CHARACTERISATION OF CARBON FIBRE-REINFORCED TILES IN THEIR APPLICATION TO VENTILATED FACADES

Orozco Messana, J.; Ferrer Giménez, C.; Cárcel González, A.

Universidad Politécnica de Valencia
Instituto de Tecnología de Materiales, Valencia (Spain)

1. INTRODUCTION

The present study focuses on the search for a product innovation, which enables obtaining attractive technical performances for the use of ceramic materials in outer envelopes, avoiding the cost restrictions, and thus offering a positive balance for the industry.

2. SELECTED MATERIALS

Property	unit	
Plastic limit	% by weight	20 ± 4
Plasticity index	% by weight	33 ± 8
After-pressing expansion	cm/m	0'9 ± 0'3
Green bending strength	MPa	1'0 ± 0'2
Drying shrinkage	cm/m	0'3 ± 0'1
Fired bending strength (900°C)	MPa	30 ± 5
Reduction in firing	% by weight	3 ± 3
Water absorption after firing	% by weight	15 ± 4

Table 1. Technological properties of the raw material.

With regard to the carbon fibre used, an industrial consumer product has been selected, made in Japan, which is supplied as a fabric formed on the basis of a 1 cm wide tape and 24,000 carbon fibre filaments (polyacrylonitrile base). The tapes are braided in an orthogonal lattice, 1 metre wide, with a weight of 160 g/m². The material has been compacted by pressing at 600 kg/cm² with the addition of the lubricant specified by the supplier in the proportion stipulated on the product technical data sheet.

3. MATHEMATICAL DESIGN

A product design is envisaged in the form of a tile, 12 mm thick, with improved bending strength capacity owing to the reinforcement in both faces. This involves placing a sheet of carbon fibre fabric in each face of the tile at an optimum distance from the surface to obtain the necessary reinforcement effect without the fibre burning during firing. In addition, a minimum layer of 1 mm over the fabric has been considered to avoid delamination of the tile. With these data the location of the reinforcements have been optimised by finite elements.

4. EXPERIMENTAL

The forming of the material has been limited to the test specimens for the standard three-point bending test in advanced Technical Ceramics. For the test specimens, the reinforcement used was not the fabric but independent fibres in tape format with density of 24,000 filaments per centimetre width. The fibres were arranged longitudinally.

The three-point bending test was conducted using an accredited assembly for standard UNE-EN 843-1. The test machine used was a single column Instron model 3342 machine. The mean breaking load was determined for each lot of test specimens and it was verified that the standard deviation did not depart more than 10% from the mean. The figure shows the results for each lot of test specimens.

It was necessary to reject 12% of the test specimens because of cracking problems after firing. The positioning of the fibres was extremely complex and doing this manually made the process difficult and could bias the results.

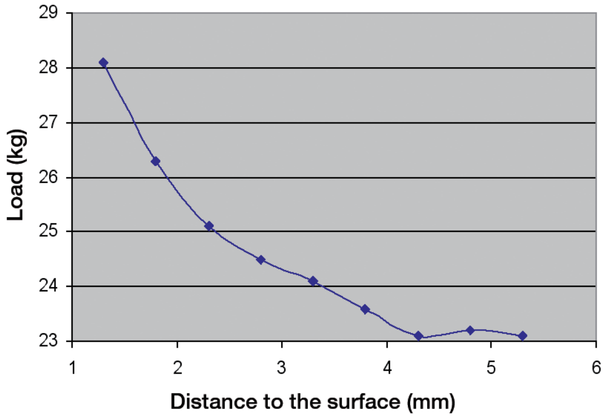

Figure 1. Bending test breaking load versus distances of the fibres to the surface.

The failures displayed fibre pull-out and possible problems of adhesion.

5. CONCLUSIONS

In view of the significant increase in bending strength after fibre encapsulation, this line of work is considered to display possibilities that should be researched using other forming systems in which the ceramic product achieves the desired thickness by using techniques such as tape-casting.

It is also essential to investigate the evolution of the impact resistance characteristics by a standard test that enables representing the use of tiles in facades. This research should go together with a full microstructural and fractography characterisation in order to direct the development work of this possible product line.

Finally, it should be noted that that the influence of the anchorage systems of this product needs to be introduced as a characterisation variable.

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