

EFFECT OF MAGNETIC FIELD EXPOSURE TIME ON FRESH AND HARDENED PROPERTIES OF MAGNETIC WATER CONCRETE

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ABSTRACT - Concrete is a most widely used man made building materials in the world. The engineering society is always emerging towards, to improve the strength properties with various methods like fiber reinforcement concrete mix, usage of admixtures including super-plasticizers etc. In concrete, water plays a vital role in the hydration process of cement during mixing and curing of concrete. Demand of potable water goes on increasing day by day. From the construction point of view, normal water used for construction is not within their standards limits. A new technology has been introduced to improve the properties of concrete by magnetic field treated water. The work investigates the effect of magnetic field exposure time of water on fresh and hardened properties of concrete. The water magnetization is done with a help of 0.5 hp motor having an intensity level of 0.9 Tesla for different duration such as 60mins, 30mins, 15mins and instant circulation of water flow. From the optimum value with respect to duration of time exposed in water, concrete samples are casted and cured with magnetic water concrete and ordinary water concrete in four different cases, for the M40 grade of concrete and tested for 7,14,21 &28 days respectively. The main objective of the study is to improve the quality of water as per Indian standards with respect to exposed time duration and study on curing ages with respect to concrete strength parameters.

Key words: Magnetic Water, Exposure time, Compressive Strength, Curing Ages.

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INTRODUCTION

Water will play a traditional role on concrete, with significant influences on its engineering properties. The magnetic water treatment received some attention from the scientist community (1). Researchers from industrialized countries such as Russia and mainland China

(2) have shown that using magnetic water for concrete mixing can increase its workability, accelerate hydration, and improve the hardened properties and Freeze-thaw resistance. After applying a strong magnetic field, water will behave as Diamagnetism, as a result, water molecules are oriented in certain direction (3).

Magnetization improves negative ionic hydration, thus intensifying the damaging effect on the water crystal structure (4). While mixing of water and cement, hydration process will takes place on the surface of the cement particles and hydrated product is formed. Thus further hydration of the cement particles is hinders which preventing the development of mechanical strength of concrete. In case of magnetic water is used instead, water molecules penetrate into cement particles more freely; allowing complete hydration process occurs and enhances the strength parameters (5). The amount of improvement to the concrete strength is 10%, savings of cement by 5% (6).

The magnetic treatment of the water reduces the hardness caused initially by calcium and magnesium (7). On the other side, usage of GBFS in place of cement, will improve the structure of concrete by making it denser and reducing dry shrinkage (8). Reduction of surface tension will make molecules more dynamic and fluid, which in turn gives better bonding of materials added to water (9). Usage of magnetic water on concrete does not require addition of chemical admixtures, thus overcoming environmental pollution. Magnetized water has been used in several application including health, environmental, agriculture, construction industry. The mixing process involves passing the water through the magnetic field, followed by the addition of fine and coarse aggregate, cement. The operation is easy to function and has good potential for application in concrete, pre-mixing plants and building construction (10).

EXPERIMENTAL DETAILS

2.1 Materials

The cement used is Ordinary Portland cement Type I produced by ultra tech cement company. Crushed coarse aggregate with nominal size of 12mm and 20mm maximum size obtained from the local crushing plant and fine aggregate (sand) is sourced from a local supplier. Their physical properties and size gradation are shown in table1 and 2 & 3 as per IS: 2386-1963.

Table 1 Physical properties of cement

PROPERTIES	RESULT
Normal Consistency	36%
Initial Setting Time	32 mins
Final Setting Time	5 Hrs 37 mins
Fineness (by sieve Analysis)	4.5%
Specific Gravity	3.15

Table 2 Physical properties of fine aggregate

PROPERTIES	RESULTS
Type	Uncrushed
Specific Gravity	2.71
Fineness Modulus	2.85
Grading	Zone-II

Table 3 Physical properties of coarse aggregate

PROPERTIES	RESULT
Type	Crushed
Size	20mm
Specific Gravity	2.85
Water Absorption	2.19%
Crushing Value	25%
Impact Value	18.85%

2.2 Magnetic water

In this research study, magnetic water is prepared by passing water through a PERMAG (N406) with 0.9 Tesla of intensity as shown in figure 1. The water used for mixing and with quality shown in the table 4 is produced by potable tap water in Salem district as per IS 3025-1987.

