Drive-by Fleet Monitoring Using Apparent Profiles

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ABSTRACT

This paper proposes the concept of drive-by fleet monitoring at a network level using apparent profiles. This method can monitor every bridge that traffic crosses using fleets of in-service instrumented vehicles. The most current drive-by monitoring methods use specialist vehicles to identify bridge features from vehicle vibrations, such as natural frequency, mode shape, modal curvature, and damping. Some studies show that the accuracy of the inferred features is greatly reduced by vehicle speed and surface profiles. To address this challenge, some recent researchers have identified 'contact point' vibration as a promising measurement that is less affected by speed. The contact point is the location where the vehicle wheel touches the road surface profile. As a vehicle passes over a bridge, the displacement of the wheel at the contact point is referred to as the 'apparent profile' in some studies. This apparent profile consists of the surface profile plus the bridge deflection under the wheel. The bridge deflection portion of the apparent profile can be related to axle weight through a moving reference influence function (MRIF). When the axle weights for a fleet of vehicles are known, the MRIF is determinable and can be used as a damage indicator. Even when axle weights are not known, the repeatability of traffic at a site means that the mean fleet MRIF shape tends to be repeatable and a good indicator of bridge condition.

This paper uses numerical simulation of a fleet of nearly 100 in-service non-specialist vehicles, passing over a bridge, to demonstrate the effectiveness of fleet monitoring. The MRIF is shown to be repeatable for a typical fleet of 2-axle trucks, while being sensitive to bridge condition. With the increasing digitization of the vehicle fleet, this concept has great potential to be used for universal monitoring of all bridges, 24 hours a day, 7 days a week.