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Influence of Magnetic Water on Strength Properties of Concrete

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Abstract

It is expected that in the near future, the civil engineering community will have to produce structures in harmony with the concept of sustainable development through the use of high-performance materials with low environmental impact that are produced at a reasonable cost. Magnetic water concrete, synthesized from the normal materials used for manufacturing of concrete, provides one route towards this objective. This paper presents the effect of addition of magnetic water on workability, strength and mechanical properties of concrete tested show-encouraging results, and one can easily replace normal water with magnetic water by which quantity of cement used in any concrete mix reduces and can be made as new Eco-friendly construction material for future decades.

Keywords: Magnetic Water (MW), Structure of MW, North & South Poles, Workability, Strength, Stiffness.

1. Introduction

Magnetized water doesn't mean water has acquired magnetic strength but that it has been subjected to a magnetic field which is found to change certain properties of water. These anomalous properties of water are unique and may result in many variations of macroscopic properties. Water is not homogeneous at the nanoscale and exists as clusters depending on the temperature, pressure and existing forces. Thus the density of the water may also change depending on the forces that dominate the conditions. The two forces that dominate are hydrogen bond and vanderwaal's forces.

The magnetic field can break down these water clusters and reduce the bond angle and hence increase solubility[1]. It is believed that after applying a strong magnetic field, water will show diamagnetism. Diamagnetism refers to substances that are magnetized in a way opposite to the direction of magnetic field, having pair-up electrons which cancel each other's magnetic moment because the two electrons in a pair-up rotate opposite to each other. As a result, water molecules are 'directed' to have certain orientation[2] as shown in Figure1.

Since water molecules are fixed in orientation, they are restricted to form water clusters due to chances of reducing matched orientation of water molecules in a cluster. Hydrogen bonds' association percentage will decrease. In other words, larger water clusters are cut and broken down by external magnetic field to form smaller water clusters or double water molecules [(H_2O) 2] or even single water molecule (H_2O). Yan et al.[1] also states that by light spectrum, the bond angle decreases from 104.5° to 103° because magnetic field deflects the bond pairs and squeezes the bond pairs to be closer together (Figure 2). Decreased bond angle also reduces repulsion between electrons in bond pairs of H_2O and electrons in solute molecules/ions because the bond pairs have a narrower coverage and water molecules contract in terms of electric field. As a result, energy for acquiring stability is lower and more solute can be packed in the same volume

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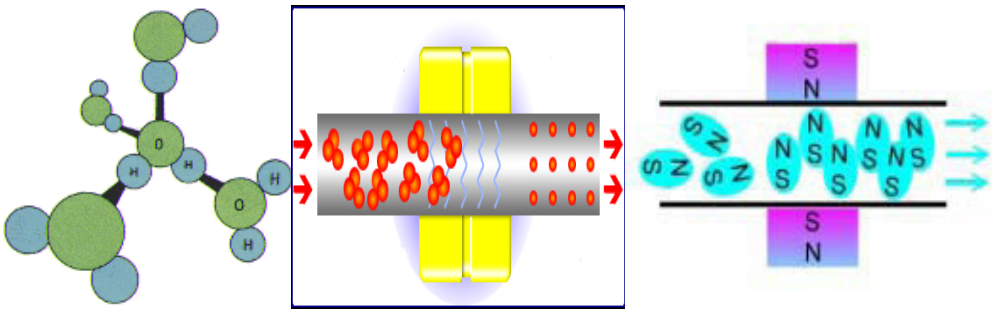

Figure 1. Mechanism of magnetic water: A. water cluster; B. breakage of cluster; C. orientation.

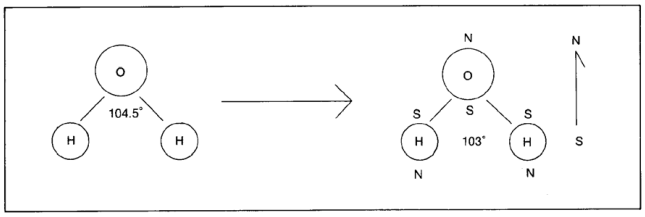

Figure 2. The decrease in bond angle in water molecule exposed to magnetic field.

