THE ORIENTATION AND THE SLENDERNESS DATE PALM FIBERS EFFECT ON THE REINFORCED CONCRETE BEHAVIOR

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Abstract

At the aim of using vegetable fibers as much as biomaterial in the field of construction, we propose the use of date palm fiber (SAOURA region, Southwest ALGERIAN) as reinforcement of concrete. We have to study the physical and mechanical characteristics of date palm fiber reinforced concrete (DPFC), namely the tensile and compressive strengths, in addition the effect of some parameter such as the orientation and slenderness fiber on these characteristics.

The experimental results show that the reinforcement concrete with date palm fibers improves the behavior of the concrete. The orientation and the slenderness have also an effect on this behavior.

Keywords: (date palm fibers , concrete, orientation, slenderness, compressive and tensile strength)

1. Introduction

The reinforced concrete with fibers has a major importance especially with vegetable fiber such as (jute, sisal, bamboo…) [1]. Many studies find that these fibers have acceptable mechanical proprieties which allow using them as reinforcement for concrete [2]. These fibers have always been considered as promising reinforcement of cement matrices because of their availability, low cost and low power consumption. [3].

The research found that coconut fibers have been retained a higher percentage of their initial resistance than any other fiber after the specified exposure in different environments. [4].

Recent studies (2011) were made on composites of natural fibers, as an example, the study of Fernando Pacheco-Torgal and Said Jalali "cement-based building materials reinforced with plant fibers" on sisal fibers, bamboo and banana fibers. [5].

Afro-Asian countries have an enormous wealth of vegetable fibers such as date palm; these fibers have mechanical properties that can be used in technical fields [6]. In Algeria,

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every year after harvesting, these fibers are either thrown or burned, there are only a small percentage which is exploited by the artisanal production [7][8]..

2. Experimental Method

2.1 Material and methods used

1. The date palm fibers (Phoenix Dactylifera L.) are harvested in the region of SAOURA (Béchar, Algeria) and it's known as the date palm has a fibrous structure, the fibers that we used in this work are the fibers of the palm, exactly in the part called "leaflets" (Figure I). These fibers have a green or light green color, and a cross-section that can be considered rectangular, its characteristics are grouped in Table I.

Table I: Physical and mechanical properties of palm fiber

	Date palm fiber
Ttensile stress (MPa)	100
Length (mm)	40
Width (mm)	10
Thickness (mm)	0.55
Water content (%)	53
density (Kg/m3)	720
Absorption coefficient (%)	132

Figure I: date palm fibers (Leaflet)

2. The cement matrix used in this study is the concrete. For the concrete confection we chose the DREUX GORISSE method, where C/E = 1.89, the table II give the portion of the materials used in this confection.

Table II: Physical and the portion of the materials used in the concrete confection

	absolute density (t/m^3)	**Volume (L)**	**Mass (Kg)**
Cement	3.1	122.58	380
Send	2.6	263.11	673.2
Gravel (3/8)	2.65	117.71	306.9
Gravel (8/15)	2.72	311.58	834
Water	1.00	204.64	204.64
Fiber	0.72	/	5.79

2.2 Mechanical testing on reinforced concrete

For the mechanical proprieties of the concrete reinforced with date palm fibers, the compressive and flexion tests are chose.

Mechanical test were carried out, according the European standards EN 12390-3 and EN 12390-3.

3. Results and discussion

3.1 Tensile and Compressive reinforced concrete strengths

The test specimens used are prisms of 7x7x28 cm^3 for the flexion tests; however cubes of 10x10x10 cm^3 for the compressive tests, the age of the tests is 28 days.

The tensile strengths were calculated using a three point flexural test.

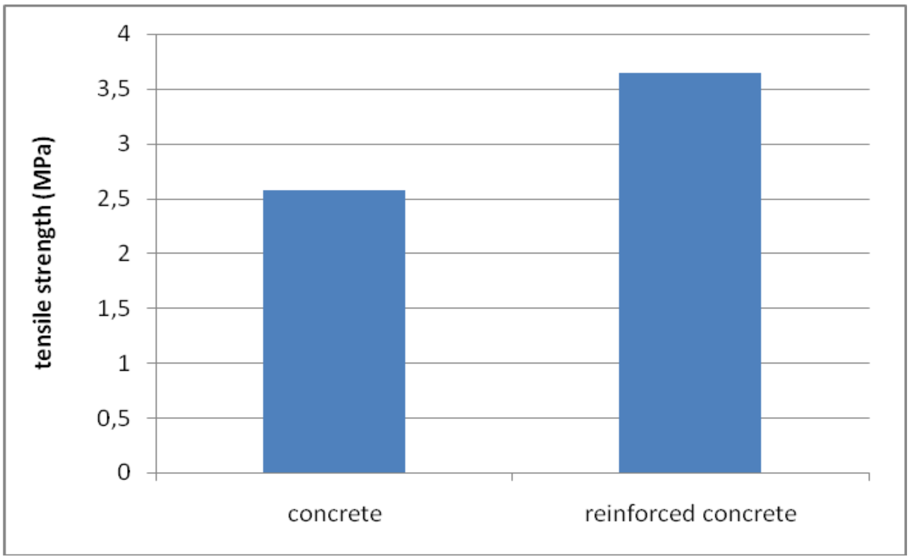

Figure II: tensile strength of reinforced and non reinforced concrete.

