An Experimental Study on Use of Magnetic Water in Concrete

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Abstract— Normal water treated with a magnetic field to change water properties and that water mix to concrete it improve concrete properties. The magnetic water process charges the water particles, reducing the cluster size of water molecules from 13 to approximately 5 or 6. This paper focuses on assessing water quality standards through physiochemical analyses, including measurements of electrical conductivity, pH, and total dissolved solids, under varying exposure times to the magnetic field. The study evaluates the fresh, hardened, and microstructural characteristics of concrete made with magnetic water, utilizing a permanent magnet with a strength of 1000 Gauss. M-sand is used as the fine aggregate to examine the effects of magnetized water on the quality, strength, and suitability for M20 grade concrete. Results indicate that increasing the exposure duration of water to the magnetic field leads to significant improvements in concrete properties, including enhanced workability and compressive strength. This suggests that replacing normal water with magnetic water in concrete mixes could reduce the quantity of cement required, making it a more sustainable and environmentally friendly construction material for the future.

Index Terms- Magnetic water, pH, TDS, EC, Compressive strength, tensile strength and flexural strength.

I. INTRODUCTION

In this paper, introduced utilizing normal tap water treated with a magnetic field to improve concrete properties. The magnetic water process charges the water particles, reducing the cluster size of water molecules. This reduction in water cluster size decreases water hardness, which in turn enhances the strength of concrete compared to mixes using regular water. Large water clusters are broken down to form smaller clusters or single water molecules Due to magnetization, the optical properties of water and infrared absorption property become altered. In addition, the physiochemical properties of the magnetic water are considerably changed due to magnetization. For instance, water conductivity is increased, but the surface tension is decreased. Hence, this paper focuses on the physiochemical properties of water such as pH, Electrical Conductivity and Total Dissolved Solids before and after magnetization and the results are compared. Here, locally available normal water was considered, and the magnetized water was prepared using the permanent magnet of 1000 gauss intensity at different exposure periods, the role of the applied magnetic field was maintained from instant magnetic water exposure and the results were optimized. Then, the magnetic water was used to prepare M20-grade concrete, and its effect on fresh and hardened properties was evaluated. The significant contributions of this project are to replace normal tap water with magnetically treated water in the preparation of concrete mixes and to evaluate its effect on fresh and hardened concrete properties through water magnetization.

II. EXPERIMENTAL INVESTIGATION

2.1 ORDINARY PORTLAND CEMENT (OPC)

The binding material of Ordinary Portland Cement (opc) of grade 53 is used for this present study for concrete mix. The specific gravity of cement is found as 3.15 and the standard consistency was 40%. The various results conduct on the cement are shown in table 1. The cement used in this study is fresh and without any lumps.

Table -1: properties of cement

FINENESS	225m^2/s
SETTING TIME(INITIAL)	30min(min)

SETTING TIME(FINAL)	600min(max)
COMPRESSIVE STRENGTH(3DAYS)	27MPa
COMPRESSIVE STRENGTH(7DAYS)	37MPa
COMPRESSIVE STRENGTH(28DAYS)	53MPa

2.2 FINE AGGREGTE (M-Sand)

Manufactured sand confirming to grade zone -II as per IS: 383-1970 specification is used as fine aggregate. M-sand used in this study for making concrete is well graded, passing through 4.75mm and retained on 300 microns and obtained from locally available plant. Properties of M-Sand shown table 2.

Table -2: properties of M-Sand

PROPERTIES	VALUES
FINENESS MODULUS	2.48
WATER ABSORPTION (%)	1
SPECIFIC GRAVITY	2.65

2.3 COARSE AGGREGATE

The crushed angular metal conforming to table 3 of IS 383 of maximum nominal size of 20 mm and down size is used as coarse aggregate. The nominal size of coarse aggregate should be large as possible within the limits specified but in no case greater than one- fourth of the minimum thickness of the member.

