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Effect of Magnetic Field Treated Water on Fresh and Hardened Properties of Concrete

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Abstract—*Using magnetized water in concrete mixtures causes an improvement in the workability and compressive strength of concrete. Also, this magnetically processed water causes a reduction in the cement content required for the specified compressive strength value. In this project work, the effects of magnetic water on properties of concrete such as workability, strengths have been studied. When water is exposed to different poles of the magnet. The Mixed pole water (i.e. 50% of North Pole water +50% of South Pole water) is showing improvement in workability and compressive strength compared to normal water concrete. The results of tests showed that, M20 grade concrete made with magnetic water (MWC), has higher compressive strength values than those of control concrete (up to 50%). Present research work also investigated that harmful salt water which is not suitable for mixing water in concrete can be magnetized to suit this water for mixing in concrete and tests showed that this magnetized salt water is same as normal water in imparting strength to concrete. This improvement in strengths is due to enhanced hydration in MWC, making the concrete dense by modifying the pore structure.*

Keywords*: magnetic field treated water, magnetic water concrete, special concrete, compressive strength, and magnetization.*

1. INTRODUCTION

According to the magnet vendors, magnets can be used to improve blood pressure, circulation, cure and prevent diseases, tooth decay and hair damage, increase vehicles mileage, reduce fuel consumption, control pollution, improve plant growth, soften water, prevent scale deposition [8], [10], [1], and even increase the strength of concrete by 23 % [5]. Generally water is transparent and treated to be homogenous consisting of just two hydrogen atoms bonded to a single oxygen atom. But at nano-level, water is not homogeneous, water exists in clusters of molecules and this cluster size depends on the temperature, pressure and forces existing around the water. These clusters of molecules are held by hydrogen bond and vanderwaal's forces [2]. When water is exposed to the magnetic or electric fields these clusters break down changing certain properties of water. Usually water in the living system normally exists as cluster system of 12, 14, 17, 21or more molecules and these clusters changes when there are variations in temperature and pressure of surrounding environments [3] [4].

2. PRINCIPLE OF MAGNETIC WATER CONCRETE

When water is subjected to the magnetic field the water clusters breaks and the size of water cluster decreases by which the surface area of water per unit volume increases compared to non-magnetic water.[6][7] 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 that the number of water molecules decreases to a smaller amount and is usually about the size 5-6. Thus water when exposed to magnetic field has better dispersion or in simpler terms increased specific area. Hydration process depends on the surface areas of water and cement, when cement comes in contact with this water, the hydration process begins, as more water is available for hydration more number of cement particles are hydrated and this results in better quality and density of hydration products of cement [9]. This increase in hydration may lead to increase in the compressive strength of the concrete.

3. LITERATURE REVIEW

Su & Wu (2000) show that the compressive strength and workability of concrete containing fly ash and prepared with magnetic water increases by (9-19)%, (10-23)% respectively more than that prepared with normal water also he was found that magnetic water had increasing the rheology, amount of slump and concrete hydration.

Setyowati E W et.al, (2012) studied the effect of high temperatures on the compressive strength of concrete. The study also included the degradation in micro structure of concrete using XRD and SEM techniques.

Adnan Flayih Hassan (2008) [01] investigated the influence of magnetized water on the initial and final setting time, consistency and compressive strength of cement mortars cubes at very ages of 1 and 7 day. The results indicated that the use

of magnetized water in preparing cement mortars increases the compressive strength and the initial and final setting time of cement mortar decreased.

Dale P.B and Paul E.S (2006) [09] describes the effect of full and partial curing and hydration on the pore structure of the concrete. The connectivity of the pores in the structure are the results of improper curing which effects the durability of the concrete at later ages.

Nan Su, Chea-Fang Wu (2003) [29] investigated on the compressive strength and workability of mortar, which is mixed with magnetic water and granulated blast-furnace slag (GBFS). The test variables included the magnetic strength of water, the content of GBFS in place of cement, and the water-to-binder ratio (W/B). Results showed that the compressive strength of mortar samples mixed with magnetic water increased by 9–19% more than those mixed with tap water.

