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Load Rating of a Steel Bridge by Inclination Measurement

Di Su, Eid Jonathan, Tomonori Nagayama

The University of Tokyo, Tokyo, Japan

Contact: su@bridge.t.u-tokyo.ac.jp

Abstract

Bridges are aging in Japan and the maintenance of these structures has become a major issue. In this current research work, in order to fully exploit in-service data obtained from structural monitoring, a methodology for evaluation of an existing steel bridge has been proposed to update live load effects and improve structural performance evaluation. Inclination data are chosen as a live load effect for all limit states then processed using extreme value theory and reliability theory. Incorporating the results from finite element analysis for resistance represented by inclination, the reliability index of the structural member is deduced by utilizing Second Order Reliability Method (SORM) together with its rating factor by Load and Resistance Factor Rating (LRFR). Rating factor results show higher rating than the procedure detailed in the AASHTO Manual for Bridge Evaluation (MBE), which is majorly based on design condition assumptions.

Keywords: load rating; inclination; finite element analysis; measurement.

1 Introduction

Bridges are aging in Japan in the recent years. It has been estimated than more than half of the bridges in Japan with a span of 15 meter or more are going to be more than 50 years old by the year 2025. Furthermore, it is necessary to have a current knowledge of bridge conditions in a particular local area to allocate efficiently funds for highway roads management. In this context, the assessment of existing bridges has become an important issue. The accuracy of the performance evaluation only from visual observations is still open to discussion. It appears that, for now, the rating of the structure is performed from qualitative observations and not from quantitative data. Moreover, a risk that condition rating conclusion due to visual condition is subjective and depends on the technical level of the inspector. Currently, there are no specifications for evaluation of structures in Japan. Nevertheless, the AASHTO Manual for Bridge Evaluation [1] is a specification widely used in the United States for structural assessment of highway bridges and bridge evaluation currently. In the Manual for Bridge Evaluation, the Load and Resistance Factor Rating (LRFR) is described. The key point of this methodology is that it ensures uniform target reliability between bridges while being consistent with the Load and Resistance Factor Design (LRFD) with load rating as an objective.

In the literature, there have been attempts to obtain more accurate results of load rating by using in-situ strain data monitoring [2][3] and extreme value theory [4][5] for load updating. However, some points in the extreme value theory are not discussed. No research papers have presented continuous measurement performed during a period long enough to account for seasonal modifications of traffic conditions and the return-level value obtained should be discussed, as it might not be representative of the actual future extreme live load effect. Directly correlated to this

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