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Comparative Experimental Investigation on Strength Characteristics of Concrete Mixed with Magnetized Water

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ABSTRACT: This project aims to study the variations in properties of concrete when magnetic water is being used instead of potable water and also comparing the properties with the properties of normal mix concrete. To reduce the effects of hard water, as an alternative to water softening magnetic water treatment is been used. Results show that the compressive strength of concrete mixed with magnetic water is higher than those prepared with normal tap water when magnetic water is been used for curing and mixing. In early ages, the increase in compressive strength of concrete prepared with magnetic water was more significant.

KEYWORDS: Magnetic water, Concrete, Compressive strength, Portable water.

I. INTRODUCTION

Concrete is the most widely used man-made building material on the planet. OPC reacts with water to form hydration products, which glue together the reacting cement particles to form a cement paste, which is hard. When cement & water are mixed with sand and coarse aggregate the resulting product is called concrete. In the near future, it is expected that, the civil engineering community structures in harmony will be produced with the concept of sustainable development by the use of high-performance materials with low environmental impact. Adding chemicals and admixtures while mixing alters its properties thus obtaining a concrete with desired property. In many cases, these are added to get concrete with increased strength. The chemicals that are required for increasing the strength will be rarely available in rural areas and it will cost more in case of large projects. Magnetic water treatment is a proposed method of reducing the effects of hard water and increase in strength of concrete mixed with magnetized water.

Magnetized water does not mean that water has acquired magnetic strength but it has been subjected to a magnetic field. This field changes certain properties of concrete. These unique properties of water may result in many variations of macroscopic properties.

II. RELATED WORK

Several research papers and journals are available on the use of magnetic water in concrete as an effective method to increase the strength characteristics of concrete. The various experimental investigations carried out in the research papers highlight the effectiveness of magnetized potable water (magnetic water) and how the method can be made as new Ecofriendly construction material for future decades. Details of the prominent literature relevant for this experimental study are given below:

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Siva Konda Reddy B. et al. (2014) In this paper mixing and curing is done by the use of magnetized portable water. A circular magnet of 985 Gauss is used in this research, which can be collected from scientific store. The preparation of magnetic water is done by retaining the water in a glass beaker which is kept over the magnet. The Magnetic water is obtained by placing the beaker filled with water over the magnets for a period of 24 hours. The water absorbs magnetism when magnetic field penetrates through the glass into the water and this magnetized water is used for making concrete. Encouraging results were shown when tested for strength of concrete mix treated with magnetized water and for mixing and curing of concrete, one can easily replace normal water with magnetic water.

Ghorpade V.G. et al. (2014) This investigation shows the influence of magnetic water on Strength Properties and workability (consistency) of concrete. For this purpose magnetic water of 985 gauss strength is used. The investigation work on M20 grade of concrete mix trials. The Trial mix was fixed using three different magnetic water: 1. Water exposed to North Pole 2. Water exposed to South Pole and 3. Mixed pole water (N+S, half North Pole and half South Pole waters. Normal Tap Water and Distilled water were the two water used for this research.

Tawfic Y.R. et al. (2013) This research investigates the fresh and hardened properties of concrete fabricated with magnetized water. An experimental program consists of eighteen concrete mixes were Casted with different constituent materials. Concrete mix made of Magnetized water and tap water is used for the purpose of comparison. The water magnetization strength was 0.75 Tesla. To identify the fresh concrete properties compaction factor test and slump were done. The consistency, the initial and final setting time, and the compressive strength were investigated for three different types of cement mix made with magnetic water.

Ahmed S.M. (2008) The compressive strength and workability (consistence) of concrete with the influence of magnetic water were investigated in this research. Magnetic fields are produced by the motion of charged particles. Here an electromagnet is used to generate magnetic field. All the samples used for finding compressive strength were standard cubic specimens (150*150*150mm).

Hassan Karam et al. (2009) This research was done to investigate the physical and mechanical properties of this concrete. Through magnetic field tap water were passed and obtained water is Magnetized. Special apparatus to generate the magnetic field has been purchased and assembled with immerse-able water pump, for the laboratory study known as water magnetizer. Concrete strength characteristics is determined.

