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A guided wave-based bolt looseness detection method using magnetostrictive transducer

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ABSTRACT

Bolt connected joints are widely used in civil engineering structures. However, due to a variety of external loads and environmental factors, bolt looseness will occur during the operational stage, posing a safety risk to the whole structure. Thus, it is of vital importance to develop effective bolt looseness detection methods. A wave energy-based guided wave method is presented in this study for bolt looseness detection and localization of a joint with multiple bolts. At first, a magnetostrictive transducer was designed for generating and receiving SH-typed guided waves. Then, a bolt looseness index was defined based on the normalized energy ratios between the transmitted wave through the joint and the directly incoming wave from the actuator. For a single damage case, four damage indices were derived from four wave propagation paths using different combinations of actuators and receivers. Various bolt looseness scenarios were simulated, and the normalized bolt looseness indices were input into the back propagation neural network to evaluate the bolt looseness conditions. Experimental tests were also performed to validate the proposed method, and the results demonstrate that the locations and severities of bolt looseness can be successfully estimated.

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