1.1.16. EXTREME LOW FREQUENCY MAGNETIC IMAGING METHOD FOR DETECTION OF DEFECT INSIDE WELDING PARTS OF IRON PLATE

Keiji Tsukada, Teruki Hasegawa, Mituteru Yoshioka, Toshihiko Kiwa,
Okayama University, 3-1-1 Tsushimanaka, Okayama, Japan;
Katsumi Inoue, Mes Testing & Research Center, 3-1-1, Tamano, Okayama, Japan

1. Introduction. Some detection methods are available for nondestructive tests to examine the abnormality of constructions such as industrial plants, bridge girders, aircraft, pressure vessels, etc. Magnetic measurement employing a search coil that detects inductance change due to eddy current is usually used for the non-destructive evaluation of metals. However, it is limited to the application of surface clack because of the limitation of skin depth of the magnetic exposure. Therefore, X-ray inspection or ultra-sound examination is usually used to detect a defect inside the metal. However, these methods are not so easy because of the restriction of measurement location and necessity of expertness, respectively. In this study, we developed a method of magnetic imaging using a magnetic resistive (MR) sensor to improve the skin depth limitation. Using this measuring technique operated at extreme low frequency up to a few Hz, we examined the detection possibility of defects inside the welding parts of a thick iron plate.

2. Experimental. The measuring system consists of an exposure coil making the magnetic field (z-) component perpendicular to the sample surface, a pair of MR sensor detecting x- and y-magnetic field components, a sample scanning stage, and measuring circuits (fig. 1). To expose the magnetic field to wide area of the sample, the radius of the coil was 80 cm and separated 53 cm from the sample. Iron plate samples without and with a slit like artificial defect of 50 mm in length inside the welding parts (fig. 2) were measured on the sample stage moving in the x- and y-direction in 2 mm increments. These samples have a thickness of 8.5 mm and the welding part width was about 10 mm.The

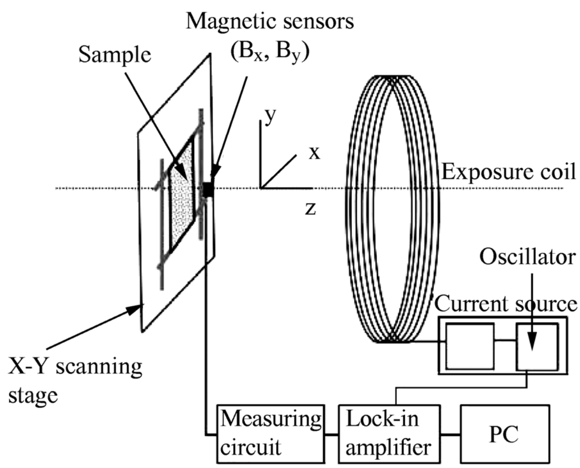

Fig. 1. Schematic diagram of extreme low frequency magnetic imaging system

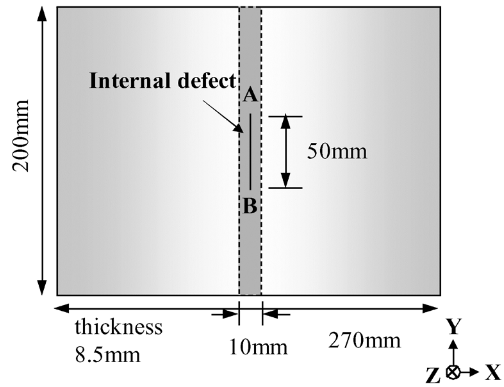

Fig. 2. Iron plate with a slit like artificial defect of 50 mm in length inside the welding parts

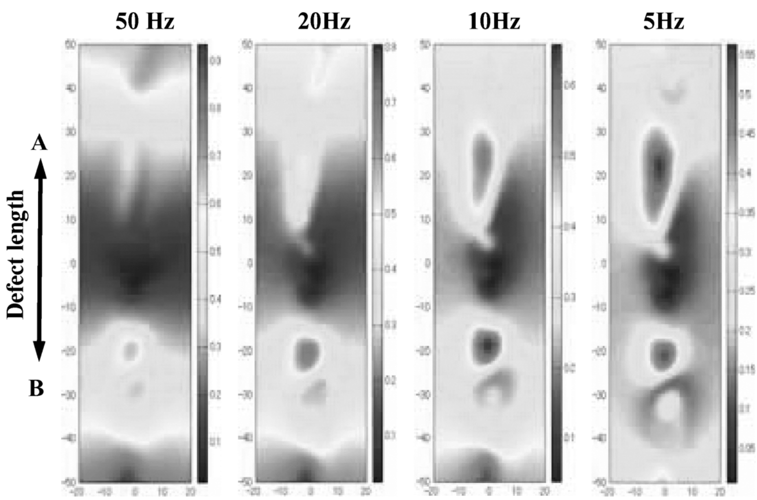

Fig. 3. Frequency dependence of magnetic images of the y-component at the welding part

defect shape was measured by X-ray, ultra-sound and fracturing observation. Each of the magnetic field vectors at the measuring point was calculated from two parameters of signal amplitude and phase obtained by a lock-in amplifier. The tangential component of the exposure magnetic field was not zero at the sensor position, therefore the measured component included not only from net component from the sample but also the residual component. To obtain the net component from the sample, a vector analysis method was developed.

3. Results and discussion. At the high frequency of 1kHz, the eddy-current distribution of both samples showed homogenous circulated flow across the welding parts. Weak disturbance of the eddy current at the welding parts was observed because of morphological change by welding. On the other hand, the eddy-current distribution pattern was changed to the distribution of the exposure magnetic field due to the ferromagnetic property of the sample according to the decrement of frequency, and was focused at the welding parts at low frequency. The separated and opposite magnetic field along the welding parts were observed. The sample with the internal defect showed abnormal magnetic field distribution in the y-direction at lower than 50 Hz even though a similar magnetic field pattern was shown in the x-direction to the normal sample (fig. 3). The abnormal magnetic field distribution in the y-direction was focused on both edges of the defect, and the distance of the two focused magnetic places was coincident to the length of the defect. According to decrement of the frequency, the focused magnetic field distribution reflected the depth profile of the defect inside the welding part.

4. Summary. The magnetic field image inside the ion plate was obtained by extreme low frequency. By abnormality of the tangential magnetic field distribution, detection of defects inside the welding parts of the iron plate was enabled.

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