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Finite Element Analysis on the Failure of the Composite/Honeycomb Sandwich Insert Joints under Pull-Out Loading

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Summary

A damage zone approach based on the finite element method was proposed to predict the pull-out failure loads of composite sandwich insert joints. In the damage zone approach, the sandwich joint is assumed to fail when the ratio of the volume of the failed region of the core to the filler-potted volume exceeds a critical value. The critical ratio of the volume is determined by the combined finite element analysis and test. To obtain the experimental failure loads of the sandwich joint, a total of 35 specimens of 7 different types depending on the core depth, density, and face thickness were tested. For specimen fabrication, a Nomex honeycomb core and a carbon-epoxy composite face were used. The film-type adhesive FM73 was used for core and face co-cured bonding. To determine the critical ratio, average experimental failure load is applied to the three dimensional finite element models and the volume of the failed core area is calculated. A quadratic failure criterion was applied to evaluate the core shear failure. The critical ratio of the failed core volume to total potted core volume showed linear variation from 2.41 to 2.21 (8.3% decrease) while the core depth changes from 17.78 to 27.94 mm (57.1% increase). As the core density increases form 48 to 128 kg/m^3 (166% increase), the ratio changes 2.41 to 2.51 (4.1% increase). While the face thickness increases double (0.84 to 1.68 mm), the ratio linearly increases by 183% (2.41 to 6.81). With the evaluated damage zone ratios, the failure loads was predicted with the maximum of 15% deviation from the experimental results for various core depths and densities. As the face thickness changes, the critical damage zone ratio should be recalculated.

keywords: Sandwich, Insert, Joint, Composite material, Honeycomb

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