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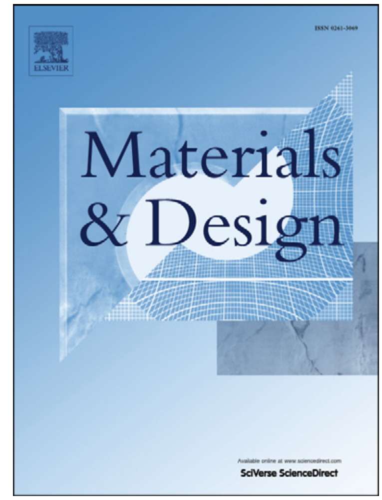

Technical report

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R. Petrucci, C. Santulli, D. Puglia, F. Sarasini, L. Torre, J.M. Kenny

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MECHANICAL CHARACTERISATION OF HYBRID COMPOSITE LAMINATES BASED ON BASALT FIBRES IN COMBINATION WITH FLAX, HEMP AND GLASS FIBRES MANUFACTURED BY VACUUM INFUSION

R. Petrucci[1], C. Santulli[2*], D. Puglia[1], F. Sarasini[2], L. Torre[1], J.M. Kenny[1]

[1] Università di Perugia, Civil and Environmental Engineering Dept., Materials Science and Technology, Strada di Pentima 4, 05100 Terni
[2] Sapienza Università di Roma, Dept. of Chemical, Materials and Environmental Engineering, via Eudossiana 18, 00184 Roma, Italy

ABSTRACT

This work concerns the production by vacuum infusion and the comparison of the properties of different hybrid composite laminates, based on basalt fibre composites as the inner core, and using also glass, flax and hemp fibre laminates to produce symmetrical configurations, all of them with a 21-23% fibre volume, in an epoxy resin. The laminates have been subjected to tensile, three-point flexural and interlaminar shear strength tests and their fracture surfaces have been characterised by scanning electron microscopy. The mechanical performance of all the hybrid laminates appears superior to pure hemp and flax fibre reinforced laminates and inferior to basalt fibre laminates. Among the hybrids, the best properties are offered by those obtained by adding glass and flax to basalt fibre reinforced laminates. Scanning electron microscopy (SEM) observation of hybrid laminates showed the diffuse presence of fibre pull-out in hemp and flax fibre reinforced layers and a general trend of brittle failure.

Keywords: basalt; flax; glass; hemp; hybrid composites; vacuum infusion; mechanical properties; fracture morphology

1. Introduction

Hybridization is a commonly used procedure to obtain properties, which are intermediate between the two originating materials. Dealing with polymer composites, hybridization may result in a compromise between mechanical properties and cost to meet specified design requirements, as one of the reinforcements is usually cheaper than the other one. A number of studies have been performed recently, which suggest that mechanical properties can be possibly tailored using hybridization based on glass or basalt fibre laminates and including other natural (aiming at a more sustainable material) [1-3] or synthetic fibres [4-5].

In particular, with respect to plant fibres, which equally show thermal and acoustic insulation properties, the higher specific weight of basalt fibres (around 2700 kg/m³) is widely compensated by their higher modulus, excellent heat resistance, good resistance to chemical attack and low water absorption [6]. This suggests that hybrid laminates, based on basalt fibres and plant fibres, and/or glass-plant fibre hybrid laminates, the latter being particularly studied when it comes to the need for sufficient impact resistance [7], may have some interest. This would possibly result in a more sustainable end-of-life scenario without substantially affecting the structural performance of the laminates.

As a matter of fact, hybridization of basalt fibres has been attempted with ceramic fibres, to provide improved hot wear resistance to friction materials [8], with high tensile strength fibres, such as carbon [9-10] and aramid [11-12], and with glass fibres [6, 13]. In these cases, basalt provided an impact and environmental resistance superior to that provided by the corresponding hybrids with

* Corresponding author, telephone: 0039-06-44585408, e-mail: c.santulli@alice.it