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Research Article

Study the strength of concrete by using silica fume and GGBS with magnetized water

Shivam Singhal, Abhishek Tiwari* and Anuj Kumar

Civil Engineering Department, Swami Vivekanand Subharti University, Meerut, India

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Abstract

The compressive strength and workability of the concrete by using magnetized water have improved assertive percentages depending on the development of the formation of this concrete. The experiments contain the preparation of standard cubes from this concrete according to the standard ratios of ingredients, admixtures and mixed with magnetized water, which was prepared by passing normal water through the devices of different magnetic strength in terms of Gauss. Then the aspect affecting on some physical and mechanical properties were studied. To complete the scope of the present experimental results, the study was constrained the preparation of similar cubes utilizing ordinary tap water. It was also appeared from the tests for compressive strength of concrete mixed with magnetic water and GGBS that there is an increase ranging between (30-35%) compared to the results of the control cubes.

Keywords: *Magnetic water, Concrete, Magnetic field, Compressive Strength, silica fume , GGBS.*

1. Introduction

Concrete's adaptability, durability, sustainability, and economy have made it the worlds most extensively used construction material. The term concrete attribute to a mixture of aggregates, usually sand, and gravel, held together by a binder of cementitious paste. The paste is consistently made up of Portland cement and water and may also contain supplementary cementing materials (SCMs), such as fly ash or slag cement, and chemical admixtures.

Presently we are using different grades of concrete like M20, M25, M30, M35, M40 etc. The difference in strength of M30 and M35 is nearly 15%. But we come to cost the difference to produce 1 m^3 is nearly INR 500. We have found a way in which by using the design mix of M30 we can get the strength of M35 i.e. we have manage to increase the current strength of concrete mix by nearly 15%. It will help to minimize the cost of the comprehensive structure without compromising with the strength of the structure.

The cement molecules undergo the process of hydration. When we use tap water the cement particles undergo hydration with small bunch of molecules. But when we use magnetized water, the particles are precisely hydrated with individual molecules of water, due to which complete hydration of cement particles takes place. Due to this complete hydration, strength is gained with all admixtures.

2. Literature review

Saddam M. Ahmed (2009) Investigates the influence of magnetic water on compressive strength and workability (consistence) of concrete. Results show that the compressive strength of concrete samples prepared with magnetic water increases 10-20% more than that of the tap water samples. In the present study, increasing in compressive strength of concrete is achieved when the magnetic strength of water is 1.2 T, and velocity of water current that passes through magnetic field is of 0.71 m/s. It is also found that magnetic water improves the workability (consistency) of fresh concrete.

Siva Konda Reddy, Dr.Vaishali ,G Ghorpade and Dr.H.Sudarsana Rao (2013) Investigates the effect of magnetic field exposure time of water on workability and compressive strength of concrete mixed with magnetic water. Water used for mixing in concrete was exposed to North and South poles for different durations. The results indicate that the 24 hours of magnetic field exposure is optimum for usage of magnetic water in manufacturing of concrete.

*Corresponding author **Abhishek Tiwari** (ORCID ID: 0000-0003-3614-8077) and **Anuj Kumar** are working as Assistant Professors; **Shivam Singhal** is a M.Tech Scholar
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Chikoti Sateesh(2017) - Investigates the effect of "magnetisation" on the compressive strength of concrete mixed with different treated waste water. In this technology, by passing water through a magnetic field, some of its physical properties change and as a result of such changes, the number of molecules in the water cluster decrease from 13 to 5 or 6, which causes a decrease in the water surface tension. The nanostructure of water molecule changes due to Magnetisation which helps in the increase of strength of concrete. In this work, concrete cubes were casted using three different water. Primary treated waste water (P-I), Secondary treated wastewater (S-I) and Tertiary treated waste water (T-I) obtained from a local waste water treatment plant.