Manjupriya T. et al. (2016) The equipment called PERMAG (N406) with the magnetic field intensity of 0.9 Tesla is used for preparing Magnetized water in this research. The study is to replace the normal water with magnetically treated water by which quantity of cement used in any concrete mix is reduced. To improve strength and workability of concrete by using magnetized water and also to reduce the cement content quality in the concrete mix are the main objectives.

Masoud Rasoolian et al. (2014) In this paper the phenomenon of magnetized water is being explained elaborately. Water when magnetized shows diamagnetism which in turn increases the ion solubility in water. The paper also studies the effect of magnetic water on slump test of concrete.

III. SCOPE OF PROJECT

Concrete is an extensively used construction material, given that it is more economical (compared to metals and other materials). The negative aspects are that its fabrication generates CO₂ through calcinations of raw materials and ^{fuel} consumption and also the chemicals used to increase strength may be rare and expensive. The use of Magnetic water in concrete mix reduces the quantity of cement in turn reducing the carbon dioxide emission and also is comparatively economical giving desired properties to the concrete.

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IV. PROPERTIES OF CONCRETE

Cement

Cement is one of the major component in concrete mix. It is a binder which is used in construction which hardens and binds aggregate and sand together. Out of which OPC is the most common cement used in general concrete construction. The different grades available are grade 33, grade 43 and grade 53. OPC grade 53 is used in this investigation. The properties of cement are shown in Table-1.

Table 1: Properties Of Cement

Test	Result	Range
Specific gravity	3.06	3-3.15
Standard consistency	30%	26%-33%
Initial setting time	55 minutes	not less than 30 minutes

Fine Aggregate

Fine aggregate and coarse aggregate are the major components of aggregate used in concrete mix. Manufactured sand has been used as fine aggregate. Fine aggregate is usually crushed stones or natural sand. The specific gravity and void ratio were found out and are 2.64 and 1.84 respectively. The particle size distribution was determined by sieve analysis and they belong to zone II.

Table 2: Physical Properties Of Fine Aggregate

Fine aggregate	
Specific gravity	2.64
Bulking	32.3%
Fineness modulus	3.83
Bulk density	1.81g/ml
Void ratio	1.89

Coarse Aggregate

Coarse aggregate are components of aggregates used in concrete mix. Some of the coarse aggregate used are sand, gravel, crushed stones, slag, recycled concrete and geosynthetic aggregates. Here used coarse aggregate is locally available crushed granite aggregate of 20mm downsize conforming to IS 383. The specific gravity and void ratio is found to be 2.74 and 1.22 respectively for 20mm size. The results of sieve analysis of coarse aggregate are shown in Table-3.

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Table 3: Physical Properties Of Fine Aggregate

Coarse aggregate	
Specific gravity	2.74
Crushing value	32.3%
Fineness modulus	4.3
Bulk density	1.47g/ml
Void ratio	1.22

Magnetic Water

Magnetized water does not mean that water has acquired magnetic strength but it has been subjected to a magnetic field. This magnetic field changes properties of concrete. These unique properties of water may result in many variations of macroscopic properties.

The increase in solubility and decrease in bond angle of the water molecules which was broken down by magnetic field. After applying a strong magnetic field, water will show magnetization in a way opposite to the direction of magnetic field which is having pair-up electrons which cancel each other's magnetic moment. As a result, certain orientation was done on water molecules., they are restricted to form water clusters due to chances of reducing matched orientation of water molecules in a cluster Association percentage of hydrogen bond will decrease. In other words, larger water clusters are cut and broken down by the external magnetic field to form smaller water clusters or single water molecule or double water molecules. The bond pairs are deflected and squeezes the bond pairs to be closer together by the magnetic field. Decreased bond angle also reduces repulsion between electrons in bond pairs of H₂O because the bond pairs have a smaller coverage and the contract of water molecules in terms of electric field. As a result, energy for acquiring stability is lower and more solute can be packed in the same volume of water, thus increasing solubility of water.

