Damage Identification of Bridges based on Changes in Modal Characteristics

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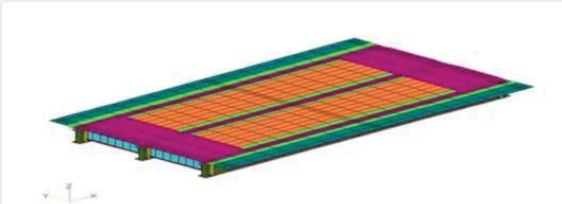


Fig.1 Analytical model of steel girder bridge

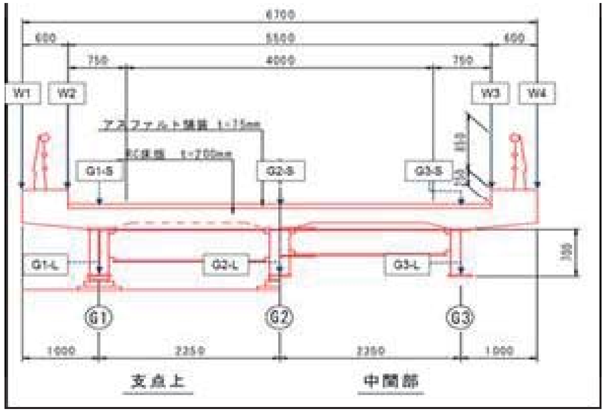
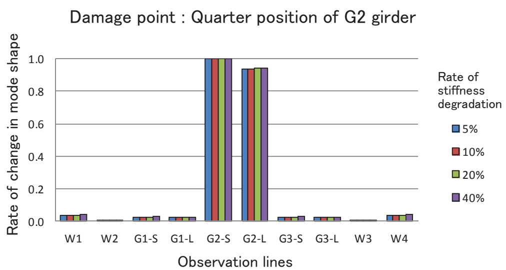


Fig.2 Points for measurement of vibrations (Ten points：W1～W4)



$$MAC(\phi_a,\phi_b)=\frac{|\{\phi_a\}^T\{\phi_b\}|^2}{(\{\phi_a\}^T\{\phi_a\})(\{\phi_b\}^T\{\phi_b\})}$$

$$\alpha = 1.0 - MAC(\phi_a,\phi_b)$$

ϕ_a : mode vector before damage
ϕ_b : mode vector after damage

Fig.3 Rate of change in mode shapes at each observation line

Content:

I deal with a method for damage identification of composite girder bridges based on the changes in the modal characteristics. Generally damage to structure causes any change in modal characteristics of the structure.

In this study, from the results of modal analyses of a girder bridge with sixty damage scenarios, it became clear that the changes in the primary mode shapes of target lines and in the primary natural frequency have a close relation to the places and degrees of damages to the bridge. We proposed a method for damage identification of girder bridges based on the changes in modal characteristics and examined the validity of the method based on the results of damage identification for other damage scenarios of the bridge.

Fig.1 shows an analytical model of steel girder bridge used in this study. Fig.2 shows the cross section of the bridge and the vibration measurement points are indicated on it. The rates of change in the first mode shape in the case that quarter position of G2 girder is damaged are shown in Fig.3. From Fig.3, it is clear that the rate of change in the first mode shape at the points near G2 girder are predominant. This suggests that we can find the damaged girder from the change in the first mode shape.

The other analytical results show that the changes in both the first mode shape of observation lines and the first frequency respectively give the damage location and degree. I will study further on damage identification method for road bridges both analytically and experimentally and finally verify our method through the application to real bridges.

Keywords：modal analysis, damage identification,
stiffness degradation, bridge

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