

EFFECT OF VARYING MAGNETIC FIELD STRENGTHS ON PROPERTIES OF MAGNETIC WATER CONCRETE

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Abstract— This paper presents the effect of magnetic structured water on the properties of magnetic water concrete of M25 grade. Cubes of standard size 150mmx150mmx150mm and cylinders of diameter 150mm and height 300mm were cast with magnetic structured water subjected to constant magnetic fields (viz., 0.2T, 0.4T, 0.6T) for 24 hours and 12 hours and cured with potable water, magnetic structured water and also under constant magnetic field. The workability, compressive strength and split tensile strength were determined and compared with conventional concrete. It was found that the compressive strength of cubes cast with 0.6T magnetic water subjected to 24 hours of magnetic field and cured under constant magnetic field of intensity at 0.6T was found to be 58.36 MPa; which was 2.86% higher than the highest compressive strength (56.68MPa) of cubes cast with 0.6T magnetic structured water subjected to 24 hours of magnetic field and cured with magnetic structured water of intensity 0.6T. Which is again 13.7% higher than the compressive strength (50.356MPa) of cubes cast with 0.6T magnetic structured water subjected to 24 hours of magnetic field and cured with potable water. Which is again 31.45% higher than the compressive strength (40MPa) of conventional concrete. Whereas the split tensile strength of cylinders cast with 0.6T magnetic water subjected to 24 hours of magnetic field and cured under constant magnetic field of intensity at 0.6T was found to be 8.001MPa which was 3% higher than the highest split tensile strength (7.77Mpa) of cylinders cast with 0.6T magnetic structured water subjected to 24 hours of magnetic field and cured with magnetic structured water of intensity 0.6T. Which is again 9.7% higher than the split tensile strength (7.22MPa) of cylinders cast with 0.6T magnetic structured water subjected to 24 hours of magnetic field and cured with potable water. Which is again 37.5% higher than the split tensile strength (5MPa) of conventional concrete.

Keywords— Magnetic field, Compressive strength, split tensile strength, conventional concrete, Magnetic field treated water.

I. INTRODUCTION

The word magnet is derived from the name of an island in Greece called magnesia, where magnetic ore deposit was found as early as 600 B.C. Water passing through a magnetic field with certain intensity is called as magnetic field treated water. Magnetic Field Treated Water improves the properties of concrete without addition of any admixture in concrete mix, increase in strength by 20% and more, Compare to normal water concrete. The reason why Magnetic field treated water increase the strength, water cluster of large size molecules are breakdown into smaller one i.e 13 into 5 (or) 6, which helps magnetic water to penetrate easily into the cement particles, which enhances the hydration process and decrease the surface tension of water. Density of water may also change depending on the forces that dominate the conditions. The two forces that dominate are Hydrogen bond and Vander wall's Forces. Yan et al also states that by light spectrum, the bond angle decreases from 104.5o to 103o because magnetic field deflects the bond pairs and squeezes the bond pairs to be closer together. The magnetic field can break down these water clusters and reduce the bond angle and hence increase solubility. Therefore, hydration process will be done efficiently, which in turn improves concrete strength. This technique is safe, simple, and environmentally friendly, has low operating costs and is proven to have no harmful effects.

II. OBJECTIVES

- To establish the procedure for producing the Magnetic Field Treated Water.
- To study the magnetic water concrete characteristics in terms of workability and strength aspects.
- To compare the compressive strength and split tensile strength of Normal water concrete and Structured magnetic water concrete for M25 grade of concrete mix.

III. MATERIALS USED AND THEIR PROPERTIES

A. Cement

The cement used is Ordinary Portland cement of 53 grade manufactured by RAMCO Cement Company. The specific gravity of the cement is 2.92, Initial setting time and final setting time is 52mins and 562mins respectively and fineness of cement is 3%.

B. Coarse aggregate

The coarse aggregate used is Crushed granite stone of maximum size 12mm confirming to IS 383-1970 and the grading zone is zone I as per Indian standard specification, which are procured from local quarry. Specific gravity of the coarse aggregates is 2.88, fineness modulus is 7.32 and bulk density is 1.52.

C. Fine aggregate

The fine aggregate is used which was passing through 4.75mm sieve and the grading zone of fine aggregate was zone II as per Indian standard specification, which are procured from local quarry. Specific gravity of the fine aggregate is 2.56, fineness modulus is 3.2 and bulk density is 1.676.