Table 1. Physical properties of aggregates used in the mix

S.No.	Properties	Fine aggregate	Coarse aggregate
1	Fineness modulus	2.88	7.23
2	Specific gravity	2.60	2.60
3	Bulk density in lose state	1550 kg/m^3	1360 kg/m^3

Table 2. Physical properties of cement used in the mix

Property	Specific gravity	Fineness (by sieve)	Initial setting time	Final setting time	Compressive strength (28 Days)	Soundness
Result	3.02	3%	52 min	560 min	54.7 N/mm^2	2 mm

of water because electric field of each H_2O molecule contracts, thus increasing solubility of water[3].

2. Scope of the Present Study

Concrete based on Portland Cement (PC) is extensively used construction material, given that it is more economical (compared to metals and other materials). One of the negative aspects of PC is that its fabrication generates CO_2 through calcination of raw materials and fuel consumption. It is calculated that 1 ton of PC generates 1 ton of CO_2[4]. The present paper investigates the method of improving strength of given grade of concrete by reducing the usage of cement in a mix without effecting the other properties of concrete by replacing normal water with magnetic water for mixing of ingredients in concrete.

3. Constituents of Magnetic Water Concrete (MWC)

In the present investigation work, magnetic water was prepared by retaining water in a glass beaker over a round magnet of 985 Gauss magnetic field that was obtained from scientific store. The Magnetic water was produced by placing the beaker filled with water over the magnets for a period of 24 hours[5] as shown in Figure 8. During this time, the magnetic field penetrates through the glass into the water and this magnetized water is used for making concrete. Natural sand obtained from the local market is used as fine aggregate. The crushed coarse aggregates of 12 mm and 20 mm maximum size, obtained from the local crushing plants were used in the present investigation. The physical properties of fine and coarse aggregate such as specific gravity, gradation, and fineness modulus were tested in concurrence of IS: 2386 as shown in Table 1. 53–Grade ordinary Portland cement was used. The physical properties are shown in Table 2.

4. Mix Proportions of MWC

The investigation work on M20 grade of concrete mix trials was carried out on procured material. The Indian standard mix design procedure was adopted (i.e., IS: 10262-2009) to arrive at the mix proportions for M20

grade of concrete. The detailed mix design procedure of M20 grades of concrete is given in Table 3.

5. Manufacturing and Testing of MWC

The Trial mix was fixed as shown in Table 3 using three different magnetic water: 1. Water exposed to North Pole (N) 2. Water exposed to South Pole and 3. Mixed pole water (N+S, half North Pole and half South Pole waters). Two types of waters (Normal Tap Water (TW) and Distilled water (DW)) were used. The magnetic water placed on magnet for 24 hour duration, considered to be optimum duration[5] was added to the cement, and aggregates were prepared in saturated surface dry condition. The wet mix was usually in cohesive condition. The workability of the fresh concrete was measured by means of the conventional slump test. The prepared concrete mixture was casted in cubes, cylinders and beams. After removing the concrete cubes from the moulds, the specimens were placed in water tub and were left for curing, until they were loaded in testing machine for different tests at the specified age in accordance with the relevant Indian standards.

Table 3. Trial mix proportions for 1m^3 of concrete

S.No.	Material	Quantity in Kg
1	Cement	310
2	Sand	719
3	20mm Aggregates	700
4	12mm Aggregates	466
5	Water	170.5

Table 4. Slump test results for concrete with and without magnetic water

S.No.	Description	Normal water	Magnetic water		
			North	South	North & South
1	Tap Water	50	50	50	55
2	Distilled water	50	50	50	55

Table 5. 7th day compressive strength of concrete with and without magnetic water in N/mm^2

S.No.	Description	Normal water	Magnetic water		
			North	South	North & South
1	Tap Water	18.86	22.62	20.52	30.01
2	Distilled water	21.52	23.92	23.24	34.37