Sunil Kumar and C.V.S. Kameswara Rao (1994) [51] made an experimental investigation in which the effects of sulphates on the initial and final setting times of ordinary Portland cement and compressive strength of concrete are studied.

4. OBJECTIVES OF THE PRESENT PROJECT

The main research objectives of the work are to establish the procedure for producing the magnetic water (MW) and to understand the magnetic water concrete (MWC) and its characteristics in terms of workability and strength aspects.

4.1 Magnets Used

In the present investigation work, the rounded Magnets were obtained from scientific store. The strength of magnet was determined by Gauss meter. The average magnetic strength of four magnets is 985 Gauss.

Fig. 4.1: Magnets used for magnetizing water

4.2 Magnetized water

Magnetic water is obtained by placing the glass beaker filled with potable water (IS: 3025 – 1986) over the magnets for a period of 24 hours. During this time magnetic field penetrates through the glass into the water, which absorbs the magnetism and this magnetized water was used for making concrete. Water was exposed to North Pole, South Pole and the water so obtained was used in our investigation.

Fig. 4.2: One litre beakers placed over the magnets

The material quantities obtained as per mix design method, (i.e., IS: 10262-2009) arrived in trial mix as per mix proportion are is presented below.

Ordinary Grade Concrete (M20):

Mix proportion 1: 2.27: 3.45: 0.54

Cement : 320.4 kg

Fine aggregate : 727.3 kg

Coarse aggregate : 1105.4 kg

Water : 173 L

5. TEST RESULTS AND DISCUSSIONS

5.1 Effect of Magnetic Field Exposure Time

5.1.1 Test methodology

To find the effect of magnetic field exposure time on workability and compressive strength of concrete, standard concrete cubes (150mm x 150mm x 150 mm) were casted by using Normal water, North pole water, South pole water and Mixed pole water (50% NP water + 50% SP water) with different magnetic field exposure time starting with 1h,2hr …. Up to 72 hours of exposure time.

5.1.2 Compressive strength

To determine the efficient pole water to be used in the concrete for mixing the ingredients and to find the optimum exposure time of water to the magnetic field. Concrete cubes of (150mm x 150mm x 150 mm) were casted with different pole orientations and with hourly exposed water to the magnetic field and compressive tests were done on this cubes after 28 days. The test results are shown in Table 1

It is observed that in the initial hours of magnetic field exposure the strength of MWC is less than the NWC and the compressive strength of MWC is found to be decreasing and has minimum value at 5 hours and after that the strength values are increasing with the time up to 24 hours. This behavior in concrete is explained as, whenever any object is brought under the influence of magnetic or electric field the particles in that object gets disturbed and all the particles tries to move in different directions as water has continuous three

dimensional clusters water tries to come closer aswater has memory by which it tries to be in its previous form.

Table 1: 28 days Compressive Strength of concrete with and without MW

28 days Compressive Strength of concrete in MPa					
S. No.	Time in Hours (hrs)	Normal water Concrete (NWC)	Magnetic water concrete(MWC)		
			N	S	N+S
1	1	28.6	25.1	23.4	27.0
2	2	28.6	24.5	23.6	27.0
3	3	28.6	24.0	22.0	26.7
4	4	28.6	23.7	22.1	25.0
5	5	28.6	23.0	21.9	25.1
6	6	28.6	29.4	27.1	32.3
7	12	28.6	31.5	30.3	33.9
8	18	28.6	35.0	34.1	37.0
9	24	28.6	40.5	37.3	43.0
10	36	28.6	40.6	37.5	43.3
11	48	28.6	40.7	37.0	43.4
12	60	28.6	40.8	37.8	43.3
13	72	28.6	41.0	37.2	43.5

So to start with water clusters come very closer during initial hours as exposure time is increased water tries to reorient itself to the magnetic field and undergoes changes. After 24 hours, the process of breaking the bonds and re-uniting will be saturated so therefore there is no much increase in the strength of MWC. As there is no much increase in the strength of concrete after 24 hours the optimum exposure time of water to the magnetic field is taken as 24 hours (1day). Also the strength of MWC is more compared to NWC, among the three magnetic water the concrete casted with N+S water is giving more compressive strength than that of N pole water and N pole water concrete is showing good improvement in compressive strength compared to the S pole water. Therefore for further all investigations on MWC the Optimum duration of 24 hours with N+S Magnetic water as mixing water in concrete.

