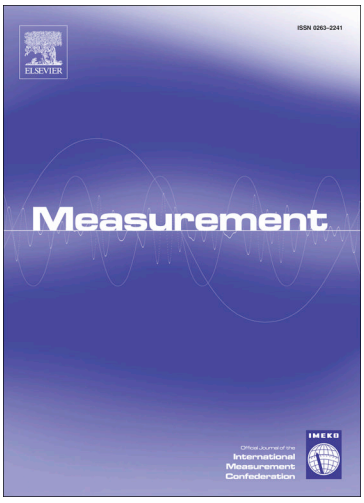

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Load Monitoring of the Pin-connected Structure based on Wavelet Packet Analysis Using Piezoceramic Transducers

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Abstract: Pin-connections have wide applications in civil structures, such as bridges. Health monitoring of the pin connection plays a significant role to ensure the safety and longevity of these structures. In this paper, a contact model for the pin connection and the normal applied force on the connection was first built based on the Hertzian contact theory, and the validity of the model was verified by the simulation results from a 3D finite element model of a pin connection. The contact model indicates that the contact area between the pin and the pin support increases with the applied force on the connection. Based on this contact model, the authors then present a feasibility study on the load monitoring of pin-connected structures using Lead Zirconate Titanate (PZT) transducers. A tension-controllable structure with a pin connection was fabricated and investigated to verify the effectiveness of the proposed method. Two PZT patches are mounted on the pin and the connected structural surface, respectively. One PZT patch, acting as an actuator, generates a swept sine wave that propagates through the contact area of the pin joint interface and the other one, acting as a sensor, detected the response signal. In the experiment, wavelet packet analysis was employed to quantitatively analyze the transmitted signal between two PZTs when different load levels were applied on the connection. Experimental results demonstrate that energy of the transmitted signal monotonously increases with the load on the pin connection, which is consistent with the simulation result of the contact model. The proposed method has the potential to be employed in real-time monitoring of the loading status of pin connections in practical applications.

Keywords: Pin connection, Lead Zirconate Titanate (PZT), Active sensing, Load monitoring, Wavelet packet analysis.

1. INTRODUCTION

Structural health monitoring (SHM) of the connection elements is of great significance in terms of safety and longevity of the structures, especially for high load structures. Benefiting from the low cost, easy assembly and high load capacity, pin connections have been widely used in civil structures, such as bridges and other industries [1]. For example, as shown in Figure 1(a), a pin joint is used to connect the suspension cable and the bridge deck in a suspension bridge in Manhattan, NY, and, in Figure 1(b), the pin joint is employed to bear on the approach span in Braga Bridge. However, in some cases, excess tension or stress beyond the load-carrying ability of the pin connection may change the interface tightness degree of the connection, which can cause damage to the connection or reduce the load capacity of the structure [2].