Analysis evaluation study on the fatigue crack propagation behavior of the structures with one-sided welding of the fillet welded joint for load carrying type.

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Introduction. The structures of the hydraulic excavator have numerous one-sided welded joints. However, attachments with box like structures are difficult to weld at both sides. Therefore, high accurate evaluation method is needed in one-sided welded joint. In this study, the fatigue properties and the fracture mechanism of the load carrying type fillet joints with one-sided welding were investigated experimentally to evaluate its fatigue damage with high accuracy based on the experimental results and FEM analysis results.

Materials and methods. The base material was high strength steel SS400 (JIS) which is used in the attachment part of a hydraulic excavator. The fatigue test was performed by a hydraulic servo-controlled fatigue strength-testing machine. The loading type of the machine was reproduced by applying a up and down cyclic load. The Fig. 1 is the analysis model same as test piece. We used crack propagation property obtained according to unloading elastic compliance method. In Fig. 2, we found linear relation in Paris law. A fixed number of crack propagation properties are $C=4.5 \times 10^{-14}$ and $m=4.36$.

Crack propagation behavior and analysis results. The three-dimensional observations revealed that fatigue cracks initiate at an early stage of the fatigue development and fatigue cracks in the test piece initiated from the tip of the unwelded portion and propagated into the welding materials. Cracks were initiated at multiple sites in the test piece. As the number of cycles increased, these cracks propagated and combined. Next, we modeled initial crack of FEM according as three-dimensional observation of fatigue crack propagation. As the results, we improved analysis results accuracy and analysis results were close to the experimental results.

Conclusions. This study, observed crack initiation in a machine piece with one-sided welding of the fillet joints, and crack propagation into the welding material. The aim was to clarify the fatigue properties of the fillet weld and fatigue fracture and estimate lifetime by FEM analysis. Our conclusions are summarized below. 1. The three-dimensional observations revealed that fatigue cracks initiate at an early stage of the fatigue development, and persist throughout the lifetime. We infer that the fatigue lifetime is chiefly governed by the crack propagation lifetime. 2. Cracks were initiated at multiple sites in the test piece. As the number of cycles increased, these cracks propagated and combined. 3. We improved analysis results using crack propagation property obtained according to unloading elastic compliance method and analysis results were close to the experimental results.