3P2-4

Proceedings of Symposium on Ultrasonic Electronics, Vol. 35 (2014) pp. 423-424
3-5 December, 2014

A Basic Study of Non-contact and Non-destructive Method by High-intensity Aerial Ultrasonic Wave -Comparing with Continuous Wave and Burst Wave-

強力空中超音波による非接触非破壊検査の基礎検討
-連続波とバースト波の比較-

Ayumu Osumi[1‡], Tatsunori Saito[1] and Youichi Ito[1] ([1]Coll.Sci. and Tech., Nihon Univ.)
大隅 歩[1‡], 斎藤 辰徳[1], 伊藤 洋一[1] ([1]日大 理工)

1. Introduction

We have developed a new method that used high-intensity aerial ultrasonic waves and optical equipment.

In previous study[1,2], it was clarified the detect result of the defect in solid materials was affected from the defect size, shape, and the boundary condition of the defect because this method was used by continuous wave. One of the method is avoided above the problem is used the burst wave. Here, a conventional method used a sound source with bolt-cramped Langevin type transducer (BLT) generated the high-intensity aerial ultrasonic wave. However, BLT is not possible to generate the high-intensity burst wave because the rise up time of this transducer is generally a long time (approximately 40~60 ms).

In this report, we examined to detect the defect in solid material by burst wave from a point converged sound source with ultrasonic transducer which has a short rise up time (less than 1 ms).

2. Experimental set up and method

Fig.1 shows a schematic view of experimental device. The experimental device is consist of the point converged ultrasonic sound source and optical equipment (LDV). As shown Fig.1, a prototype point converged sound source had structure which is the 240 transducers (frequency: 40 kHz) of are arrayed evenly inside the half-sphere (material: PVC, diameter: 150 mm). Therefore, the sound wave from these transducers converged the center point in this half-sphere.

Fig. 2 shows a waveform of sound wave at the converged point. For this measurement, the input signal is 5 cycle and the input power is 10W. As a result, it was confirmed that this sound source has a characteristics of very short rise up time which is 630 us.

Fig. 3(a)~(c) shows the sound pressure distribution around the convergence point at each time, for an example. It was measured at the time of (a) 460 us, (b) 508 us, (c) 630 us after it was applied the input power to the sound source. In add-

----

E-mail:oosumi@ele.cst.nihon-u.ac.jp

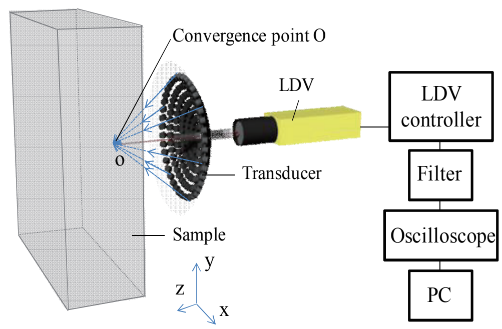


Fig. 1 Schematic view of experimental device

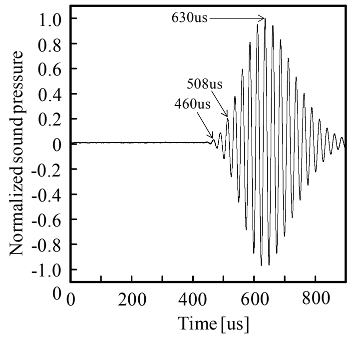
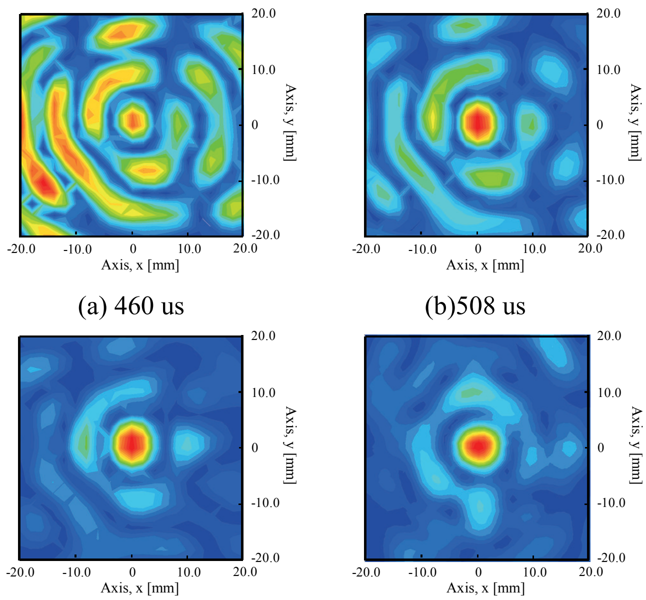


