A STUDY ON FATIGUE CHARACTERISTICS OF SCARF JOINT-REPAIRED COMPOSITE LAMINATE UNDER VARIOUS TEMPERATURE ENVIRONMENTS

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ABSTRACT

Composites are often used in aircraft main structures due to their high specific-strength and stiffness. However, unlike metal structures, composite structures have a large impact on physical properties even for small cracks due to brittle fracture. Proper repair studies have been carried out to overcome the disadvantages of these composite structures. In the early days, the mechanical fastening method was used for repairs of composite aircraft, but in recent years, a scarf repair method which does not change the appearance of the aircraft is preferred. However, the scarf repair method shows differences in properties depending on temperature changes. In this study, fatigue tests of scarf joint specimens were performed with temperature changes. The test results showed that the strength decreased with increasing temperature.

1 INTRODUCTION

Composite materials are widely used in primary structures of aircraft due to their high specific-strength and stiffness. There may be localized flaws in composite structures due to operational fatigue damage and environment conditions. Localized flaws in primary composite structures have to be repaired. However, cost for repairing composite structures is more expensive than that for metallic structure. Therefore, optimal repair process is required to reduce the cost. During service, aircrafts undergo various environmental conditions. Accordingly, repaired part should be examined under the same working conditions as the service environment. In this study, the fatigue behaviors of scarf adhesive joints are examined with the focus on various thermal conditions and adhesive bonding methods. We believe the test results could serve as the important data to design the composite structures exposed to thermal environment.

2 GENERAL SPECIFICATIONS

We fabricated scarf adhesively bonded joint specimens and conducted tension-tension fatigue test to investigate the fatigue characteristics in various thermal conditions. The tests were conducted with 4 different temperature conditions and 2 different bonding methods. The specimen configuration was designed according to the ASTM D3039 specification. We used the unidirectional prepreg, USN-200A (SK chemical). The bonding length of scarf joint was 99 mm. FM-300 film adhesive was used to bond composite parts. Fabricated specimen consists of 16 plies with a stacking sequence of $[45/0/-45/90]_{2S}$. Four considered environmental conditions were RTD (23±5℃, 45~55% relative humidity (RH)), 75℃, 100℃ and 125℃. Two bonding methods were co-bonding and secondary bonding method. We controlled temperature in the following process: Heat the chamber to target temperature within 5 minutes and then maintain them for 3 minutes at target temperature. We set up the stress ratio (minimum stress/maximum stress) to be 0.1. The test frequency was 5 Hz. Specimens exceeding million cycles of fatigue load were considered to have an infinite life. All test data are compared with the strength of reference specimen without thermal exposure and repaired.

3 CONCLUSIONS

The fatigue strength at 25℃ and 100℃ atmosphere for the laminate specimens, secondary bonding specimens, and cobonding specimens was 61%, 35%, 33% and 62%, 35%, 33% respectively, based on static strength. The test results showed that the strength decreased with increasing temperature.

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