2P2-1

Non-contact Imaging Defect in Flat Plate Using Surface Wave Generated by Focus Aerial Ultrasonic Wave

空中集束超音波励起による表面波伝搬を利用した
平板中欠陥の非接触イメージング

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1. Introduction

We have been developed a noncontact and nondestructive method using high-intensity aerial ultrasonic waves and optical equipment[1,2].

In this method, an object is forcibly excited with high intensity aerial ultrasonic wave and the vibration distribution on the object is measured in noncontact way by optical equipment. In addition, it is imaged a defect by this vibration distribution.

Here, recently, a long-range screening technique with guided waves for building structure and tunnel using a laser induced ultrasonic wave and air-coupled ultrasonic wave have developed.

In this report, as a basic study, we investigate a method of noncontact imaging defects by observing a sound speed variation of the guided wave of a defect area and a defect free area when its wave in flat plate is generated by using high intensity aerial ultrasonic wave.

2. Experiment

2.1 Experimental device

Fig.1 shows an experimental devices. These devices consist of ultrasonic sound source, laser Doppler vibrometer (LDV), a data logger, a PC. This sound source is a focus sound source has a structure in which 263 transducers (drive frequency : 40 kHz) are distributed evenly inside a hemisphere(diameter : 150 mm). The focal circular area was about 10 mm. The sound wave from this sound source is irradiated at an incident angle is 45 degree with respect to the object.

2.2 Experimental method

First, the guided wave is generated by exciting an one point of the flat plate with acoustic waves. The vibration waveform on the surface due to guide wave generated from the excitation point are measured by LDV. This measurement is scanned by LDV over the measurement area and the guide wave is observed from the obtained vibration velocity distribution at the same time. In addition, the sound source is driven at 3 cycles and an applied voltage of 45 V, and the waveform is acquired over a measurement time of 1 ms.

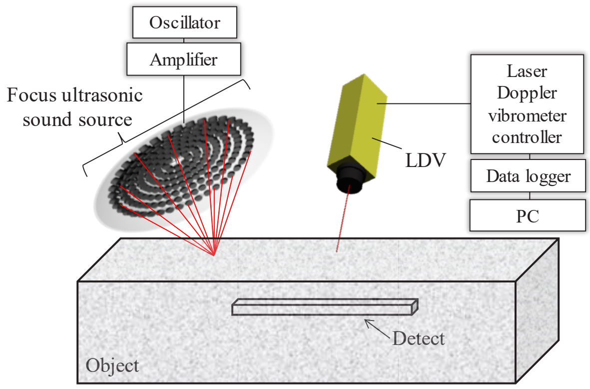

Fig. 1 Experimental device.

2.3 Experimental sample

Fig.2 shows the schematic view of sample. We prepare a 10-mm-thick acrylic sample with dimensions of 200 × 300 mm. The defect is about 5 mm width, length 50 mm, 2 mm depth in figure. The shaded area in the figure is the measurement area (30 mm width× 50 mm length) of this experiment. In addition, the vibrating part is located 10 mm away from the defect part as shown in the figure. In the experiment, the measurement area is measured in 1-mm intervals.

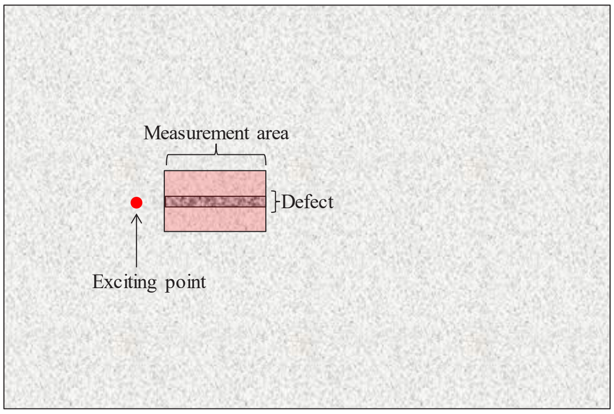

Fig. 2 Sample detail.

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3. Result and discussion

3.1 Experimental result

Fig.3 shows the experimental result. The result shows the vibration velocity distribution after 750 μs as an example. As the result, it is difficult to confirm the propagation of the guide wave in a specific mode from this result because several guide waves are observed to propagate in an overlapping manner. It is considered that this is due to the fact that the sound speed of the guide wave propagating through the healthy area differs from the sound speed of the guide wave propagating through the defect area.

