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Investigation of the Effects of Water Absorption and Post-Absorption Drying on Adhesive Strength

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This study examines fabrication methods for lap-shear specimens with the objective of quantitatively evaluating the effects of water-induced degradation on fatigue performance. In addition, the influence of water absorption and subsequent drying on static strength was investigated. As an alternative to copper wires traditionally used to control adhesive layer thickness, 200-µm glass beads were selected because they are less susceptible to corrosion and closely match the 230-µm diameter of the copper wires. To determine the optimal bead placement that stabilizes the adhesive layer thickness while preventing bead infiltration at the bond edges, the Type F method—masking the bond edges with tape prior to bead dispersion—was identified as the most effective approach. (Fig.1)

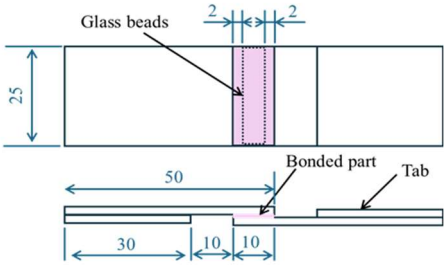

Fig.1 Type F specimen.

To evaluate the effect of water absorption on static strength, similar-material adhesive joint specimens were fabricated using the Type F method and exposed to 80°C / 90%RH. The exposed specimens exhibited a progressive decrease in static shear strength with increasing immersion time. Importantly, none of the drying treatments—including high-temperature drying (100°C × 24 h) and vacuum drying (110°C)—restored the original strength. Once degraded by moisture, the adhesive–adherend interfacial bond is irrecoverable. These findings indicate that post-absorption drying is not a viable strategy for strength recovery. (Fig.2)

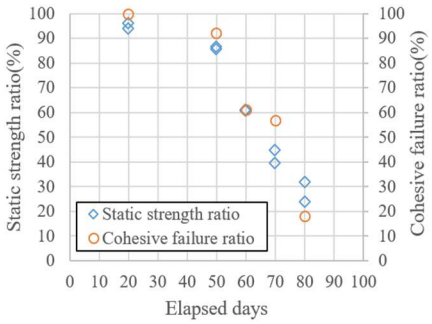

Fig.2 Static strength ratio (After degradation / Initial).

Dissimilar-material specimens were also fabricated, and their post-exposure strength showed the same trend: continuous degradation after 30 and 60 days of immersion. FT-IR analysis was conducted to investigate changes in adhesive properties. The degree of hydrolysis (Dh) at the bond edges more than doubled between 30 and 60 days, whereas degradation in the interior region progressed more slowly due to limited water ingress. Across all conditions, long-term strength reduction was consistently attributed to hydrolysis-induced embrittlement of the adhesive. (Fig.3)

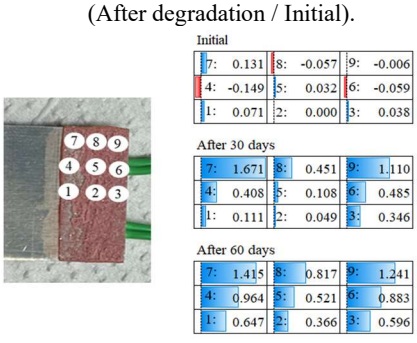

Fig.3 Degree of hydrolysisDh of the adhesive lap shear specimens.