講演番号 348

Study on the Fatigue Strength of Dissimilar Adhesive Joints between Steel and Aluminum Alloy

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KEY WORDS: Materials, Adhesive, Fatigue, Joining, Fracture, Strength (D3)

This one-page summary highlights the fatigue evaluation methodology and the effects of water-absorption-induced degradation on adhesively bonded dissimilar joints between steel and aluminum alloy plates. Fatigue test results obtained for various adherend combinations and adhesive thicknesses were analyzed using both stress-based and fracture-mechanics-based parameters. While fatigue life could not be consistently organized using principal stress at the adhesive edge, the stress intensity factor successfully unified the fatigue lives across different joint configurations,indicating predominantly crack-propagation-controlled behavior.(Fig1)

Furthermore, the static strength of lap-shear joints after water absorption was experimentally and numerically investigated. Specimens were exposed to 60 °C water for up to 60 days, resulting in a significant reduction in maximum load with increasing exposure duration. Finite element analyses employed adhesive material properties obtained from JIS No.6 dumbbell tensile specimens subjected to identical aging conditions; however, the predicted strengths were substantially lower than the experimental results under degraded conditions.(Fig2)

To clarify this discrepancy, the degradation behavior of the adhesive layer was examined using the degree of hydrolysis, Dh, as an index of degradation severity. Measurements of Dh revealed a pronounced non-uniform degradation distribution within the adhesive layer, with higher hydrolysis near exposed edges and lower values in the central region constrained by the adherends. (Fig3)This non-uniform degradation indicates that material properties derived from uniformly degraded bulk specimens may not adequately represent the effective mechanical response of adhesively bonded joints. These findings suggest that incorporating spatially varying degradation characteristics is essential for reliable strength prediction and durability assessment of adhesively bonded joints in humid environments.

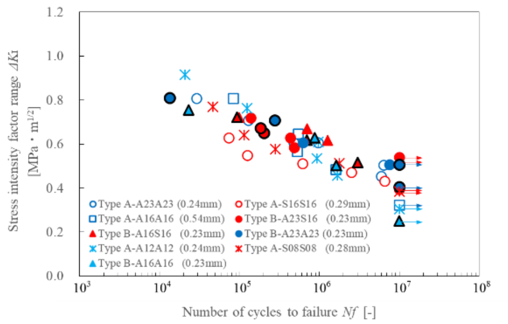

Fig 1 Relationship between fatigue life and stress intensity factor range ⊿K Ⅰ in adhesive layer.

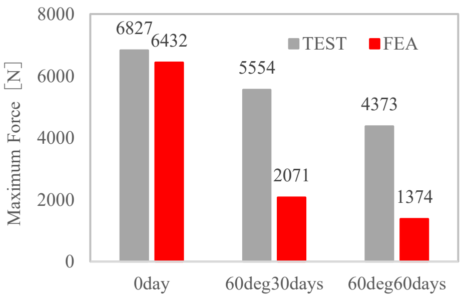

Fig. 2 Static test and FEA results.

7: 1.415	8: 0.817	9: 1.241
4: 0.964	5: 0.521	6: 0.883
1: 0.647	2: 0.366	3: 0.596

Fig. 3 Degree of hydrolysisDh of the adhesive lap shear specimens.

2026 JSAE Annual Congress (Spring) - Summarized Paper
Issued on May 22, 2026