Table -2: properties of M-Sand

PROPERTIES	VALUES
FINENESS MODULUS	6.4
WATER ABSORPTION(%)	0.55
SPECIFIC GRAVITY	2.7

2.4 MAGNETS

In the present investigation work, the Magnets were obtained from scientific store. The shapes of magnets are flat rectangular. Three types of strength magnets we used. The average magnetic strength of two bar magnets. Bar magnets, heavy duty magnets with double-sided adhesive, rare earth magnet perfect for fridge, DIY, garage, kitchen, science, craft, office-60x10x3mm. When the magnetic field is passed through by the water the water gets demagnetizing property called magnetized water.

III. PREPARATION OF MAGNETIC WATER

3.1Equipment Required:

- Permanent Magnet: Typically, a magnet with a strength of 1000 Gauss or higher is used. The type and strength of the magnet can influence the effectiveness of the water treatment.
- Container: A clean, non-reactive container to hold the water during the treatment process.
- Water: Regular tap water or distilled water, depending on the desired quality and application.

3.2 PROCEDURE:

3.2.1 SELECT THE MAGNET: Choose a permanent magnet with the desired strength. Ensure the magnet is clean and free of any contaminants that could affect its performance.

3.2.2 PREPARE THE WATER: Fill the container with the amount of water you need for your application. This can be tap water or distilled water based on your requirements.

3.2.3 POSITION THE MAGNET: Place the magnet around or near the container of water. The exact placement can vary depending on the setup:

Direct Contact Method: Attach the magnet directly to the side or bottom of the container if it's strong enough to influence the water directly.

Inductive Method: Place the magnet close to the container, ensuring there is a sufficient magnetic field passing through the water.

3.2.4 EXPOSURE TIME: Allow the water to be exposed to the magnetic field for a specific period. The exposure time can vary based on the strength of the magnet and the intended use of the water. Typical exposure times range from a few minutes to several hours.

3.2.5 COLLECTION: After the exposure period, remove the magnet. The water is now treated and ready for use.

3.2.6 STORAGE: Store the magnetically treated water in a clean, non-reactive container. Avoid re-exposing the water to strong magnetic fields if it's intended for immediate use in concrete or other applications.

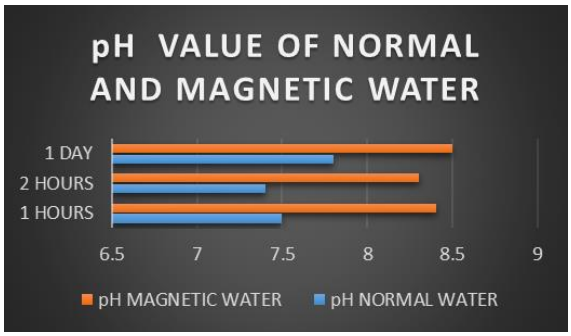
3.2.7 QUALITY CHECK: For applications requiring specific water quality standards, test the treated water for parameters such as pH, electrical conductivity, and total dissolved solids to ensure it meets the required specification.

FIG 1. SETUP OF MAGNETIC WATER

IV. RESULT AND DISCUSSION

4.1 pH TEST

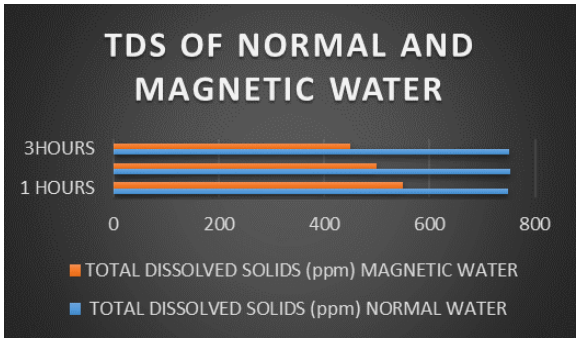
The variation in pH impacts the alkalinity value before and after magnetization. Flow chart displays the difference in pH for normal water and magnetic water with different exposure periods varying from some intervals. It was found that the pH of normal water 1hr was 7.5 and the pH of magnetic water was 8.4 for magnetic water 1hr exposure. The ions present in the water were responsible for the change in the pH value. In this experiment, the pH value increased with respect to exposure, which indicates that the OH^- ions were logically responsible. After applying the magnetic field of 1000 Gauss, there was a formation of calcium carbonate along with other alkalis using hydroxide ions. This naturally increases the pH, which reduces the acidity. With the increase in exposure, there was a significant change in the raising rate of ph. The highest compressive strength was recorded in the alkaline environment, which has a higher surface hardness, and less porosity and hydrated structure compared to the neutral condition. The positive effect on workability and compressive strength of cement can be achieved when the pH is increased to 13. The increase in the pH value of the water with the increase in the magnetic exposure duration than the normal water is mainly owed to the constant ion product of water becoming affected by the magnetic field, thereby affecting the detachment of the aqueous solution, resulting in enhanced pH value.



