2015 IERE – CRIEPI Tokyo Workshop

"Tapping AE for Inner Damage Detection"

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Keywords: Non-Destructive Testing, Acoustic Emission Testing, Tap testing, Tapping AE, Carbon Fiber Reinforced Plastic

Abstract

Various Non-destructive testing (NDT) methods, e.g. Ultrasonic testing, Tap testing and Acoustic Emission (AE) testing are applied for preventive maintenance in engineering fields. When focusing on the usability, Tap testing is known as one of the simplest test to conduct, since it requires only tap motion. Although, the detectability of the Tap testing is lower than other testing, since the test utilizes the change in stiffness due to defects. On the other hand, when focusing on the detectability of defects, Ultrasonic testing and AE testing have high detectability. However, the usability of the testing is low.

We proposed the new NDT method, named "Tapping AE", by combining Tap testing with AE testing. In this research, the feasibility of Tapping AE was examined experimentally.

We first developed hammer for the Tapping AE method. The hammer has two built-in sensors, load sensor and AE sensor, at the tip of the hammer. The load sensor measure load history during the hammering as like usual tapping hammer. In the proposed Tapping AE method, contact duration of the hammer with the inspected specimen is decided by the measured load history. When damaged specimens are impacted by the hammer, AE signals are generated from damaged points due to the frictions of the fracture surfaces. High sensitive AE sensor at the hammer tip measure these AE signals during the hammering.

In the experiment, a sound strip specimen made of Carbon Fiber Reinforced Plastic (CFRP) was prepared and both the ends were fixed by a rectangular flange. And entire front-surface area of the specimen was tapped by the developed hammer. And then, internal damages were installed in the specimen by applying local static load and the Tapping test was repeated. Both the impact history and the AE waves were measured during the Tapping test for sound and damaged specimens.

As it is well known that the contact duration is changed with stiffness and the stiffness is affected by damages, we first investigated contact durations during the hammering from the measured impact histories. Contrary to expectations, contact duration is not only changed with the damages, but also by the tapping positions due to fixed condition at the specimen ends affects stiffness. Then, we investigated the signal detected by AE sensor during the test. In order to judge the existence of damages, new parameter, RMS_{ratio} was defined in this study. RMS_{ratio} was defined as the ratio of the RMS value of the AE signal in contact duration to that in non-contact duration. RMS_{ratio} is highly affected by existence of damages compared to the change in stiffness. As a result, detectability of proposed Tapping AE method is higher than conventional Tap testing which only uses information of impact history.