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Mechanism of the Passive Tap-Scan Damage Detection Method

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ABSTRACT

In recent years, the vehicle scanning method for bridge inspection has drawn much attention by researchers because of its simple operation and high efficiency [1]. Besides the natural frequency, modal modes and other information of bridges, damage can also be detected in this way [2]. For example, we proposed the passive tap-scan damage detection method [3], which scans the bridge with the tapping force generated by a toothed wheel, mimicking the hunting behavior of woodpeckers. In this talk, we will discuss two critical aspects related to the mechanism of this method. One is the quantitative relationship between the vehicle acceleration and the damage. Another is the details of the tapping force. To discuss the first aspect, we establish a theoretical model that implies the amplitude of the vehicle acceleration is very sensitive to the stiffness transition in bridge girders and can be quantified as a quadratic function of the stiffness change ratio [4]. To discuss the second aspect, we propose a novel moving force identification (MFI) method to identify the tapping force. To improve the well-posedness of MFI, the response matrix is transformed to the time-frequency domain by wavelets and the Element-wise Bayesian regularization is adopted to apply regularization on each force element [5,6]. Since regularization weights are determined by the measurement with noise, the optimal weights can be obtained by adding certain white noises, showing a stochastic resonance phenomenon. All these findings are quantitatively verified by numerical simulations and experimental tests.

KEYWORDS

Vehicle-bridge interaction; tap-scan method; stiffness transition; moving force identification; noise-enhancement

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