4.2. ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLID

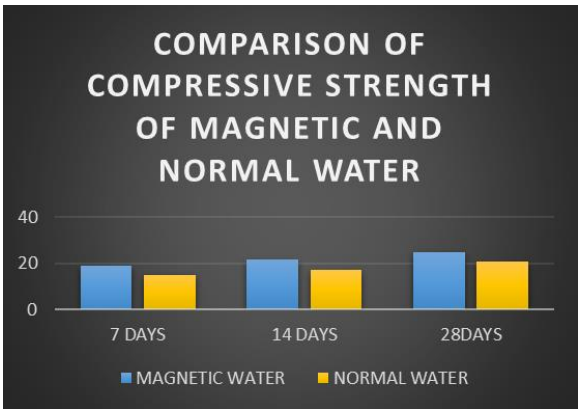
The amount of total dissolved solids and electrical conductivity in the normal water and magnetic water where measured using a total dissolved solids 3m and HM digital, in which the electrical conductivity was measured in terms of µs/cm, temperature in ℃, and TDS in terms of ppm or mg/L. The values of total dissolved solids were measured using the direct analysis method. The total dissolved solids value were measured as per standard, and the value of electrical conductivity may tend to increase gradually with a higher concentration of total dissolved solids which enables the relationship between total dissolved solids and EC. Due to the magnetic effect, the values of the electrical conductivity and decreased up to 19.7% and 25.7%, respectively, when compared to the normal water. It can also be understood from the figure that the total dissolved solids and electrical conductivity values reduced tremendously with the magnetic field exposure. Here, the hydration of cement is closely related to the degree of electrical conductivity of mortar. The electrical conductivity of mortar depends on mixing water as the water contact is the main reason for dissociating alkali salts in the cement and the calcium hydrate, making them electrically charged

ions. Hence, it is possible to correlate cement's hydration with water's electrical conductivity.



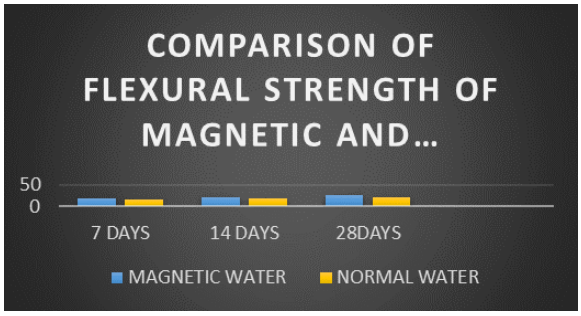
4.3EFFECT ON COMPRESSIVE STRENGTH:

