SOME MECHANICAL PROPERTIES OF CONCRETE REINFORCED WITH REED FIBERS

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Abstract

This research produces a new results about using of locally available reed fibers in concrete. The main parameter of this study was the volume fraction of fibers. The reed fibers were added to the mix in percentages of 1, 2, 3, 4,and 6%. The test program included: slump, compressive strength, splitting tensile strength and impact resistance. It was found that the presence of reed fibers leads to reduce workability, compressive, splitting tensile and impact strength. It was also found that, generally, this reduction increases as the volume percentage of fibers is increased.

keywords: reed fibers, impact resistance, compressive strength, splitting tensile strength

بعض الخواص الميكانيكية للخرسانة المسلحة بألياف القصب

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الخلاصة

يقدم هذا البحث نتائج جديدة حول استخدام ألياف القصب المتوفرة محليا في الخرسانة . المتغير الرئيسي في هذه الدراسة هو النسبة الحجمية للألياف حيث أضيفت بنسب 1و 2و 3 و4 و6 % . تضمن برنامج العمل فحوصات الهطول و مقاومة الانضغاط ومقاومة الشد الانشطاري ومقاومة الصدم . أظهرت النتائج إن وجود ألياف القصب في الخلطة يؤدي إلى نقصان كل من قابلية التشغيل و مقاومة الانضغاط ومقاومة الشد الانشطاري ومقاومة الصدم وبصورة عامة يزداد هذا النقصان بزيادة النسبة الحجمية للألياف .

Introduction

There has been a rising interest in utilizing natural fibers for making low cost building materials in latest years. Some investigations (Aziz et.al, 1981, Mansur and Aziz, 1982, Mansur and Aziz, 1983, Soroushian et. Al, 1995) have previously been carried out on various mechanical properties of concrete materials using natural fibers from coconut, husk,sisal,bamboo, jute and cellulose fibers. These researches have shown encouraging results such as improved tensile and flexural strength of the matrix. Only very few studies have been carried out to use reed fibers for making a suitable building materials (Raouf and Mahdi, 2005) .

(Raouf, 1986) studied some mechanical properties of a reed. He concluded that the modulus of elasticity and tensile strength are relatively low and vary from 10 to 43 KN/mm^2 and 89 to 144 N/mm^2, respectively.

(Raouf and Mahdi, 2005) investigated the flexural behavior of reed reinforced concrete. They used concrete prisms (100*100*1000mm) reinforced with five strips of the reed (10mm wide and

3mm thickness). They concluded that the reed reinforcement does not affect the modulus of rupture but it changing the nature of failure from brittle to ductile.

In the present research, an attempt has been made to produce a concrete reinforced with reed fibers .

Test Program

This study consisted of determining the workability, compressive strength, splitting tensile strength, and impact resistance of reed fiber reinforced concrete. The concrete mix given in **Table 1** was designed according to ACI committee 544 recommendations (1988, 1993).

Materials

It is known that fibers have been produced from steel, plastic, glass, and natural materials in different shapes and sizes(ACI committee 544.1R,1982). In addition, when used in concrete, they should be discontinuous and discrete. In this research, the reed fibers, which are a type of natural fibers, were used. They were cut to the length of 60 mm and width of 5mm. The thickness was 1 mm. The average tensile strength and density of the fibers was 105 MPa and 580 kg / m^3, respectively.

Ordinary Portland cement produced in India conforming to Iraqi specification (IOS) NO.5 : 1984 was chosen. The compressive strength of this cement was 28.2 and 34.7 MPa at 3 and 7 days respectively. The fineness (Blaine) was 321 m^2/ kg.

The fine aggregate consisted of natural sand. The coarse aggregate from a type of gravel and 10 mm maximum was used. They conform to (IOS) NO.45:1984.

Test Specimens

The following specimens were made:

1- Eighteen (152mm) compression cubes.
2- Eighteen (152mm * 305mm) splitting tension cylinders.
3- Eighteen impact specimens (152 * 64 mm).

Test for Plastic and Hardened Concrete

The freshly mixed concrete was tested for slump according to ASTM C 143. The hardened concrete was tested for compressive strength , splitting tensile strength , and impact resistance at age of 28 days .

