

# Effect of Magnetized Water with Coconut Fibre Reinforced Concrete



C. Nived, M. Sherin Babu, P. Adithya Das, Noble M. Babu, and P. E. Kavitha

**Abstract** Sustainability is a wide accepted concept in modern construction scenario. Even though the construction industry is revolutionizing in a significant manner in terms of both equipment and materials used, the cost of construction has skyrocketed along with the deteriorative impact on environment. This resulted in the adoption of a more balanced approach with the environment which lead to the adoption of natural coconut fibre for the strength enhancement in concrete. Coconut fibre is available in abundance, which makes it quite viable as a reinforcement material in concrete. Significant changes in constituents and properties of concrete were initiated and Engineers started using coconut fibre as supplementary materials in concrete, often with adequate considerations. Through research and tests the change in properties of concrete when normal water is replaced by magnetic water is observed. The magnetized water helps in increasing the compressive strength in concrete and the problem of shrinkage crack formation due to the higher heat of hydration is eliminated by the addition of coconut fibre [1]. Addition of Coconut fibre helps in increasing the flexural strength of concrete. The magnetized water contributes to higher strength characteristics of the concrete and fibre being natural in origin is ecologically sustainable and can bring down the global carbon footprint quite effectively.

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## 1 Introduction

Concrete is most widely used man-made construction material in the world. Recent studies show variation strength of concrete with type of water used. The construction industry is revolutionizing in two major ways. One way is the development of construction techniques, such as using automated tools in construction. The other is the advancement in high-performance construction materials, such as the introduction of high strength concrete. Among these high-performance materials, fibre reinforced concrete (FRC) is gradually gaining acceptance from civil engineers. In recent years, research and development of fibers and matrix materials and fabrication process related to construction industry have grown rapidly. Their advantages over other construction materials are their high tensile strength to weight ratio, ability to be molded into various shapes and potential resistance to environmental conditions, resulting in potentially low maintenance cost. These properties make FRC composite a good alternative for innovative construction. They are also non-abrasive in nature, cheap and easily available. Research work is being carried out to find the possibility of coconut-fibre as a vertical reinforcement in mortar-free interlocking structures. This is believed to be a cost-effective solution to earthquake-resistant housing. This study aims to investigate the effect of using magnetized water on concrete reinforced with processed coconut fibre. The objective is to compare the engineering properties of magnetized water concrete and concrete with ordinary tap water.

## 2 Constituent Materials

The constituent materials used are cement, coarse aggregates, fine aggregates, magnetized water, and coconut fiber.

Cement used was OPC 53 grade Dalmia cement. Tests were conducted to make sure that the cement was up to the Indian standard of specification. The Specific gravity of Cement was found out to be 3.19. Fineness modulus was 6% and the initial setting time of cement mortar was 42 min.

M-sand was used as fine aggregate. Tests were conducted and the results obtained are mentioned below: Specific gravity: 2.5, Fineness modulus: 2.7, Water absorption: 1.10% and conforming to grading zone-II (Fig. 1).

Coarse aggregate of 20 mm nominal size were used and the specific gravity was found out to be 2.71. The water absorption was 0.6%. The results of tests were acceptable and the materials were proven to meet the required standards.

The admixture used is Viscosity modifying admixture (VMA). Coconut fibre was processed and combined before adding.

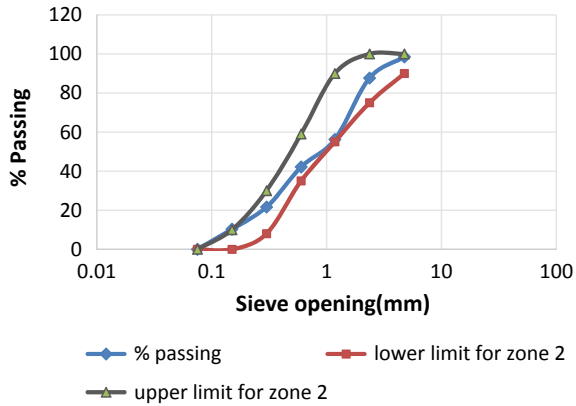


Fig. 1 Particle distribution curve for fine aggregate

### 2.1 Magnetized Water

For magnetizing water it is circulated through a magnetic field of 1 T. The effect of magnetizing is influenced by the time of exposure [2]. Water is magnetized for 24 h, 48 h, 72 h and 96 h. The magnetic field can break down these water clusters and reduce the bond angle and hence increase solubility [3]. The magnetized water shows greater value for pH. In other words pH value indicates whether the water is magnetized or not.

PermagN-406 is for magnetizing water at constant magnetic field. The set up consist of a motor, pumps for circulating water and a magnetizer (Fig. 2). The exposure time for magnetizing was 24 h, 48 h, 72 h and 96 h [4].