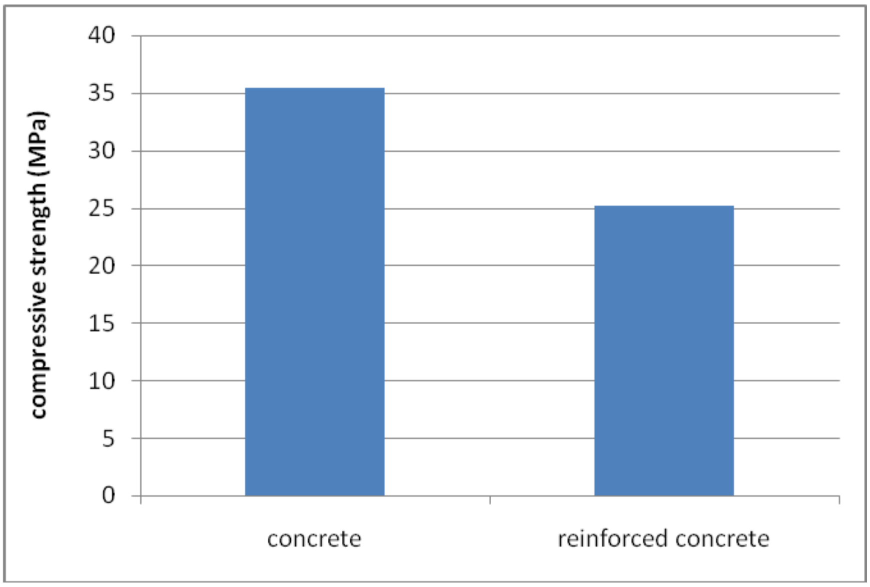

Figure III: compressive strength of reinforced and non reinforced concrete.

The results carried out show that the adding of the fiber on the concrete increases the tensile strength of the last, where it equal 3.64 MPa for a reinforced concrete, however it equal just 2.57 MPa for a normal concrete . These results encourage us to use this fiber as reinforcement. These fibers reduce the cracks formation even their size.

However the fibers reduce the concrete compressive strength nearly (30%) 35 MPa for a non reinforced concrete and 25MPa for reinforced concrete. This decrease in compressive strength is due to the fibers, which create voids inside the concrete therefore the decrease in compressive strength.

3.2 The fiber orientation effect on the concrete behavior

3.2.1 tensile strength

The figure IV shows the effect of fiber orientation on the behavior of the reinforced concrete in tensile; the fibers orientations are (0 °; 45 °; and the mixture). The orientation angle is considered the angle between the longitudinal axis of the specimen and the axis of the fiber; in addition the mixture means that the fibers are mixed with the constituents of the concrete during the mixing step.

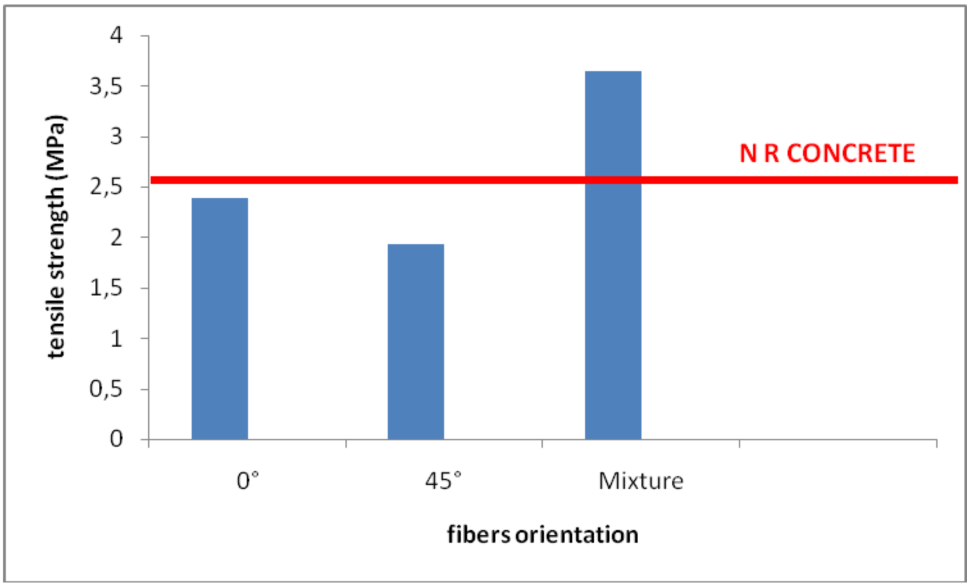

Figure IV: the concrete tensile strength versus the fibers orientations

At the test age of 28-day the results show that the addition of the fibers during the concrete mixing (mixing) give the best result of the tensile strength, where it's equal to 3.94 MPa. However it's equal only 2.39 and 1.93 MPa for the case of 0 ° and 45 ° respectively.

