2P2-9

Investigation of Guided Wave in Flat Plate Generated by High-intensity Line Focus Aerial Ultrasonic Wave
強力空中線集束音波励起による平板中のガイド波の検討

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1. Introduction

We have investigated non-destructive testing using guided waves generated by high-intensity aerial ultrasonic waves. In a previous study, we used point excitation to generate guided spherical waves [1]. However, guided plane waves would be effective for accurate imagining of defects in materials and objects. In this study, guided plane waves were generated in experiments by non-contact excitation using high-intensity line-focused aerial ultrasonic waves and the propagation characteristics of the guided waves in a flat plate were examined.

2. Experiment procedure

Fig. 1 (a), (b) show an overview and a cross-sectional view of the experimental setup. To generate guided plane waves in a plate-like sample, an ultrasound source was used to produce high-intensity line-focused aerial ultrasonic waves.

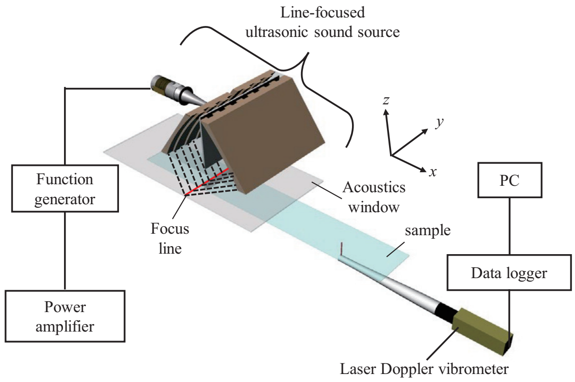
The experimental devices included the ultrasound source (drive frequnecy: 19.6 kHz) [2], a laser Doppler vibrometer (LDV) for measuring vibration velocity on the target surface, and other devices. The sound waves were focused in a straight line about 160 mm from the ultrasound source.

In the focus area, a sound pressure of about 2000 Pa can be obtained with an input power of 50 W. Line-focused ultrasonic waves were irradiated onto the target surface through an acoustic waveguide (length: 25.5 mm, inner diameter 8.5 × 160 mm) placed at the line focus area. The acoustic waveguide was used to remove the side rope of the focused sound waves and reduce the impact of the acoustic field on the LDV laser.

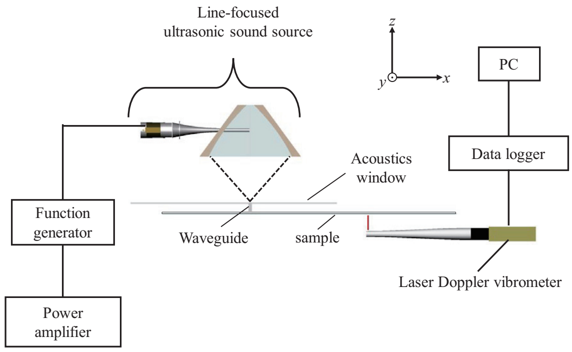
Fig. 2 shows the instantaneous sound pressure distribution around an open end of the acoustic waveguide. Results were normalized by the maximum value.

The emitted sound waves were radiated almost completely in phase in a narrow line area.

The guided waves were measured using the LDV laser on a precision stage. For measuring vibration velocity, the trigger timing was the voltage rise applied to the ultrasound source immediately



(a) Schematic view



(a) Cross-sectional view

Fig. 1 Experimental setup

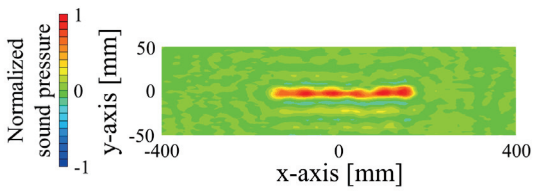


Fig. 2 Sound pressure distribution around open end of acoustic waveguide

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after the laser beam was moved to the measurement point.

The vibration velocity waveform obtained using the LDV was band-pass filtered at 19.6 kHz. This operation was performed over the entire measurement area, and a guided wave propagation image was obtained by displaying in two dimensions the instantaneous vibration velocity waveform at each measurement point in synchronization.

Fig. 3 shows an overview of the sample used in the experiment and the measurement area. The sample was an acrylic plate (100 × 1000 × 3 mm). The excitation area and measurement area were as shown in the figure. Measurements were taken in 2 mm steps.

3. Experimental result

Fig. 4 shows experimental results for the distribution of instantaneous vibration velocity. The voltage applied to the ultrasound source was 50 V, the input signal was 300 cycles, the sampling time was 20 ms, and the sampling frequency was 1 MHz. Results were normalized by the maximum value. The results in the figure were 4 ms after voltage applied to the ultrasound source.

It can be seen that guided waves generated in the sample plate propagated almost as plane waves.

Fig. 5 shows the vibration velocity distribution along the x-axis at y = 0 mm (y-axis shown in **Fig.4**).

Table 1 shows a comparison of phase velocity between the experimental results shown in Fig. 5 and the theoretical value of the phase velocity of A0 mode Lamb waves.

As the result, the experimental value was in good agreement with the theoretical value.

4. Conclusion

We have investigated the generation of guided plane waves in a flat plate by excitation using line-focused ultrasound. Our experiments showed propagation of guided plane waves (A0 mode Lamb waves), with phase velocity in good agreement with the theoretical value.

Acknowledgment
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References

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2. Y. Ito, Y. Kitamura and A. Osumi: Jpn. J. Appl. Phys. 53 (2014) 07KE16.

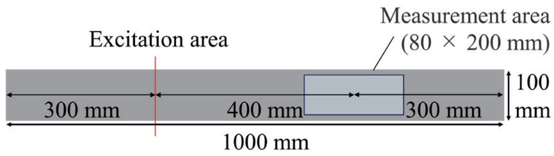

Fig. 3 Schematic view of sample and measurement area

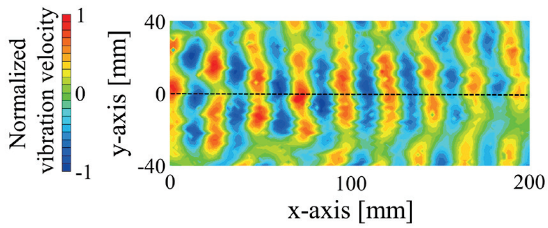

Fig. 4 Instantaneous vibration velocity distribution in measurement area

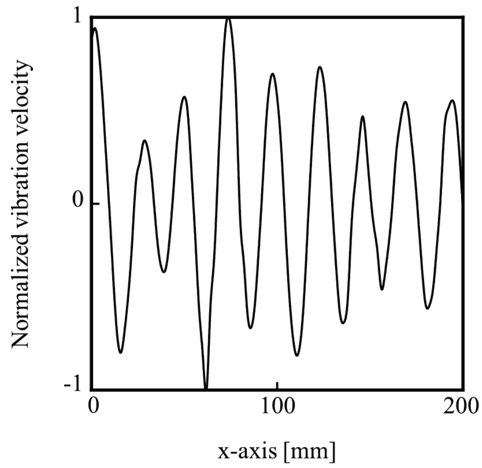

Fig. 5 Vibration velocity distribution along x-axis at y = 0 mm

Table I Experimental and theoretical values of phase velocity

	Experimental value	theoretical value
phase velocity [m/s]	485.6	506.5