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MECHANICAL PERFORMANCE AND FRACTURE BAHAVIOR OF ADHESIVE-MULTI PIN JOINTS BETWEEN COMPOSITE AND METALLIC MATERIALS

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ABSTRACT

In order to improve the integration between composite materials and metallic materials in structural applications, the adhesive-multi pin joint method was proposed. The mechanical performance and fracture behaviour of the new joints were investigated through tensile tests. Through the analysis to the test results, its load capacity, failure strain and failure modes are all discussed in detail. It is found that, comparing to traditional adhesive joint, the new joint has excellent mechanical performance and will change failure mode of the joint.

Keywords: composite and metal, adhesive-multi pin joint, failure mode, failure strain.

INTRODUCTION

The popularity of carbon fiber reinforced polymers (CFRP) in the aerospace industry has been increasing thanks to their desirable mechanical and physical properties. They show high resistance to corrosion and have low thermal expansion coefficient. In addition, they are light and durable, properties that allow manufacturers to produce lighter airplanes that consume less fuel [Stelzer, 2015].

Traditionally, there are mainly three approaches to join the composite and metallic materials together: mechanical fastening, adhesive bonding and a combination of both (Hybrid joint) [Parkes, 2014]. However, each method has their own shortcomings due to their nature. To overcome the shortcomings of the traditional joint approaches and reinforce the composite-to-metal joint in through-the-thickness direction, a new joint named as adhesive-multi pin joint, will develop and propose. A typical adhesive-multi pin joint with particular dimensions is illustrated in Figure 1. Both the CFRP and aluminium plate are 2 mm in thickness, 100 mm in length and 25 mm in width. The material of the pins is stainless steel and the diameter is 0.8 mm.

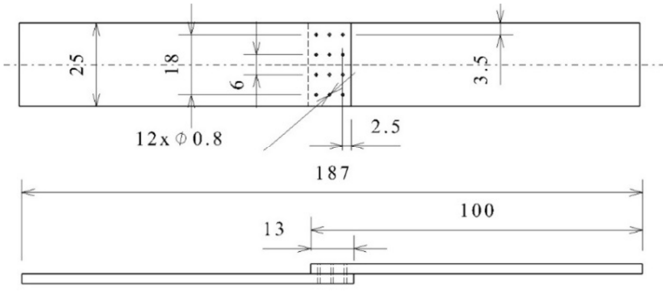

Fig. 1 - Geometry and dimensions of the single-lap joint (all dimensions in mm)

The mechanical performance and fracture behavior of the joint will also be investigated by both experimental methods.

RESULTS AND CONCLUSIONS

The load-displacement curve from the tensile tests is shown in Figure 2, from which it can be seen that the pins' incorporate increase the failure load of the adhesive joint by about 20%, the broken strain by about 10 times.

The failure modes are shown in Figure 3, from which, it can be seen that the new method apparently changed the failure mode.

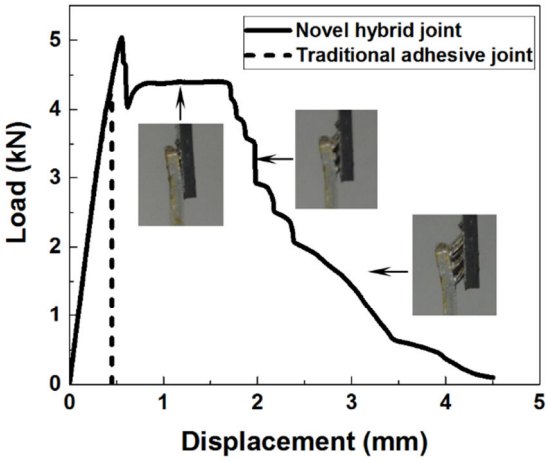

Fig. 2 - Load-displacement curves between adhesive joint and adhesive-multi pin joint

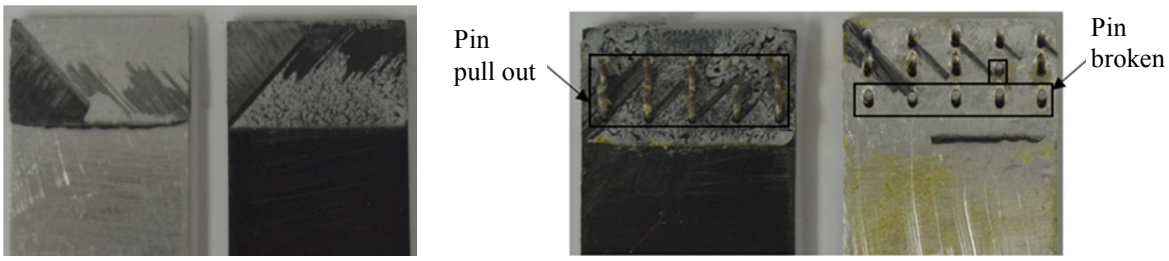

Fig. 3 - Failure modes of traditional adhesive joint and adhesive-multi pin joint

This study shows the advantages of the new joint method between composite and metallic materials.

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