Evaluation of damage severity and load carrying capacity of steel girder-end using local vibration modes

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Abstract

Corrosion at girder-ends is a major deterioration pattern of steel bridges. The severity needs to be quantified though the evaluation is not trivial. As an alternative, this paper proposes to use Local Vibration Modes (LVM). The existence of LVMs and the sensitivity of their frequencies to damage are examined. The damage severity is then quantified using a superposition method. This method calculates LVM frequencies under various damage severities and shapes using database of LVM of a limited number of fundamental damage patterns, which is prepared in advance by finite element analysis (FEA). The result is then used to evaluate damage severity from the measured LVM frequencies. Furthermore, relationship between LVM and load carrying capacity, prepared by FEA on various corrosion patterns, is used to evaluate the load carrying capacity from measured LVM frequencies. The developed methods are examined on a FE model of a steel bridge girder end.

Keywords: damage quantification, load carrying capacity, girder-end, local vibration mode

1 Introduction

In case of steel girder bridges, the major cause of corrosion is the accumulation of storm-water along with the dissolved salts in soil and dust particles. The storm-water leaks through the expansion joints, often provided at the girder ends, mainly from the road sides and thus the exterior girders tend to be affected by corrosion. Same fact is supported by a survey of around 220 bridges [1].

To maintain the bridges in safe operational condition, their remaining load carrying capacity should be known, which depends on the location and severity of corrosion. Once this information is available, the maintenance priorities of bridges can be determined accordingly. The damage quantification of bridge members is thus important. Currently, the 'degree of corrosion' of bridge members is either roughly estimated by comparing the corroded bridge member with pictures of typical corroded members or by directly measuring member thickness after cleaning the corroded surfaces. The first approach is subjective while the second one is time-consuming and costly. Alternative method to evaluate the 'degree of corrosion' with more ease, efficiency, and accuracy is needed.

Damage quantification using vibration approach is one possible alternative. As the natural

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