We attempted this measurement result is processed by two-dimensional FFT to extract each the guide wave.

3.2 Experimental result (2D FFT)

Fig. 4 and 5 shows the measurement result of two-dimensional FFT processing.

As the results, it can be confirmed that the guide wave with fast sound speed propagates over the measurement area (in Fig.5). Therefore, this guide wave is considered to be a plate wave which is a guide wave propagates through the flat plate.

On the other hand, it can be confirmed that the guide wave with slow sound speed propagates while separating at defect area and defect free area. That is, this guide wave is estimated a plate wave propagates through a defect area which is a thin plate. In addition, **Table I** shows the measurement results of sound velocity. As the result, it almost agrees with the theoretical value of A0 mode of Lamb wave.

Moreover, the guide wave of the defect area propagated with a larger amplitude value as compared with the defect free area.

Above the results, it is possible to image the defect by detecting the guide wave propagating through the defect area.

4. Conclusion

We investigate a method of defect imaging by guide waves generated in flat plates using by the high intensity aerial ultrasonic waves and optical equipment.

As the result, it is confirmed that defects can be imaged by observing of the generated guided wave.

References

1. A.Osumi, M.Ogita, K.Okitsu, Y.Ito : Jpn. J. Appl. Phys. 56 (2017) 07JC12.
2. A. Osumi, T. Saito and Y. Ito : Jpn. J. Appl. Phys. 51 (2015) 07HC07.

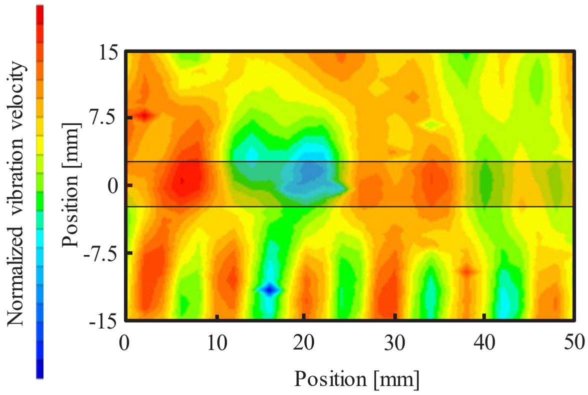

Fig. 3 Vibration velocity distribution on sample surface.

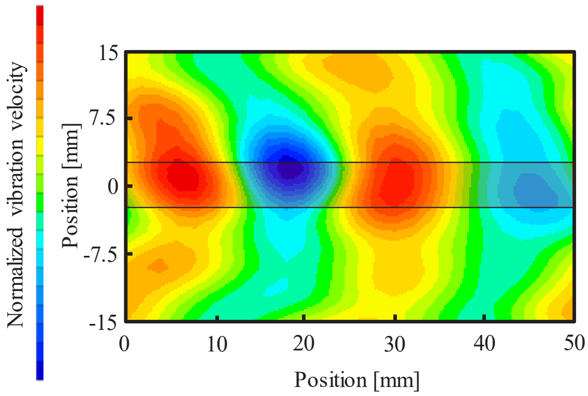

Fig. 4 Vibration velocity distribution on sample surface by two-dimensional FFT processing (sound speed is high).

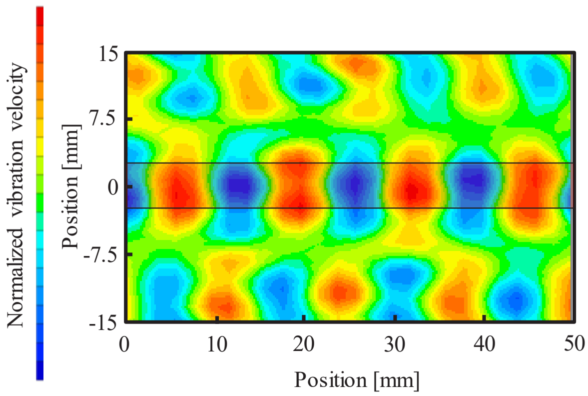

Fig. 4 Vibration velocity distribution on sample surface by two-dimensional FFT processing (sound speed is low).

Table I Sound speed of guided wave

Experiment value [m/s]	theoretical value [m/s]
542	590