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An Experimental Study on the Effect of Magnetized Water on Mechanical Properties of Concrete

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Abstract. This experimental study involves the examination of magnetized water on the workability and strength properties of the concrete. The water is magnetized in static treatment process with two different strengths of magnets with 0.986 and 2 Tesla. The water exposed to magnetic field is used in concrete on replacing ordinary water it results to increase the workability and mechanical properties of the concrete. The compressive, split tensile and flexural strength tests were carried using 24-hour magnetized water in production of concrete. Concrete made with magnetized water possess higher strength than concrete made with ordinary water. The extent of the study is to improve the nature of the water according to the standards and reduce the water-cement ratio thereby reduce the utilization of cement content and porosity of the concrete.

1. Introduction

In constructions, concrete is extensively used in world-wide due to its competence to attain cast in any form and shape. The properties of concrete such as strength and durability are also altered by generating convenient changes in the ingredients of concrete [1]. Predominantly including certain chemical compounds during the process of mixing concrete is utilized to change the different properties of concrete and to achieve a concrete with wanted property. But in more prominent of the cases there admixture are enhanced to make concrete with expanded quality. Various admixtures that are used to enhance the strength of concrete are not available in rural areas and cost of that admixtures are also high to use in massive projects. The utilization of water is increasing as the people essentials are developed. The modern industrialized sector has come in 2nd of 20 % of water utilization after the farming sector which represents 70% of the water used [2]. The water utilized for the production of concrete plays an important part in concrete mix, primarily in the hydration process of cement and provide appropriate curing period to attain the preferred strength. In the production of concrete usually tap water or drinking is used to avoid the presence of impurities. Using water which is magnetized has encouraging the mechanical properties, durability properties and potentials in preserving the water quantity used in construction. Most of the researcher concentrated their attention on producing economical concrete with higher strength using modern techniques [3].



1.1. Magnetized water

Water exhibit changes in certain properties (physical, chemical) when subjected to magnetic field. The variations in Macroscopic properties is due to existence of unique anomalous properties of water the perception towards water is as ordinary fluid but majority of the research study includes towards water. Water is transparent in nature and considered as homogenous mixture comprised of two hydrogen atoms are bonded to a single oxygen atom as shown in Figure 1. When turned deeper at imperceptible level water is not equivalent, its water exists as clusters of molecules and the size of this cluster purely depends on the coercion, potency and temperature conditions extant over the water. Vander Waal's forces and hydrogen bond holds these clusters of molecules in place [4]. Clusters break down into even smaller cluster when they are exposed to magnetic field therefore changing certain properties of water [4].

