Advances in Aircraft and Spacecraft Science, *Vol. 5, No. 3 (2018) 401-410*
DOI: https://doi.org/10.12989/aas.2018.5.3.401

Geometrical parameters optimizations of scarf and double scarf bounded joint

Sidi Mohamed Fekih*, Kuider Madani, Smail Benbarek and Mohamed Belhouari

LMPM, Department of Mechanical Engineering, University of Sidi Bel Abbes, BP 89, Cité Ben M'hidi, 22000 Sidi Bel Abbes, Algeria

(Received September 4, 2017, Revised November 21, 2017, Accepted December 27, 2017)

Abstract. The aim of this work is to optimize the geometrical parameters as the adhesive thickness and the beveled angle to reduce the edge effect of the scarf and V bounded joint. A finite element analysis is done to define the generated stresses in the bounded joint. The geometrical optimum is obtained using the Experimental Design Method. Results show that the double scarf (V) joint is better than the simple scarf bounded joint.

Keywords: scarf bounding; V bounding; finite element analysis; stresses distribution; experimental design method; optimization

1. Introduction

The adhesive bounding experienced the first applications in the early 20's when the first nitrocellulose-based adhesives appear and allow the assembly of construction materials (Volkersen 1938); several authors had followed this work as (Goland and Reissner 1944, Matthews *et al*. 1982, Lubkin 1944, Li *et al*. 2000, Assih *et al*. 2001, Xinglei and Wang 2016, Bouchiba and Serier 2016).

After the Second World War, the adhesive bounding took another boom; the development of new chemicals product has brought new properties of adhesion and the setting time of the adhesive. This has made it possible to adapt this assembly technique to other applications. Nowadays; the adhesive bounding has developed greatly in several areas (Aeronautics, automotive, Building, etc.). This technique is used to connect several different materials in order to repair or strengthen them; it also allows the design of mixed structures (Composite patch on Aluminum plate) (Baker *et al*. 1984, Jones 1983, Tarn and Shek 1991, Fekih *et al*. 2012, Yala and Megueni 2009, Elhannani *et al*. 2016, Fioriti 2014).

The adhesive bonding method is an effective alternative solution against the conventional assembly processes; it has many advantages: Homogeneous stress distribution, weight gain, thin materials assembly, Vibration attenuation and Design (From the aesthetic point of view, it is possible to obtain parts with a smooth appearance and the assembly will not very visible).

Assemblies that minimize stress concentrations and do not promote the appearance of the

*Corresponding author, Ph.D., E-mail: fekih_moh@yahoo.fr

http://www.techno-press.org/?journal=aas&subpage=7 ISSN: 2287-528X (Print), 2287-5271 (Online)

type. All these results make it possible to deduce that there are several parameters that significantly influence the mechanical performance of the adhesive joint. A summary of all numerically carried out tests are given in the following table.

Numerical calculations show that the V-shaped (double scarf) assembly gives satisfactory results compared to the double scarf-bonded assemblies.

References

ABAQUS/CAE (2007), *Ver 6.9 User's Manual*, Hibbitt, Karlsson and Sorensen, Inc.

Tamijani, A.Y., Mulani, S.B. and Kapania, R.K. (2017), "A multilevel framework for decomposition-based reliability shape and size optimization", *Adv. Aircraft Spacecraft. Sci.*, **4**(4), 467-486.

Assih, J., Li, A. and Delmas, Y. (2001), "Strengthened concrete beams by gluing carbon fiber composite sheet: application of damage theory", *Compos. Constr.*, **127**, 623-628.

Baker, A.A., Callinan, R.J., Davis, M.J., Jones, R. and Williams, J.G. (1984), "Repair of mirage III aircraft using BFRP crack patching technology", *Theor. Appl. Fract. Mech.*, **2**(1), 1-16.

Eriksson, L., Johansson, E., Kettaneh-Wold, N., Wikström, C. and Wold, S. (2000), *Design of Experiments: Principles and Applications*, Learnways AB, Sweden.

Frigon, N.L. and Mathews, D. (1996), *Practical Guide to Experimental Design*, Wiley, U.S.A.

Goland, M. and Reissner, E. (1944), "The stresses in cemented joints", *J. Appl. Mech.*, **11**, 17-27.

Jones, R. (1983), "Neutral axis offset effects due to crack patching", *Compos. Struct.*, **1**(2), 163-174.

Li, A., Assih, J. and Delmas, Y. (2000), "Influence of the adhesive thickness and steel plate thickness on the behaviour of the strengthened concrete beams", *J. Adhes. Sci. Technol.*, **14**(13), 1639-1656.

Lubkin, J.L. (1944), "A theory of adhesive scarf joint", *J. Appl. Mech.*, **11**, 17-27.

Elhannani, M., Madani, K., Mokhtari, M., Touzain, S., Feaugas, X. and Cohendoz, S. (2016), "A new analytical approach for optimization design of adhesively bonded single-lap joint", *Struct. Eng. Mech.*, **59**(2), 313-326.

Fioriti, M. (2014), "Adaptable conceptual aircraft design model", *Adv. Aircraft Spacecraft Sci.*, **1**(1), 43-67.

Matthews, F.L., Kilty, P.F. and Godwin, E.W. (1982), "A review of the strength of joints in fibre reinforced plastics. Part 2: Adhesively bonded joints", *Compos.*, **13**(1), 29-37.

MODDE 5.0 (Modeling and Design) (1999), *Umetrics AB*, Umea, Sweden.

Bouchiba, M.S. and Serier, B. (2016), "New optimization method of patch shape to improve the effectiveness of cracked plates repair", *Struct. Eng. Mech.*, **58**(2), 301-326.

Fekih, S.M., Albedah, A., Benyahia, F., Belhouari, M., Bouiadjra, B.B. and Miloudi, A. (2012), "Optimisation of the sizes of bonded composite repair in aircraft structures", *Mater. Des.*, **41**, 171-176.

Tarn, J.Q. and Shek, K.L. (1991), "Analysis of cracked plates with bonded patch", *Eng. Fract. Mech.*, **40**, 1055-1065.

Yayli, U.C., Kimet, C., Duru, A., Cetir, O., Torun, U., Aydogan, A., Padmanaban, S. and Ertas, A.H. (2017), "Design optimization of a fixed wing aircraft", *Adv. Aircraft Spacecraft Sci.*, **4**(1), 65-80.

Volkersen, O. (1938), "Die niektraftverteilung in zugbeanspruchten mit konstanten laschenquerschritten", *Luftfahrtforschung*, **15**, 41-47.

Cheng, X. and Wang, J. (2016), "An elastoplastic bounding surface model for the cyclic undrained behaviour of saturated soft clays", *Geomech. Eng.*, **11**(3), 325-343.

Yala, A. and Megueni, A. (2009), "Optimisation of composite patches repairs with the design of experiments method", *Mater. Des.*, **30**(1), 200-205.

EC