Development of simplified Bridge-Weigh-In-Motion based on displacement evaluation using an accelerometer

Nanami Ashizawa, Kouichi Takeya, Eiichi Sasaki

Tokyo Institute of Technology, Civil and Environmental Engineering, Tokyo, Japan

Junji Yoshida

University of Yamanashi, Civil and Environmental Engineering, Kohu, Japan

Contact: ashizawa.n.aa@m.titech.ac.jp

Abstract

In this study, an influence line of the girder displacement of the bridge was estimated by Bridge-Weigh-In-Motion using an accelerometer. Displacement was calculated by two times of integration of the measured acceleration. The data has the problem of low sensitivity due to a single sensor, and it contains measurement noise. To compensate for these problems, two correction methods were applied to the integration result. They were the baseline correction method and the drift correction method using boundary conditions of traffic-induced vibrations. It was shown that the result of integration was improved by using these methods. A calibration process to estimate the influence line of the bridge was proposed using iterative calculation method to optimize the result using local buses. It was shown that by using this method, vehicle detection and weight estimation can be performed with high accuracy, especially for large vehicles.

Keywords: bridge, accelerometer, numerical integration, baseline correction, vehicle detection optimization method, bridge-weigh-in-motion, health monitoring.

1 Introduction

There are many bridges that have aged and damaged such as fatigue and corrosion. Understanding traffic load and traffic frequency is important for maintenance because the main causes of fatigue damage to bridges are traffic volume and overloaded vehicles. The understanding of traffic characteristics would make maintenance efficient within a limited time and budget.

The methods to measure the traffic load are classified into two types, direct or indirect methods. Direct methods such as an axle load meter embedded in the road have an advantage in accuracy, but it is expensive and disturbs the traffic flow. On the other hand, an indirect method, Bridge-Weigh-In-Motion (B-WIM) estimates the axle load from the structural response of the bridge when a vehicle passes. This concept was firstly proposed by Moses in 1979 [1]. B-WIM has an advantage in low-cost without disturbing the traffic flow. Low-cost includes system cost, time cost, and labor cost. However, accuracy is considered to be inferior to the direct method. B-WIM can also work as traffic census or structural monitoring by following the structural response of the bridge over the long term.

As the method to measure the structural responses, the use of the accelerometer has been proposed