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A Study On Influence Of Magnetic Water On The Strength Characteristics Of Concrete.

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ABSTRACT

In the near future it is expected that in civil engineering, structures will have to be constructed with the concept of sustainable development through the optimal use of raw materials with low impact to the environment and also at a reasonable cost. Therefore, researchers are always finding new ways to improve the use of raw materials in concrete which in turn improves sustainability. This led to the use of magnetic water in concrete. The use of magnetic water in concrete is an evolving technique being used by concrete technologists and engineers in the aim of producing high workable concrete. Thus, the influence of magnetic water on the strength properties of concrete were examined. The magnetic water was produced in the laboratory using a simple setup. Concrete cubes were made with magnetic water and tested. The results show that there is an increase in the compressive strength of concrete compared to the concrete with ordinary water. Also, there is a reduction in the use of cement when the cubes were made with magnetic water for the specified compressive strength. Also, the slump values of concrete made with magnetic water were found to be higher than the concrete samples made with ordinary water.

Keywords: Compressive strength, Concrete, Magnetic/ magnetized water, Slump, Workability

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INTRODUCTION

The consumption of water is increasing as the population grows. Water consumption is essential in all the sectors and the industrial sector is in second place with 20% water consumption following the agricultural sector with 70% water use. In concrete water plays a crucial role starting from initiating the hydration process to proper curing and required strength achievement. Also, workability and durability depend on the water used in making the concrete. Drinking water is mainly used to avoid impurities and other deleterious materials to deter the strength of concrete. Utilization of magnetized water in concrete shows promising potentials in saving the amount of water used in concrete production [1]. When water flows through a magnetic field at a specified speed, it gets magnetized and thus magnetic water is produced. Much of the research is being conducted in Russia, China, and Japan with the aim to improve the concrete's workability, compressive strength, impermeability, free- thaw resistance and also to accelerate the hydration reaction [2-10].

Magnetic water

The magnetic water is produced by passing a stream of water through a magnetic flux at a constant speed. The level of magnetization of the water is controlled by three factors namely magnetic flux density, duration of exposure of water to the magnetic field and the amount of exposure of water to the magnetic field [11]. When the magnetic field is applied, the structure of water is aligned in one direction and the size of the molecules changes as the bond angle between oxygen and hydrogen molecules changes which in turn increases the viscosity and surface area of the water and thus the hydration increases. On examining the effect of the static magnetic field, stronger hydrogen bonds were found to be formed due to the broken hydrogen bonds caused by the magnetization. This caused a cluster of water molecules to be formed which increased the viscosity of the magnetic water. Since there is a reduction in the size of water molecules, the water layer which surrounds the cement becomes thin when compared to the normal water molecules thereby reducing the water demand for the preparation of concrete [12].

Chemical molecular configuration of the magnetized water

A material is said to be magnetized only when its molecules can be aligned in a certain direction when an external magnetic field is applied. In a liquid or gas, this phenomenon can occur when the molecules process an odd number of electrons. But a water molecule has ten electrons which makes it a diamagnetic material, meaning the electrons are not attracted to the magnetic field. Instead, the electrons are repelled, and the water molecules get oriented in the opposite direction. Figure 1 shows the structure of a water molecule and the bond angle between the oxygen and hydrogen atom is nearly 105° and when the magnetic field is applied the bond breaks and gets decreases below 105° [12].

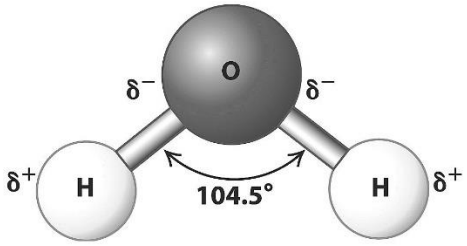

Figure 1 Structure of water molecule

EXPERIMENTAL STUDY

Materials and preparation of specimens

The magnetic water in this experimental research was produced in the laboratory using a simple setup [13]. The magnetizing equipment consist of n35 magnets of size 50 mm x 9 mm x 9 mm and were placed inside the two grooves with the aim of producing a magnetic field of strength 2T and a PVC pipe of 25mm diameter was setup between the groves through which water flows and get magnetized which is shown in Figure 2.