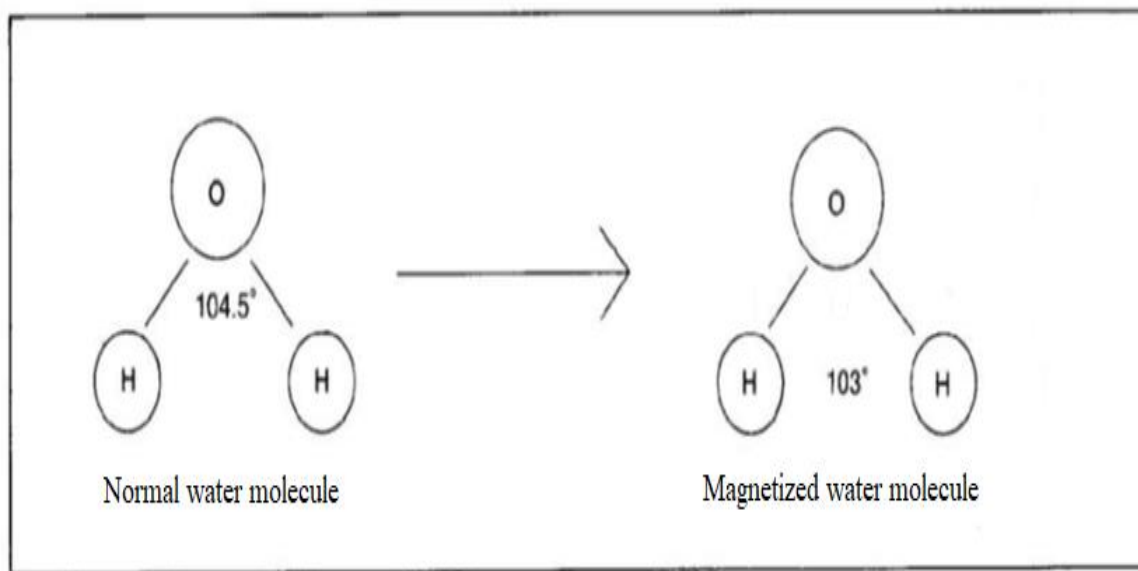


Figure 1. Structure of water molecule from Tap water to Magnetized water.

Siva kondareddy [5] stated that when water is placed for magnetization there is change in size of water molecule due to magnetic exposure. Generally, water the structure of water molecule is H_2O which is bonded as a regular triangle with its upper angle is 104.5° . When normal water is exposed to magnetic field then the bond angle is reduced to below 104.5° . This leads to change in properties of water both physical and chemical.

1.2. Magnetized Water's Influence on Concrete

- The strength properties of concrete like compressive, split tensile and flexure strength were presented to be enhanced using magnetised water in concrete [6].
- The properties like Efficiency and volume of concrete are also looking to increase. Due to more hydration occurs it seems to be producing higher strength and it also reducing content of cement [4].
- Due to use of magnetized water, it reduces the emission of greenhouse gases.

2. Material and Methodology

2.1. Constituent Materials

The materials used for concrete are succinctly studied in the following category:

2.1.1. Cement. The binding material of Ordinary Portland cement (OPC) of 53 grade were used in the present study for concrete mix. It were used in the examination for physical and chemical properties as per IS: 12269-2013[7]. The various tests results conducted on the cement are shown in Table 1.

Table 1.Cement properties.

Cement	Units	Results	Requirements as per (IS:12269-2013)
Normal Consistency	%	31	-
Specific Gravity	-	3.13	-
Fineness of Cement	%	3.35	Less than 10%
Setting Time -Initial	Minutes	42	Minimum 30
-Final	Minutes	320	Maximum 600

2.1.2. Aggregates. Aggregate is a term for any particulate material. The aggregates such as gavel, crushed stones, sand etc. The two main elements in the concrete is fine aggregate and course aggregate. Fine aggregate used in this study is M sand free from impurities and the specific gravity of M sand was found to be 2.6 by conducting experiment as per IS 2386 (Part III) – 1963[8]. Tests were made to fine the fineness modulus of fine aggregate and it is confirmed that the sand belongs to Zone II as per IS 383 -1970[9]. Coarse aggregate was obtained by crushing the black granite stones and passing through 20 mm and it is angular and graded coarse aggregate as per IS 383 -1970, the specific gravity was found to be 2.7 by conducting experiment as per IS 2386 (Part III) – 1963. The test result of crushing value was 27, impact value was 22 and Los Angeles abrasion value was 28, and the test results confirmed that the aggregate was very good quality and the same was used for project work.

2.1.3. Magnets. During this study, the rectangular and round Magnets wastook from scientific store. The strength of two pairs of magnets is 0.986 T and 2T respectively. The magnetic strength was determined by Gauss meter[10].



Figure 2. Square magnets of strength 2T.



Figure 3. Circular magnets of strength 0.986T.

2.1.4. Normal Water (Tap water).One the most important element in the concrete is water. For mixing and curing of concrete water is essential. For this studytap water were used and the chemical properties are show in Table 2, confirming to IS: 3025-1986[11] and IS: 456-2000[12].

Table 2.Chemical properties of normal water.