D. Water

Two types of water are used in the experimental work for both mixing and curing:

- 1) Preparation of magnetic field treated water and
- 2) Potable water which is free from impurities

1) Preparation of magnetic field treated water

In the present investigation work, magnetic water was prepared by retaining water in a glass beaker over a magnet of different intensities 0.2Tesla, 0.4Tesla, 0.6Tesla. The Magnetic water was produced by placing the beaker filled with water over the magnets varying in the time period of 12hours and 24 hours as shown in Figure 2. During this time, the magnetic field penetrates through the glass into the water and this magnetized water is used for making concrete and also for curing.



Figure-1 Showing the preparation of magnetic field treated water

E. Neodymium Magnets

A Neodymium magnet the most widely used. It is a rare type of earth magnet, is a permanent magnet made from an alloy iron and boron. So, it is in pure form its magnetism only appears at extremely low temperatures.

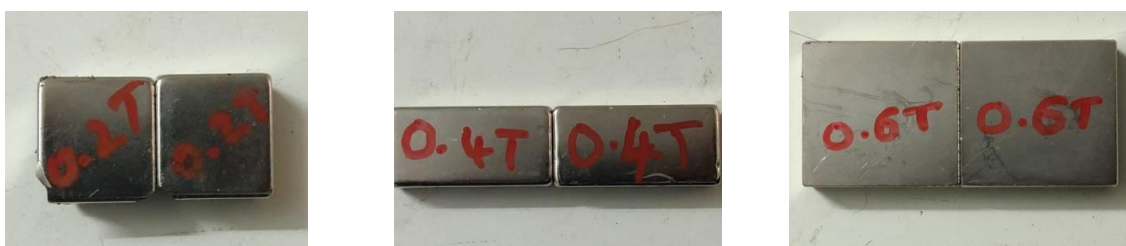


Figure-2 Neodymium Magnets with different Magnetic power (0.2T,0.4T,0.6T)

IV. EXPERIMENTAL INVESTIGATION

A. Mix Design

Mix design for M25 grade of concrete was done as per IS: 10262(2009) with mix Proportions 1: 1.52: 3.06 with 12.5mm coarse aggregate with a water cement ratio of 0.43 are adopted.

B. Casting

Casting is a manufacturing process in which a liquid material is usually poured into a mould in three layers with each layer being given 25 blows with a tamping rod. At the end of casting, the top surface was made plane using trowel to ensure a top uniform surface. which contains a hollow cavity of the desired shape, and then allowed to solidify. Casting is done in 2 ways:

1. Using Potable water
2. Using magnetic water with different intensities (0.2T,0.4T,0.6T).

To investigate the effect of magnetic water on the compressive strength of the concrete cubes of size 150x150x150 mm and split tensile test for cylinders of 300mmx150mm was used.



Figure -3 Showing the casting of the specimens

C. Curing

After casting the specimens are demoulded and curing is done for 28days by immersing in water. Curing is done in 3 ways:

1. Curing in potable water
2. Curing in magnetic water with intensity of 0.6T
3. Curing in constant magnetic field of 0.6T.



Figure -4 Curing in potable water



Figure -5 Curing in magnetic water with intensity of 0.6T



Figure -6 Curing in constant magnetic field of 0.6T

D. Preparation of test specimen

For the experimental study cubes of size 150x150x150 mm is used for compression test. Cylinder of 150x300 mm used for split tensile test. The specimens are prepared and cured in normal and magnetized water.

We have used different types of mixes

1. Casting with potable water and curing in potable water
2. Casting with magnetic water and curing in potable water
3. Casting with magnetic water and curing in magnetic water with intensity of 0.6T
4. Casting with magnetic water and curing in constant magnetic field of 0.6T.

E. Testing

The Compressive Strength and Split-Tensile strength were done on 200T Universal Testing Machine confirming to IS: 516-1959. The Compressive strength test is conducted on samples at 28 days of curing with variation in time of 12hrs and 24hrs. The tables are shown varying the time. The results show a significant increase in the compressive strength for the mix with magnetic water used for casting and curing. There is a slight increase in strength for 12hrs of magnetization but for 24hrs magnetization a noticeable increase can be seen. The maximum load applied on the specimen was recorded. Compressive strength = (Load in N/ Area in mm²)



Figure -7 Compressive strength test of Cubes under ultimate load

The split tensile strength of cylinders is the standard test, to determine the tensile strength of concrete in an indirect way.

