Accepted Manuscript

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PII: S1359-8368(16)32829-3

DOI: 10.1016/j.compositesb.2017.11.027

Reference: JCOMB 5389

To appear in: *Composites Part B*

Received Date: 24 November 2016

Revised Date: 10 November 2017

Accepted Date: 17 November 2017

Please cite this article as: Liu F, Lu X, Zhao L, Zhang J, Hu N, Xu J, An interpretation of the load distributions in highly torqued single-lap composite bolted joints with bolt-hole clearances, *Composites Part B* (2017), doi: 10.1016/j.compositesb.2017.11.027.

An interpretation of the load distributions in highly torqued single-lap composite bolted joints with bolt-hole clearances

Fengrui Liu[1], Xuheng Lu[2], Libin Zhao[1,*], Jianyu Zhang[3,*], Ning Hu[3], Jifeng Xu[4]

1 School of Astronautics, Beihang University, Beijing 100191, PR China

2 Technique Dept., Shanghai Electric Wind Power Group Co., Ltd., Shanghai 200241, PR China

3 College of Aerospace Engineering, Chongqing University, Chongqing 400044, PR China

4 Beijing Key Laboratory of Civil Aircraft Structure and Composite Materials, BASTRI, COMAC, Beijing 102211, PR China

Abstract: A detailed interpretation of load distribution in composite single-lap bolted joints is presented based on theoretical, experimental and numerical investigations. Modified instrumented bolts (MIBs) were used to measure bolt shear loads consisting of the bolt bearing load and the friction force between the laminate and nut. The bolt-load carrying mechanism in single-bolt joints and the load transfer mechanism in multi-bolt joints with various tightening torques and bolt-hole clearances were revealed based on theoretical and numerical analyses and validated against experimental results. The load transferred by each bolt in a multi-bolt joint was determined with greater fidelity, and the load distributions obtained using a three-dimensional finite element (FE) model and a spring-based method were compared. The load distributions obtained from the established 3D FE model were found to be identical to those obtained using the spring-based method; the bolt-hole clearances significantly impacted the load distributions, but the effects of the bolt tightening torques on the load distributions could be ignored.

Keywords: Composites; Bolted joints; Contact force; Clearance; Tightening torque

*Corresponding author: Libin Zhao, E-mail: lbzhao@buaa.edu.cn

*Corresponding author: Jianyu Zhang, E-mail: jyzhang@cqu.edu.cn