6. Results and Discussions

1. The workability results of slump for three different (kinds of) water: N, S, N+S are presented in Table 4 and the results show that in case of the concrete made with mixed pole (N+S) magnetic water, the slump was slightly higher. Both mixes had good flow ability and there was no sign of bleeding as well as segregation. The concrete made with MWC was very greenish compared with Normal Water Concrete (NWC).
2. The compressive strength for 7th day and 28th day for the three kinds of water i.e., N, S, N+S both using normal and distilled water are presented in Tables 5 & 6 respectively. It is shown in Figures 3 & 4 that the compressive strength of concrete increases with the usage of magnetized water, and this increase in the strength is due to cluster concept of water and also memory of water concept. The magnetized water is observed to have better bioavailability and is due to the reason that the clusters formed by the water in magnetized state are of smaller size. Usually, a water cluster consists of many water molecules of size 11–50 depending on the dominating force in the water molecule. But when water is exposed to magnetized field, it is observed

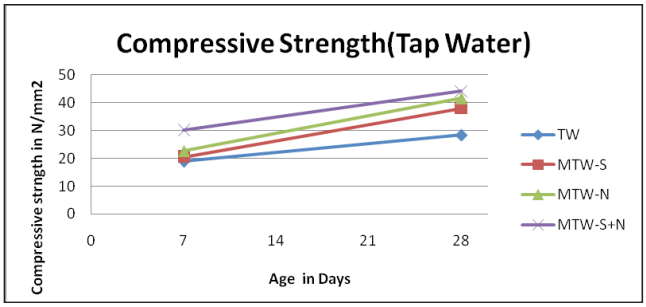

Figure 3. Compressive strength of concrete caste with and without magnetized tap water.

Table 6. 28th day compressive strength of concrete with and without magnetic water in N/mm^2

S.No.	Description	Normal water	Magnetic water		
			North	South	North & South
1	Tap Water	28.29	41.5	38.01	44.06
2	Distilled water	30.64	42.92	40.91	45.02

that the number of water molecules decreases to a smaller amount and is, usually, of about the size 5–6. Thus, water when exposed to magnetic field has better dispersion (or in simpler terms increased specific area). As the more water is available for hydration, the more number of cement particles are hydrated, and this result in better quality and density of hydration products of cement. This increase in hydration may lead to increase in the compressive strength of the concrete. This effects increase in efficiency of cement used in concrete.

3. Split tensile strength & Flexure strength of concrete with and without magnetic water are tabulated in Table 7 & 8. The results in Figures 5 & 6 indicate that the split tensile strength and flexural strength of concrete increased with magnetization of tap water, and these values further improved with distilled magnetic water, and the reason for this improvement is discussed above.
4. Water absorption and density tests were conducted for all concrete mixes with and without magnetic water and are tabulated in Table 9. The results show that the concrete made with magnetic water is exhibiting more density and less water absorption. This is due to more hydration of cement due to magnetic effect, which reduced the pores in the concrete.
5. The load deformation plot is drawn for studying the effect of magnetic water on the behavior of concrete cylindrical specimens. As shown in Table 10 & Figure 7, the concrete cylindrical specimens with

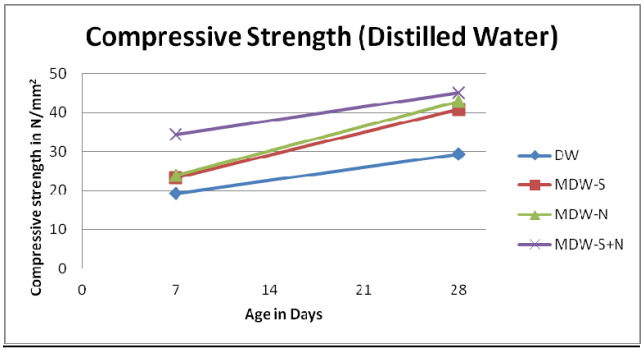

Figure 4. Compressive strength of concrete caste with and without magnetized distilled water.