Cylinder is placed horizontally between the loading surfaces of compression testing machine. In this test cylinder of 150mm diameter × 300mm length is used for testing. The split tensile strength test is conducted on samples for 28 days of curing varying in 12hrs and 24hrs of magnetization of water. The Splitting Tensile Strength is calculated using the formula:

$$T_{sp} = \frac{2P}{\pi DL} \text{ Where, } P = \text{Applied Load, } D = \text{Diameter of the Specimen, } L = \text{Length of the Specimen}$$



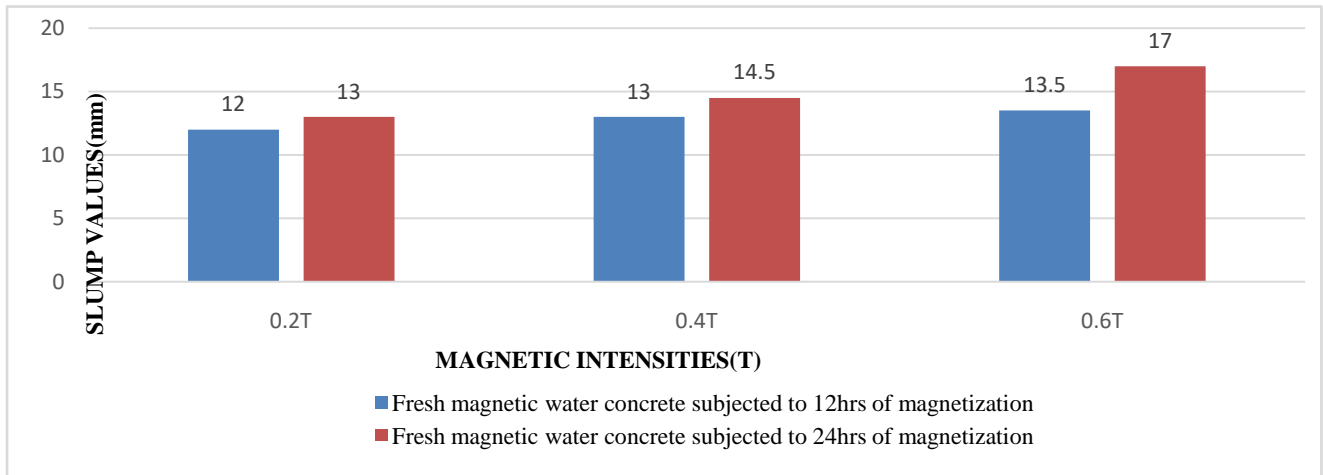
Figure -8 Split tensile test of Cylinders under ultimate load

F. Test Results and Discussions

1) Workability:

TABLE-I WORKABILITY OF CONCRETE

Grade of concrete	Fresh normal water concrete	Fresh magnetic water concrete subjected to 24hrs of magnetization (MPa)			Fresh magnetic water concrete subjected to 12hrs of magnetization (MPa)		
		0.2T	0.4T	0.6T	0.2T	0.4T	0.6T
M25	10	12	13	13.5	13	14.5	17



