8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

DETERMINATION OF DEPTH OF SURFACE CRACK WITH TIME DOMAIN BIEM IN LASER-ULTRASONIC NDE

*** Hitoshi Yoshikawa[1], Tomokazu Kawada[2] and Naoshi Nishimura[3]**

[1] Kyoto Univ.
Nishikyo-ku, Kyoto, 615-8540, Japan
yosikawa@mbox.kudpc.kyoto-u.ac.jp

[2] Kyoto Univ.
Sakyo-ku, Kyoto, 606-8501, Japan
kawada@mbox.kudpc.kyoto-u.ac.jp

[3] Kyoto Univ.
Sakyo-ku, Kyoto, 606-8501, Japan
nchml@i.kyoto-u.ac.jp

Key Words: *Crack determination, time domain BIEM, laser-ultrasonic NDE.*

ABSTRACT

This presentation discusses an determination of depth of surface crack with time domain BIEM in a laser-ultrasonic non-destructive evaluation (NDE) problems. We use a pulsed Q-switch Nd:YAG laser generator to produce a thermal expansion which generates elastic wave field in a test piece having an unknown crack[1]. A laser interferometer is then used to measure normal velocities on a surface of the test piece in laser-ultrasonic non-destructive testing.(Fig.1) We carry out an inverse problem to determine the thermally expanded source with the measured velocimetory waveform data using Green's function of heat conduction problems and that of elastodynamics. With the thermally expanded source thus determined, we can calculate the laser generated elastic wave field numerically using the time domain BIEM. We then represent the unknown crack in the material with shape parameters and compute the normal velocities on the surface of the test piece with BIEM. The shape parameters of the crack are determined by a comparison between the computed waveforms and the corresponding measured data at the measuring points.

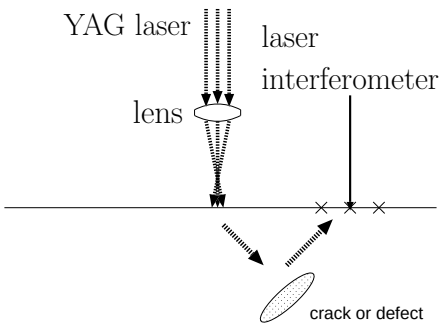

Figure 1: Laser-ultrasonic measurements.

In our previous study, we determine the location of an unknown surface crack with our proposal method. However the depth of the surface crack which is the most important parameter, is not determined. This is because that we generates Rayleigh waves having the wavelength of 3mm in the test piece having the surface crack with the depth of 5mm. The scattered Rayleigh surface waves from the crack are then used to the determination of the surface crack(Fig.2). In the previous study, almost all Rayleigh waves are reflected from the surface crack because Rayleigh wave exists in the domain with the depth of the wavelength(Fig.3).

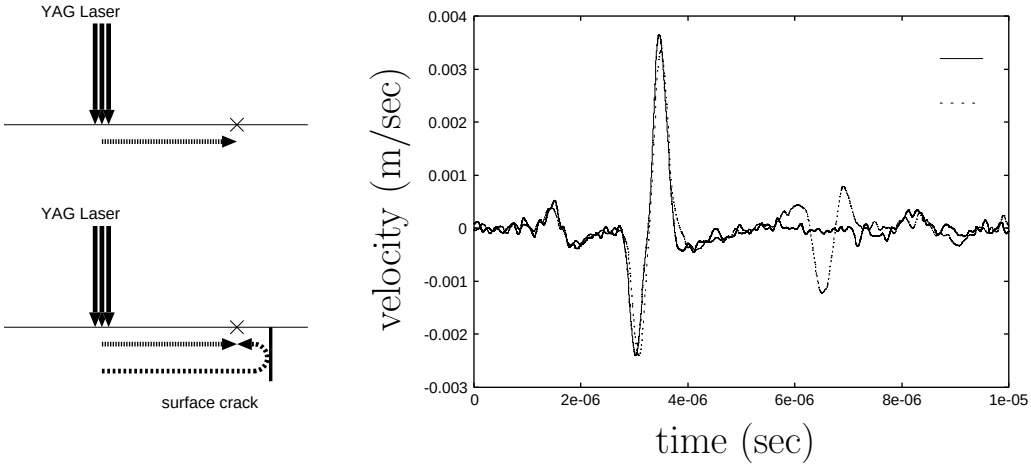

Figure 2: The solid line: the measured velocity with no crack, the broken line: the measured velocity with the surface crack.

In this study, we generate Rayleigh waves having the wavelength longer than the depth of the surface crack. The waveform of the scattered Rayleigh surface waves differ with the depth parameter of the surface crack in the numerical analysis. The depth parameter is then determined by a comparison between the computed waveforms and the corresponding measured data.

We will show that we can determine the depth of the surface crack acculately using our proposal laser-ultrasonic NDE using time domain BIEM.

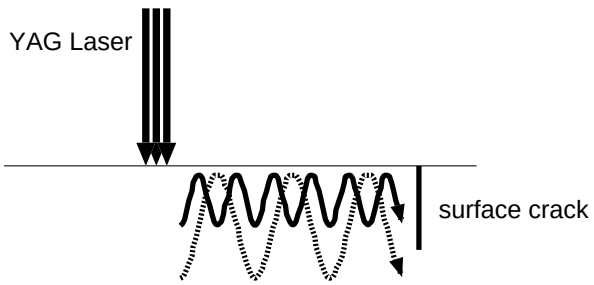

Figure 3: Rayleigh waves.

REFERENCES

[1] L.R.F. Rose.“ Point-source representation for laser-genetated ultrasound”. *J. Acoust. Soc. Am.*, Vol.**75**, No.3, 723–732, 1984.