Malathy,N. Karuppasamy, S.Baranidharan (2017) Their study involves the investigation of influence of magnetic water on the workability and compressive strength of concrete. The water is initially magnetized with the help of 0.5hp motor having a 0.8 T magnet at its inlet pipe. Both the physical and chemical properties oh water is to be studied. Concrete samples are then prepared and cured with magnetic water and ordinary water in four different cases. About 48 concrete cubes are casted for M25 grade and tested for 7, 14, 21 and 28 days respectively. The main scope of the study is to improve the qualities of water as per standards and reduce the water cement ratio thereby reducing the consumption of cement content and curing days.

3. Production of magnetized water

By using the concept of solenoid, magnetic water was prepared. A box built of plywood/cardboard of dimension 0.5m x 0.5m x 0.5m was used with a wax coating inside it. This box is put up inside a cube of bricks. Copper wire of 20 gauges of about 10m.An ac/dc converter was used to convert the AC voltage at home to DC voltage. Current of about 3 ampere and voltage of 19.5 V was obtained. With 100 numbers of turns of copper wire wrapped on a core was used. The water was passed inside the solenoid through PVC pipes at a constant rate of 10cc/s. The water is contain in the water container of mixer to be used at site but since the container is made of metal we need to coat it with wax as water starts falling its magnetization with contact of metal.

Fig. 1 Model for production of magnetized water

3. Material Used

3.1. Cement

Ordinary Portland Cement of 53 grade confirming to IS: 12269-1987(9) was used in this study. The properties of Portland cement are shown in Table 1.

Table 1: Properties of Cement

S. No	Property	Results
1	Normal Consistency	32%
2	Initial Setting Time	45min
3	Specific Gravity	3.15
4	Fineness of Cement	5%

3.2. Fine Aggregate

Natural sand as per IS: 383-1987 was used. Locally available River sand having bulk density 1860 kg/m3 was used The properties of fine aggregate are shown in Table 2.

Table 2: Properties of fine

S. No	Property	Result
1	Specific Gravity	2.57
2	Fineness modulus	2.28
3	Grading Zone	II

3.3. Coarse Aggregate

Crushed aggregate confirming to IS: 383-1987 was used. Aggregates of size 20mm and 12.5 mm of specific gravity 2.74 and fineness modulus 7.20 were used.

3.4. Silica Fume (Grade 920 D)

The Silica fume is used as a fractional replacement of cement. The properties of silica fume are shown in Table 3.

Table 3: Properties of silica fumes

S.No	Property	As Per manufacturers manual
1	Specific Gravity	2.2
2	Bulk Density	576, (Kg/m^3)
3	Size (Micron)	0.1
4	SurfaceArea, (m^3/kg)	20,000
5	Sio2	(90-96)%
6	Al_2O_3	(0.5-0.8)%

3.5 Ground granulated blast furnace slag (GGBFS)

The ground granulated blast furnace slag (GGBFS) is a derivative of iron manufacturing which when combined to concrete improves its properties such as workability, strength and durability.

Table 4 Properties of GGBFS

Property	Value
Physical Form	Off white powder
Bulk density (kg/m^3)	1200
Specific Gravity	2.9
Specific surface (m^2/kg)	425 – 470

3.6 Normal water

Normal water having H2O molecules. These molecules are bonded to each other via hydrogen bonds. These bonds are shown in the figure due to hydrogen bonding the water molecules are present in bunch in the sample.

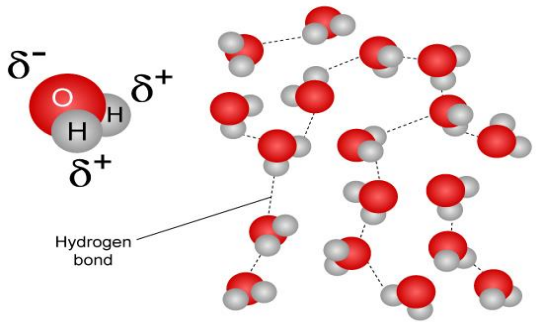

Fig.2 Bond in Normal Water

3.7 Magnetized water

Water is travelled through a magnetic field of high intensity ranging between 0.25T to 0.75T.Due to this the molecules are arranged in a certain direction. The hydrogen bonding present in water breaks. Initially the water is present in bunch of molecules formed due to hydrogen bonding. When passed through magnetic field the bunch breakdowns and single molecules are left as shown below.