Fig.2 Waveform of sound wave at the convergence point



(a) 460 us (b)508 us

(c) 630 us (d) continuous wave

Fig.3 Sound pressure distribution around the on convergence point in free field

-ition, Fig. 3 (d) shows the result of the continuous wave. As a result, this sound wave is not almost converged at the time of 460us. In addition, it is confirmed the sound wave gradually converged at the converged point as time advances. Moreover, the focusing property of the sound wave at the time of 630us is the same as that of continues wave. Here, Sound pressure of the continuous wave at the converged point is approximately 2000 Pa (input power 10W constant). In the experiment, the measurement point on the surface of the sample is set to coincide with the convergence point O of the radiated ultrasonic waves on the x-axis. Under ultrasonic irradiation, the velocity of vibrations on the sample surface is measured with the LDV. In this experiment, the vibration velocity of LDV at each time is exactly measured by oscilloscope.

Fig. 4 shows the detail of sample. We prepared an 30 mm thick acrylic sample has dimension of 150×150 mm^2 by boring square holes of 20 mm in diameter into its rear face as air gaps. The defect depth is 2 mm from the sample surface.

3. Result

Fig. 5 shows a waveform of vibration velocity by LDV at the center of the defect area on sample. As a result, a waveform of vibration velocity is almost similar to that of sound wave in Fig. 2. Therefore, it was measured the vibration waveform by oscilloscope on the condition of Fig.3 and imaged the defect area on the sample.

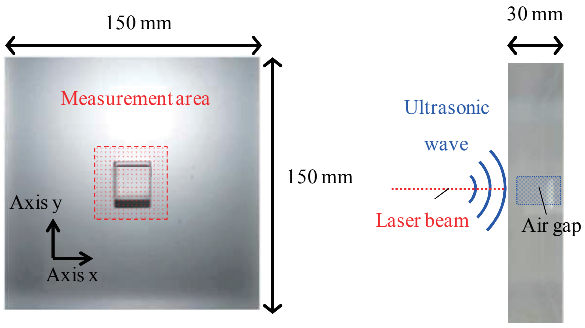
Fig. 6 shows the detect result, for an example. The measurement area is dashed red area in Fig. 4(a). Fig. 6(a) shows the result at the time of 508 us, and Fig. 6(b) shows the result of the continuous wave. In Fig. 6(a), the vibration velocity distribution on the sample clearly imaged the defect size and shape. On the other hand, in Fig. 6(b), the vibration velocity distribution imaged the defect has the surface asperity because we consider the vibrational mode on the sample with defect area is promoted. In addition, it was confirmed to be possible to image the defect size and shape in the solid material depend on the time of vibration waveform acquisition.

4. Conclusion

We examined to detect the defect in solid material by high-intensity aerial ultrasonic burst wave. As a result, it was confirmed the method by burst wave is possible to detect the defect in a similar manner by continues wave. In addition, it was confirmed to be possible to image the defect size and shape depend on the time of vibration waveform acquisition.

Acknowledgments

This work was supported by JSPS KAKENHI Grant-in-Aid for Young Scientists (B) 25870784.



(a) Front view (b) Side view

Fig. 4 Sample detail

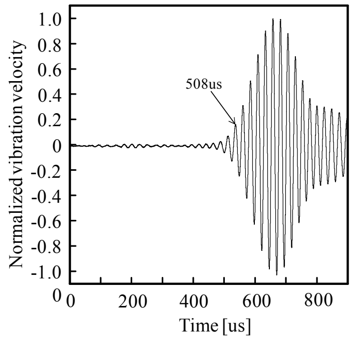
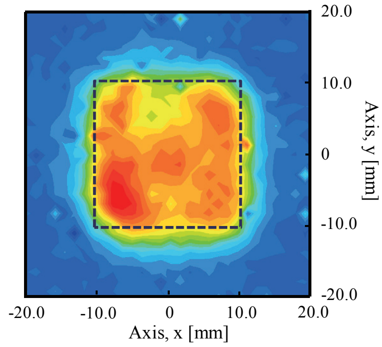
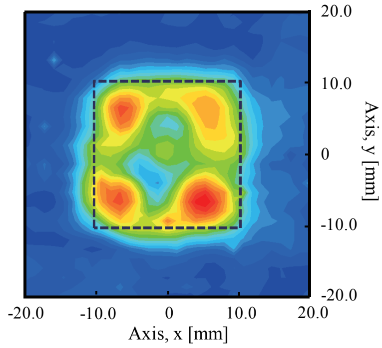


Fig.5 Waveform of vibration velocity by LDV at the center point of defect area on the sample.



(a) 508 us



(b) Continuous wave

Fig. 6 Vibration velocity distribution on the surface of sample (measurement step is 1 mm)

References

1. Ayumu Osumi et al 2012 Jpn. J. Appl. Phys. 51 07GE04.
2. Ayumu Osumi et al 2011 Jpn. J. Appl. Phys. 50 07HE30.