# Effect of Surface Treatment on the Behavior of Square Concrete Members Confined by JFRP Composites

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Abstract: This paper presents the behavior of concrete square columns reinforced by jute fibers fabrics composites. The fibers are treated for 24h in 2% of the KOH and 4% of the NaOH solution. Eighteen specimens are evaluated by using the compression test. The results are presented in terms of the ultimate load, and the composites morphology. An increase of the ultimate load capacity was noted in the case of specimens reinforced by fibers treated in 4% NaOH. On the other hand, the maximum load capacity noted a decrease in the case of specimens treated in 2% of KOH solution comparing to untreated ones. At the microscopic level, the resin was distributed uniformly in both cases of specimens in which the fibers are treated.

## 1 INTRODUCTION

The use of composites based on synthetic fibers for the rehabilitation of civil engineering structures has been successful in recent years (Al Nuaimi and al., 2020; Hawileh and al., 2011; Naser and al., 2012, 2019; Nawaz and al., 2016). Increases in both strength and rigidity as well as a reduction in cracks have been observed with the bonding of concrete by strips or fabrics based on fibers (carbon and glass) (Hawileh and al., 2015). However, these types of materials are not of natural origin because their production causes strong impacts on the environment. Faced with these problems, the trend in recent years is the gradual replacement of old materials by new ecological materials (Thakur and al., 2014). The use of natural fiber-reinforced polymer composites such as flax fibers, increases the maximum load-bearing capacity, ductility, and energy absorption capability (Cervantes and al., 2014; Chakraborty and al., 2013; Huang and al., 2016; Kumar and Sharma, 2007; Wang and al., 2019; Yan et al., 2013). According to (Tan and al., 2015), wrapping concrete columns with jute fibers reinforced polymer increased the ultimate load of the columns (Ed-dariy and al, 2020). Nevertheless, these fibers are hydrophilic, which confers low compatibility with resins and leads to a decrease in mechanical properties (Gholampour and Ozbakkaloglu, 2020; Sugiman and al., 2020).This negatively influences the quality of the fiber-matrix interface as the effectiveness of the reinforcement depends, to a large extent, on the charge transfer to the concrete-fiber interface. Hence, the improvement of this interface can enhance the behavior of the reinforced element and, in order to adjust it, the modification of the surface of fibers could be a solution (Ed-dariy and al, 2020). Several treatments can reduce the problems caused by the nature of the fiber namely, the chemical, thermal and mechanical treatments. The most used surface modification to improve the resistance is the alkali treatment(Gupta, 2020; Huang et al., 2016; Van de Weyenberg et al., 2006; Vinayagamoorthy, 2020). On the contrary, natural fibers can be destroyed by using the excessive treatment. (Benedetti and al., 2016; Salama et al.,

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2019, Ed-dariy and al, 2020). In this context, this study describes the mechanical behavior of square concrete members reinforced with composite materials using both untreated jute fibers and treated fibers in 2% potassium hydroxide and treated fibers in 4% NaOH solution, respectively. All the samples are subjected to the compression test. The materials and the methodology are presented in the first section. The second section resumes the results obtained from the compression test in terms of maximum load capacity and the third section illustrates the influence of alkali solution on the composite morphology.

# 2 METHODOLOGY

## 2.1 Treatment of Jute Fibers by Alkali Solution

The fibers are treated for the first category in a liquor ratio of 10:1 of 2% of KOH solution and for the second one in 4% of NaOH solution.The both of them have been left for 24 hours, under 88% of relative humidity and 18°C of temperature.

So as to remove residues of the alkali solution the fibers are washed in distilled water whose PH reaches 7 and they are dried for 6 hours at 100°C.

## 2.2 Preparation of Specimen

The jute fiber fabrics are applied to the concrete using the epoxy resin which the properties are presented on the table 1. The 4:1 is mixing ratio of the resin and hardener used. The samples are left for curing under the ambient conditions for 7 days.

# 3 TESTING

## 3.1 Compression Test

As presented on the Table. 2 the code abbreviations of the eighteen samples, which three are the reference specimens and the others ones reinforced with the Jute fibers fabrics. All the specimens are tested in the laboratory of Composite Materials, of the Faculty of Civil Engineering and Building Services, Gheorge Assachi Technical University, Iasi, Romania. And are subjected to the compression test which the loading speed applied was 4kN/s. The results are obtained using the data acquisition system Maxtest software.

Table 1: Properties of Sikadur 330

| Resin | Density Kg/dm$^3$ mixed | Compressive strength $fc$[MPa] | Tensile strength $ft$[MPa] | Module of elasticity $E$[GPa] | Elongation at break $\varepsilon_u$[%] |
|---|---|---|---|---|---|
| Sika-dur 330 | 1.3 | 30(7 days + 23°C) | 33.8 (7 days + 23°C) | 4.5 (7days + 23°C) | 0.9 |

Table 2: Abbreviations

| Code | Signification |
|---|---|
| C1-R | Plain concrete (reference) |
| C1-JFRP | JFRP reinforced concrete |
| C1-JFRP-NaOH | JFRP reinforced concrete with fibers treated during 24 hours in liquor ratio of 10:1 of 4% of NaOH |
| C5-R | Plain concrete (reference) |
| C5-JFRP | JFRP reinforced concrete |
| C5-JFRP-KOH | JFRP reinforced concrete with fibers treated during 24 hours in liquor ratio of 10:1 of 2% of KOH |

# 4 RESULTS

## 4.1 Maximum Load Capacity

Figures 1 and 2 represent the maximum load capacity for specimens reinforced with untreated fibers and with fibers treated in 4% of NaOH and 2% of KOH solution, respectively. The reinforcement of concrete with the JFRP composites, have increased the capacity of concrete from 294.2 kN to 332.2 kN as compared to unreinforced concrete members, which is an increase of 13%.

