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A Study of Noncontact Ultrasonic Thickness Gauging for Steel Structure in Ports.

港湾鋼構造物の非接触肉厚測定に関する研究

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1. Introduction

Japan is a maritime nation facing the sea, many steel structures such as steel sheet pile wall and steel pipe pier exist in ports. Steel structure was low cost compared with concrete structure. Thus, most of the structures were buit during high economic growth. Presently, the deterioration of the majority of the existing structures is problem. An efficient inspection technique is desired.

Ultrasonic thickness gauging, which is one of the conventional inspection technique, estimetes health condition of the object by calculating from exisiting thickness. In ports, a diver measures the thickness. However, surface of the object is covered with a lot of shells. The diver must clean up them. This process occupy 50 % of all working process.

To make the inspection more effective, the authors have developed noncontact ultrasonic measurement technique[1-2]. This is government-commissioned research. First, we made focused ultrasonic transducer as a noncontact probe. Second, to verify ability of the transducer, we carried out test tank experiments and field test.

2. Noncontact Ultrasonic Thickness Gauging

An image of proposed inspection technique is shown in **Fig. 1**. The diver holds ultrasonic transducer and moves along surface of the object. **Fig. 2** is its profile. Aperture is 80 mm of diameter. Radiated ultrasonic pulse is focused at 300 mm distant from the transducer. Then, waveform of **Fig. 3** will be measured. The waveform contains a transmitted ultrasonic pulse and a surface reflection and multiple reflections. Polarity of surface and multiple reflections are inverted. Interval of multiple reflections is constant. The interval corresponds to thickness of the object. If sound speed of the object is given, we will know thickness of the object. Advantage of the proposed technique is to be able to measure in continuity without cleaning up.

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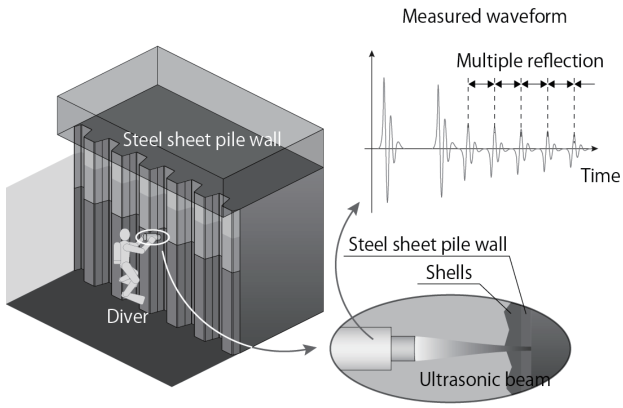

Fig. 1 An image of the proposed inspection technique for steel structures in ports.

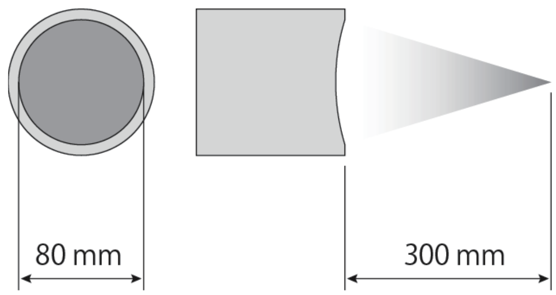

Fig. 2 A focused transducer for noncontact ultrasonic thickness gauging.

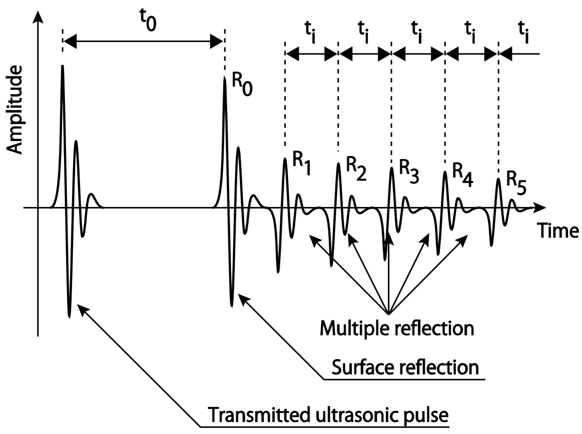

Fig. 3 An image of measured waveform.