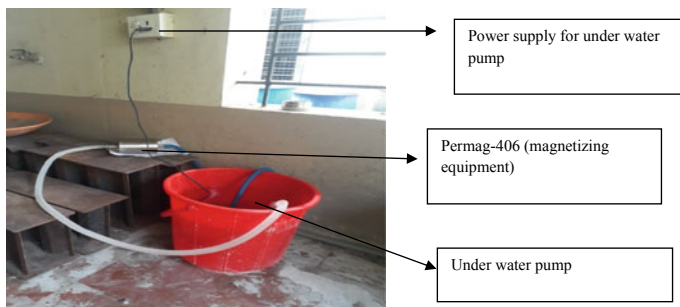


Fig. 2 Magnetization setup

## 2.2 Coconut Fibre (Fig. 3)

The advantages of coconut fibre are its low cost, reasonable specific strength, low density, ease of availability, enhanced energy recovery, biodegradability and its ability to be recycled in nature in a carbon neutral manner [5].

## 3 Test on Material Properties

### On Magnetized Water:

**PH and Hardness test:** Increase in pH value will change the nature of water from acidic to basic which decreases the corrosion rate (Fig. 4) [6]. Hardness decreases with magnetization which shows induction of magnetic flux in water changes the property of hardness (Fig. 5) [7].



Fig. 3 Processed and combed coconut fibre

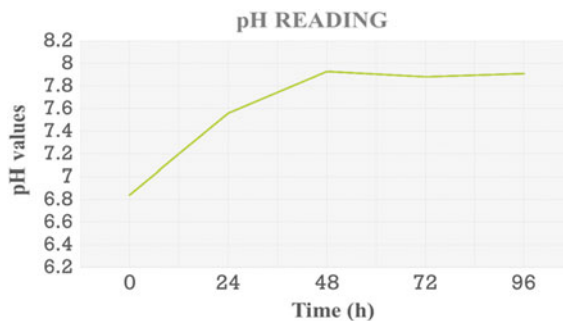


Fig. 4 Variation of pH value with duration of applied magnetic flux

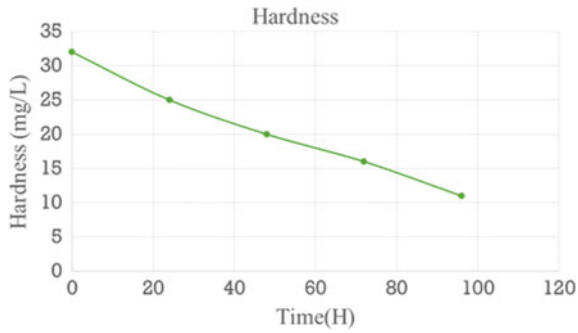


Fig. 5 Variation of hardness with duration of applied magnetic flux

**On Coconut Fibre:**

**Water absorption test:** Obtained water absorption is 111.76%.

**Workability:** Good workability of 18.75% is obtained for magnetized concrete mix with coconut fibre when comparing to normal water concrete with coconut fibre.

**4 Test Procedure**

Tests on cement, coarse aggregate and fine aggregate are conducted to ensure that they meet quality standards. Water is magnetised and tested using the pH meter.

Mix design used as per IS 10262:2019 [8] is of M 20 grade, cement grade: 53, size of aggregate: 20 mm, W/C: 0.45 (by experience) using viscosity modifying admixture as chemical admixture. Trial and error method is adopted to arrive at the suitable normal concrete mix. Hence arrived at different mix proportions, Trial mix 1 = 1:3.7:2.04:0.45, Trial mix 2 = 1:3.23:1.76:0.4, Trial mix 3 = 1:2.95:1.62:0.4 the strength of which is tabulated below (Table 1).

From the obtained values it is evident that trial mix 3 has greater strength and good workability than the other two mixes hence arrived at trial mix 3.

Compressive strength of cubes (M20 grade) are tested with specimens made with magnetized water with varying magnetising time (0 h, 24 h, 48 h, 72 h, 96 h). The optimum time for magnetisation is obtained. Concrete mix is made with varying

Table 1 Compressive strength of trial mix done in concrete cubes (Fig. 6)

Mix	7th day strength (MPa)	28th day strength	Slump
Trial mix 1	16.07	17.00	Shear slump (65 mm)
Trial mix 2	19.29	21.64	Shear slump (78 mm)
Trial mix 3	20.89	29.71	True slump (98 mm)



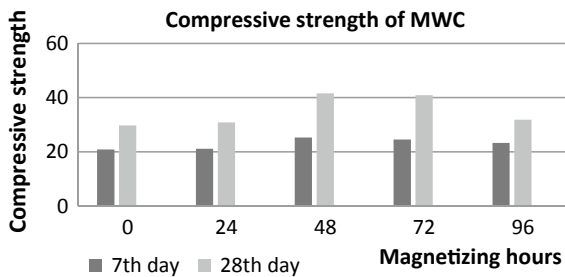
**Fig. 6** Cubes for testing

coconut fibre content (3%, 5%, and 7%) and tests are conducted. Sustainable concrete mix is obtained.

