

An Application to Welded Joints of the Crack Inspection System by Using Magnetic Properties

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ABSTRACT

We have a development of Non-Destructive Testing (NDT) system for fatigue crack detection in steel structures. This system can detect a crack by change of the magnetic characteristics which a fatigue crack causes. It can measure by non-contact, and does not have a bad influence on environment. When this system was applied to the butt welded joint, it detected the crack, not only the same side (near side) to the sensor but also opposite side (far side). However, it has not succeeded in detection of the far side crack of fillet weld joint. In this research, two points were clarified by some experiments. One is that the far side crack in a fillet welded joint is detectable with change of a magnetization cycle, and another one is that the crack of a fillet welded joint can be detected by our NDT system.

KEY WORDS: non-destructive testing; magnetic property; fillet weld; boxing fillet weld; crack detection; far side crack

INTRODUCTION

Crack damage begins from discontinuous parts in ship structure such as welding joints. Small surface cracks generated at weld toe grow gradually and crack size increases rapidly when these cracks reach a critical size, to cause serious damage to the structure. In order to prevent the serious damage, it is important to find and repair the small cracks in early stage.

At present there are several damage detection systems based on non-destructive techniques such as Ultrasonic Test (UT), Penetrant Test (PT), Radiographic Test (RT), Eddy-Current Test (ET), etc. However, there is no measure of finding a small surface crack by easy operation. It is desired that non-destructive test system have following general functions.

- Needs no special knowledge or special incidental expenses.
- High-speed and high-reliable result.
- Harmless to humans and environments.
- Needs no pre-treatment and post-treatment for inspection.
- Capability to detect the crack both of near-side of sensor and the far side.

It is thought that detection of cracks by the non-destructive test consists of the following three levels.

- 1) Detection of the existence of cracks in the inspection area.
- 2) Confirmation of geometrical location of the detected crack, the near side, inside or far side (Fig. 1)
- 3) Confirmation of the shape and size of the crack.

The aim of our research is development of the non-destructive test system which it is safe and easy to use to environment and the operators, and it is based on magnetic properties.

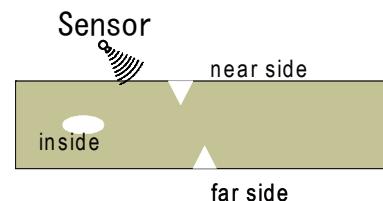


Fig. 1 Position of the crack

MEASUREMENT SYSTEM

The magnetic characteristic is expressed by magnetic hysteresis loop (Fig. 2). It is generally expressed by permeability, coercive force, residual magnetic flux, maximum magnetic flux, hysteresis energy, etc. In this research, the crack was analyzed using the maximum magnetic flux B_0 and B_m shown in Fig. 2. B_0 is the maximum magnetic flux at the initial condition, and B_m is at time of inspection.

Measurement system was explained in detail by the previous report (Hashimoto, 2004; 2006). However, we did improvement which adds two feedbacks to the previous measurement system. One is the feedback which uses the detector coil installed in the excitation core, and it succeeded in giving the excitation magnetic flux stabilized. Another feedback is using the compensation coil installed in the pickup core, and it succeeded in absorption of the lift-off effect. By these, detection accuracy was improved remarkably. The block diagram of the improved measurement system was shown in Fig. 3.