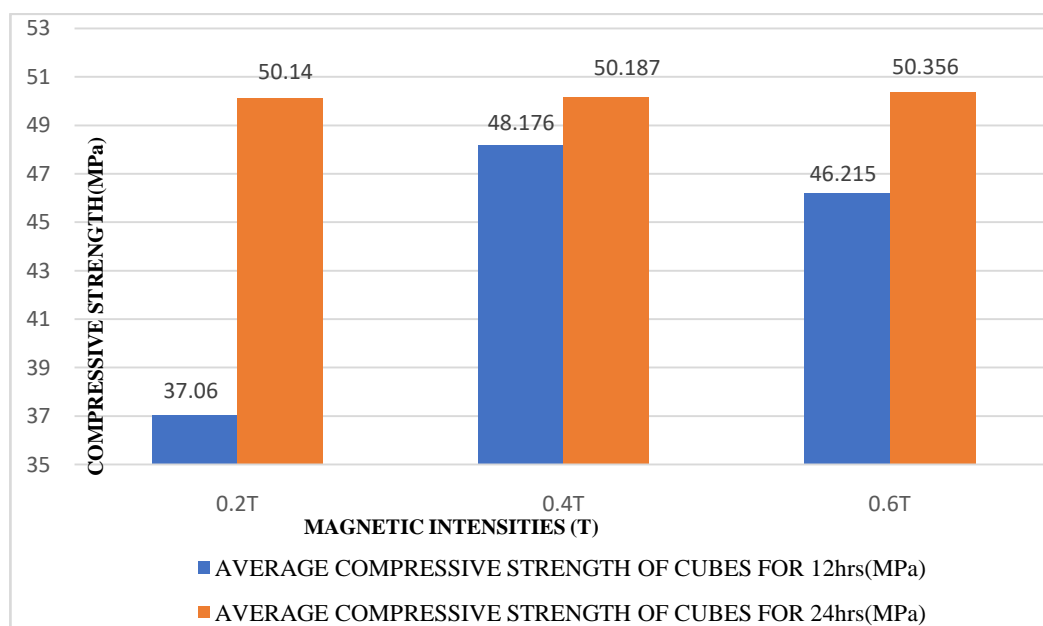
From the observations it is found that slump value of magnetic water concrete is higher than that of potable water concrete. The magnetic water concrete is highly workable when compared with potable water concrete. It shows that magnetic water enhances the workability of concrete. The increase in the slump value is due to the increase in viscosity and increase in the surface area of the mix when magnetized water is used.

2) Compressive Strength on cubes:

For M25 grade of concrete average compression strength of cubes by Potable Water casting and curing in potable water is 40Mpa.

TABLE-II MAGNETIC WATER CASTING AND CURING IN POTABLE WATER

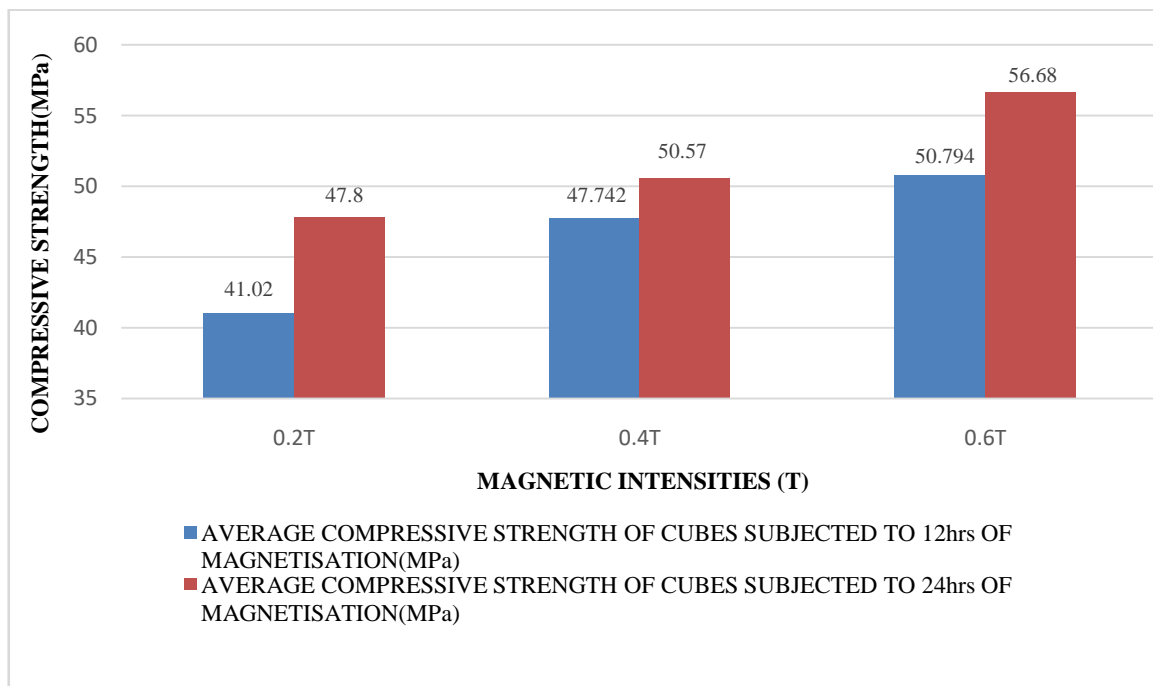
Tesla	Average compressive strength of cubes for 12hrs (MPa)	Average compressive strength of cubes for 24hrs (MPa)
0.2T	37.06	50.14
0.4T	48.176	50.187
0.6T	46.215	50.356



