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ステップチャープ信号により変調された空中超音波を用いた Lamb 波のパルス圧縮の基礎検討
～金属薄板への適用～

Basic Study of the Pulse Compression of Lamb Waves Using Airborne Ultrasounds Modulated by Step Chirp Signals
～Application to Metal Plates～

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Abstract: The authors have proposed pulse compression of Lamb waves by airborne ultrasonic excitation using step-chirp signals. In this method, Lamb wave modulated by step chirp signals. the step chirp signal changes its frequency stepwise over time. The pulse compression of Lamb waves with velocity dispersion is realized by applying dispersion compensation processing to the Lamb waves.

1.　Introduction

We have studied non-destructive testing by scanning airborne ultrasound source technique using an Airborne Ultrasound Phased Array (AUPA). [1]

In this report, we verified a method of pulse compression considering the dispersion of Lamb waves in metal plates excited by airborne ultrasound.

2.　Pulse Compression Considering Velocity Dispersion

The authors have proposed a dispersion compensation method and a pulse compression method using a step-chirp wave and a band-pass filter. Fig. 1 is a schematic diagram of a step chirp signal, and as shown in the figure, it has the characteristic that the frequency changes stepwise with time. By using this chirp signal, it is possible to extract each frequency component with a bandpass filter, as shown in Fig. 2.

Pulse compression is performed by the following procedure. (1) Excite Lamb waves using a step chirp signal for metal plates. After that, each frequency component is extracted with a bandpass filter. (2) Dispersion compensation is performed by time-shifting the waveform of each extracted frequency component according to the propagation distance and the dispersion curve. (3) Perform correlation processing using the transmission waveform for the dispersion-compensated propagation waveform.

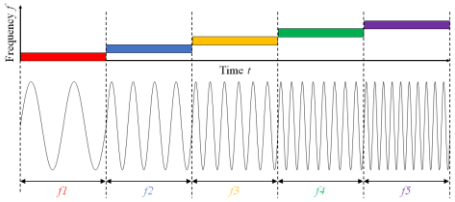

Fig. 1. Overview diagram of step chirp signals.

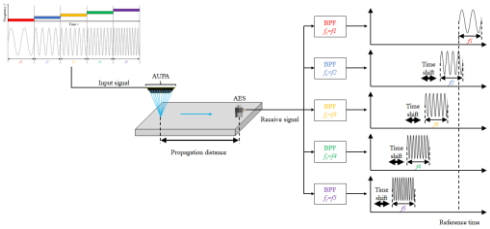

Fig. 2. Schematics of dispersion compensation using step chirp signals.

From the above, pulse compression of Lamb waves is realized.

3.　Result

By applying pulse compression, it was confirmed that the Lamb wave propagating in the sample was compressed into an extremely short pulse wave and propagated.

4.　Conclusions

As a method of pulse compression considering the dispersiveness of Lamb waves in metal plates excited by airborne ultrasounds, we investigated a pulse compression method of Lamb waves using step chirp signals based on dispersion curves. As a result, we confirmed that it is possible to visualize Lamb wave propagation with short pulses.

References

[1] K. Shimizu, A. Osumi and Y. Ito: Jpn. J. Appl. Phys. 59 (2020) SKKD15.

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