And in the case of treated fibers in 4% of NaOH solution, the capacity was increased from 294.2 to 357.9 kN, which is an increase of 21.65%. In the second category, the specimens reinforced by untreated jute fibers an increase of 14.63% of the concrete capacity was noted. A decrease of 13.91% was noted in the case of specimens reinforced who the fibers are treated in 2% of KOH (Fig.2).

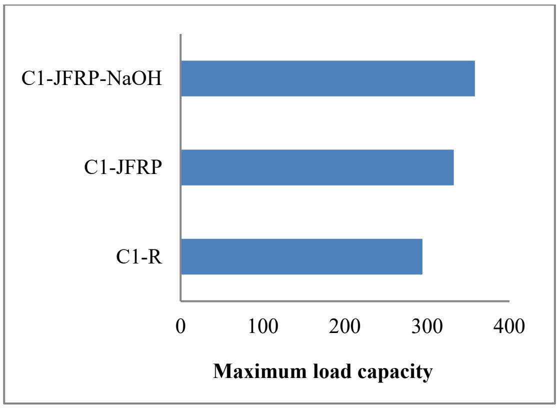



Figure 1: Maximum load capacity for specimens reinforced with fibers treated in 4% of NaOH solution.

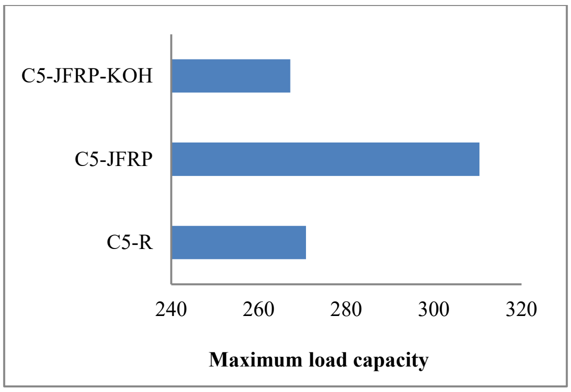
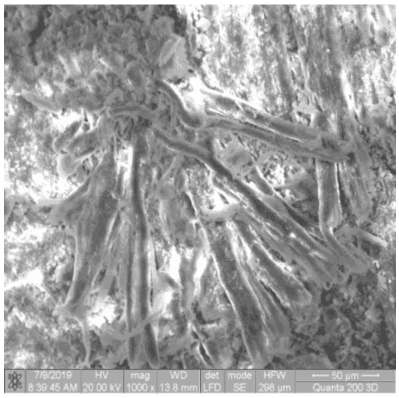
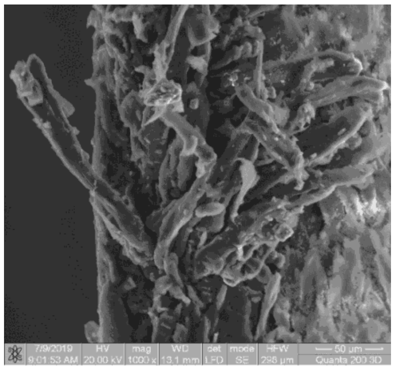


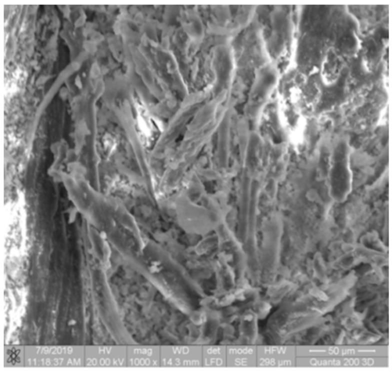

Figure 2: Maximum load capacity for specimens reinforced with fibers treated in 2% of KOH solution



a) Untreated fibers



b) Treated with NaOH



c) Treated with KOH

Figure 3: Microscopic (SEM) view of composites

## 4.2 Composites Morphology

The influence of the alkali treatment on composite morphology is presented on figure 3 which at the microscopic level, the resin was distributed correctly in both cases in the case of 2% of KOH and in the case of 4% NaOH. And as shown, the fibers treated are surrounded by more particles, which is not the case for untreated fibers, in which an average void ratio was observed between the fibers and the matrix. The increase in resistance shown in the case of fibers treated with 4% of NaOH can be explained that the improvement is due to a combination of a better mechanical connection by dint of a rougher topography and a larger number of individual fibrils (Van de Weyenberg and al., 2006). It's the effect of a better chemical bond due to the surface of the purified fiber, which made it possible to form more hydrogen bonds between the hydroxyl groups of the cellulose and the resin. On the other hand, the 2% of KOH was enough to degrade the fibers; this is why the maximum load capacity has noted a decrease.

# 5 CONCLUSIONS

The following conclusions are drawn from the results of this study:

- The reinforcement of the concrete using the jute fibers fabrics increase the maximum load capacity.
- Using 4% of NaOH can improve the properties of the fibres which lead to an increase of the maximum load capacity of the specimens
- The 2% of KOH deteriorates the properties of the fibers, which negatively influences the maximum load capacity of the specimens reinforced with Jute fibers fabrics.

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