then, the team had to perform a detailed comparison between the AASHTO STD LTS-6 and the LRFD LTS-1 specifications. Finally, a complete review and conformance test was performed on the SABRE/LRFD programs.

WHAT WAS THE OUTCOME?

First, a complete model analysis of the traffic signal structure, including structure foundation, was conducted using ANSYS and SABRE programs and self-developed Excel calculation sheets. Second, this research determined that AASHTO ASD LTS-6 quadrangle, coordinates, slope dimensions (and LRFD LTS-1 have different approaches in analyzing wind speed. It was recommended that Maryland be divided into three regions: the Eastern Shore, the Appalachia Mountain, and the Baltimore-Washington corridor; since the current 100mph wind speed was no longer reasonable. If LRFD is adopted for Maryland designs, wind speed of 120mph should be adopted.

Next, the Maryland signal poles that need to be modified in order to increase the fatigue resistance were identified with recommended modifications. The recommended modifications of the current design on the signal poles include: a) Groove welds for arm connections, b) Groove welds for pole connections, c) Adopting AASHTO build-up box type for arm connections, and d) 6-bolt patterns for both arm and pole connections. Other structure changes and recommendations were discussed in this study, such as tube-to-tube connections between main chords and bracings for sign structures. An analysis of the typical Maryland foundation types, including shaft foundations for signal poles, shaft foundation with wing walls for cantilever sign structures, and mat found with pedestal for overhead structures was completed. Then, through the detailed comparison between AASHTO LTS-6 and LRFD LTS-1, it was discovered that the expressions for allowable stress were dramatically different. The tube sections are used to demonstrate such differences in expressions and their effects. The interaction equations are also significantly different since one is based on combined stress ratio while the other is combined force. Samples from Maryland Standards were used for checking Strength I Limit State. For the fatigue study, four cases studies were discussed and verified using SABRE and STAAD analysis. The verification process indicates that SABRE is accurate for the fatigue analysis. Finally, a complete review and conformance test on the SABRE program was performed. SABRE design models of highway sign, high post, and traffic signal post were verified by an alternate commercial licensed finite element analysis software, STADD Pro. The comparisons are in good agreement.

HOW WILL MDOT SHA USE THE RESULTS?

MDOT SHA will use these results to implement the new design standards for the overhead sign structures and signal structures.

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