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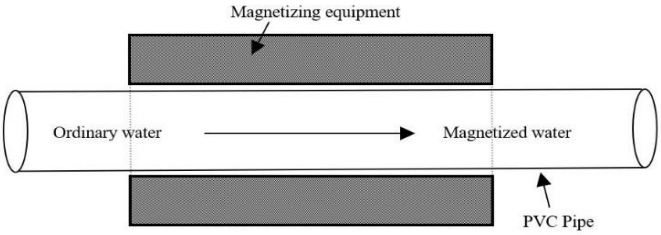

Figure 2 Schematic representation of magnetization

Concrete with characteristic strength of 40 N/mm^2 was used in this study. Three different mix ratios- 0.45, 0.5 and 0.55 were used on six concrete mixes in which three samples were made with normal water and three samples were made with magnetized water. Ordinary Portland Cement of grade 53 was used as the binding material and the coarse and fine aggregates used were according to the standards specified in IS 10262 [14]. After the materials were procured, fineness and initial and final setting time of the cement were checked to meet the requirements. Also, for coarse and fine aggregates, specific gravity and water absorption were checked to meet the standards. Sieve analysis test was conducted to check the grading of fine aggregates. All the tests were conducted as per the IS standards [15-19] . Normal tap water as per specified in the code and magnetized water were used in the preparation of cubes. Six cubes of size 150mm x 150mm x 150mm were cast and cured for 28 days.

Testing of specimens

First, the slump test was conducted on fresh concrete to study the effect of magnetic water on the workability of concrete. Six mixes were tested for slump and the results were tabulated in Table 1. Compressive strength was conducted on the cast cubes after 28 days of curing using the standard compression testing machine to study the influence of magnetic water on one of the main characteristic property of concrete. The results of the compressive test were tabulated in Table 2.

RESULTS AND DISCUSSION

Slump test

The results of the slump test were tabulated in Table 1 and the graph (Figure 3) shows the influence of magnetic water on the workability of fresh concrete. For a nominal mix with ordinary water, a slump value of 110 mm was observed. From the graph, it can be seen that the magnetic water has clearly amplified the slump value of concrete indicating higher workability. The slump value increases by 19% for 0.45 w/c ratio, 16% for 0.5 w/c ratio and 14% for 0.55 w/c ratio compared to the normal concrete. The test results obtained compiles with the results from the literature which states that the increase in the slump value has been attributed to the fact of the increase in viscosity and surface area of magnetic water.

Table 1: Slump values

w/c ratio	Slump values (mm)	
	Normal water	Magnetic water
0.45	90	107
0.50	106	124
0.55	121	138

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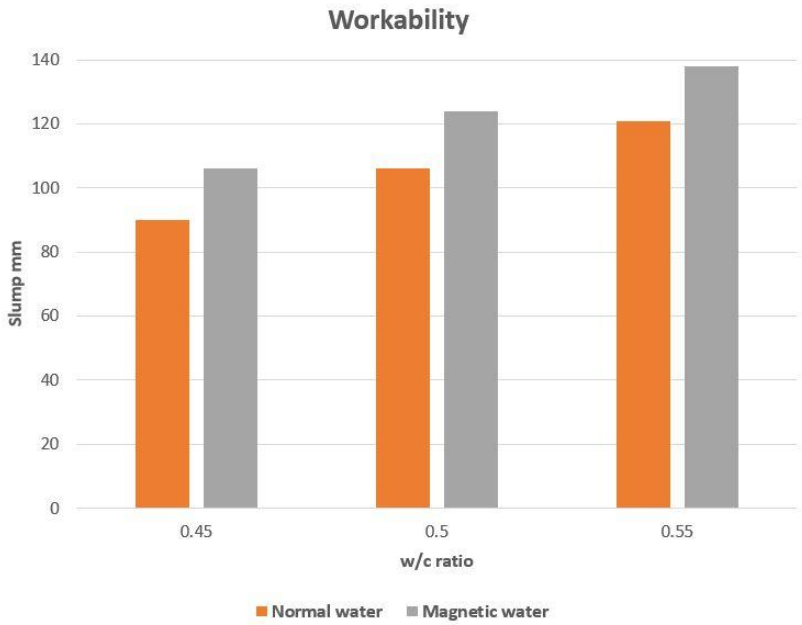