Parameter	Units	Results	Limits as per IS 456-2000
pH	-	7.14	6.5-8.5
Hardness	Mg/l	830	<600 for drinking water
Calcium Ion Concentration	Mg/l	71.48	-
Alkalinity	Mg/l	100	250
Turbidity	NTU	6.3	<10

2.1.5. Magnetized water. The two magnets are to be place below the glass beaker and replete with normal water for 24 hours magnetization[13]. In the time of magnetization the magnetic flux penetrates through the glass beaker into the water, thus water alters to magnetized water are shown in Table 3. In this study, the magnetized water was used to examining the strength properties of concrete.

Table 3.Chemical properties of Magnetized water.

Parameter	Units	Results(2T)	Results(0.986)	Limits as per IS 456-2000
pH	-	8.24	8.13	6.5-8.5
Hardness	Mg/l	755	800	<600 for drinking water
Calcium Ion Concentration	Mg/l	93.35	90.83	-
Alkalinity	Mg/l	25	75	250 RCC works
Turbidity	NTU	6	6.1	<10

2.2.Preparation of magnetized water

The Pyrex glass Flask is used to prepare the magnetized water. Before the flask is using the flask want to clean with distilled water. About 5 Litres of water is used to magnetize the water in that flask. Arrange the magnets in a North - North poles which is in repulsion. The Pyrex glass flask is placed on the magnets about 24 hours to get water magnetized are shown in Figure 4. After 24 hours the chemical properties of water such as pH value, calcium ion concentration, hardness, alkalinity, turbidity of water are to test.



Figure 4. Preparation of Magnetized water for 2T strength.

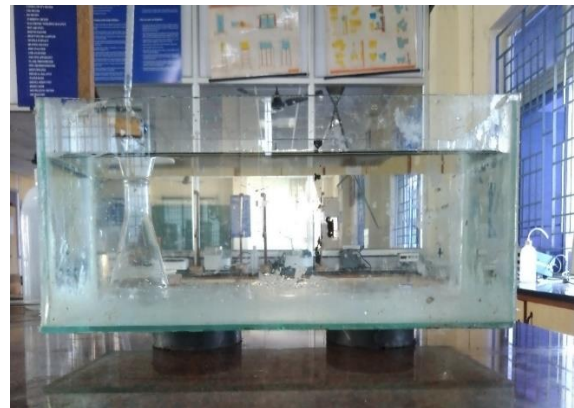


Figure 5. Preparation of Magnetized water for 0.986T strength.

3. Results

The mechanical properties of concrete were obtained by using magnetized water.

3.1. Compressive Strength

The compressive strength of concrete is a measured of the concrete's capability to prevent loads which influence to compress it. Instead of normal water, water influenced with magnetization is used in the concrete for mixing of ingredients and to find the maximum exposure time of water to the magnetic field. The concrete cubes of 100mm × 100mm × 100mm were casted with two different strength of magnetized water. The compressive tests were done on this cubes after 3, 14, 28 days. The test results are shown in table 5 and changes are presented in Figure 6.

Table 5. Compressive strength for NWC and MWC

Concrete Mixes	Compressive Strength(N/mm ²)		
	3 Days	14 Days	28 Days
NWC	19.86	30.83	42.63
MWC (0.986T)	22.36	35.10	48.75
MWC (2T)	24	40.26	55.45