The compressive strength test was carried out according to B.S 1881 part 116 :1983.

The splitting tensile strength was determined according to ASTM C 496.

The impact resistance was measured by using the operation shown in **Figure 1** which is recommended by (ACI committee 544.2R, 1988). It consisted of (1) a standard 4.54 kg compaction hammer with a 475 mm drop (ASTM D1557), (2) a 64 mm diameter steel ball, and (3) a base plate with a positioning bracket and four positioning lugs. The specimen is placed on the base plate within the positioning lugs with its smooth surface down. The bracket is then bolted in place and the hardened steel ball is placed on top of the specimens. The compactor is placed with its base up on the steel ball. The test was performed on a smooth rigid floor to minimize loss due to bouncing . The hammer is dropped consecutively and the number of blows required to cause ultimate failure are recorded. Ultimate failure is reached when the cracks have opened sufficiently to make the specimen touch three of the four positioning lugs at the base plate.

Results and Discussion

A summary of the data obtained in the fresh and hardened tests is presented in **Table 2.**

Slump Test Results

Figure 2 shows the measured values of slump of fresh plain and fibrous mixes versus volume fraction of reed fibers . It is obvious from the figure that fresh mix workability is damaged by increasing the volume fraction of reed fibers. The reason of this behavior is that a part of mixing water is absorbed by the fibers. Additionally , interparticle friction of fibers and fibers and aggregates is an other factor reducing fresh mix workability of reed fiber reinforced concrete.

Compressive Strength Test Results

In Figure 3, the effect of reed fiber volume fraction on the compressive strength of concrete is shown. It can be seen that the presence of reed fibers is associated with decrease in strength. This decrease is 6.7, 27.3, 33.5, 34.4, 52.3% at 1, 2, 3, 4,6% fiber volume fraction, respectively. This can be attributed to the interlocking of fibers and consequently, formation of fiber balls which can be decreasing the density and then the strength of concrete.

Splitting Tensile Strength Test Results

The results of splitting tensile strength as a function of volume percentage of fibers is plotted in **Figure 4**. It can be observed that the splitting tensile strength decreases with increasing the percentage of reed fibers. This reduction may be attributed to the reduction in workability of the mixes and presence of fibers balling during mixing which lead to incomplete compaction and more voids. On the other hand , the comparatively low tensile strength and modulus of elasticity of this type of fibers is the reason of the no positive effect of this type of fibers on the tensile properties of concrete .

Impact Resistance Test Results

The influence of reed fiber content on the impact resistance at failure is shown in **Figure 5**. It can be seen from the figure that the presence of reed fibers in the concrete mixes gives a reduction in the impact resistance. The maximum reduction occurs at 2% volume of fibers and it is about 35.5 % comparing to the plain mix. The reason of this reduction is that the fibers tended to cluster together resulting in a more voids and less density. Again, as with the splitting tensile strength, the explanation of the no encouraging effect of the reed fibers on the impact resistance is the low its tensile strength and modulus of elasticity.

Conclusions

This study investigates the effect of volume fraction on the workability, compressive, splitting tensile and impact strength of reed fiber reinforced concrete.

The results have indicated that a decrease in workability, compressive, splitting tensile and impact strength could be achieved by the inclusion of reed fiber in concrete. It was found that this reduction is more pronounced when the amount of fibers is increased except that for impact resistance which is not follow the same trend.

The decrease in compressive strength is varied from 6.7 and 52.3 % at 1 and 6 % volume percentage of fibers, respectively while that for splitting tensile strength is 3.5 to 40 %. The maximum decrease in impact resistance occurs at 2 % volume of fibers . This decrease is 35.5 % relative to the corresponding plain specimens. .

