Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7275

PERFORMANCE OF DUAL-SHOULDER-MOUNT-TRUSS WEATHERING-STEEL OVERHEAD SIGN STRUCTURES IN WEST VIRGINIA

Wael Zatar(*), Hai Nguyen
College of Information Technology and Engineering, Marshall University, United States
(*)*Email:* zatar@marshall.edu

ABSTRACT

This article focuses on evaluating 15 dual-shoulder-mount-truss weathering steel overhead sign structures (DSMT-WSOSSs) in Charleston Interstate System in West Virginia. Non-destructive testing technique examined key components of the sign structures while the other components were inspected by a traditional visual inspection technique. A rating methodology was developed to evaluate the sign structures at both the element level and their overall condition. The element condition was rated based on a developed rating criteria and score. The overall condition of each sign structure was then evaluated by the ratio between the total score of each structure (S) and its maximum possible total score (S_{max}). The study revealed that all the DSMT-WSOSSs performed relatively well after more than 40 years of service and exposure to moist weather condition of Kanawha County (climate zone 4A). The developed rating methodology resulted in showing that 93 percent of the sign structures are in fair condition and 7 percent are in good condition.

Keywords: DSMT-WSOSSs, non-destructive testing, visual inspection, condition rating.

INTRODUCTION

Weathering steel (WS) is a high-strength, low-alloy steel and best known under the trademark COR-TEN or Corten steel. In the state of West Virginia, there are approximately 100 WS bridges and numerous WS overhead sign structures (WSOSSs) throughout the state. Inspection of these WS structures is essential to maintain public safety. This paper summaries the results and findings of a study aimed at evaluating the performance of the above-mentioned WSOSSs.

RESULTS AND CONCLUSIONS

Structural elements (component) of each sign structure were evaluated using an element condition rating system. The element condition rating system includes a sequential rating score (with '1', '2', '3', '4' scores representing 'good', 'fair', 'poor', 'severe' conditions, respectively) and an importance weight for each structural element. The importance weight was derived after consultation with experts in the field. Highest importance weights were assigned for critical components such as base plates, anchor bolts, connections between base plates and vertical columns, and section loss of vertical columns near column bases. The overall condition of each sign structure was evaluated using an overall condition rating system. Overall condition rating is estimated by Equation 1, which is based on the ratio between the total score of each sign structure (S) and its maximum possible total score (S_{max}):

$$\begin{cases} S_{\min}/S_{\max} \le S/S_{\max} < \left(3S_{\min} + S_{\max}\right)/4S_{\max} & \text{: Good Condition} \\ \left(3S_{\min} + S_{\max}\right)/4S_{\max} \le S/S_{\max} < \left(S_{\min} + S_{\max}\right)/2S_{\max} & \text{: Fair Condition} \\ \left(S_{\min} + S_{\max}\right)/2S_{\max} \le S/S_{\max} < \left(S_{\min} + 3S_{\max}\right)/4S_{\max} & \text{: Poor Condition} \\ \left(S_{\min} + 3S_{\max}\right)/4S_{\max} \le S/S_{\max} \le 1 & \text{: Severe Condition} \end{cases} \quad (1)$$

Table 1 shows the results of both the element and overall condition ratings for all the inspected DSMT-WSOSSs. The sign structures in Table 1 are sorted by descending order of their S/S_{max} ratio. Out of 15 dual-shoulder-mount-truss sign structures, 14 structures were found to be in fair condition with the S/S_{max} ratio ranging from 0.43 to 0.57 and the remaining structure was determined to be in good condition with the S/S_{max} ratio of 0.41. Average maximum section loss near base plate for these sign structures was 25.6%. Ultrasonic inspection of anchor bolts showed that most of the anchor bolts were in a good shape with no significant deficiencies. The element and overall condition rating systems assist the WVDOH making rational decisions on whether there is a need to repair or replace at-risk elements or connections. To detect any serious defects, which may endanger the structure or the traveling public, in-depth evaluations are recommended for the sign structures with the most deficient condition. Further evaluations are recommended for the sign structures with a fair condition rating. Normal periodic inspections are recommended for the sign structures with a good condition rating.

Table 1 - Results of Element and Overall Condition Rating

Structure number	Element rating score												S/S_{max}	Overall cond. rating
	C1	C2	C3	C4	C5	C6	C7	C8	C9E	C10	C11	C12		
064-57.89	1	1	1	1	1	1	3	–	2	3	3	1	0.41	Good
079-01.57	2	1	1	1	3	1	2	1	2	2	2	2	0.43	Fair
064-57.87	1	1	1	1	1	1	4	–	4	2	2	1	0.45	Fair
077-101.23	1	1	2	2	3	1	1	3	2	1	2	3	0.46	Fair
077-100.08	1	1	2	2	1	1	3	1	3	3	2	2	0.46	Fair
077-102.65	1	1	1	2	3	1	2	1	3	2	2	2	0.46	Fair
119-18.46	1	1	2	2	1	1	3	1	4	2	2	3	0.48	Fair
064-55.46	1	1	1	3	1	1	3	1	4	2	2	2	0.48	Fair
077-100.98	2	1	1	2	3	1	2	3	2	2	2	2	0.50	Fair
077-103.14	2	1	1	2	2	2	2	2	3	2	2	2	0.50	Fair
064-53.72	1	1	1	2	3	1	2	1	2	4	2	3	0.50	Fair
064-55.48	1	1	2	2	3	1	3	1	2	2	2	3	0.51	Fair
079-00.68	1	1	1	1	3	1	4	1	2	2	2	4	0.51	Fair
060-11.44	1	1	1	2	2	1	3	1	2	4	2	4	0.52	Fair
077-103.38	2	1	1	2	3	1	3	2	3	2	3	3	0.57	Fair

Note: C1 = Foundations; C2 = Drainage issue; C3 = Grout pad under base plate; C4 = Base plates; C5 = Anchor bolts, nuts, and washers; C6 = Connection between base plate and vertical column; C7 = Section loss of vertical column near base plate; C8 = Vertical weld lines between tubes constituting vertical column; C9E = Exterior of vertical column; C10 = Connections between vertical column and horizontal chords; C11 = Horizontal chords and secondary vertical posts; C12 = Attachments (e.g. vertical sign supports; horizontal light arms; bolts connecting vertical sign supports and horizontal light arms among others)

REFERENCES

[1] Zatar, W. and Nguyen, H. Condition Assessment of Ground-Mount Cantilever Weathering-Steel Overhead Sign Structures. Journal of Infrastructure Systems, 2017, 23(4), pp. 05017005.

[2] Zatar, W. and Nguyen, H. Evaluation of weathering steel overhead sign structures in West Virginia. Marshall University, 2014.