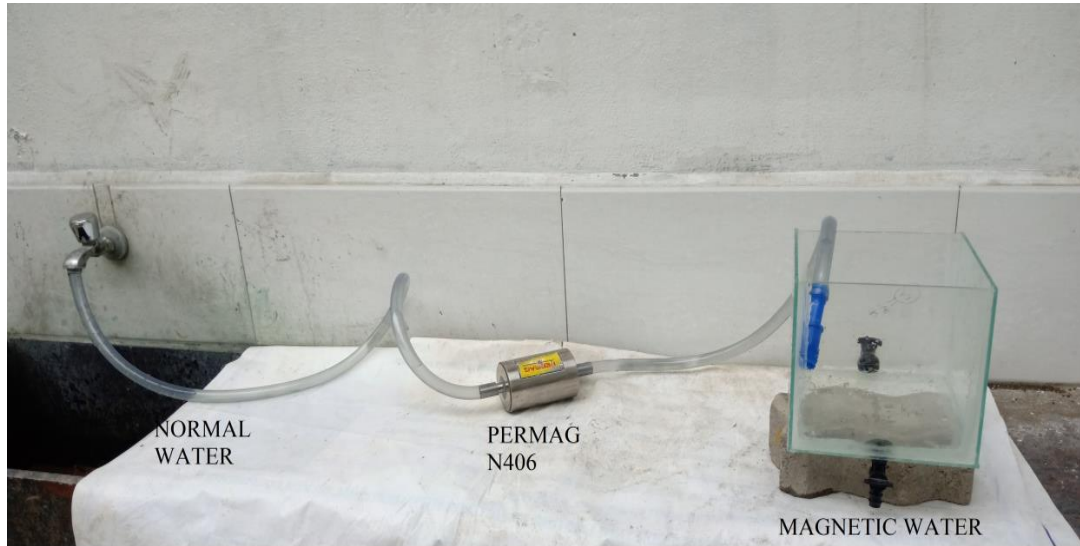


Figure 1 Magnetic water set-up

Table 4 Properties of water

RESULTS			
PROPERTIES	BEFORE MAGNETIZATION	AFTER MAGNETIZATION	PERMISSIBLE LIMITS
pH	7.6	8.0	6.5 to 8.5
Hardness	240 mg/l	68.33mg/l	< 600mg/l
Cl	77.47 mg/l	67.47 mg/l	< 500mg/l
S ₀₃	134 mg/l	115mg/l	< 200mg/l
Iron	0.1mg/l	0.1mg/l	< 1 mg/l
Suspended matter	100 mg/l	50mg/l	<2000mg/l

2.3 Mix composition

In the present research study on M40 grade of concrete mix trials were done on produced materials. The Indian Standard mix design procedure is adopted (i.e, IS: 10262 - 2009) to arrive the mix proportions for M40 grade concrete. The mix proportion as shown in the table 5.

Table 5 Mix proportion

	CEMENT	FA	CA	W/C	SUPER PLASTICIZER
RATIO	1	1.39	2.61	0.38	0.0087

2.4 Experimental variables

2.4.1 Magnetic field strength

Tap water is magnetized by flowing through the magnetic field of 0.9T and 0T denotes plain tap water.

2.4.2 Magnetization time

Tap water is exposed to magnetic field for 60mins, 30mins, 15mins and Zero minutes denotes instant pumping through magnetic field.

2.4.3 Dosage of super plasticizer

The percentage of super plasticizer in water by 1%, 0.8%, 0.6%, 0.4%, 0.2% and 0% indicates zero dosage. The dosage is calculated according to the liters.