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Table 1 : Mix proportions, Kg/ m^3

water	cement	sand	gravel	reed fibers, percent by volume				
				1	2	3	4	6
234	427	768	939	6	12	18	24	36

Table 2 : The test results

Mix	V_f (%)	Slump (mm)	28 Days compressive strength (MPa)	28 Days splitting tensile strength (MPa)	28 Days impact strength (number of blows)
1	0	160	32.5	3.67	45
2	1	150	30.3	3.54	41
3	2	140	23.6	3.20	29
4	3	80	21.6	2.87	33
5	4	60	21.3	2.63	32
6	6	40	15.5	2.20	40

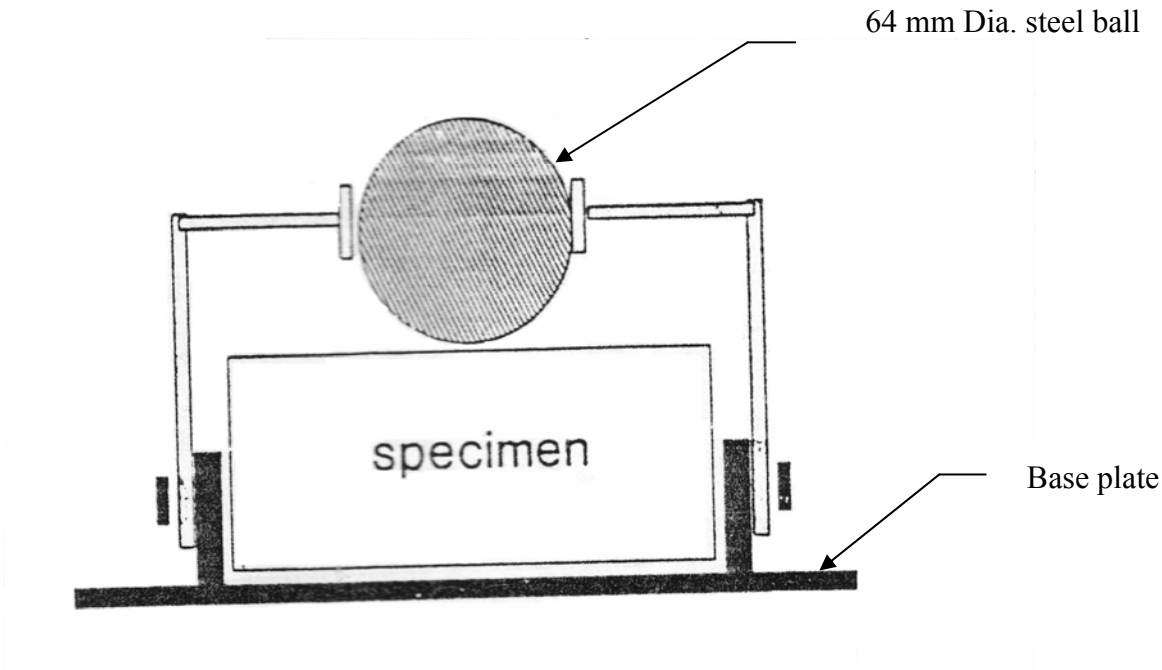

Figure 1: Impact test apparatus

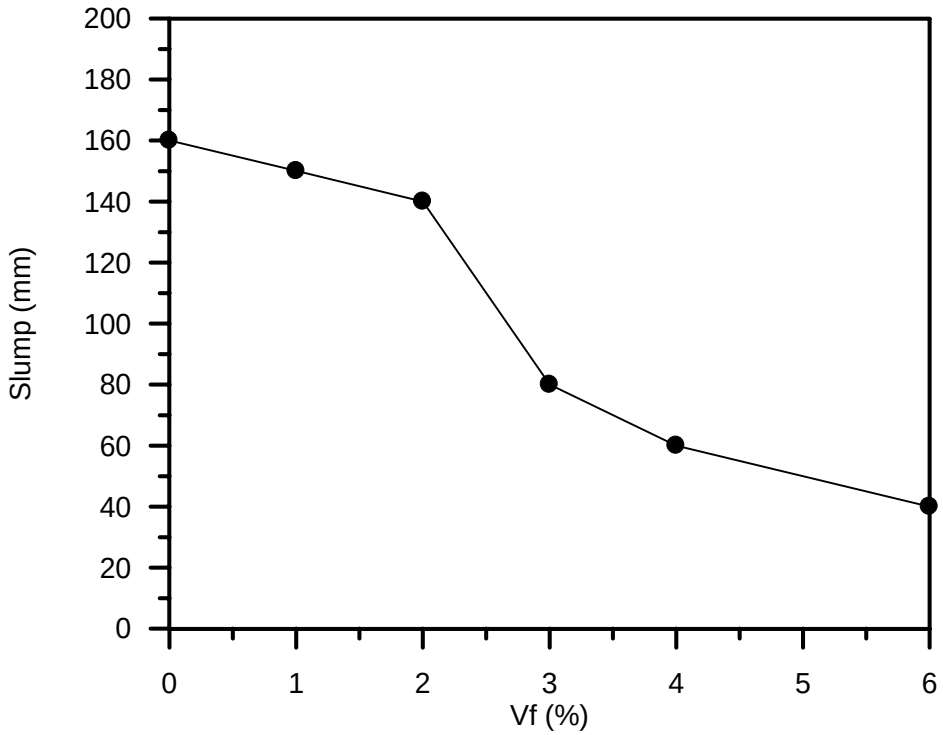

Figure 2 : Effect of volume fraction of reed fibers on the slump of concrete

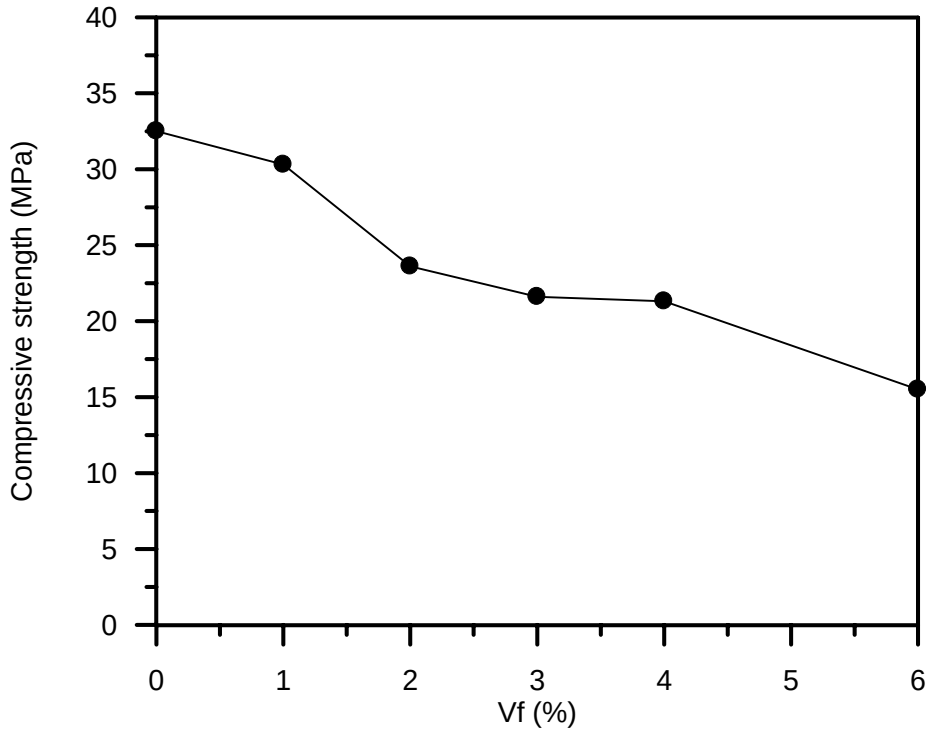

Figure 3 : Effect of volume fraction of reed fibers on the compressive strength of concrete

