Condition Assessment and Maintenance Strategies for Bridges at Individual and Network Level

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Abstract

Bridges degenerate due to severe environment, over loading, initial structural defects, disasters or some other factors. How to evaluate and ensure the safety of these structures, at individual level as well as network level, is a question attracting enough attention. At individual level, this paper proposes the Neutral Axis Indicator (NA) based on strain measurements, to evaluate the performance of an individual bridge and to investigate challenges associated with the neutral axis for structural health monitoring purpose. At network level, a framework is proposed to evaluate bridge groups and to compute the optimal maintenance plan applied to the bridges at a given network. The proposed framework is applied to the bridge network located in Hebei province, China. Results are performed through the data collected from hundreds of bridges over a few years, and the effectiveness and advantages are finally validated.

Keywords: Neutral Axis Indicator; network level; structural health monitoring; highway bridge, machine learning.

1 Introduction

Over the past decades, significant efforts have been made in China to improve transportation infrastructure system and to launch an enormous investment in highway bridge network construction. According to an uncompleted statistic, there were 832,500 bridges throughout the country, covering a total length of 52,256,200m, most of which were categorized as Grade II or even lower with inadequate condition ratings. Similar cases are to be found worldwide. The average age of 607,380 bridges in US was 42 years as ASCE reported [1]. In addition, nearly a quarter of them were classified as structurally deficient or functionally obsolete.

Great progress has taken place so far in the field of structural health monitoring (SHM) all around the world, but mainly focuses on large bridges or irregular bridges. As for middle and small spanned bridges, typically concrete box girder bridges, much less effort has been made to improve their traditional management and maintenance pattern. Concrete box girder bridges always consist of flexural members such as beams. Therefore, the neutral axis position is considered to be a key