Measurement Method of Absolute Ultrasonic Nonlinearity excluding System Nonlinearity of Pulser

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The ultrasonic nonlinear parameter $\beta$ is used to quantify nonlinearity, which is measured from the displacement amplitudes of the fundamental and second-order harmonic frequency components. A few techniques have been designed to measure the ultrasonic nonlinear parameter $\beta$ such as capacitive detection method, laser interferometer method, and piezo-electric method. Among them, the piezo-electric method developed by G.E. Dace [1] is more commonly used than the other methods, because this method has advantages that equipment of conventional ultrasonic nondestructive testing (NDT) can be used, the signal-to-noise ratio is relatively high, and the measurement result is less affected by surface roughness. This method converts the electrical output from the transducer into displacement via a transfer function that is obtained in advance from the calibration. Nevertheless, there still is a problem that the measured ultrasonic nonlinear parameter contains not only the material nonlinearity but also the system nonlinearity from pulser. Therefore, the pure material nonlinearity excluding system nonlinearity cannot be measured.

In this study, we propose an advanced algorithm which can measure the displacement amplitude of the fundamental and the second-order frequency component incident into the specimen. From this, the system nonlinearity from pulser can be measured, which is subtracted from the result obtained by the conventional piezo-electric method to estimate the pure material nonlinearity. The experimental procedure of the proposed method is similar to the conventional piezo-electric method. The difference thing is that the conventional method conducts calibration only for the receiving part but the proposed method conducts calibration for both of the transmitting and receiving parts. Thus, the proposed method can improve the reliability of the nonlinear parameter measurement. Experimental result for a fused silica specimen showed good agreement with the reference values.

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