2.4.4 Age of curing

All samples are cured under water at $23 \pm 1^\circ\text{C}$ for 7, 14, 21, 28 days before the entire test are performed.

2.5 EXPERIMENTAL PROCEDURES

2.5.1 Slump

The standard slump cone shown in figure 2 has been used for slump of concrete mix. The slump measures the amount of water content in the mix. The slump of each group of concrete mixes was carried out according to the mixes.



Concrete prepared using normal water

Concrete prepared using magnetized water

Figure 2 Change in the plasticity level in fresh concrete

2.5.2 Compressive strength

The Compressive test machine UTM-200T is used to test concrete samples according to IS 516:1959.

2.6 RESULTS AND DISCUSSION

2.6.1 Effect on time of exposure of magnetic field

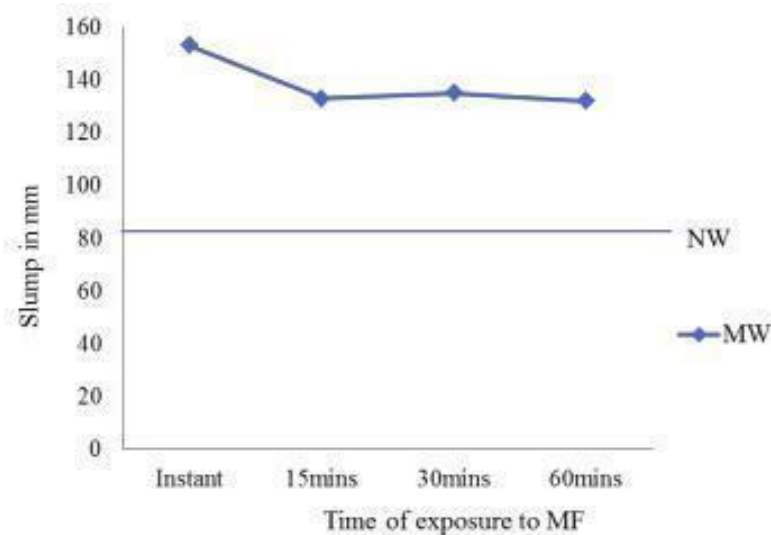


Figure 3 Slump Vs Time of exposure to MF

Figure 3 shows the various exposure time of water circulated through a magnetic field. The increase in water exposed to magnetic field decrease the workability of the slump gradually, not beyond the normal water limits. The greatest percentage of slump arrived by instant pumping is 30%, greater than exposure time up to 60mins duration. The increase in slump is due to following theory. Water is at Nano state, which exists in clusters, this clusters size depends upon the dominating force in the water molecules. When water exposed to a magnetic field, cluster of molecules breaks down, decreases the bond angle between hydrogen atoms from 105° to 103° which arrived through macroscopic properties (11). Water exposed to magnetic field will provide better dispersion and increase surface area of water for hydration with cement passed in concrete.

2.6.2 Dosage of super plasticizers

Figure 4 shows that the slump value of magnetized and normal concrete sample. As shown, the slump values of magnetized concrete were higher than those of non-magnetized concrete. Figure 4 shows the slump variations in the concrete samples with increase in percentage of super plasticizer and the slump of the sample will improve. The slump value of concrete sample of normal water with 1% of super plasticizer is achieved by 0% of super plasticizer with magnetic water. Due to the effect of magnetic water on the properties of concrete,

magnetized water acts as super lubricant has an effect on the electrical loam of the cement particles and it causes the separation of molecules inside the water Cluster and facilitates access of water flow efficiencies around the cement particles.