The concrete cubes were casted with the normal water and magnetic water and tested for their compressive strength performance. Displays the effect of the normal water and magnetic water on the compressive strength of concrete mixes at 7, 14, 21, and 28 days of curing age. An average of three cube specimens for each mix were taken for determining the compressive strength of the tested mixes. It can be observed that the mixing of the magnetic water at 28 days improved the compressive strength by 24.1% more than that of the normal water concrete. The target, i.e., the strength of M20-grade concrete, was achieved in 21 days, and hence, the magnetic water concrete saved the cement content and reduced the curing period. The enhanced strength of the magnetic water concrete over the normal water Concrete may be attributed to a more homogeneous mixture with the magnetic water, which results in the complete hydration of the cement particles. Moreover, it reduces the capillary pores and the discontinuity in packing. The theme behind the magnetic field treat water is that the chemical composition (CaCO3) of scaling is reduced and it produces a greater quantity of smaller water clusters. Due to magnetization, water molecules penetrate more easily into the cement particles to stimulate the hydration process of the concrete mix. Subsequently, the mechanical properties of the concrete mix improves. It has been observed that the magnetization effect on the normal tap water can remain for hours or days after magnetization. Hence, magnetic water improves the cement hydration process from the beginning and provides an early strength gain at 3 days. The rate of increase in the strength was found to be more for concrete prepared with magnetic water at later ages than the concrete mixes prepared with normal water. This might be due to the distribution of water molecules by the magnetic water, thereby increasing the hydration properties of cement, resulting in improved compressive strength at later ages than at early ages. It was observed that the improved compressive strength of concrete mixes prepared with the magnetic water maybe attributed to the larger specific area of magnetized water than the normal tap water. In addition, the magnetized water splits up the heavier water mass into smaller water masses or individual water molecules, allowing the cement particles to fully react with the water. In addition, the hydrogen bonds in the water molecules contribute to the synthesis of hydration products and form a dense C-S-H gel, resulting in enhanced compressive strength.



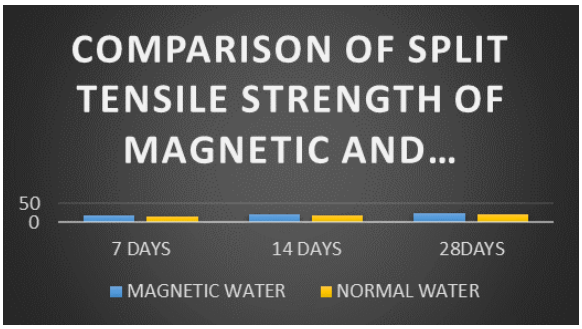
4.4. FLEXURAL STRENGTH TEST:

Flexure is the state of being flexed. The Flexure strength represents the high stress experienced within the material at its moment of rupture. The Flexural strength also known as modulus of rupture, bend strength or fracture strength. The bearing surface of the supporting and loading rollers shall be wiped clean any loose sand or other material removed from the surface of the specimen they are to make contact with machine. The specimen shall be placed on the machine in such a manner that the load be applied to the uppermost surface as in the cast of the mould, along two spaced 13cm away from bottom support to the specimen on either sides. The load is gradually applied.



4.5. SPLIT TENSILE STRENGTH TEST

Split tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. Take the wet specimen from water after 28 days of curing. Wipe out water from the surface of specimen set the compression testing machine for the required range. Place the specimen in Compressive testing machine. Apply the load gradually in Compressive testing machine note down the breaking load.



CONCLUSION

In this report, the water quality standards were evaluated using physiochemical properties, namely electrical conductivity, pH, and TDS, with the magnetic water at different exposures magnetic water and compared with those of the normal tap water. The experimental results showed that the magnetic field improved the physiochemical properties of water with an increase in the exposure time. It was observed that the absorption of magnetic water crystals showed a higher integrity of molecules inside the crystal. It was also shown that the TDS and EC values decreased by 19.7% and 25.7%, respectively, after applying the magnetic field of intensity 1000 gauss. As the workability of concrete improved. The increase in the slump value of concrete with the magnetic water concrete helped in fixing the cement-to-water ratio, thus reducing the cement content in the concrete. It can be concluded from this research work that the compressive strength of the magnetic water concrete increased up to 24.1% when compared to the normal water concrete, and the 28-days strength of the normal water concrete was achieved at 21 days itself with the magnetic water. Split tensile strength and Flexural strength significantly increased in the concrete specimens casted with magnetized water, with a 35 % improvement seen after 28 days of curing. In addition, experiments proved that when the properties of the magnetic water were enhanced, there was an enhancement in cement hydration and workability-related properties. Finally, it was observed that the utilization of the magnetic water for mixing concrete improved the physiochemical properties of fresh and hardened concrete with the minimum usage of water and curing period. Due to water magnetization, the quality of water in the concrete industry improved, which directly enhanced the quality and life span of structures. The need of magnetic water concreting is urgent and there is important demand to construct Sustainable building structures with a reduced usage of potable water, thereby increasing Sustainability in the construction industry.

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