Vehicle Weight Estimation using Bridge Bearing with Embedded Piezoelectric Material

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Summary

This paper presents a new method to estimate vehicle weight by using piezoelectric material embedded in the bridge bearings. A piezoelectric material one that produces an electric charge when a mechanical stress is applied. The bearing has been conceived by introducing adequately a piezoelectric material within conventional steel pot bearing or rubber elastomeric bearing. This piezoelectric material not only supplies the electrical power required for the operation of the embedded sensors but can also be used to perform real time control of the passage of overloaded trucks by adopting built-in load measuring function.

Compared to other vehicle weight identifying system, the advantage of this method is that it is possible to install without additional work, since it is installed as a component of the bridge. Besides, its power generation capacity (energy harvesting) is also providing a new energy source that can be exploited to supply power to the monitoring system for gathering database of vehicle weight. Dynamic vehicle loads induce vibrations depending on bridge's natural frequency and vehicle's velocity. This study demonstrated that vehicle weight estimation is properly performed through analytical solution and numerical analysis when vehicle load is measured by the bridge bearing.

Keywords: piezoelectric material; bridge bearing; vehicle weight estimation; energy harvesting; renewable energy

1. Introduction

When it comes to designing bridge, vehicle weight information is essential for determining the structural and maintenance requirements of bridges. Overloaded trucks passing on the bridge are causing fatigue failure through repeated stress. Therefore, identifying such data is needed to evaluate safety of superstructure throughout its remaining service life.

This study presents a new method to estimate vehicle weight by using piezoelectric material embedded in the bridge bearing. Sensor embedded smart bearing system has been studied for monitoring vehicle weight by Subramaniam (1995), Nims et al. (1996). They have analytically verified that elastomeric bearing has enough deformation under the superstructure which is subjected to vehicle load and feasibility of identifying vehicle weight [1,2]. Ghosh et al. (2003) has developed strain gauge embedded smart bearing which can measure strain in real-time [3].

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