Figure 3 Variation of slump with w/c ratio

Water absorption

Before testing, the average weight of the cube specimens was recorded and examined. The graph (Figure 4) shows the effect of magnetic water on the concrete weight. The weight of concrete is expected to increase with age as it gets solidified. The mix with 0.45 w/c ratio has the lowest weight in the group. This can be attributed the fact that during magnetization the molecules break into much smaller and hence the lower volume. A reduction in weight of 15% for 0.45 w/c ratio, 13% for 0.5% w/c ratio and 10% for 0.55 w/c ratio. Thus, the reduction in weight proves that the use of magnetic water reduces the consumption of water in preparation of concrete.

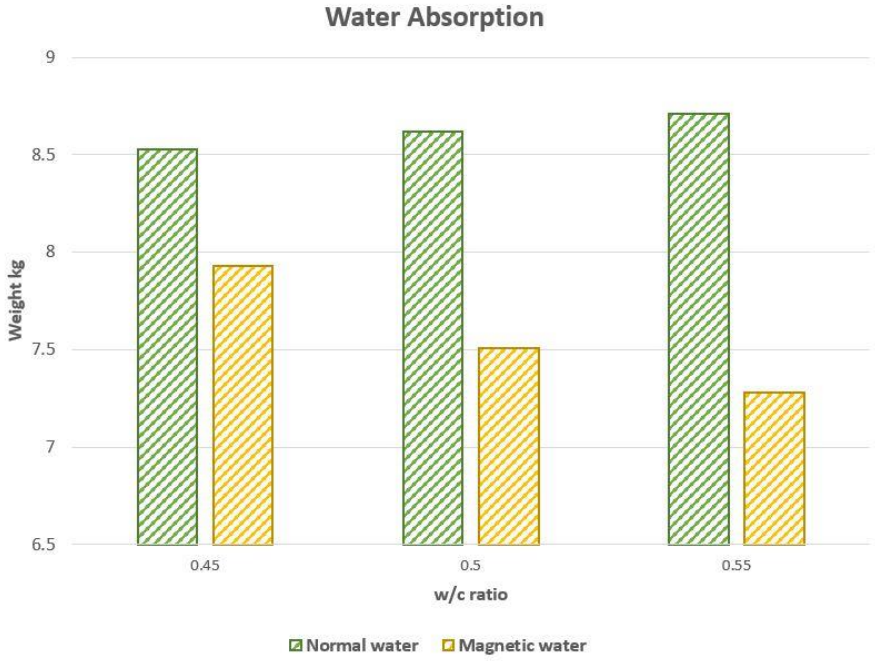

Figure 4 Variation in weight of concrete with different w/c ratio

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Compressive strength

Six cubes were tested, and the results were tabulated in Table 2. The graph (Figure 5) shows the effect of magnetic water on the compressive strength of concrete. From the graph, it can be seen that the compressive strength increased with the increase in water cement ratio. Comparing the results of the compressive strength of concrete for nominal mix and the mix with the magnetic water, the magnetized water has improved the compressive strength by an average of 20% for all the water-cement ratios used in this experiment. This can be attributed to the fact that the magnetization caused a higher spreading of particles which was observed from the increased slump, which in turn implies that with the reduced cement content, the same water reacts with the entire concrete content.