Table 7. 28 days split tensile test results in N/mm²

Description	TW	MTW-(N+S)	MDW-(N+S)
Split Tensile Strength	2.54	2.86	3

Table 8. Flexural strength test results in N/mm²

S.No.	Days	TW	MTW-S+N	MDW-S+N
1	7	3.98	4.56	5.18
2	28	5.2	6.32	6.5

Table 9. Water absorption and density values for tap water and N&S pole distilled water

S.No.	Description	% of Water Absorption	Density in kg/m³
1	Tap Water	5.21	2490
2	North and South pole Magnetic distilled water	3.51	2620

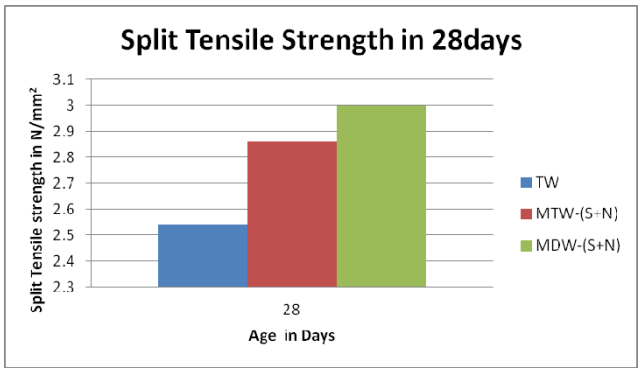

Figure 5. Comparison of split tensile strength for 28 days.

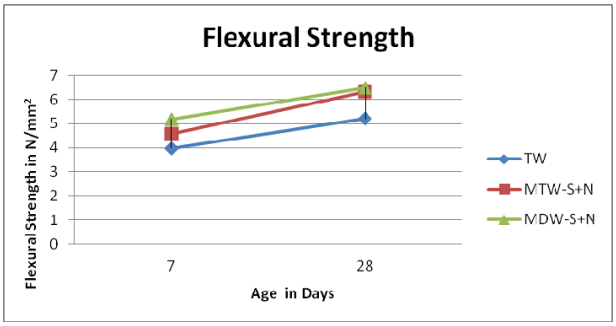

Figure 6. Comparison of flexural strength for concrete with and without magnetic water.

Table 10. Load-deformation test results for concrete with and without magnetic water

Description	TW	MDW-(S+N)
Load in KN	264	312
Deformation in mm	8.29	6.18

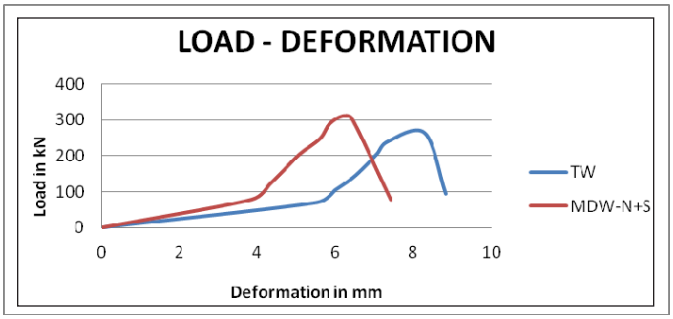

Figure 7. Load-deformation plot for concrete with and without MW.

magnetic water are carrying higher loads with less deformation compared to non magnetic concrete specimens at failure condition. Further, the stiffness of magnetized cylindrical specimens is increased by 59% as compared to concrete cylinders casted with non magnetized normal tap water.

7. Conclusions

This investigation shows the influence of magnetic water on workability (consistency) and strength properties of concrete. For this purpose, the magnetic water of 985 gauss strength is used. The conclusions obtained from this work are as follows:

- The workability of magnetic water concrete is slightly more than that of NWC.
- The density of magnetic water concrete is high and water absorption is less as compared to NWC.
- During magnetization of water the mixed pole water gave more compressive strength than North Pole and South Pole water.
- Magnetized Distilled water concrete showed more compressive strength than the Magnetized tap water concrete.
- The Compressive strength of Magnetized water concrete is more than that of NWC by 55%.
- The Tensile strength of concrete is improved by 18% when Magnetic water is used instead of Normal water for preparing concrete.
- The Flexural strength of Magnetized water concrete is more than that of NWC by 25%.

Magnetized water concrete cylindrical specimens are found to be 59 % more stiffer than Normal water concrete cylindrical specimens.

8. References

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