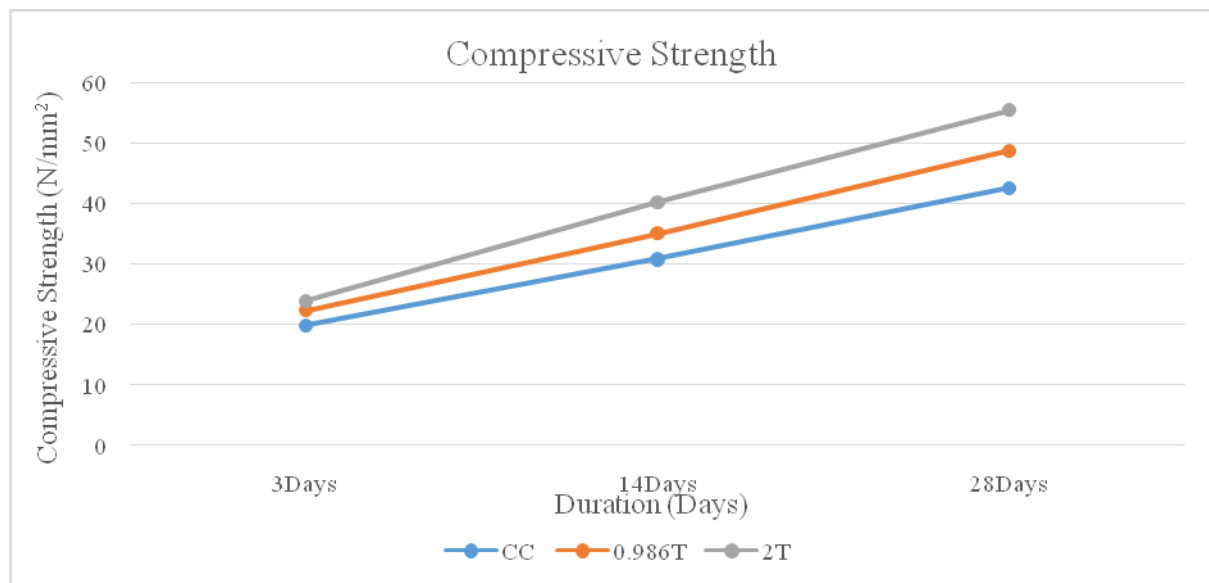


Figure 6. Compressive strength results for NWC and MWC.

3.2. Split Tensile Strength

This study was accomplished to examine the splitting tensile strength of NWC and MWC. The cylinders of size 100mm x 200mm are casted and tested to study the splitting tensile strength at 3, 14 and 28 days. The Split tensile Strength was done on these cylinders at 3, 14 and 28 days for concrete with and without magnetized water. The outcomes are enumerated in Table 6 and their deviations are presented in Figures 7.

Table 6. Split Tensile strength for NWC and MWC.

Concrete mixes	Split Tensile Strength(N/mm ²)		
	3 Days	14 Days	28 Days
NWC	2.23	3.01	4.31
MWC (0.986T)	2.39	3.2	4.93
MWC (2T)	2.53	3.31	5.62

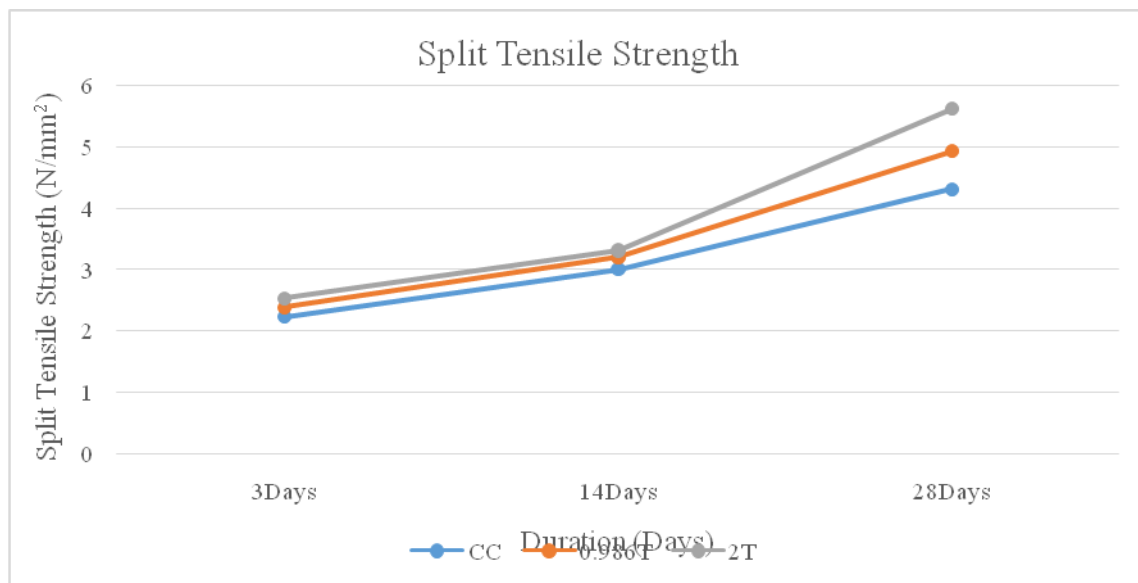


Figure 7. Split tensile strength results for NWC and MWC.

