

Rotation-based Virtual Axle of Bridge Weigh-in-Motion for Bridge Health Monitoring

Joshua Irawan

Keywords: Rotation angle, Virtual Axle, BWIM, Bridge Health Monitoring

【Background】

The practicality of Bridge Weigh-in-Motion (BWIM) systems in estimating axle weights has led to extensive research on their application in bridge health monitoring. Previous studies mainly relied on statistical properties derived from estimated gross vehicle weight (GVW). However, this approach faces two significant limitations since it depends on a strain-based algorithm and requires prior information on the actual GVW. In 2015, the virtual axle concept was introduced, proposing that an imaginary axle could indicate bridge health. However, the initial formulation of the virtual axle weights results in susceptibility to ill-conditioned problems that occur in the BWIM computation algorithm. Furthermore, it still relies on the strain-based algorithm, which has sensitivity limitations. Thus, posing setbacks and limitations of BWIM application for BHM.

【Objective】

- Investigate the feasibility of the **rotation-based** virtual axle concept.
- Improve the feasibility of the virtual axle concept for bridge health monitoring.

【Approach】

A non-dimensional virtual axle weight definition and an index to summarize the virtual axle measurement, Virtual Axle Indicator (VAI), were proposed.

$$VA = \frac{\widehat{GVW}^+ - \widehat{GVW}}{\widehat{GVW}} \quad VAI = \sqrt{\frac{1}{n} \sum_{i=1}^n VA_i^2}$$

- VA : Virtual Axle
- \widehat{GVW}^+ : Estimated GVW with Virtual Axle
- \widehat{GVW} : Estimated GVW
- VA : Virtual Axle Indicator

【Publication plan】

- Journal article

【Results】

The proposed approach was validated through an in-house moving vehicle experiment at Kyoto University. The results shown in **Figure 1** indicate that the proposed approach is feasible for bridge damage identification. It shows that the proposed VAI increased as the damage severities increase.

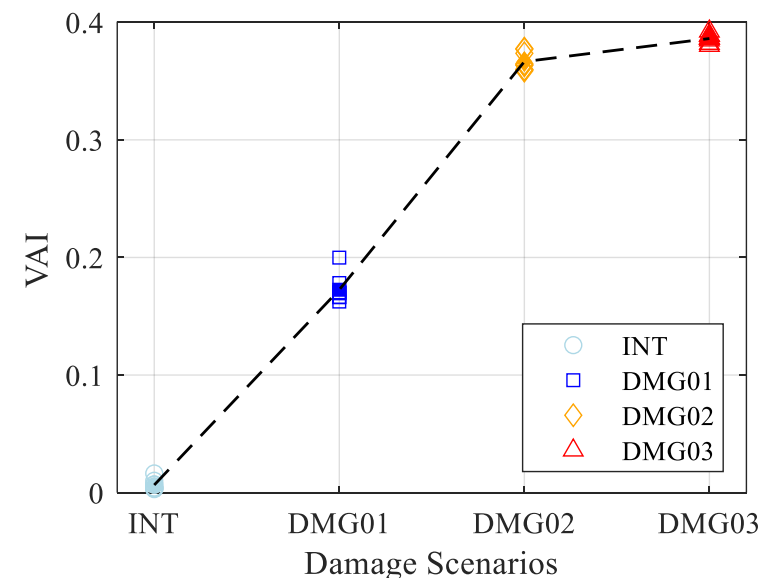


Figure 1. VAI Results Across Damage Scenarios