For M25 grade of concrete average compression strength of cubes for 12 hrs by using Magnetic Water casting and curing in potable water for 0.2T is 37.06MPa. For M25 grade of concrete average compression strength of cubes for 24hrs by using Magnetic Water casting and curing in potable water for 0.2T is 50.14Mpa. For M25 grade of concrete average compression strength of cubes for 12hrs by using Magnetic Water casting and curing in potable water for 0.4T is 48.176Mpa. For M25 grade of concrete average compression strength of cubes for 24hrs by using Magnetic Water casting and curing in potable water for 0.4T is 50.187Mpa. For M25 grade of concrete average compression strength of cubes for 12hrs by using Magnetic Water casting and curing in potable water for 0.6T is 46.215Mpa. For M25 grade of concrete average compression strength of cubes for 24hrs by using Magnetic Water casting and curing in potable water for 0.6T is 50.356Mpa.

TABLE -III MAGNETIC WATER CASTING AND MAGNETIC WATER CURING

Tesla	Average compressive strength of cubes for 12hrs (MPa)	Average compressive strength of cubes for 24hrs (MPa)
0.2T	41.02	47.8
0.4T	47.742	50.57
0.6T	50.794	56.68



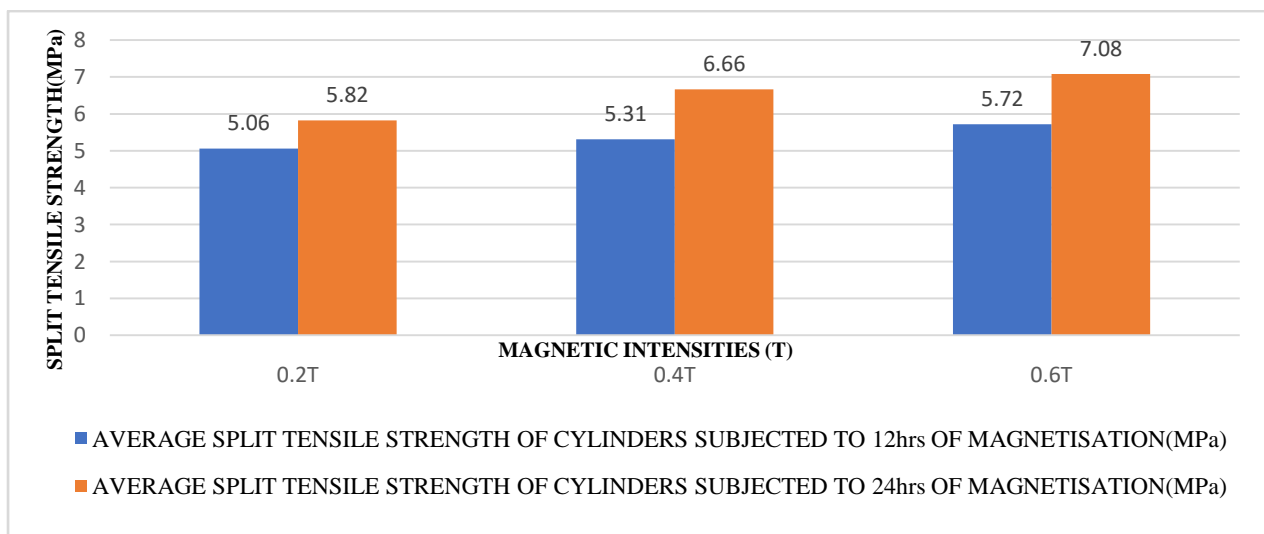
For M25 grade of concrete average compression strength of cubes for 12hrs by using Magnetic Water casting and curing in magnetic water for 0.2T is 41.02MPa. For M25 grade of concrete average compression strength of cubes for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.2T is 47.8MPa. For M25 grade of concrete average compression strength of cubes for 12hrs by using Magnetic Water casting and curing in magnetic water for 0.4T is 47.742MPa. For M25 grade of concrete average compression strength of cubes for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.4T is 50.57MPa. For M25 grade of concrete average compression strength of cubes for 12hrs by using Magnetic Water casting and Magnetic Water Curing for 0.6T is 50.794MPa. For M25 grade of concrete average compression strength of cubes for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.6T is 56.68MPa.

