# Monitoring System by Vibration Power Generation of Steel Railway Bridges

**Yoshinori YOSHIDA**
Assistant Senior Researcher, Steel and Hybrid Structures, Structures Technology Division

## 1. Introduction

Structural monitoring is a technology with potential to improve the efficiency of maintenance. However, there are problems with providing power to the monitoring systems. Since structures do not normally have a power source, the costs to install electrical power to a monitoring system are large. Although battery-powered monitoring systems have been developed in recent years, these systems incur running costs due to periodic battery replacement. To address these problems, we attempted to generate power for monitoring systems by utilizing the vibration of a steel railway bridge when trains pass.

## 2. Vibration power generation

Our vibration power generation system consists of attaching piezoelectric devices to bridge members whose vibration induces stress on the piezoelectric devices to generate power. Since piezoelectric devices are capable of generating power almost permanently, there is no need to replace batteries. Another advantage is easy installation, which means the system can be installed at low cost.
Since the power generated by vibration is very small, we studied a method which efficiently generates power by changing the conditions of actual bridge members and piezoelectric devices. As a result, we found that the bridge member that causes continuously high-frequency vibrations generates power more easily (Fig. 1).

## 3. Monitoring system using power generated by vibration

We developed two types of monitoring systems operated by power generated by vibration, and conducted a field test that simulates actual operation. One system type is designed to detect a defect of a bridge and report the result. The other type monitors changes in conditions of bridges. The former detects defects in the bridge by a sensor and transmits the result of the sensing to the train passing on the bridge by wireless, so that the transmitted data can be obtained on-board (Fig. 2). The latter system measures at constant time intervals and dynamic response when trains pass to monitor changes in the bridge conditions over time by storing the power generated by vibration.
Figure 3 is an example of the monitoring results for the bridge temperature and the displacement of the bearing which have been continuously measured for more than two years by a system using only power generated by vibration. Such results can be effectively utilized to detect changes in bridge conditions by monitoring the response to temperature.

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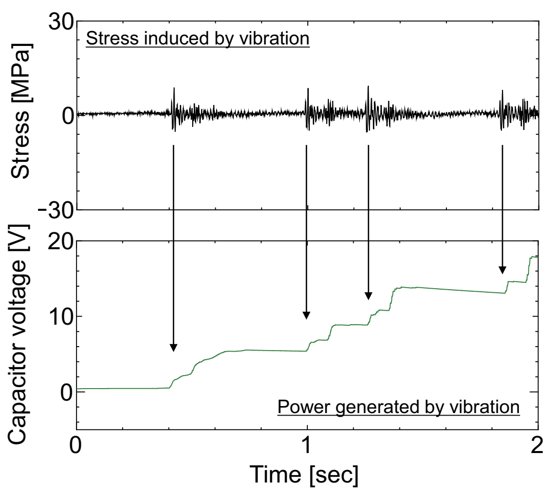


Fig. 1 Power generated by vibration

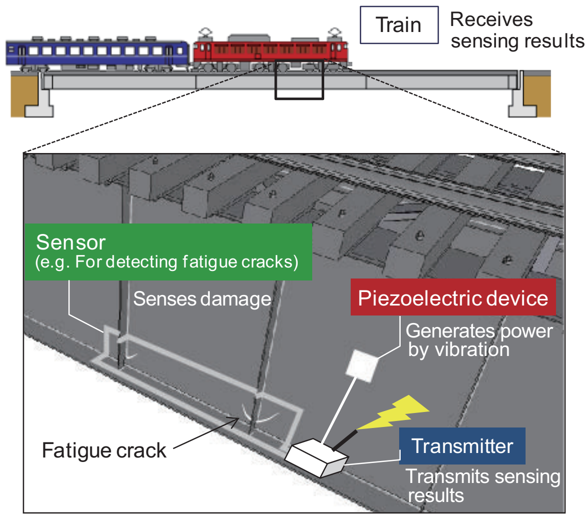


Fig. 2 Concept of monitoring system

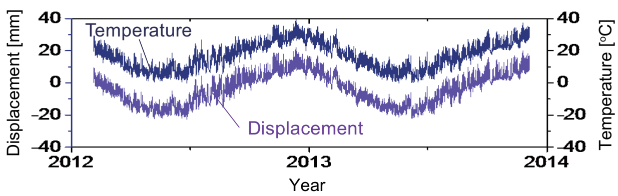


Fig. 3 Data from bridge monitored by developed system