Application of Acoustoelastic Stress Measurement Systems Using a Grazing SH-wave Sensor to Actual Constructions

Yoshihiko HASHIMOTO[1], Yorinobu MURATA[2], Masami IKESHITA[1], Hiroki TODA[3]

[1]Graduate School of Systems Engineering, Wakayama University
[2]Faculty of Systems Engineering, Wakayama University, [3]Electron Science Institute

Background and Purpose

By the influence in the East Japan great earthquake that collapsed Fukushima nuclear power plant, the concern in the durability of structures is increasing more and more. Stress evaluation of a structure attracts attention as a means evaluating the unbalance of force in the structure, and the method that can measure the residual stress of it in use is desired strongly.

The aim of this study is to apply a grazing SH-wave acoustoelastic method to the stress measurement

Angle steel

Many structures were built at rapid economic growth

For example

Power transmission steel towers

Overage structures worries its durability

Collapsed the power transmission steel tower of Fukushima nuclear power plant

May 16, 2011

The component of a power transmission steel tower is angle steel

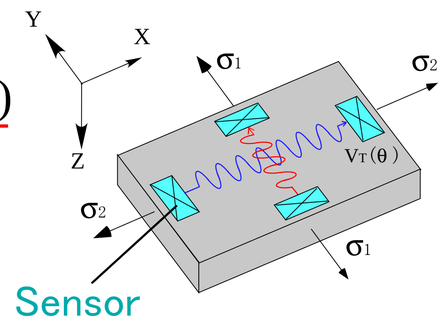
Target

Acoustoelasticity

Acoustoelasticity is the behavior that the velocity of ultrasonic wave propagating in a solid changes by its stress condition

$$\Phi_S = \frac{V_T(0^\circ) - V_T(90^\circ)}{V_{T0}} = C_S(\sigma_1 - \sigma_2)$$

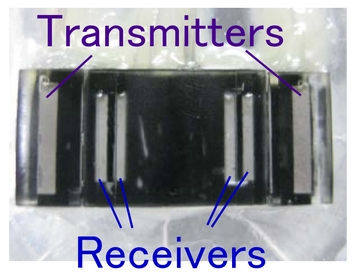
Measuring velocity of two-orthogonal axis



A principal stress difference can be calculated

T-type grazing SH-wave sensor

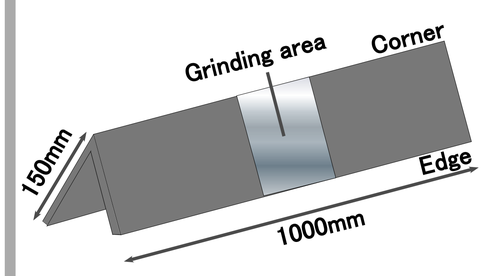
Consists of two transmitters, four receivers



The propagation time is able to obtain ignoring the effect of contact medium

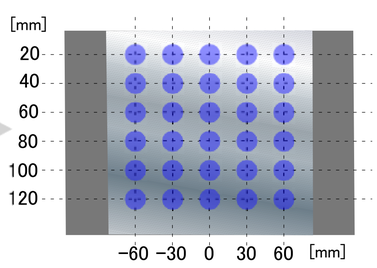
Stress measurement

The low residual stress part of the angle steel was searched



Overall view

Measuring part in grinding area



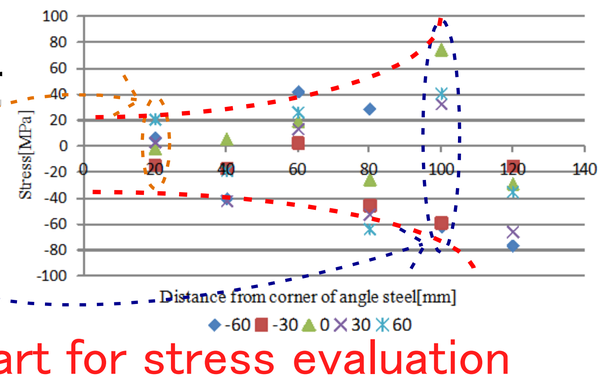
Detail view

Finding the optimal measurement part for stress evaluation

Residual stress was small near the corner

20mm from the corner within 20MPa

100mm from the corner −60～80MPa



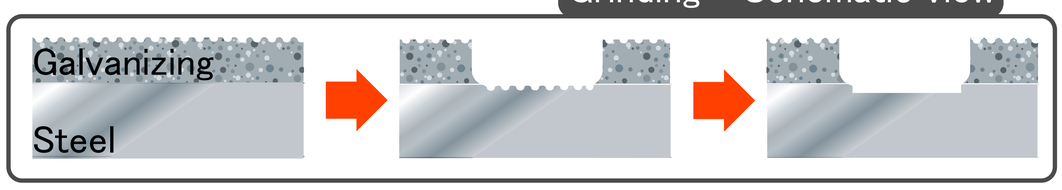
Optimal measurement part for stress evaluation

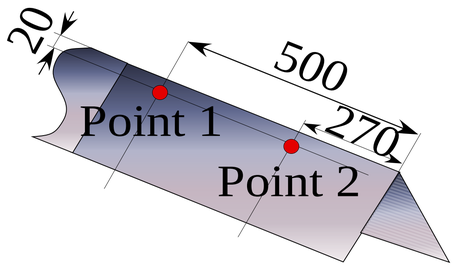
20 mm position from the corner

Grinding method

- A portable grinder using a small drilling machine
- A belt sander

Grinding – Schematic view





Availability of proposed grinding method for angle steel

After the grinding

The stress at the Point 1,2 was measured

Point 1				
Angle[°]	Average[m/s]	Max-Min[m/s]	Frequency	Stress[MPa]
0	3296.94	0.12	5	−10.35
90	3296.73	0.18	5	

The problem in the remove of galvanizing and in the smoothing have been overcome

Conclusion

In this study, the stress evaluation of angle steel used in power transmission steel was noticed, and the grinding method for making a smooth measuring plane and finding the optimal measurement part for stress evaluation were also discussed.

It was found that residual stress near the corner of angle steel was small and that its dispersion was also small. A portable grinder which can use in the field was developed, and its availability was confirmed.