3. Test Tank Experiment

To measure accuracy of the proposed technique, we carried out experiments at test tank. **Fig. 4** shows steel plates with different thickness (8.5 mm, 11.5 mm, 18.5 mm, 24.5 mm and 28.0 mm) for this experiment. **Fig. 5** is resultant linearity of the proposed technique. In this figure, circles indicate measured value. Maximum error is 0.5 mm. It is enough accuracy for inspection.

3. Field Test

To verify ability of the proposed technique for actual condition, we carried out field test at Kitakyusyu Tanoura wharf. **Fig. 6** shows position of field test. Divers operated equipment and measured data. **Fig. 7** shows an example of measured waveform. You can see the multiple reflections. Its interval is 9.13 μs. Sound speed of steel is 5941 m/s. Estimated thickness is 27.1 mm. Existing thickness is 27.48 mm. Therefore, error is 0.38 mm.

3. Conclusion

We developed noncontact ultrasonic thickness gauging technique. We focused on ultrasonic multiple reflection, and it made noncontact measurement possible. To validity of the proposed technique, test tank experiment and field test were performed. As a result, we confirm that the proposed technique has enough ability for actual inspection.

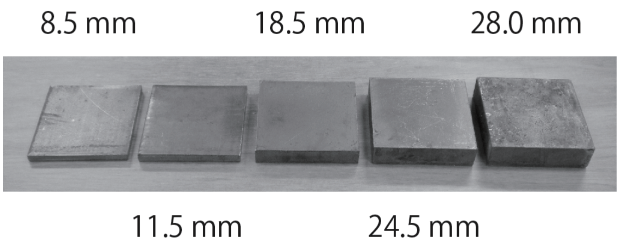

Fig. 4 Steel plates for accuracy verification.

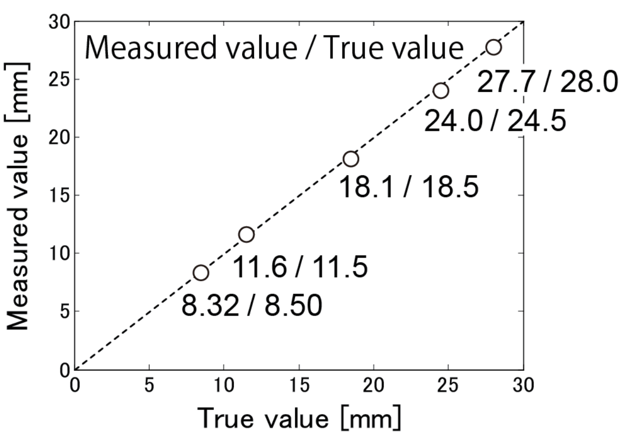

Fig. 5 Linearity of the proposed technique.

References

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Fig. 6 Map of test field (Kitakyusyu Tanoura wharf).

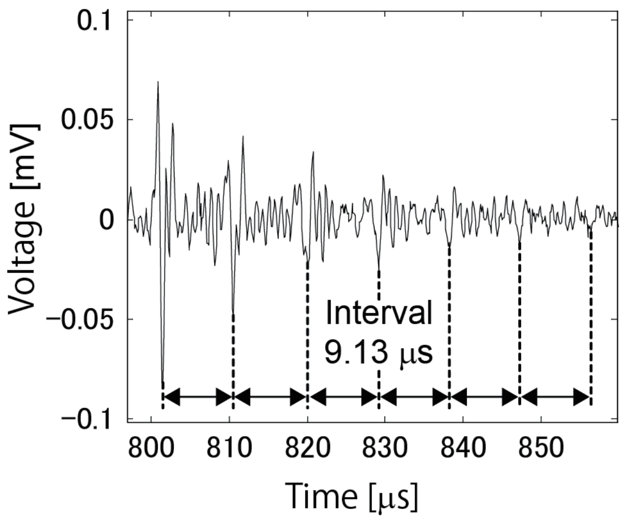

Fig. 7 An example of measured waveform.