5.2 Use of Magnetic Water as mixing water in concrete

This investigation is carried out to study Workability and the compressive strength of M20 grades of Normal water concrete (NWC) and Magnetic Water concrete (MWC) cured in normal water at 28 days. Magnetic water with N+S poles with 24 hours exposure to magnetic field was considered in mixing various ingredients of concrete.

5.2.1 Test methodology

Concrete was mixed with and without magnetic water and the Concrete cubes of 150mmx150mmx150mm were casted with Normal water and with magnetic water with N+S water retained on Magnets for 24 hours and tested to study the compressive strength under axial compression on completion of 28 days as per IS: 516-1999“Method of test for strength of concrete”.

5.2.2 Compressive Strength of Magnetic Water mixed concrete

The results of the compressive strength at 28 days M20 grades of Normal water concrete (NWC) and Magnetic Water concrete (MWC) are tabulated in Table 2.

Table 2: Compressive strength of NWC and MWC (M20)

Compressive strength of M20 grade Concrete in MPa			
Age in Days	Normal water Concrete (NWC)	Magnetic water Concrete (MWC) N+S Pole	% increase
28	28.2	44.6	55.7

The cube compressive strengths of concrete with and without magnetic water at 28 days are given in Table 2. It is observed that with the addition of Magnetic water for mixing in concrete there was significant increase by 55.7% at 28 days. The increase in strength of concrete is due to more hydration of cement in MWC, which fills up the pores in the concrete making the concrete microstructure dense.

5.3 Use of Magnetic Water in Curing Of Concrete

This investigation is carried out to study the effect of, use of MW in curing of concrete, for which the compressive strength of M20 grade of Normal water concrete (NWC) and Magnetic Water concrete (MWC), cured in MW at 28 days are compared. Magnetic water with N+S poles with 24 hours exposure to magnetic field was used as curing water in this study.

5.3.1 Test methodology

Due to problem in generating MW in laboratory in large scale, we concentrated on the compressive strength of concrete samples cured in MW. In present investigation we studied the effect of MW on compressive strength of concrete, when MW was used in mixing and curing of the concrete. Concrete cubes of 150 mm x 150 mm x 150 mm were casted with Normal water and with magnetic water with N+S water retained on Magnets for 24 hours and both concrete samples were cured in tubs containing magnetic water. To study the compressive strength, casted cubes were tested under axial compression on completion of 28 days as per IS: 516-1999“Method of test for strength of concrete”.

5.3.2 Compressive Strength of Magnetic Water cured concrete

The results of the compressive strength at 28 days M 20 grade of Normal water concrete (NWC) and Magnetic Water concrete (MWC) cured in NW and MW are tabulated in Table 3. The cube compressive strengths of concrete specimens with and without magnetic water and cured in Normal water at 28

days are given in Table 3. It is observed that with the use of magnetic water for mixing increased its compressive strength by 55.7% at 28 days. The increase in strength of concrete is due to more hydration of cement in MWC, which fills up the pores in the concrete, making the concrete microstructure dense.