3) Split Tensile Strength on cylinders:

For M25 grade of concrete average split tensile strength of cylinders by Potable Water casting and curing in potable water is 5.23MPa

TABLE-IV MAGNETIC WATER CASTING AND NORMAL WATER CURING

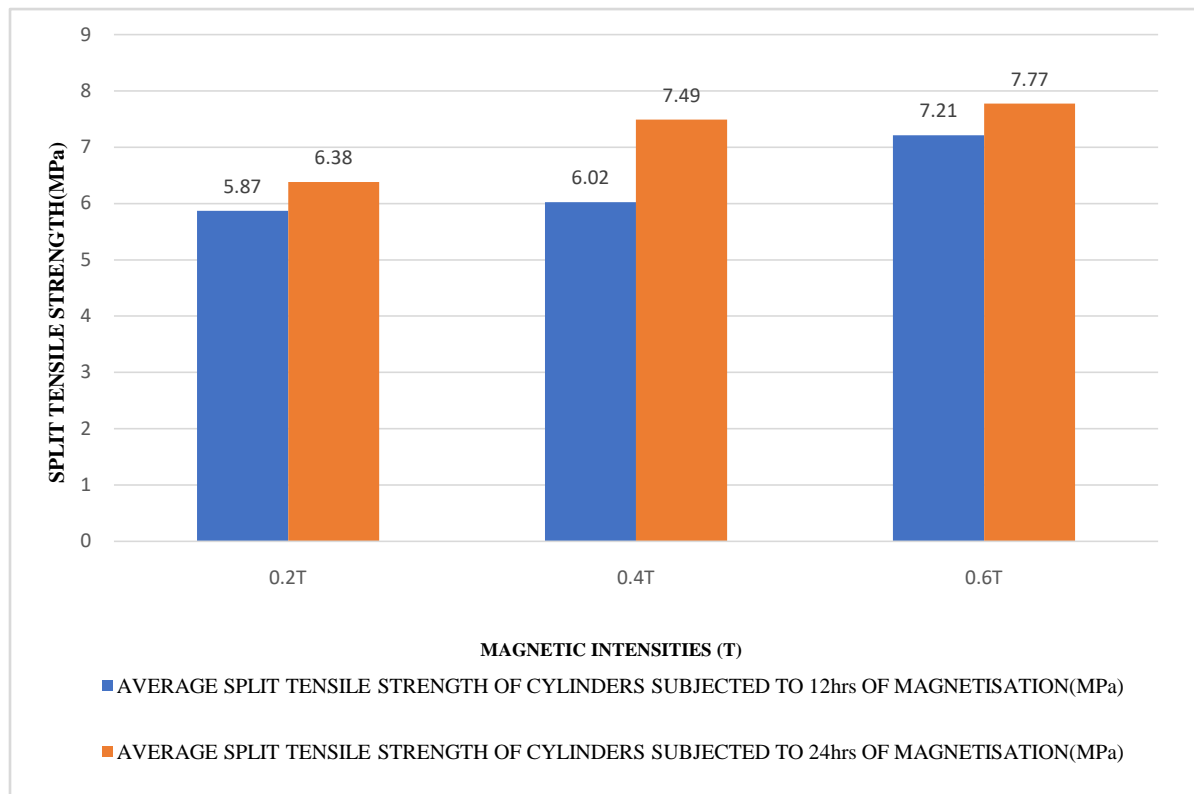
Tesla	Average split tensile strength of cubes for 12hrs (MPa)	Average split tensile strength of cubes for 24hrs (MPa)
0.2T	5.06	5.82
0.4T	5.31	6.66
0.6T	5.72	7.08



