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NON-DESTRUCTIVE ULTRASONIC METHOD FOR DEFECT DETECTION IN WOODEN RAFTERS

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Most ancient buildings in Sri Lanka are wood-framed. The wood components of antique buildings deteriorate with age. Insects and rapid changes in humidity are two of the most common causes of deterioration. Non-destructive testing (NDT) methods are required to preserve the wood components in old buildings. Various NDT methods such as X-ray, drilling resistance test, stress wave, and ultrasound are used to inspect the safety of antique wooden buildings. Among them, ultrasonic testing is simple, accurate, and inexpensive. Rafters are one of the main important components of antique buildings and are severely deteriorated. The main objective of this study was to develop a quantitative ultrasonic test methodology for detecting internal defects in wooden rafters of ancient wooden buildings. In addition, this study aimed to assess and evaluate the wood qualities such as acoustic velocities along longitudinal, radial, and tangential directions of wood and the modulus of elasticity (MoE) of wooden materials. Applying the ultrasonic test directly is challenging because of the connection between wooden parts or the contacted or hidden part by a wall or ceiling or other construction materials. Hence, an indirect ultrasonic testing method was required. Therefore, it was proposed to conduct ultrasonic tests with a newly developed prototype of an ultrasonic system. It is hard to make an artificial defect on the wooden rafter and quantify the amount of deterioration. Hence, a simple artificial slit was considered as an indicator of the deterioration. Regression models were proposed to describe the relationship between the artificial deterioration of the specimen and ultrasonic parameters. Time of flight amplitude (TOF-a), maximum amplitude, time of flight energy (TOF-e), energy value (EV) and pulse length (PL) were considered as the ultrasonic parameters. Ultrasonic parameters of the received ultrasonic signals were analysed using LabVIEW software. Correlation analysis of each ultrasonic parameter and the artificial slit depth showed that TOF-e and PL were proper ultrasonic parameters to predict the size of defects in wooden rafters. Multiple linear regression analysis was performed using TOF-e, PL and the artificial slit depth to establish a prediction equation. The established prediction equation showed a coefficient of determination of 0.77 for the wooden material of Teak. Therefore, the method was found to be effective to evaluate the deterioration in wooden rafters.

Keywords: Internal defects, MoE, Rafter, TOF (time of flight), Ultrasonic testing