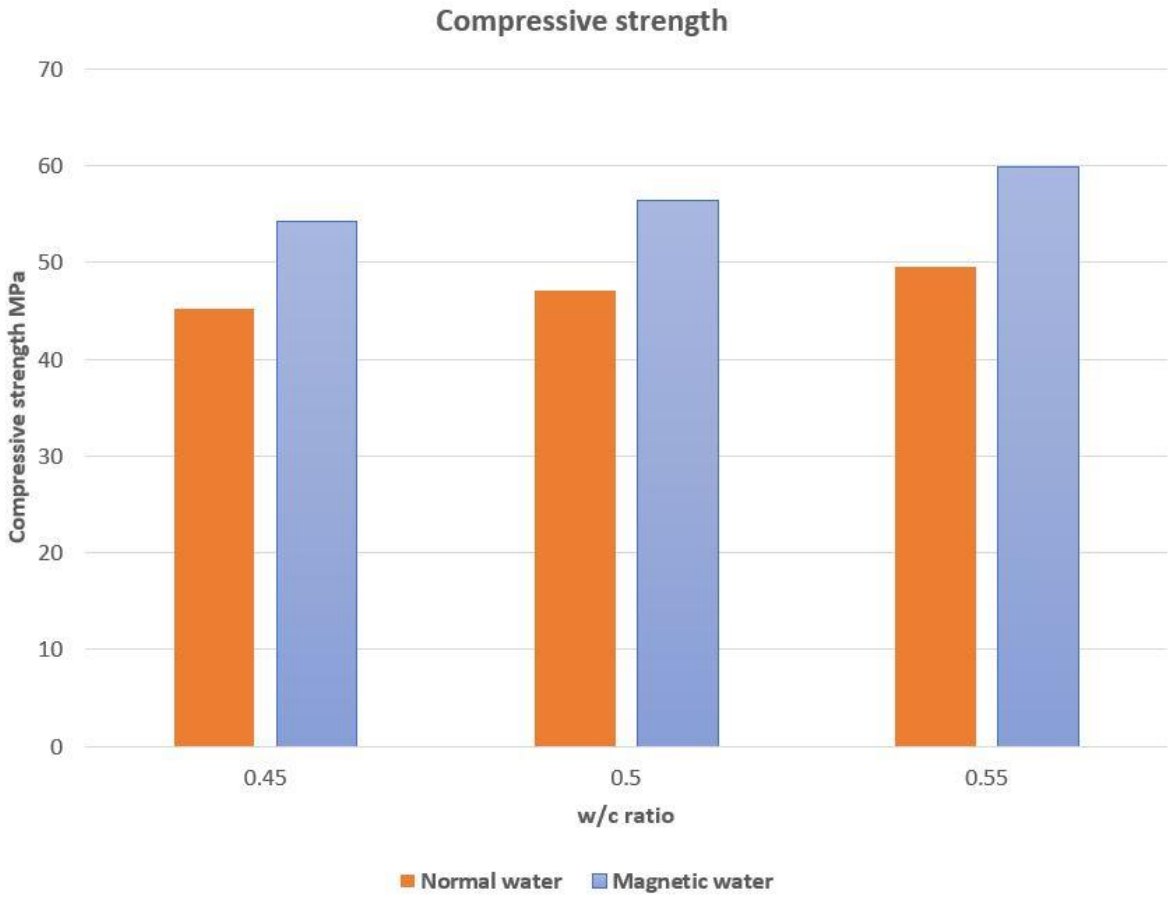

Figure 5 Variation of compressive strength with w/c ratios

Table 2: Results of the compression test

w/c ratio	Compressive strength MPa	
	Normal water	Magnetic water
0.45	45.23	54.26
0.50	47.12	56.41
0.55	49.57	59.83

CONCLUSION

The effect of magnetic effect on the strength parameters of the concrete was studied and the following conclusions were made:

- The magnetic water can be effectively used to enhance the strength of concrete thus encouraging sustainable use.
- The workability of concrete was improved on an average of about 12% compared to the nominal mix.
- The concrete cube's weight approximately reduced by 13% with the use of magnetic water.
- Compressive strength is increased up to 20% with the utilization of magnetized water in concrete.
- Cement content can also be considerably reduced when magnetic water used in the production of concrete thereby reducing the use of raw materials.

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