Damage investigation through dynamic characteristics of existing bridge deck panels

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Abstract

Reinforced concrete (RC) deck slabs are often observed to be deteriorated due to reinforcement corrosion leading to horizontal cracks within the slabs which are difficult to judge by visual inspection. This study focuses on investigating damage and deterioration of RC deck panels of an existing steel girder bridge using modal parameters identified through vibration measurements and finite element (FE) analysis. In the analytical models, to incorporate the actual bridge deterioration at different locations, the results of visual inspection and compressive strength test of deck panels were used. Deck panel in a relatively healthy state was chosen as reference. For damaged panels, two models were considered in the FE analysis; first with reduced Young's modulus and second with horizontal cracks at different locations. The comparison of experimental and analytical results led to consider the possibility of existence of horizontal cracks within the damaged deck panels.

Keywords: Reinforced concrete (RC) deck slabs; horizontal cracks; damage detection; vibration measurements; natural frequency; mode shape; finite element analysis; stabilization diagrams.

1 Introduction

The structural deterioration and damages of the bridges during their service life due to increased traffic loads, aging and challenging environmental conditions have been under the attention of engineering community. The deterioration of RC deck slabs is one of the growing issues, and it is estimated that the repair and renewal of RC bridge decks account for more than half of the total maintenance costs in Japan [1]. One of the main reasons for deterioration in RC bridge deck slab is rebar corrosion leading to horizontal cracks within the slab. Growing crack width causes reduction in the integrity of deck slab that in turn shortens the service life of bridge superstructure [2]. Since such cracks are difficult to judge by visual inspection, no proper repair and preventive measures can be conducted based on only visual inspection results.

Vibration-based structural health monitoring (SHM) has been employed as valuable alternative and assistance to visual inspection in investigating the infrastructure's deterioration process through non-destructive sensing and data processing [3-4]. The SHM techniques are based on the fact that structural damage influences the mechanical properties of the structure that affects its dynamic characteristics. These techniques can provide the