Changes in modal frequencies of a steel plate girder caused by local damage and thermal expansion

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ABSTRACT

This study is intended to investigate how the local damage and varying temperature affect changes in modal frequencies of a steel plate girder bridge. A damage experiment on a real bridge was conducted, and acceleration responses of the bridge under a single moving vehicle were monitored and utilized for the damage detection. Fatigue cracks observed in actual steel plate girder bridges were considered as local damage, and artificial cracks were applied to the lower flange and web plate near base plate of shoe in the damage experiment. The longitudinal displacement of the bridge at supports were also monitored to investigate structural behaviors of supports under local damage and varying temperature. Observations showed that frequency of the 1st bending mode increased due to artificial damage though frequencies of the 2nd bending mode and the 3rd bending mode decreased. Generally, it is expected that the natural frequency of bridges will decrease due to damage for damage leads to decrease of bending stiffness. Changes in boundary condition due to damage as well as temperature change are considered to examine the mechanism of increasing the frequency of the first bending mode while those of the second and third bending modes decrease. A sensitivity analysis considering influences of changes in rigidity and boundary condition due to damage is conducted. The sensitivity analysis demonstrated that the first bending mode was more sensitive to changes in the boundary condition than change in flexural stiffness so as to show increase of the first bending frequency due to the damage.

Keywords: damage experiment; local damage; steel plate girder bridge; structural health monitoring; thermal expansion