

CONCRETE REINFORCED BY BRAIDED FIBRE COMPOSITE RODS

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1. INTRODUCTION

One of the most serious problems affecting concrete is corrosion of the steel reinforcement. Corrosion may occur due to reaction of lime present in hydrated cement with carbon dioxide or to the action of chlorides. The braiding technique is probably the most ancient production process for textile structures. Normally used for ropes and cables, braided fabrics are also very interesting for composite reinforcements due to their characteristics: in-plane multiaxial orientation, conformability, excellent damage tolerance and cost. The braiding technique can produce a wide range of preforms for composite reinforcements (T's, I's, hollow fabrics).

2. BRAIDED REINFORCED COMPOSITE RODS

2.1 Production

The samples have been produced on a conventional braiding machine specially adapted to impregnate simultaneously the braided fabrics. In order to increase roughness of the braided reinforced composite material rods, and then its adhesion to the concrete, braided fabrics have been produced as a ribbed structure, as shown in Figure 1.

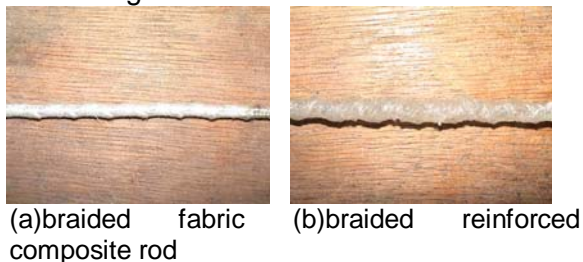


Figure 1 – Ribbed structure

The glass braided fabrics have been produced and simultaneously impregnated with a polyester thermosetting resin during the braiding process. The characteristics of the

composite material rods produced are shown in Table 1.

Table 1 - Characteristics of the composite material rods

Braided fabric type	Fibre type	Thickness (mm)	Fiber volume fraction (%)	Resin type
Core reinforced	Braiding yarns: 110 tex, E glass fiber Core reinforcement: 12 E glass fiber 900 tex rovings	3.7	63.44	polyester

2.2 Mechanical properties

For the evaluation of the tensile properties of the braided reinforced composite rods produced, experimental work has been undertaken using a HOUNSFIELD universal tensile tester, according to ASTM D638 standard, at a cross-head speed of 1 mm/min. The results obtained are shown in Table 2.

Final Strength (MPa)	Extension at maximum stress (%)	Young's modulus (MPa)
946.81	6.93	17700

Table 2 – Tensile properties of composite reinforced rods

2.3 Adhesion to the Concrete

In order to evaluate the adherence between the braided composite rods and the concrete, 8 samples have been prepared. The samples have been tested (Figure 2) on an universal tensile tester, at a cross-head speed of 0.1 mm/s, according to standard NP EN 10002-1 usually used for steel. The braided composite rods have completely adhered to the concrete up to the breaking point.



Figure 2 – Adherence test

3. CONCRETE BEAMS REINFORCED BY BRAIDED REINFORCED RODS

3.1 Samples preparation

Three concrete beams reinforced by an armour of braided composite rods (Figure 3) and three concrete beams reinforced by an armour of steel were prepared.



Figure 3 - Composite rods reinforcements used

The curing process occurred in three different steps: 24h in the place where the beams were made; 20 days in water at a temperature of 20 °C; 6 days at a room temperature of 20°C.

3.2 Testing and results

The beams have been tested in bending in a servo-controlled system with a speed of 10 $\mu\text{m/s}$. Tables 3 and 4 present the results obtained for each type of beam tested.

Table 3 - Bending test results for beams reinforced

	Strength (KN)	Elongation at failure(mm)
Beam 1	58.1	4.4
Beam 2	63.3	2.5
Beam 3	60.1	3.4
Mean	60.5	3.4

Table 4 - Bending test results for beams by steel reinforced by composite rods

	Strength (KN)	Elongation (mm)
Beam 1	32.5	8.2
Beam 2	30.3	4.8
Beam 3	30.7	6.4
Mean	31.3	6.5

Figure 4 presents a beam after testing. The broken braided reinforced composite rods are shown.



Figure 4 – Beam produced with braided reinforced composite rods after testing

Figure 5 presents the load-deformation curves for each type of beam tested.

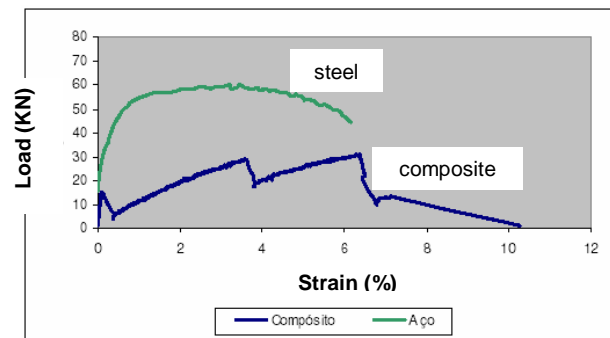


Figure 5 – Load-strain curves for concrete beams reinforced by composite rods and steel

4. CONCLUSIONS

The steel reinforced beams carry twice as much load compared to composite reinforced beams. Moreover, strain values of the steel reinforced beams are lower than those obtained for beams reinforced by the composite rods. In the load-strain curves obtained for the composite reinforced beams, three peaks are visible that correspond to the breaking point of each of the composite rods used. These peaks show that the rods in the reinforcement are not stressed simultaneously. Moreover, the first peak indicates that the reinforcement is not bearing the full load at the initial stage of testing. This behaviour is probably due to the rather loose state of the composite rods that are tensioned only after some considerable deformation of the beam. Further research work is being undertaken in order to overcome the problems encountered and reported in this work. The technology used to produce the braided composite rods is being improved in order to allow the placement of straight fibers inside the braided fabric and to allow a better distribution of the resin. The samples are now being produced with a higher density of roving in the core so that the mechanical properties of the material may be improved. Also, the beams will be longer in order to enable four point bending tests to be performed so that the results obtained may be more representative.

Bibliography

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