Material characterization and structural behaviour of GFRP pultruded profiles

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Summary

This paper presents results of experimental and numerical investigations on GFRP pultruded profiles, developed to characterize the mechanical behaviour of the GFRP material and to investigate the structural behaviour of GFRP pultruded beams, regarding both their serviceability and failure behaviour. Experimental tests were first carried out on small scale specimens in order to determine the shear, flexural, tensile and compressive properties of the material. Full-scale flexural tests were then conducted on GFRP pultruded I-section simply supported beams and cantilevers, in order to evaluate their service behaviour and the most relevant failure mechanisms and respective ultimate loads. Results from experimental tests are compared with results obtained from numerical models and analytical methods, in order to evaluate their relative accuracy.

Keywords: advanced composites, GFRP pultruded profiles, material characterization, structural behaviour, local buckling, global buckling.

1. Introduction

The durability problems of traditional materials and the need for higher construction speed have been encouraging the development of new structural solutions and materials. Fibre reinforced polymer (FRP) materials in general, and glass fibre reinforced polymer (GFRP) pultruded profiles in particular, are assuming an increasing role in this domain. In the last two decades, there has been a growing number of applications of GFRP pultruded profiles in both new construction and rehabilitation of civil infrastructure.

In fact, GFRP pultruded profiles have great potential as structural materials, presenting several advantages when compared with traditional materials, due to their high strength-to-weight ratio, lightness, electromagnetic transparency, possibility of being produced with any cross section, ease of installation, low maintenance requirements and improved durability under aggressive environments [1-3]. As drawbacks, in addition to the initial costs of GFRP profiles, that are still not competitive for mainstream applications, there are still no generally accepted design codes or guidelines available for civil engineers. Presently, most structural designs are based on manufacturers design guides, often presented in the format of tables, which are sometimes incomplete and uneconomical. In order to develop design codes, additional research is needed to understand better the structural behaviour of GFRP profiles, particularly their failure modes.

This paper presents results of experimental and numerical investigations carried out at IST [4,5], whose objective was to perform an extensive characterization of the mechanical behaviour of the GFRP pultruded material and also to investigate the structural behaviour of GFRP pultruded beams, regarding both their serviceability and failure behaviour. Experimental tests were first carried out on small scale specimens in order to characterize the mechanical behaviour of the GFRP pultruded material in shear, bending, tension and compression. Full-scale tests were then conducted in structural profiles in order to analyse the flexural behaviour of GFRP simply supported beams and cantilevers with I-section, thereby allowing to investigate their serviceability behaviour and to study the most relevant failure mechanisms and respective ultimate loads.

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