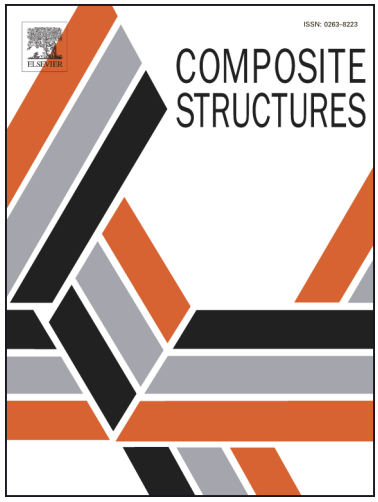

Damage Tolerance of Bio-Inspired Helicoidal Composites under Low Velocity Impact

D. Ginzburg, F. Pinto, O. Iervolino, M. Meo

PII: S0263-8223(16)30362-2
DOI: http://dx.doi.org/10.1016/j.compstruct.2016.10.097
Reference: COST 7923

To appear in: *Composite Structures*

Received Date: 21 April 2016
Revised Date: 21 October 2016
Accepted Date: 22 October 2016

Please cite this article as: Ginzburg, D., Pinto, F., Iervolino, O., Meo, M., Damage Tolerance of Bio-Inspired Helicoidal Composites under Low Velocity Impact, *Composite Structures* (2016), doi: http://dx.doi.org/10.1016/j.compstruct.2016.10.097

Damage Tolerance of Bio-Inspired Helicoidal Composites under Low Velocity Impact

D. Ginzburg, F. Pinto, O. Iervolino, M. Meo*

Material Research Centre, Department of Mechanical Engineering, University of Bath,

Bath, BA2 7AY, UK

*Corresponding author: m.meo@bath.ac.uk

Abstract

It is well known that laminated composite materials are prone to impact damage caused by foreign objects and exhibit poor damage resistance in through the thickness direction. By drawing inspiration from naturally occurring impact resistant structures, such as dactyl clubs of mantis shrimp, enhanced damage tolerance and impact energy absorption can be achieved with traditional CFRP layers by creatively arranging them into bio-inspired configurations, called helicoidal or Bouligand structures. Through an extensive numerical analyses of low velocity impact (LVI) supported by the experimental results, a further insight into the possibilities that these structures can offer in terms of damage resistance was attained. By comparing the results of three square plates with different planar sizes, it was shown that the helicoidal layups are more effective at absorbing energy while minimising through the thickness failure than standard quasi-isotropic and cross-ply laminates. Although the helicoidal composites generally exhibited a higher degree of delamination in LVI tests, the standard lamination schemes displayed higher degree of perforation, which resulted in a reduced residual strength in the compression after impact (CAI) testing of a quasi-isotropic laminate compared to several helicoidal ones subjected to 40 J and 80 J impact energy. Furthermore, using advanced finite element analysis (FEA) code LS-DYNA® for simulating LVI and CAI events, it was revealed that the helicoidal arrangement endured the least amount of fibre damage.

Keywords: helicoidal, twisted, low velocity impact, Bouligand, composite damage, LS-DYNA®, MAT162