Table 3: Compressive strength of NWC and MWC cured in NW and MW

Compressive strength of M20 grade Concrete in MPa						
Time in days	NWC			MWC		
	Normal curing	Magnetic Curing	% increase	Normal curing	Magnetic Curing	% increase
28	28.2	30.3	7.10	44.0	46.2	4.95

It is observed that in NWC with the use of magnetic water for curing of concrete showed an increase at early stages of hydration and after 28 days this increase is found to be very small. The actual % increase in compressive strength when MW is used as curing water at 28 days is found to be 7.1% respectively. This same behavior is noticed even in MWC with usage of MW as curing water, the % increase in compressive strengths is less compared to that of NWC cured in MW and this increase is found to be 4.95% at 28 days of curing. The increase in strength of concrete in both NWC and MWC with MW as curing water is may be due to the following theory:

As curing is promoting hydration of cement by control of temperature and moisture movement from and into concrete. The objective of curing is to keep concrete saturated until the originally water filled space in fresh concrete paste has been filled to the desired extent by the products of hydration of cement and this hydration of cement can take place only in water filled capillaries. This is where the loss of water by evaporation from the capillaries must be prevented. Further more water lost internally by self -desiccation has to be replaced by water from outside i.e. ingress of water into concrete must be made possible. As explained the cluster size of magnetic water is small compared to normal water, so magnetic water moves easily in to the micro pores of C-S-H gel structure and enhances hydration process by which the strength of concrete is increased. This increase in strength is high at initial stages because of the Magnetic effect on the water with alters the structure and water. But at later stages the increase is very less as water changes to original or previous form, because of the memory of water.

5.4 Influence of Magnetized Salt Water on Compressive Strength of Concrete

This investigation is carried out to study the effect of magnetized salt water (with chlorides and sulphates) usage in concrete mixing, on the compressive strength of M20 grades of Normal water concrete (NWC) and Magnetic Water concrete (MWC) cured in normal water at 28days. Magnetic water with N+S poles with 24 hours exposure to magnetic field was considered in mixing various ingredients of concrete.

5.4.1 Test Methodology

To study the effect of this Magnetized salt Water on compressive strength of concrete, Concrete cubes of 150 mm x 150 mm x 150 mm were casted with Normal chloride & sulphate water and with magnetic chloride and sulphate water (N+S water retained on Magnets for 24 hours) and tested to study the compressive strength under axial compression on completion of 28 days. Sea water prepared in the laboratory as per ASTM D1141.

Table 4: Composition of artificial sea water as per ASTM D1141

Composition	Concentration, g/lit
Sodium chloride	24.53
Magnesium chloride	5.2
Sodium sulphate	4.09
Calcium chloride	1.16
Potassium chloride	0.695

5.4.2 Compressive Strength on Magnetized Salt Water

The results of the compressive strength at 28 days M20 grades of Normal Water Concrete, Normal Salt water concrete (NSWC), Magnetic Salt water concrete (MSWC) and Magnetic Water concrete (MWC) are tabulated in Table 5.

Table 5 - Compressive strength of NWC, NSWC, MSWC and MWC

Compressive strength of M20 grade Concrete in MPa				
Age (Days)	**Normal water Concrete (NWC)**	**Normal Salt water Concrete NSWC**	**Magnetic Salt water Concrete MSWC**	**Magnetic water Concrete (MWC)**
28	28.29	26.84	33.62	44.06

It is observed that with the use of salt water in the concrete, the compressive strength of cube specimens at 28 days is decreased by 5.1%. Magnetization of salt water showed increase in compressive strength by 25.26% at 28 days compared to normal chloride water concrete.

6. CONCLUSIONS

Based on the results reported in this research work and key findings during the experimental investigations, the following conclusions can be drawn:

1. Studies conducted on water which is exposed to magnetic field indicates that the magnetic field exposure on water brings about internal molecular changes in water and increases surface area of water in unit volume.
2. When water is exposed to different poles of the magnet. The Mixed pole water (i.e. 50% of North pole water +50% of South pole water) is giving good results in compressive strength and Surface area of structured water compared to that of individual pole water.
3. For usage of MW as mixing water in concrete, 24 hours of magnetic field exposure time to water is found to be optimum.
4. It was observed that with the addition of MW the compressive strength of concrete showed very significant increase in compressive strength due MWC due to availability of more surface area of water for hydration process.

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