## 5 Result and Discussions

### 5.1 Effect of Magnetized Water on Concrete

The compressive strength of cube specimens is obtained from compression testing machine. Instead of normal water the water is magnetized for 24 hrs, 48 hrs, 72 hrs and 96 hours for casting cubes to get desirable result (Fig. 7). The compressive strength of magnetized concrete is tabulated below



**Fig. 7** Compressive strength versus magnetization hours

**Table 2** Increase in strength of 7th and 28th day of MWC (cube test)

Magnetization (h)	pH of water	7th day compressive strength (MPa)	Increase in strength (%)	28th day compressive strength (MPa)	Increase in strength (%)
0	6.84	20.89	–	29.71	–
24	7.56	21.12	1.11	30.87	3.90
48	7.93	25.29	21.06	41.60	40.02
72	7.82	24.51	17.33	40.90	37.66
96	7.43	23.31	11.58	31.83	7.14

**Table 3** 28th day flexural strength on magnetized water concrete

Specimen No.	Flexural strength	Average
1	3.4	3.53
2	3.8	
3	3.8	

## 5.2 Effect of Magnetized Water Without Coconut Fibre

Flexural strength test after 28 days of curing was performed on 3 beams of magnetized water concrete. The results are tabulated below

## 5.3 Effect of Magnetized Water Concrete with Coconut Fibre

Trial mix 1 and trial mix 2 gave shear slump of 65 mm and 78 mm respectively (Table 1), which are not within the range. Hence were rejected. In trial mix 3 mix proportion obtained is 1:1.61:2.95:0.4, slump obtained is 98 mm using 3.96 mL admixture, which is in the required range. The 28th day Strength obtained is 29.71 MPa. Hence it is accepted. Permagan-406 is used as the magnetizer. Increased strength of 21.06% and 40.02% were obtained in 48 h and after there is a decrease of 3.01% and 2.36% in 7th and 28th day's compressive strength respectively (Table 2). For 2.5 cm fiber [9] Optimum flexural strength is obtained for 5% of coconut fibre (Table 4; Fig. 8).

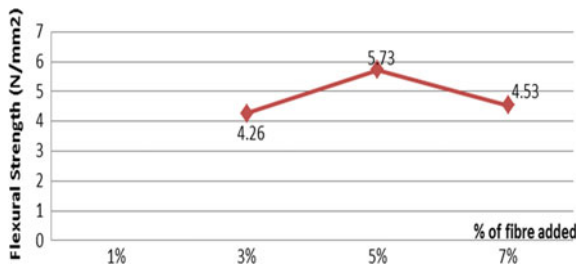
## 6 Conclusions

The following conclusions are derived based on the present study;

- It is observed that magnetization of water from zero to 96 h increased pH from 6.84 to 7.91. Hence it is inferred that the process of magnetization causes an

**Table 4** 28th day flexural strength of 48 h magnetized water concrete (coconut fibre induced)

Length	Percentage of coconut fibre (%)	Specimen No.	28th day flexural strength	Average
2.5 cm	3	1	4.20	4.26
		2	4.40	
		3	4.20	
	5	1	5.80	5.73
		2	5.80	
		3	5.60	
	7	1	4.40	4.53
		2	4.60	
		3	4.60	



**Fig. 8** Graph showing variation of flexural strength with % fibre added

increase in pH value of water making the water more basic in nature and is highly recommended in concreting.

- It is also observed that the slump of concrete mix increased from 98 to 100 mm when magnetized water is used instead of ordinary water. Hence magnetized water is recommended in concrete to improve the workability of concrete.
- Coconut fibre, a sustainable addition to improve the flexural strength of concrete has been selected for the present investigation and its disadvantage of excessive water absorption of 11.5% is overcome by using saturated surface dry coconut fibre instead of dry fibre.
- A commonly observed disadvantage of fibre reinforced concrete is its reduced workability [10]. In the present study the slump value of 80 mm is increase to 85 mm. Thus the disadvantage of fibre reinforced concrete is overcome in the present study by the incorporation of magnetic water.
- Studies on strength characteristics showed that Increased strength of 21.06% and 40.02% were obtained in 48 h magnetization and after there is a decrease of 3.01% and 2.36% in 7th and 28th day’s compressive strength respectively (Table 4).
- Based on the studies it is evident that coconut fibre reinforced shows an increased compressive strength and flexural strength (Fig. 8) compared to ordinary concrete



and its disadvantage of low workability can be overcome by the use of magnetized water.

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