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The comparison of effects of hygrothermal conditioning on mechanical properties of fibre metal laminates and fibre reinforced polymers

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Abstract

The purpose of this article is to present the effects of hygrothermal conditioning of fibre-metal laminates and conventional fibre-reinforced polymer composites on some mechanical properties of these materials. The study was carried out by long-term conditioning of tested materials at elevated temperature (60° C) and relative humidity (99%). The equilibrium of moisture absorption for both fibre-metal laminates and fibre-reinforced polymer composites was determined. The mechanical properties have been investigated by tensile strength and interlaminar shear strength tests. The obtained results show that moisture absorption of fibre-metal laminates is significantly lower that of a fibre reinforced polymer composites. After conditioning, the loss of strength properties has been identified. The tensile strength of fibre-metal laminates decreases by 1–15% and the interlaminar shear strength decreases by 9–11%, depending on the configuration. The damage analysis revealed that exposure to environmental conditions has an impact on the nature of the damage of the tested laminates.

1. Introduction

Over the past decades, fibre-reinforced polymer (FRP) composites have become very popular in many technical fields, especially in the aircraft industry [1]. A wide range of beneficial properties determines the use of this type of materials for light primary structures [2–5]. The specific structure of composite materials makes not only the mechanical properties, but also characteristic of damage process becomes the subject of detailed research [6,7]. On the other hand, however, FRP composites are sensitive to environmental factors such as temperature and humidity. It is commonly known that the impact of the environment can result in the reduction of the performance properties of polymer composites [8,9].

Different mechanisms have been proposed to describe the phenomenon of moisture absorption by FRP composites [10]. FRP composites absorb moisture mainly through diffusion in the matrix area, which, according to Fick's law, proceeds from the surface to the centre of a laminate. Moisture absorption may also take place through diffusion by osmotic swelling limited by polymer creep, and osmotic