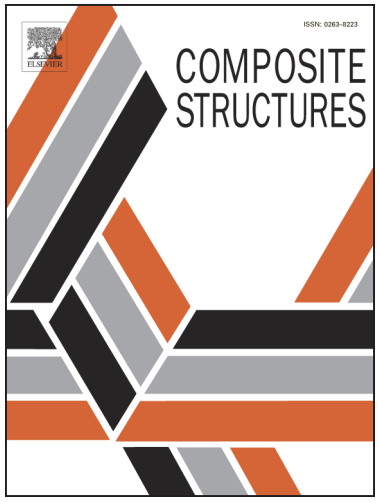

Collapse of channel section composite profile subjected to bending Part II: Failure analysis

Patryk Jakubczak, Adrian Gliszczyński, Jarosław Bieniaś, Krzysztof Majerski, Tomasz Kubiak

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Collapse of channel section composite profile subjected to bending

Part II: Failure analysis

Patryk Jakubczak[1], Adrian Gliszczyński[2], Jarosław Bieniaś[1], Krzysztof Majerski[1], Tomasz Kubiak[2]

[1] *Department of Materials Engineering, Faculty of Mechanical Engineering, Lublin University of Technology, Nadbystrzycka 36, 20-618 Lublin, Poland*

[2] *Department of Strength of Materials, Faculty of Mechanical Engineering, Lodz University of Technology, Stefanowskiego 1/15, 90-924 Lodz, Poland*

Abstract: The paper presents the failure analysis of thin-walled channel section composite beams made of GFRP laminate. Six arrangements of layers were analysed. Two scenarios were investigated in the performed tests: pure bending and bending with torsion. In order to characterise the process of failure, the following techniques were used: ultrasonic non-destructive testing, computed microtomography and scanning electron microscopy. The conducted failure analysis based on macro and microscopic tests allow to identify the location, geometry and the character of the failure areas. Furthermore, occurrence of characteristic forms and mechanisms of failure was revealed. Based on the conducted analyses it was concluded that the failure of reinforcing fibres, as a result of compressive and shearing stresses, is a major/dominant form of failure for most of the studied configurations. Detailed analysis of the failure areas allowed to determine the influence of orientation and position of particular layers on the character of damage of the tested beams. The type and distribution of the observed forms of failure indicate that the character of degradation of particular layers with different orientations remains heterogeneous to a large extent.

Keywords: composite collapse, composite failure, phased array, computed microtomography, SEM.

1. Introduction

These days, one of the most interesting engineering problems are lightweight and high-strength thin-walled structures. Such structures are currently widely used in different branches of technology, in particular in the aerospace industry [1–5]. Therefore one of the most interesting fields of research is the analysis of stability and load-carrying capacity of thin-walled structures. As far as the traditional materials are concerned, e.g.: steel or aluminium alloys, analyses of thin-walled structures, including descriptions of the failure process, have been widely investigated in the literature [6–11].

Currently the most commonly used material solution in manufacturing of thin-walled structures are composite materials reinforced with long fibres in a polymer matrix (FRP). The possibility of using different components and different stacking sequences for particular layers results in the thin-walled composite FRP structures being capable of adjusting the specification of mechanical response according to the purposes [12–14]. The use of modern manufacturing methods allows to obtain high-quality thin-walled structures with a high degree of repeatability [15,16]. Regardless of their favourable mechanical properties fibre-reinforced composite materials are distinguished by the characteristics of the failure process that is different and more complex than in the case of traditional metal materials [17,18]. The studies published in the literature, concerning thin-walled composite structures, are characterised by wide thematic scope. Nelson, Bauld and Tzeng [19], Cortinez and Piovman