

Effect of Partial Forging on the Fatigue Strength of Cast Aluminum Alloys

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This paper investigates the effect of partial forging on the fatigue strength of cast aluminum alloys containing artificial defects simulating casting porosity. Aluminum alloys are widely used for automotive lightweighting, and cast components are commonly applied because of their high design flexibility. However, casting porosities are inevitably generated during the casting process and become crack initiation sites. Therefore, it is important to clarify crack propagation behavior originating from casting porosity and to predict fatigue strength corresponding to porosity size. Fatigue tests using specimens containing artificial defects were conducted, and a fatigue strength prediction model corresponding to defect size was proposed.

In this paper, we focus on fatigue cracks originating from casting porosity in cast aluminum alloys and investigate the effect of crushing artificial defects simulating casting porosity by forging on fatigue properties.

Specimen A containing artificial defects with diameters of 2.0 mm, 0.4 mm, and 0.3 mm was prepared by drilling, while Specimen B was prepared by crushing the defects through forging. Fatigue tests were conducted using an Ono-type rotating bending fatigue testing machine under constant load amplitude conditions with a stress ratio of $R = -1$. The target number of cycles was set to 10^7 cycles, and the results were classified into fractured and non-fractured specimens.

The test results showed that the stress level for non-fracture increased as the defect size decreased. In addition, the forged specimens with crushed defects exhibited non-fracture even under higher stress conditions. SEM observations revealed crack propagation behavior considered to be Stage I cracks propagating in the shear direction during the early stage of crack growth.

These results suggest that the reduction in stress concentration due to smaller defect size and defect crushing by forging contributed to the improvement in fatigue properties. Further investigation is required regarding the effects of residual stress and grain refinement caused by forging.

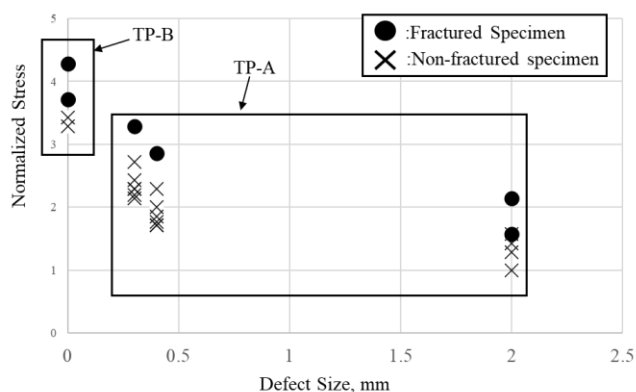


Fig.1 Relationship between defect size and normalized applied stress

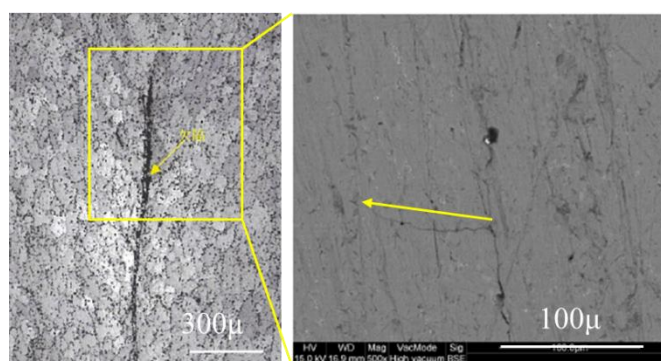


Fig.2. SEM image of crack propagation behavior SpecimenB