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Investigation on performance of water ion modified cement matrix

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Abstract. The water used in preparation of cement composite is going to be altered through magnetization. When the water is kept in magnetic field the additional hardness elements i.e., Ca, Mg and Fe get separated from water. But this separation cannot be done through normal magnetic field. Hence high electromagnetic diffuser or high-end magnets are needed. In this study Neodymium (Nd) - N52 magnets were used which has an atomic number 60. The water kept under the magnetic field for various time periods. The strength variation and development will be studied for mortar on various edges.

1. Introduction

The construction activities throughout the world are causing depletion of our natural resources especially water, so the care should be taken of using water in most efficient way[1]. As the population is increasing, the consumption rate is increased and so the requirements of human[2]. India is the second country in the list of most consumption of cement (284 MT) following China (2386 MT) in 2017[3]. Water is the most important ingredient for the formation of concrete as it causes the heat of hydration as it comes in contact with cement. Some properties of water are changed when we keep it in Magnetic field, but it does not mean that water is magnetized[4]. Clusters are formed in water by means of hydrogen bonds[5].

When water is under the influence of magnetic field, the magnetic force leads to breakage of these bonds and single particles are formed. These particles can easily and efficiently complete the hydration process as compared to normal water and increase the compressive strength[6][7]. Dosage of cement can be reduced by this method and also there is influence in compressive strength[8]. The admixtures quantity can also be reduced which causes less environmental pollution[9].

Acidic and salty water are responsible for disturbing the concrete performance[10]. It has been observed that the samples which are prepared under the magnetic influence gives the values of compressive strength more than that of normal concrete samples which can be increased up to 39%[5].

2. Experimental study

2.1. Materials

Table 1. Materials.

Material used	Specifications
Cement	JSW cement of Grade 53
Fine Aggregate	Specific gravity



	having 2.7
Water	Taken from VIT Borewell having pH 6.16

2.1.1. Neodymium Magnet

It is rare earth magnet which does not mean that they are in small amount it is because of its geochemical properties[11]. It is super magnet made up of mixture of Neodymium, iron and boron forming a tetragonal crystalline structure[6]. These are easily available in the market. They provide unparalleled levels of magnetism and resistance of demagnetization[12]. Neodymium magnets are 10 times stronger than ceramic magnets[13]. Though these magnets are very useful in various industries like electric motor manufacture, medical science etc., it can also make a huge change in construction industry[13]. Here we are using 15 thin strips having dimensions (40*10*2 mm each)[14][9].

2.1.2. Sample preparation

The sample is prepared by keeping the water under the influence of Neodymium magnetic field in centrifuge where water particles comes in contact with magnet while spinning[13].

2.2. Methodology

2.2.1. Apparatus

- Cube moulds shall be of (70.60*70.6*70.6) mm size confirming to IS: 10080-1982.
- Damping rod

2.2.2. Proportions

Table 2. The proportion for 10 cubes.

Material used	Content
Cement (kg)	1.9
Fine Aggregate (kg)	5.7
Water content (ml)	760
Mix ratio	1:3
Water cement ratio	0.4

2.2.3. Procedure

- The whole casting is carried out in laboratory.
- Then the weight of each material is taken.
- Place these materials on a nonporous plate.
- The materials should be mixed with trowel for about a minute before adding water.
- Pour the various samples of water till the sample is mixed thoroughly until it obtains a uniform color.

- The minimum time that should be taken for mixing is not less than 3 minutes.
- The mortar is placed in the first layer in the cube mould and tamped with the tampering rod[15]. Tamping the mortar is to be done for 20 times each time in three layers to avoid honeycomb formation and this process is to be continued till the mould is filled with mortar and after that the mould is to be kept undisturbed for drying,
- After a period of 24 hours, demould the sample and mark the specimen for identification.
- Immediately submerge the cubes in a curing tank and keep there until taken out just prior to test.
- For testing remove cubes 1 day earlier.



Figure 1. Cubes of water exposed for 150 seconds.



Figure 2. Cubes after testing.

3. Result and discussion

For conforming that properties of water are altered we perform pH test on each sample and recorded the values which is shown in Table 3[2].

Table 3. Temperature and pH of exposed water.

Time period (sec)	Temperature (° Celsius)	pH Value
0	30.7	6.16
150	30.5	6.90
300	30.5	7.32
450	30.3	7.38
500	30.5	7.40
750	30.2	7.42
900	30.5	7.44
1050	30.7	7.42
1200	30.5	7.44
1350	30.5	7.44
1500	30.3	7.45
1650	30.5	7.46
1800	30.2	7.46

The increment in pH value as shown in Figure 3 is because of polarization making the atoms behaving as tiny magnets having both poles. This leads to uniform arrangement of atoms.