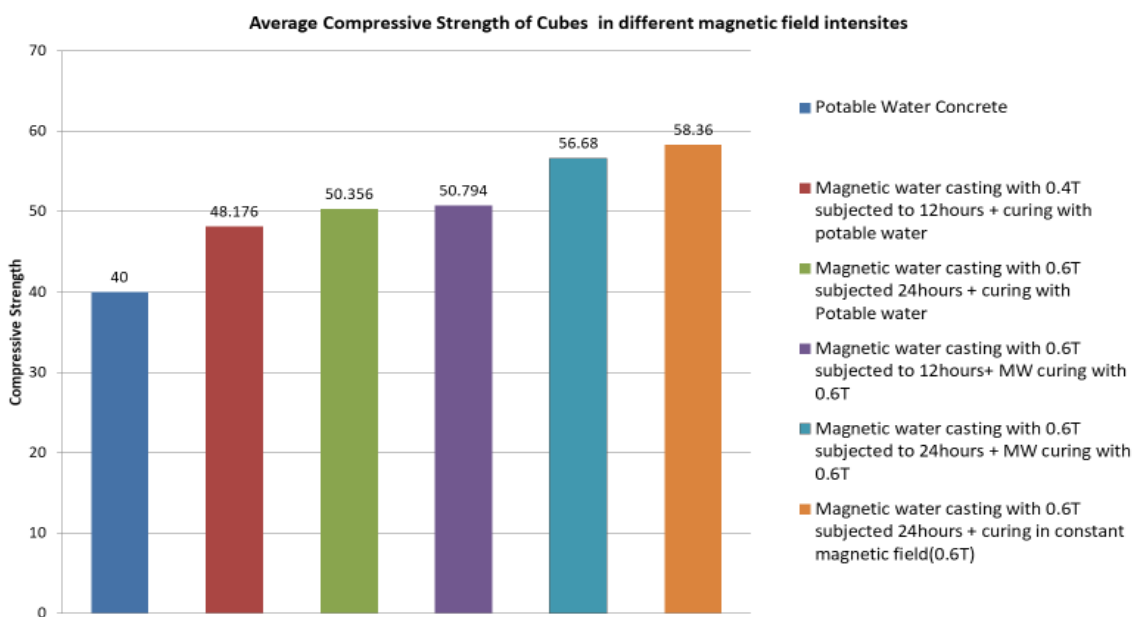
For M25 grade of concrete the average split-tensile strength of cylinders for 12hrs by using Magnetic Water casting and curing in potable water for 0.2T is 5.06MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 24hrs by using Magnetic Water casting and curing in potable water for 0.2T is 5.82MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 12hrs by using Magnetic Water casting and curing in potable water for 0.4T is 5.31MP. For M25 grade of concrete the average split-tensile strength of cylinders for 24hrs by using Magnetic Water casting and curing in potable water for 0.4T is 6.66MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 12hrs by using Magnetic Water casting and curing in potable water for 0.6T is 5.72MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 24hrs by using Magnetic Water casting and curing in potable water for 0.6T is 7.08MPa.

