I－300 SMALL DEFECT DETECTION IN A FILLET WELDED STEEL SPECIMEN BY ULTRASONIC INSPECTION

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1. INTRODUCTION: In recent years, for cost minimization and higher demand for accurate assessment of the remnant life of welded structures, NDT(Non Destructive Testing) has come to the forefront. In this study we describe ultrasonic inspection technique for detection and imaging of small defects in a fillet joint welded steel specimen. Maximum amplitude data of boundary & bottom echo and time of flight data of the reflection wave from defect can display C-scan image of the defect. The 3D images of these defects are obtained by visual data analysis with graphic software on a workstation. From presice wave analysis of defect area and 3D image of defect we can get reliable information about defect.

2. TEST SPECIMEN AND EXPERIMENTAL METHOD: The measurement technique employed is shown in the Fig. 1. This system immersion scanning in which the specimen to be inspected is immersed in a water tank and the transducer is placed above the specimen but below the water surface. The test specimen is shown in Fig. 2. The defects are artificially made drill holes during welding of 4mm, 2.3mm, 1.6mm diameter respectively at the location shown in Fig. 2. The ultrasonic waves emitted from the transducer are reflected from the specimens interior and received as electric signals and amplified by ultrasonic receiver. The transducer scans over required area set by the controller unit. During scanning the echo heights and beam time travel data stored in memories corresponding to positions of the transducer that performs measurement at predetermined intervals. The sampling gate of time axis is set with respect to the sample thickness, to receive first boundary and bottom echo. The C-scan image will display by maximum amplitude Data and time of flight data with 16 grades of color display on 2D rectangular coordinate shown in Fig. 3. DSO(Digital Storage Oscilloscope) can receive the whole reflection waves as 4096 points digital value for every wave. The digital voltage data with the reference voltage gives us image data to represent the 2D shape of defect and other subsurface conditions on the screen on a real time basis.

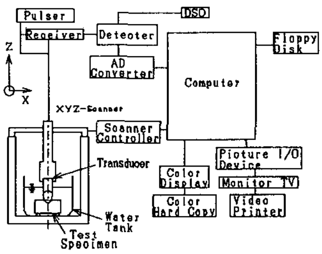


Fig. 1 Measurement system

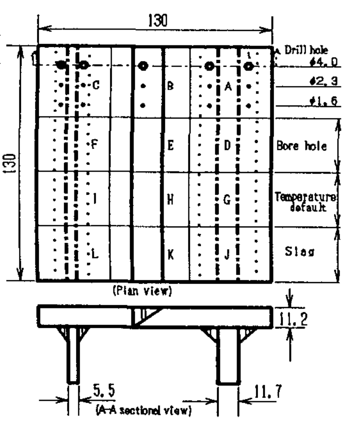
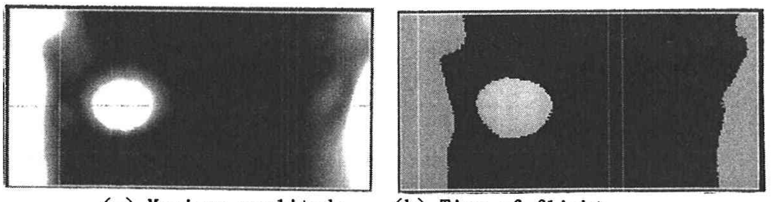


Fig. 2 Test specimen.

3. WAVE ANALYSIS AND DISCUSSION: Sometimes it is difficult to get a good defect image beacuse of wave scattering at the boundary of the defect. The scattering wave may be due to variation of wave length and size and shape of defect. The focus of the 10MHz resonance frequency transducer adjusted on the center of the drill hole then scans over the area of 10mm*5mm at location A. The reflection waves received along with the dotted line shown in the Fig. 3(a) by 100 μm pitch around the boundary of the defect and by 200 μm pitch for other area. The original wave received is shown in the Fig. 4. Where the transition of received waves from the bottom echo and the boundary echo, wave(1)(9) reflected from bottom surface outside of the welded area, wave(2)(7)(8) reflected from the welded area and wave(3)(4)(5)(6) reflected from the defect(drill hole) area of the specimen. As the reflection wave has both the boundary echo and bottom echo, it is observed that when the transducer comes close to the defect tip the amplitude of boundary echo becomes greater than bottom echo. Thus we can understand there is a boundary of defect somewhere in the transition range. In the Fig. 4 for wave(3)(4)(5)(6) we get greater amplitude of boundary echo than the bottom echo. The number shown in the Fig. 4 as (1), (2)etc. indicates the location of transducer from where the reflection waves are taken they also corrosponds to the location shown in Fig. 5. Here we obtained maximum amplitude of boundary echo(Bo), bottom echo(Ba) and the normal maximum amplitude of bottom echo(Ba0) is far from the defect boundary. We can observe from the ratio of Bo/Ba0 the undulations of the defect tips because they correspond to the distribution of the maximum amplitude of the boundary echo. The ratio of Bo/Ba0 is large around the defect tip where the ratio of Ba/Ba0 becomes small corresponds to the size of the real defect Fig. 5. We also observed when the depth of the defect is deep the Bo/Ba0 value becomes small at boundary of the defect.



(a) Maximum amplitude. (b) Time of flight.

Fig. 3 C-scan image of defect.

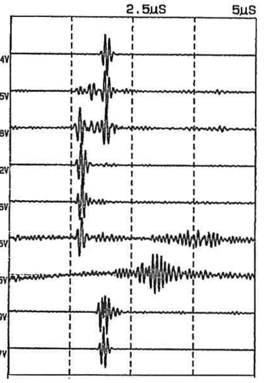


Fig. 4. Original wave.

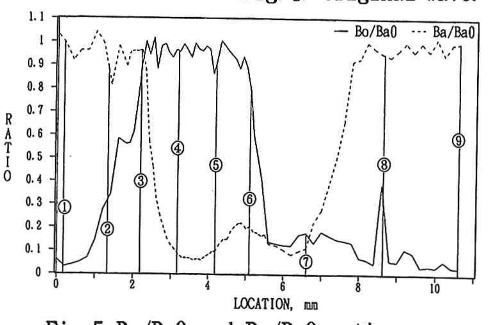


Fig. 5 Bo/Ba0 and Ba/Ba0 ratio.

4. CONCLUSION: Accurate defect shape and size can be measured by boundary and bottom echo of the reflection wave. By knowing the defect information from wave analysis we can measure strength of welded structure. We are also keeping continue our study to investigate more complex defects in fillet welded joint.

5. REFERENCES:

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