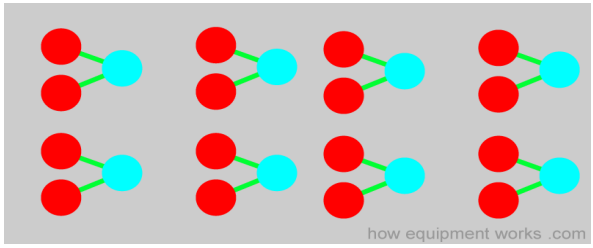

Fig.3 Bond of magnetize water molecule

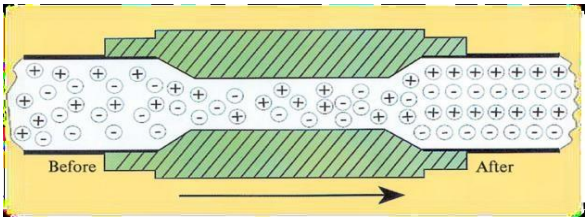

Fig. 4 Comparison Before & After Magnetization

4. Experiment result

4.1 Compressive strength by using Normal water

M30 Concrete cubes of 0.15m × 0.15m ×0.15m were prepared and checked for 28-days compressive strength. The results were: -

Table 5 Compressive Strength by using Normal Water

S. No.	Test Parameter	Unit	Observation
1.	Compressive Strength	N/mm2	31.92
2.	Compressive Strength	N/mm2	31.74
3.	Compressive Strength	N/mm2	29.48

4.2 Compressive strength by using magnetic water

Concrete sample of 0.15m × 0.15m × 0.15m was prepared using magnetic water and the results of 28-day compressive strength were as follows: -

Table 6 Compressive Strength by Using Magnetic Water

S. No.	Test Parameter	Unit	Observation
1.	Compressive Strength	N/mm2	36.73
2.	Compressive Strength	N/mm2	36.92
3.	Compressive Strength	N/mm2	37.41

Average compressive strength = 37.12 N/mm2
% increase in strength = (37.12 – 32.18) *100/32.18 = 15.35%

4.3 Compressive strength by using silica fumes

Concrete sample of 0.15m × 0.15m × 0.15m was prepared using 10% Silica fumes with magnetic water and the results of 28-day compressive strength were as follows:

Table 7 Compressive Strength by Using Silica Fumes

S. No.	Test Parameter	Unit	Observation
1.	Compressive Strength	N/mm2	37.9
2.	Compressive Strength	N/mm2	37.3
3.	Compressive Strength	N/mm2	38.0

Average compressive strength = 37.7 N/mm2
% increase in strength = (37.7 – 32.18) *100/32.18 = 17%

4.4 Compressive strength by using GGBS

Concrete sample of 0.15m × 0.15m × 0.15m was prepared using 10% GGBS with magnetic water and the results of 28-day compressive strength were as follows: -

Table 8 Compressive Strength by using GGBS

S. No.	Test Parameter	Unit	Observation
1	Compressive Strength	N/mm2	43.8
2	Compressive Strength	N/mm2	43.5
3	Compressive Strength	N/mm2	44.2

Average compressive strength = 43.83 N/mm2
% increase in strength = (43.83 – 32.18) *100/32.18 = 36.20%

Conclusions

1) The compressive strength of the sample using magnetized water is nearly 15% more as compared to sample made by using normal water.
2) When we replaced cement by GGBS the compressive strength increases up to 36%.
3) There is also an increase in workability of concrete.
4) The maximum compressive strengths 44.20 N/mm2 were attained at 10% replacement of cement by GGBS by Normal Curing.
5) If we used magnetized water then there is reduction in cost also per meter cube.
6) Reduction in annual production of carbon dioxide due to manufacturing of cement as less cement is needed for more strength.
7) Currently we are using different grades of concrete like M20, M25, M30, M35, M40 etc. The difference between strength of M30 and M35 is about 15%. But we come to cost the difference to produce 1 m3 is nearly INR 500. We have found a way in which by using the design mix of M30 we can extract the strength of M35 i.e. we have found a way to increase the current strength of concrete mix by nearly 15% in conventional concrete.

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