The pH of Magnetized water was tested. pH of distilled water = 7.01 pH of magnetized water = 7.63 pH of distilled water is less than magnetized water which shows that the magnetized water tends to be alkaline in nature.

V. MIX PROPORTION

Mix design was done as per IS 10262: 2009, IS 456: 2000 and IS 383:1997. Target mean strength for M25 grade concrete is 31.60 N/mm². Water cement ratio was taken as 0.40. Table 3 represents the quantities of mix proportion for one cubic meter of concrete.

TABLE 4: MIX PROPORTION FOR M25

MATERIAL	CALCULATED QUANTITY
CEMENT	492.5kg
COARSE AGGREGATE: 20 MM	1092kg
FINE AGGREGATE	400.3kg
WATER	197kg

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VI. METHODOLOGY

- Preliminary study of various materials to be used in concrete by various tests such as specific gravity, water absorption, grading of aggregates are done.
- Mix was designed for M25 grade concrete using the properties of aggregates obtained earlier and the quantities for 1 m³ of concrete was calculated for concrete mix.
- Slump cone test is done for concrete mixed with magnetic water in the laboratory. The test was conducted several times with addition of magnetized water to the concrete mix such that slump falls between 80 to 100mm.
- Several concrete cubes, cylinders, beam were casted with concrete mixed with distilled water and concrete mixed with magnetized water.
Specimens were tested for compressive strength, split tensile strength and flexural strength in the testing machines after curing of 24 hours.
- Effect of magnetic water on strength of concrete was studied and compared with that of a nominal mix.

VII. TESTING PROCEDURE

Specimens of concrete with cubes, cylinders and beam have been casted for checking compressive strength, split tensile strength and flexural strength respectively. Standard cast iron moulds of size 150x150x150 mm, 300mm long x 10mm diameter and 100x100x150mm are used in preparation of cube, cylinders and beam respectively. The moulds have been cleaned such as to remove dust particles and mineral oil were properly applied on all its sides. This fully blended mix is then filled into the mould and compaction is done with a tamping rod (25 times) for each three layers. After proper compaction, the excess concrete is removed with trowel and the top surface is smoothed. The specimens are stored in the laboratory at room temperature, after casting of concrete mix. After 24 hours from the specimens are removed from the moulds and are submerged in the fresh water tank immediately. The samples of both concrete mix using magnetic water and control mix were taken after 28 days of curing, the excess water is wiped out from surface and tested for 7 and 28 days strength for each three kinds of specimens which were casted in laboratory.

VIII. RESULTS AND DISCUSSIONS

Strength of concrete by using magnetic water and normal tap water are shown in Table 5. The compressive strength were recorded obtained after 7 days and 28 days, also split tensile strength and flexural strength after 28 days of curing.

Table 5: Strength Characteristics Of Concrete

Type of mix	Compressive strength		Split tensile strength (28 days)	Flexural strength (28 days)
	7 days	28 days		
Magnetic water mix	30.52	45.18	2.67	6.6
Control mix	24.14	27.63	2.5	5.5

It was observed that the maximum strength was obtained for concrete mix with magnetic water.

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IX. CONCLUSION

This investigation shows the magnetic water effect on strength properties of concrete. The magnetic water of 1200 gauss strength is used for this purpose. The conclusions obtained from this work are as follows:

- The workability of magnetic water concrete is slightly more than that of NWC.
- The concrete mixes prepared with magnetized water was tested for compressive strength at both 7 and 28 days age and were higher than the values of the compressive strength of the concrete mixes made with tap water. The increase in percentage of the compressive strength at 7-days age was 26.43%. Meanwhile, the increase in percentage of the compressive strength at 28-days age was 63.5%.
- The Tensile strength of concrete is improved by 6.8% when Magnetic water is used instead of Normal tap water for preparing concrete mix.
- The Flexural strength of Magnetized water concrete is more than that of NWC by 20%.

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