Accepted Manuscript

Experimental and numerical assessment of aerospace grade composites based on high-velocity impact experiments.

Tim Wagner, Sebastian Heimbs, Florian Franke, Uli Burger, Peter Middendorf

PII: S0263-8223(18)30677-9
DOI: https://doi.org/10.1016/j.compstruct.2018.07.019
Reference: COST 9936

To appear in: *Composite Structures*

Please cite this article as: Wagner, T., Heimbs, S., Franke, F., Burger, U., Middendorf, P., Experimental and numerical assessment of aerospace grade composites based on high-velocity impact experiments., *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.07.019

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Experimental and numerical assessment of aerospace grade composites based on high-velocity impact experiments.

Tim Wagner[a,*], Sebastian Heimbs[b], Florian Franke[c], Uli Burger[c], Peter Middendorf[d]

[a]Airbus Central R&T, 81663 Munich, Germany
[b]Airbus Operations, 21129 Hamburg, Germany
[c]Technische Hochschule Ingolstadt , 85049 Ingolstadt, Germany
[d]University of Stuttgart, 70569 Stuttgart, Germany

Abstract

The experimental and numerical assessment of different aerospace grade composite materials under high-velocity impact is treated in this study. Characterisation of the materials, including thermosets (epoxy) and thermoplastics (PEEK) with carbon (unidirectional and woven fabric) and glass fibres, was conducted using high-velocity impact experiments. The test results indicate the glass fibre composites' superiority in the domain of classical composites in terms of weight-specific impact performance. The different carbon fibre composites have very similar ballistic limits but differ in terms of delamination behaviour. Subsequently, materials models are developed which reproduce interlaminar failure through the usage of surface-based cohesive contact formulations. By these means efficient and reliable simulation methods for impact events are developed.

Keywords: High-velocity impact, Impact simulation, S-2 glass fibre, HTS carbon fibre, HTA carbon fibre, Abaqus/Explicit

1. Introduction

Fibre-reinforced plastics' (FRPs) usage in recent aerospace developments is still growing. Within the domain of composite materials, glass fibre (GF) and carbon fibre (CF) materials are most widely used. Due to their advantage of weight-specific strength and stiffness they are replacing traditional metals in more and more areas. Especially in areas that are prone to foreign object impact damage, the use of composite materials requires special attention. Compared to classical metal materials, FRPs show a much broader range of potential failure modes. Due to their anisotropy and the compound of matrix and fibre material, failure of the matrix, fibre or the interfaces between different plies can occur. This interface failure, called delamination, can play an important role in the failure of composite structures [1].

Assessment of structures through numerical methods is desirable to reduce costs for physical testing and enable fast development cycles. The finite element method (FEM) can be seen as the standard for numerical analysis. Barely visible impact damage (BVID) can be introduced through low-velocity impacts as they might occur during manufacturing and maintenance (e.g. tool drop). The numerical description of these low-velocity impacts is a large research area (e.g. [2–8]), but often requires fine meshing. This results in either high computational cost or requires special procedures, such as submodelling or multiscale methods [9] to assess large structures. Highly-dynamic impact loads often occur through objects with high weight and therefore high energies. Examples for such loads include bird strike, which is even specifically mentioned in most aviation regulations (e.g. [10] §25.631), hail impact [11] or foreign object impact damages such as runway debris, tyre debris or rim failure. These impact scenarios affect a larger area when compared to typical low-velocity impact scenarios. For such analysis the usage of a fine mesh would require unreasonably long computations. Explicit simulations of such low and high-velocity impacts often utilise cohesive element formulations to capture the interlaminar behaviour (e.g. in [12, 13]). These cohesive elements are computationally

*Corresponding author
Email address: tim.ti.wagner@airbus.com (Tim Wagner)

ACCEPTED MANUSCRIPT

Download English Version:

https://daneshyari.com/en/article/6702481

Download Persian Version:

https://daneshyari.com/article/6702481

Daneshyari.com