Accepted Manuscript

An investigation of hygrothermal effects on adhesive materials and double lap shear joints of CFRP composite laminates

Liu Shufeng, Cheng Xiaoquan, Zhang Qian, Zhang Jie, Bao Jianwen, Guo Xin

PII: S1359-8368(16)00092-5

DOI: 10.1016/j.compositesb.2016.01.051

Reference: JCOMB 4030

To appear in: *Composites Part B*

Received Date: 7 September 2015

Revised Date: 27 January 2016

Accepted Date: 29 January 2016

Please cite this article as: Shufeng L, Xiaoquan C, Qian Z, Jie Z, Jianwen B, Xin G, An investigation of hygrothermal effects on adhesive materials and double lap shear joints of CFRP composite laminates, *Composites Part B* (2016), doi: 10.1016/j.compositesb.2016.01.051.

An investigation of hygrothermal effects on adhesive materials and double lap shear joints of CFRP composite laminates

Liu Shufeng[a], Cheng Xiaoquan[*a], Zhang Qian[a], Zhang Jie[a], Bao Jianwen[b], Guo Xin[a]
[a]School of Aeronautic Science and Engineering, Beihang University, Beijing, China
[b]Beijing Institute of Aeronautical Materials, Beijing, China

Abstract: This paper was aimed to investigate the hygrothermal effects on the mechanical behavior of the double lap shear joints of Carbon/Epoxy composite laminates, which were bonded using epoxy adhesive film SY14. First, experimental method was used to evaluate the hygrothermal dependent properties of the adhesive and the static response of composite laminate double lap joints at various environment conditions. The specimens were grouped into room temperature/dry(RD), room temperature/wet(RW), elevated temperature/dry(ED) and elevated temperature/wet(EW). The wet specimens were immersed in deionized water at temperature of 90℃ for 60 hours and the elevated temperature is 95℃. Tensile tests were carried out at room temperature and elevated temperature(95℃) in a controlled chamber. Results showed that the elastic modulus and tensile strength decreased about 24% and 27% respectively after exposure to humidity environment. And a large degradation was found when exposure to high temperature while the plasticity became notable. The failure modes of the double lap shear joints were studied by visual inspection. It was found that both adhesive and cohesive failure happened for dry specimens at room temperature. While failure modes were dominated by cohesive failure after moisture exposure and adhesive failure at elevated temperature. Second, a finite element model was utilized to simulate the damage evolution of the double lap joints. The moisture diffusion process, swelling stress and thermal stress were included. And hygrothermal dependent cohesive law was considered to study the damage evolution. It revealed that failure modes were highly dependent on the weaker strength of adhesive and cohesive. Moisture absorption caused large degradation in cohesive strength, so the failure modes were mostly cohesive failure. Elevated temperature decreases strength of adhesive seriously, so adhesive failure dominates. Good agreement was achieved between the predicted failure loads and experimental results. And the predicted failure modes were also consistent with the experimental phenomenon.

Keywords: B. Adhesion; B. Environmental degradation; D. Mechanical testing; C. Finite element analysis (FEA)

[*] Corresponding author. Tel.: +86-01082338215
School of Aeronautic Science and Engineering, Beihang University, 37 Xueyuan Road, Haidian District, Beijing 100191, China
Email: xiaoquan_cheng@buaa.edu.com