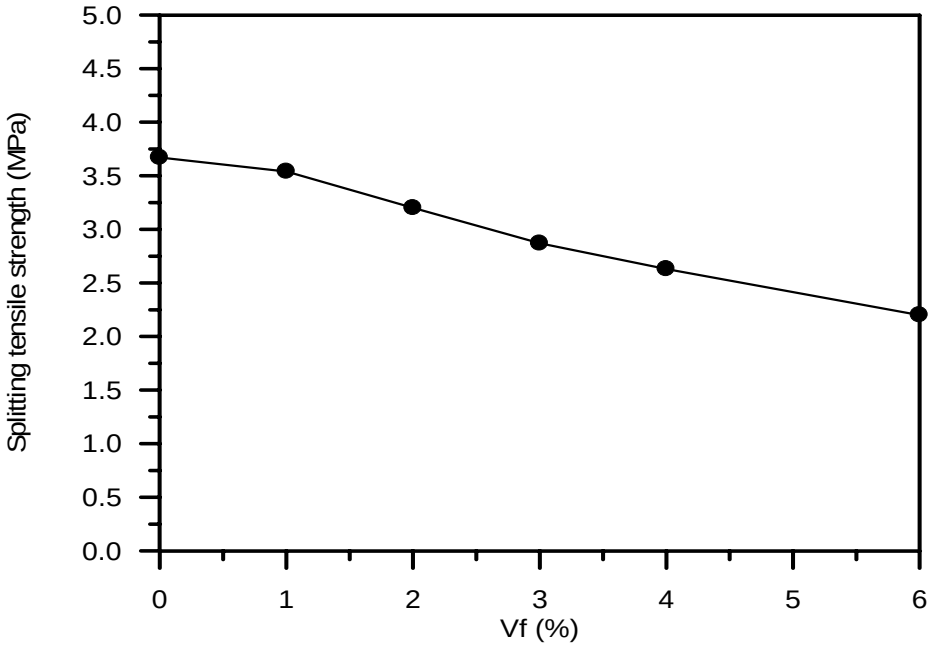

Figure 4 : Effect of volume fraction of reed fibers on the splitting tensile strength of concrete

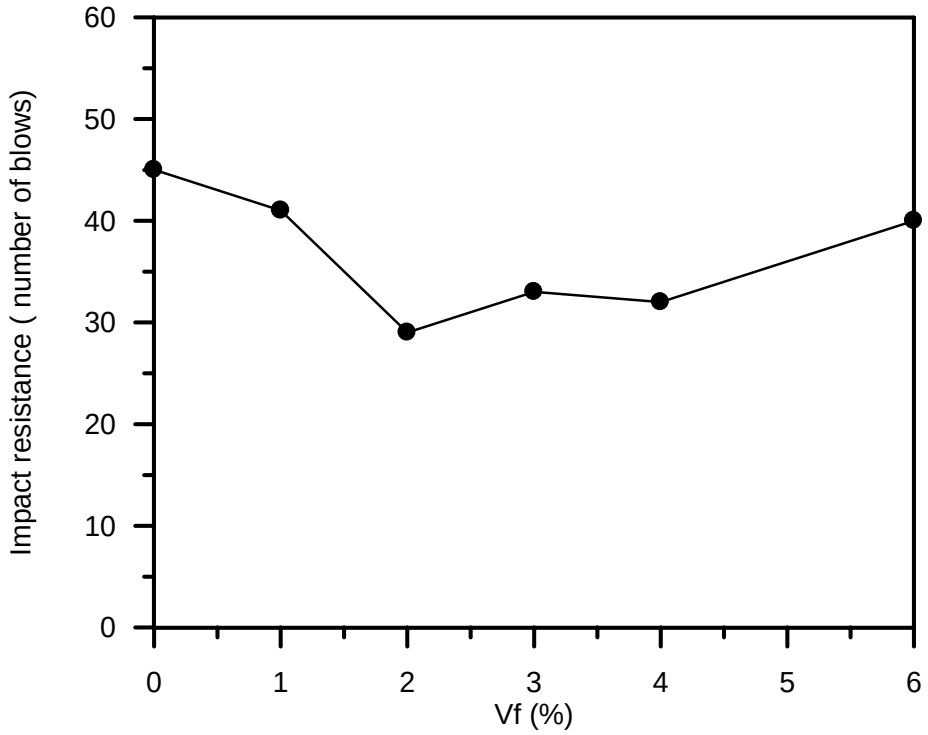

Figure 5 : Effect of volume fraction of reed fibers on the impact resistance of concrete