TABLE-V MAGNETIC WATER CASTING AND MAGNETIC WATER CURING

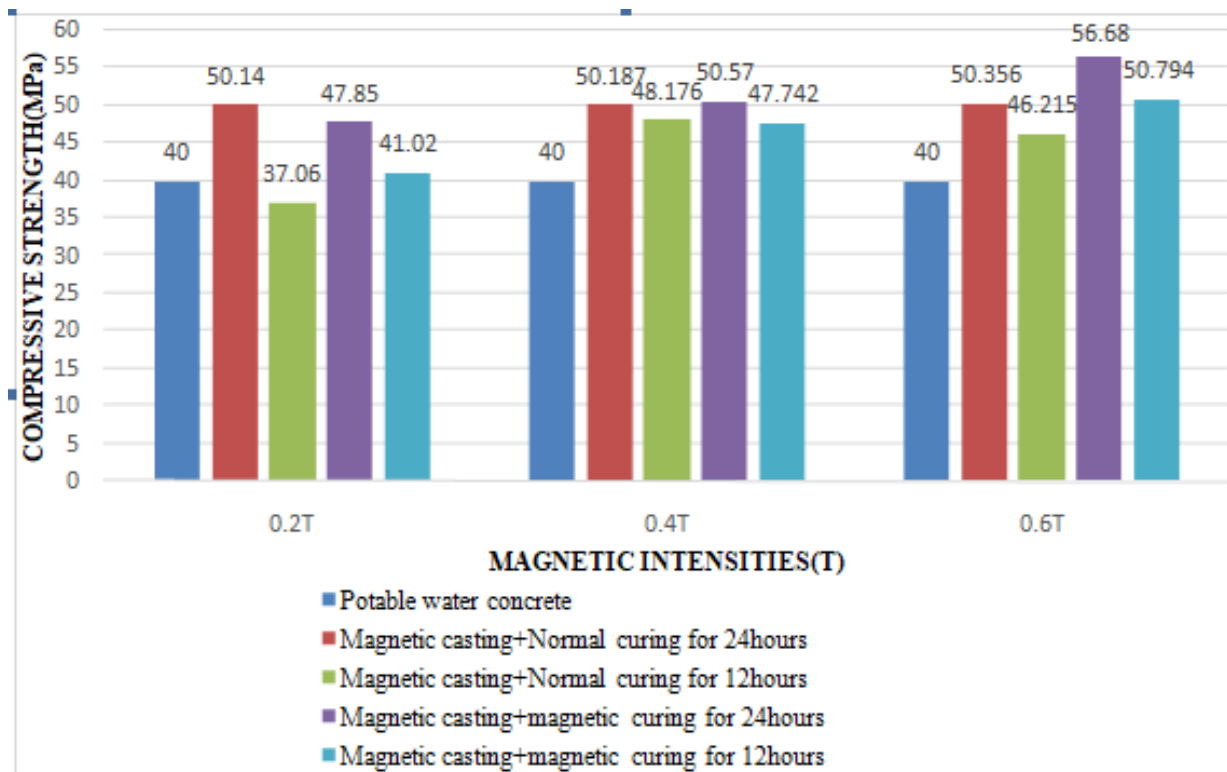
Tesla	Average split tensile strength of cubes for 12hrs (Mpa)	Average split tensile strength of cubes for 24hrs (Mpa)
0.2T	5.87	6.38
0.4T	6.02	7.49
0.6T	7.21	7.77



For M25 grade of concrete the average split-tensile strength of cylinders for 12hrs by using Magnetic Water casting and curing in magnetic water for 0.2T is 5.87MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.2T is 6.38MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 12hrs by using Magnetic Water casting and curing in magnetic water for 0.4T is 6.02MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.4T is 7.49MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 12hrs by using Magnetic Water casting and curing in magnetic water for 0.6T is 7.21MPa. For M25 grade of concrete the average split-tensile strength of cylinders for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.6T is 7.77MPa



For M25 grade of concrete maximum compression strength of cubes obtained by Potable Water casting and curing in potable water is 40MPa. For M25 grade of concrete maximum compression strength cubes for 12hrs by using Magnetic Water casting and curing in potable water for 0.4T is 48.176Mpa. For M25 grade of concrete maximum compression strength cubes for 24hrs by using Magnetic Water casting and curing in potable water for 0.6T is 50.356Mpa. For M25 grade of concrete maximum compression strength cubes for 12hrs by using Magnetic Water casting and Magnetic Water Curing for 0.6T is 50.794MPa. For M25 grade of concrete maximum compression strength cubes for 24hrs by using Magnetic Water casting and curing in magnetic water for 0.6T is 56.68MPa. For M25 grade of concrete maximum compression strength cubes for 24hrs by using Magnetic Water casting and curing in constant magnetic field of 0.6T is 58.36MPa.



For M25 grade of concrete maximum compression strength of cubes subjected to different durations (i.e 0hrs, 12hrs, 24hrs) for 0.2 by using Magnetic Water casting and curing in potable water is 50.14MPa. For M25 grade of concrete maximum compression strength of cubes subjected to different durations (i.e 0hrs, 12hrs, 24hrs) for 0.4T by using Magnetic Water casting and curing in magnetic water is 50.57MPa. For M25 grade of concrete maximum compression strength of cubes subjected to different durations (i.e 0hrs, 12hrs, 24hrs) for 0.6T by using Magnetic Water casting and curing in magnetic water is 56.68MPa.

IV. CONCLUSIONS

- Magnetized water effectively enhances the workability of concrete.
- The compressive strength of concrete increases with the usage of Magnetic water and this increase in the strength is due to formation of clusters.
- Strength properties of M25 grade mix with 24hrs magnetized water under constant curing showed better results among all the mixes.
- The compressive strength of Magnetic water concrete is more than that of potable water concrete by 45.9%
- The split tensile strength of Magnetic water concrete is more than that of potable water concrete by 48.56%

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