In the case of mixture, the fibers are distributed in all specimen directions, which gives the composite the ability to withstand tensile stresses, in addition the non-uniform distribution of the fibers minimizes the formation of voids caused by the fiber.

3.2.2 compressive strength

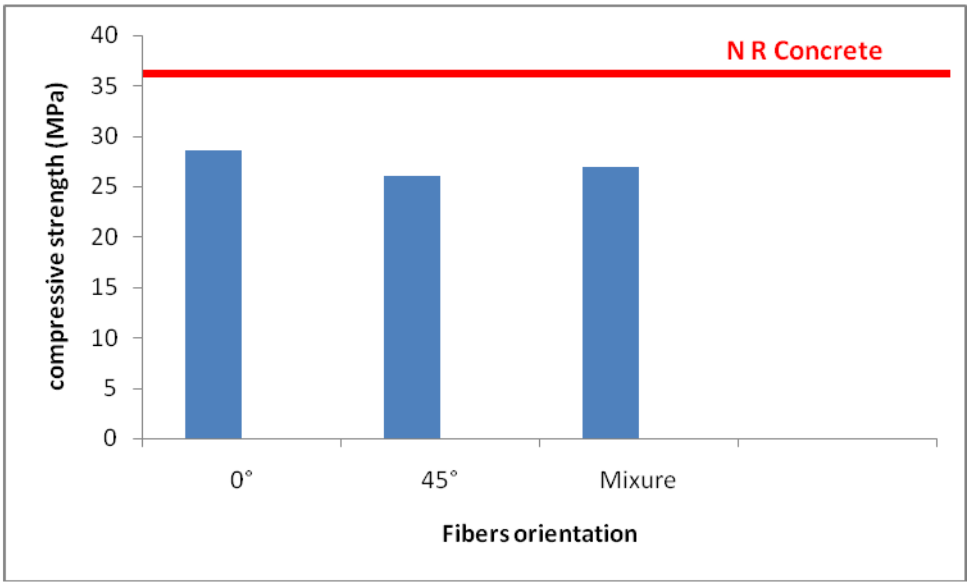

Figure V: the compressive strength of concrete according to the orientation of the fibers

For the compression test, the compressive strength of the composite is the same whether the fiber orientation (about 26 MPa), this is quite correct because the fiber is generally work on tensile.

On the other hand, the fiber reinforced concrete has a low compressive strength compared to concrete without the fibers (26 MPa and 35 MPa for reinforced and non reinforced concrete respectively).

3.3 The effect of the fiber slenderness

3.3.1 on tensile strength

To find the influence of the fiber slenderness on the behavior of reinforced concrete, flexion and compression tests were made on the reinforced concrete, including the slenderness of the fiber (ʎ is the length, width ratio) is variable between (2.6, 4 and 8).

