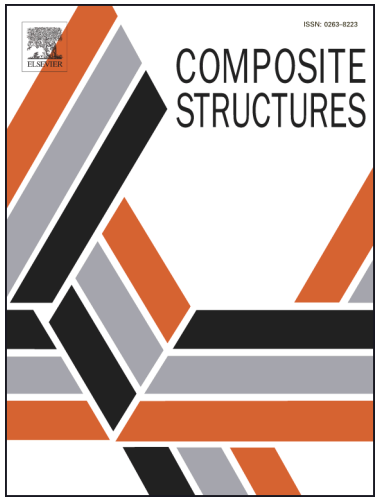

The response of laminated composite plates and profiles under low-velocity impact load

A. Gliszczynski, T. Kubiak, P. Rozylo, P. Jakubczak, J. Bieniaś

PII: S0263-8223(18)31649-0
DOI: https://doi.org/10.1016/j.compstruct.2018.09.005
Reference: COST 10151

To appear in: *Composite Structures*

Received Date: 6 May 2018
Revised Date: 20 August 2018
Accepted Date: 13 September 2018

Please cite this article as: Gliszczynski, A., Kubiak, T., Rozylo, P., Jakubczak, P., Bieniaś, J., The response of laminated composite plates and profiles under low-velocity impact load, *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.09.005

The response of laminated composite plates and profiles under low-velocity impact load

Gliszczynski A.[a*], Kubiak T.[a], Rozylo P.[b], Jakubczak P.[c], Bieniaś J.[c]

[a]Department of Strength of Materials, Faculty of Mechanical Engineering, Lodz University of Technology, Stefanowskiego 1/15, 90-924 Lodz, Poland
[b]Department of Machine Design and Mechatronics, Faculty of Mechanical Engineering, Lublin University of Technology, Nadbystrzycka 36, 20-618 Lublin, Poland
[c]Department of Materials Engineering, Faculty of Mechanical Engineering, Lublin University of Technology, Nadbystrzycka 36, 20-618 Lublin, Poland

Abstract: The effect of impact load with low velocity in thin-walled plates and profiles has been investigated. The paper deals with the relation between damage propagation, size and shape as a function of boundary conditions, layer arrangements and impact energy. The structures under consideration were made of eight-layer Glass Fiber Reinforced Polymer (GFRP) laminate with a quasi-isotropic, quasi-orthotropic and angle ply arrangement of layers. The standardised plates predefined to CAI tests and channel section profiles have been subjected to impact load. Based on the performed tests, the impact characteristics have been obtained and compared with the theoretical model (one degree of freedom mass-spring system). Further, despite it not being mentioned in the ASTM 7136 standard, characteristic curves were identified. It was noted that the impacts introducing matrix damages and the partial fracture of the fibres significantly change the course of the Force-Time histories, particularly after the maximum impact force is reached.

Keywords: Low Velocity Impact (LVI); GFRP; Thin-walled structures; Barely Visible Impact Damage (BVID); Damage assessment.

1. Introduction

In the early 1980s, there was increasing interest in the "effects of defects", as they were popularly termed, particularly in brittle carbon/glass fibre composites in order to assess the material resistance to impact, as well as to other sources of deliberately introduced defects, such as fastener holes and access cut-outs. This research resulted in the development of standardised Compression After Impact (CAI) test procedures [1], [2] aimed at the cross-sectional strength estimation of the representative section of composite structures and the assessment of damaged components, which in consequence allowed for an efficient and reliable material selection [3].

1.1 Literature review

In the international literature, a large number of papers devoted to low-velocity impacts (LVIs), as well as to CAI [4], can be found. In most papers, the typical size and shape of the specimen (i.e. plate with overall dimensions 150 × 100 mm) for impact load investigations in experimental, analytical and numerical investigations have been used. In the international literature, however, there are papers dealing with the influence of different geometrical as well as load parameters of the type and area of occurring damages. For example, Sun and Hallett [5] analysed the influence of impact position on damages – impact was introduced in the centre of the plate and at a point offsetting in the longitudinal or transverse direction. Additionally, they analysed the influence of ply thickness (16 plies with a ply thickness of 0.25 mm and 32 plies with a ply thickness of 0.125 mm) on force-time history, area of damages and delamination area. Gonzales et al. [6] have performed an analysis of the effects of ply clustering on polymer-