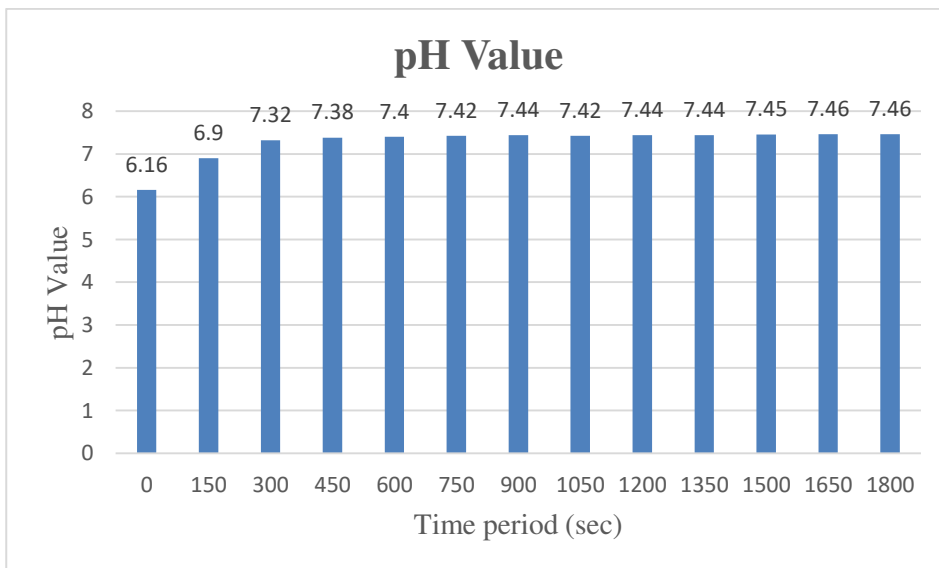
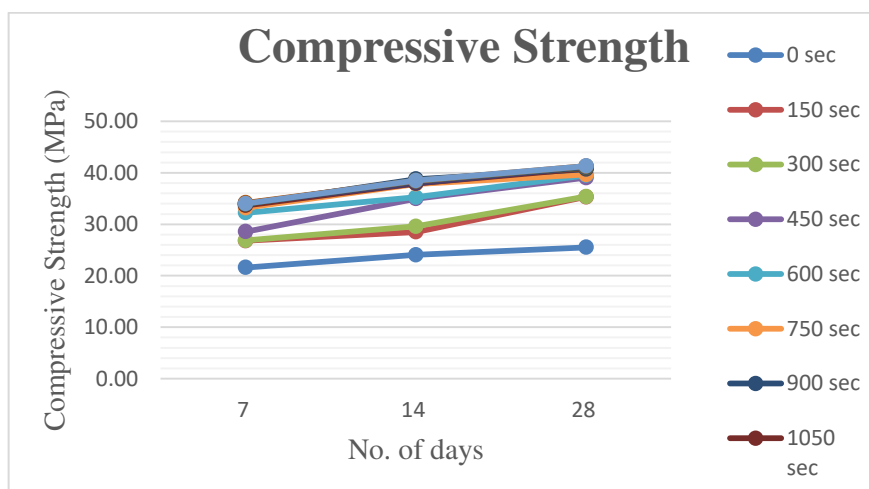
**Figure 3.** pH variation.

Table 4. Compressive strength.

Magnetisation Time (sec)	Compressive strength (N/mm ²)		
	7 days	14 days	28 days
0	21.61	24.07	25.51
150	26.80	28.50	35.31
300	26.87	29.59	35.37
450	28.57	34.97	39.05
500	32.24	35.26	39.52
750	33.20	37.82	39.66
900	33.81	38.78	40.68
1050	33.67	37.96	40.88
1200	33.94	38.50	40.97
1350	34.08	37.96	41.09
1500	34.01	38.36	41.15
1650	34.15	38.43	41.30
1800	34.01	38.50	41.32

The compressive strength for 7th day, 14th day and 28th day for the various kinds of water i.e., exposed for 0s, 150s, 300s, 450s, 600s, 750s, 900s, 1050s, 1200s, 1350s, 1500s, 1650s, 1800s to magnetic field are presented in Table 4. It is shown in Figure 4 that the compressive strength of cement matrix increases with the increased exposure of magnetized water, and this increase in the strength is due to formation of clusters of cement.

**Figure 4.** Compressive strength variation.

4. Conclusion

By following this procedure, the strength of cement matrix is increased without any dosage of admixture. Compressive strength of mortar cubes after 28 days for normal water and sample water is 25.51 MPa and 41.32 MPa respectively. As period of exposure increased the strength is increased accordingly and after certain time period it became stable. pH value also increased with increase in exposure time.

5. Reference

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