Table II : The fiber slenderness

Sample	A	B	C
fiber slenderness	2.6	4	8

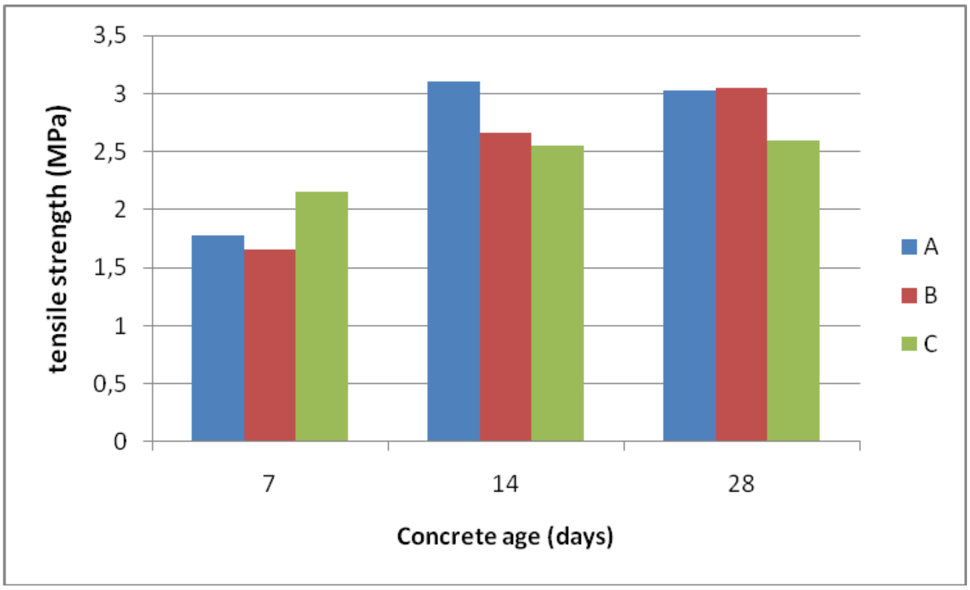

Figure VI: tensile strength of the fiber reinforced concrete according to their age with different fiber slenderness.

The results show that the slenderness ratio of the fiber has an effect on the behavior of the composite. In the early age, increasing slenderness leads to an increase in the tensile strength because the fiber strong slenderness ($\lambda = 8$) gives a maximum stress (2.15 MPa) compared to the other low slenderness. This increase in strength is due to the fiber that has a strong slenderness which is more flexible compared to the others; in added the distribution of these fibers is better than the others fibers distribution, which gives the composite a good flexion strength and consequently a good tensile strength.

In the other, and over the time, the fiber that has a strong slenderness represent a strength falling of the composite, however the others fibers slenderness give an increasing in the strength, this is quite correct because the strong slenderness makes the fiber more sensitive to the chemical cement attack on time, and therefore the degradation of their mechanical characteristics.

3.3.2 on compressive strength

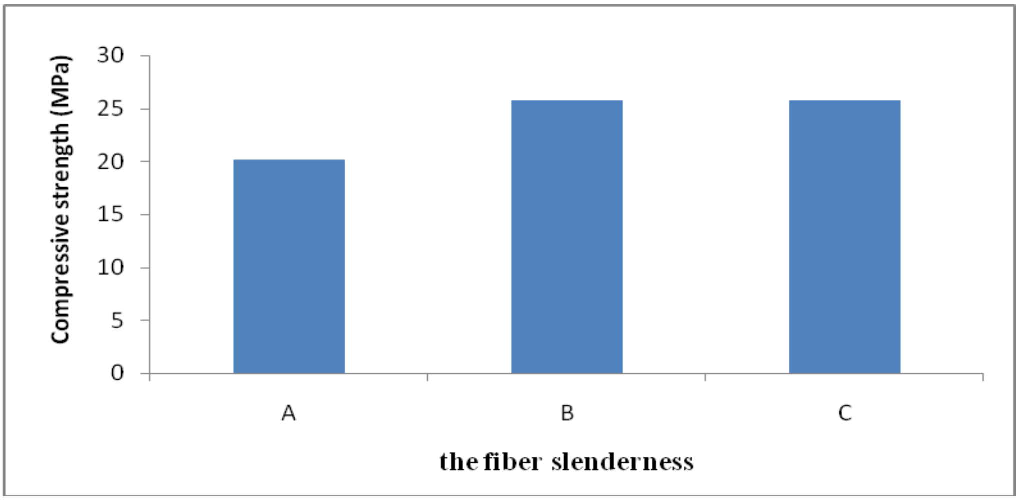

Figure VII : compressive strength of concrete according to the fiber slenderness.

The results of compression tests on the fiber reinforced concrete show that the increase of the fiber slenderness leads to an increase of the compression strength of the composite, where the fiber which have a slenderness ratio of 4 and 8 mark the best compressive strength. This increase in strength is due to the strong slenderness fibers that create fewer voids in the composite compared to the low slenderness fibers, in addition, these voids are well distributed throughout the volume of the composite, and consequently reducing the negative effect of fiber composite in the compression behavior.

4. Conclusion:

After this experimental work on the behavior of date palm fibers reinforced concrete we conclude that:

- The orientation of the fibers has an influence on the composite behavior, where the incorporation of the fibers during the mixing operation (mixture) gave the best tensile strength of the composite (3.64 MPa), this resistance is greater than that of the concrete without fiber.

For the compression behavior of the composite, the addition of fibers decreases the compressive strength of the composite by a percentage of 22% compared to the non reinforced concrete regardless of the orientation of these fibers.

- The slenderness of the fiber plays a very important role in the behavior of the composite, the fibers which have a strong slenderness give an increase in tensile strength of the composite at a young age, but a fall of resistance was observed during time due to the sensitivity of the fiber that has a strong slenderness in the cement alkaline environment.

The results of bending of reinforced concrete encourage us to use this kind of fibers for concrete reinforcement, also the fiber tensile stress (100) exceeds that of ordinary concrete which does not exceed (5 MPa).

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