3.3. Flexural Strength

The study is executed to examine the Flexural strength of concrete. The beam of size 500mm × 100mm × 100mm are casted and tested to review the flexure strength of concrete. The outcomes of the flexural strength at 3, 14 and 28 days for NWC and MWC are given in Table 7 and the changes are shown in Figures 8.

Table 7. Flexural strength for NWC and MWC.

Concrete Mixes	Flexure strength (N/mm ²)		
	3Days	14Days	28Days
NWC	1.76	2.85	4.6
MWC (0.986T)	1.98	3.34	5.27
MWC (2T)	2.05	3.71	6

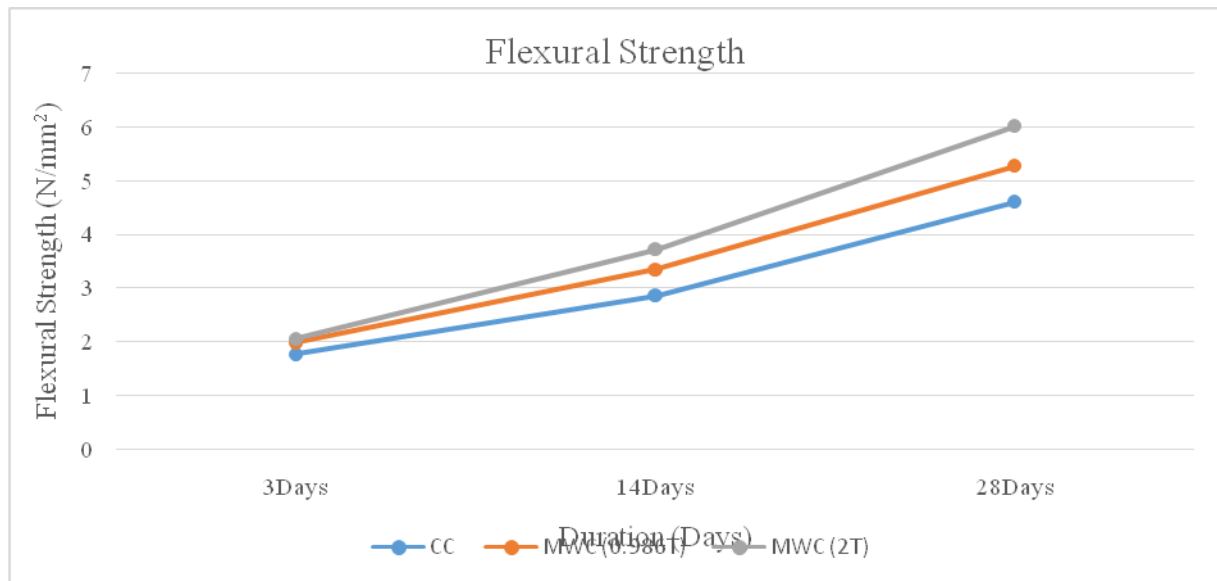


Figure 8. Flexural strength results for NWC and MWC.

4. Conclusion

- The strength studies shows that MWC is showed strength development compared with NWC. The compressive, Split Tensile and Flexural strength of MWC enhanced as the maturity of the concrete increases by virtue of continues hydration mechanism which reduces the porosity of the concrete.
- The use of magnetized water instead of tap water in the concrete it exhibits significant increase in compressive strength by 30.07% for 2T magnetized water in concrete and 14.35% at 0.986T magnetized water in concrete for 28 days curing.
- The split Tensile strength of concrete showed significant increase by 30.62% for 2T magnetized water in concrete and 14.38% for 0.986T magnetized water in concrete.
- Flexural strength of the concrete is also exhibits increment by 30.43% for 2T magnetized water and 14.56% for 0.986T magnetized water in concrete.

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