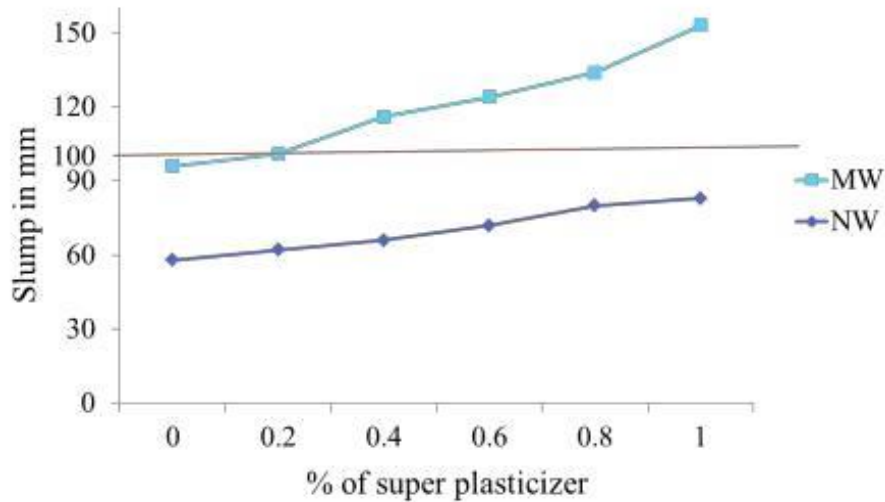


Figure 4 Slump of Magnetic water concrete Vs dosage of super plasticizer

2.6.3 Effect of MFTW on Compressive Strength

Figure 5 shows the values of the compressive strength in 28 days and the variation percentage of magnetic concrete strength in comparison with non-magnetic concrete. In the 28th day sample, we observed an increase in compressive strength with magnetic water is 52% greater than normal water. The target mean strength of 28th day sample using normal water is achieved at 21st day using magnetic water. The theme behind magnetic field treated water; chemical composition of scaling is reduced and produces more quantity of smaller water cluster.

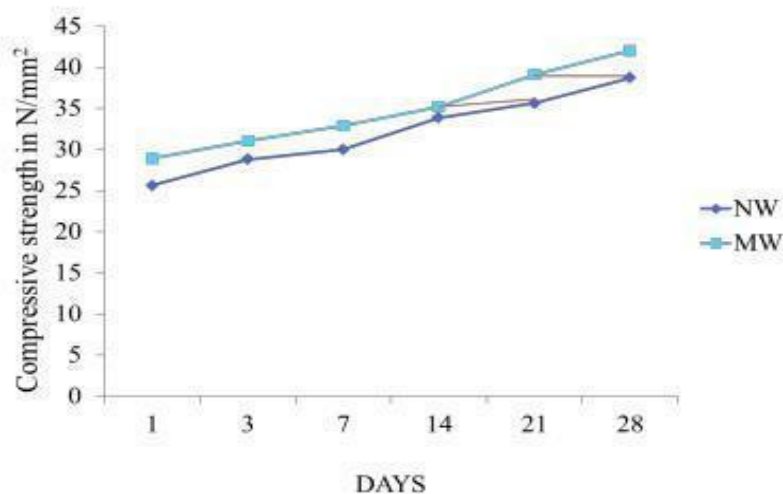


Figure 5 Compressive strength of magnetic water concrete in N/mm²

MFTW can penetrate the core region of cement particle and activate hydration process effectively. A consistent pattern of percentage increase in strength at early age achieved using magnetic water and there is a decrease in curing period when magnetic water is used

CONCLUSION

1. The strength analysis shows that magnetic water concrete behaves as normal water concrete in development of strength.
2. The zero dosage of super plasticizer with magnetic water gives similar slump for 1 % super plasticizer with normal water.
3. The increase in exposure time with magnetic water increases the slump value by 84 % compared to normal water.
4. Concrete cubes casted with normal concrete and cured in magnetic water shows very similar trends with normal water casting and curing at early at early ages.
5. The addition of magnetic water, the compressive strength of concrete showed significant increase up to 8.52% than the normal water for 28 days strength.
6. The magnetic water cube casted in early ages shows similar increase in percentage up to 12% than normal water.

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