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EXPERIMENTAL INVESTIGATION ON BEHAVIOUR OF POLYPROPYLENE FIBER REINFORCED CONCRETE WITH MODIFIED STRUCTURED WATER

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Abstract **- This research presents the experimental investigation on the behavior of polypropylene fiber reinforced concrete with modified structured water. Here, the effect of modified structured water (i.e., Magnetic structured water) of different magnetic field strengths on the properties of fresh and hardened polypropylene fiber reinforced concrete is studied. Also, the effect of magnetic structured water on Magnetic Water Concrete in curing and comparison of those results with conventional concrete in immersion curing and curing with magnetic water is studied. The concrete specimens (cubes, cylinders and beams) of standard sizes were cast with polypropylene fiber of varying percentages (0%, 0.2%, 0.4%, 0.6%, 0.8% and 1%), and magnetic structured water of varying magnetic field intensities (0.2T, 0.4T and 0.6T). Compressive strength, Split Tensile strength and Flexural strengths are determined on M25 and M30 grades of concrete. It was found that the optimum compressive strength of cubes cast with M25 and M30 grades of concrete with 0.4% of polypropylene fiber and cured with 0.6T magnetic field intensity was found to be 47.95MPa and 49.5MPa respectively for cubes cast and cured with magnetic structured water. It is 2.99% and 5.05% greater than cubes cast with magnetic water and cured with potable water (at 0.4% addition of polypropylene fiber reinforced concrete and 0.6T magnetic structured water) and 16% and 17% greater than cubes cast and cured with potable water (at 0.8% addition of polypropylene fiber and 0.6T magnetic structured water) for M25 and M30 grades of concrete respectively. At 1.0% addition of polypropylene fiber and 0.6T magnetic structured water gave an optimum split tensile strength of 5.34MPa and 5.45MPa for M25 and M30 grades of concrete respectively in case of cylinders cast and cured with magnetic structured water. It is 2.8% and 3% greater than cylinders cast with magnetic structured water and cured with potable water (at 0.4% addition of polypropylene fiber and 0.6T magnetic structured water) and 88% and 84.7% greater than cylinders cast and cured with potable water (at 0.8% addition of polypropylene fiber and 0.6T magnetic structured water). At 0.4% addition of polypropylene fiber and 0.6T magnetic structured water showed optimum flexural strength of 4.78MPa and 5.45MPa for M25 and M30 grades of concrete in case of beams cast and cured with magnetic structured water. It is 6.62% and13% greater than beams cast with magnetic structured water and cured with potable water (at 0.4% addition of polypropylene fiber and 0.6T magnetic structured water) and 68.9% and 70.7% greater than beams cast and cured with potable water (at 0.8% addition of polypropylene fiber and 0.6T magnetic structured water). Hence for both M25 and M30 grades of concrete, the strength in case of concrete cast and cured with magnetic structured water is increased compared to the strength of conventional concrete casting in immersion curing and curing with magnetic water.**

Keywords*— *Polypropylene Fiber, Magnetic structured water, Magnetic field strength, Magnetic water curing.

I. INTRODUCTION

Previous works reported that magnetic field(MF) could change physiochemical properties of water since several decades[1].MF could decrease the surface tension of water and enhance the conductivity[2,3].The compressive strength of concrete increases with the usage of Magnetic Field Treated Water(MFTW) mainly due to cluster concept[4].Exposing hardened concrete to MF increases compressive strength in the range of 7.77%-50%[5,6,7,8]. Magnetic water enhances workability of concrete up to +400% [8]. The increase in concrete performance can be achieved when magnetic strength is from 260Mt-300Mt[9,10].Curing in magnetically treated water is more effective than that of casting by using magnetically treated water[9].Workability and strength of mixed pole magnetic water concrete is slightly more compared to normal water concrete.24Hrs magnetic field exposure time to water is optimum[10].Inclusion of 0.1% polypropylene Fibers was found to be beneficial for concrete. The optimum compressive strength is obtained with fiber volume ratio of 1.5Kg/cubic Mt [11,12]. Plastic shrinkage cracks were reduced by 50-99% [12]

Although many studies are made using magnetically field treated water (MFTW) and inclusion of polypropylene fibers into concrete mix separately, here by using MFTW the behaviour on the properties of polypropylene fiber reinforced concrete were studied.

II. OBJECTIVES

The main objective of this experimental work is to study the effect of structured water on the properties of polypropylene fiber reinforced concrete for M25 and M30 grades of concrete. The main parameters involved in this research are,

1. To study the effect of magnetic structured water on the properties of fresh polypropylene fiber reinforced concrete.
2. To study the effect of magnetic structured water on the properties of hardened polypropylene fiber reinforced concrete.
3. To study the difference in strength of cubes, cylinders and beams using normal water and structured water with the curing period of 28 days for M25 and M30 grades of concrete.
4. To study the Flexural behaviour of polypropylene fiber reinforced concrete of grades M25 and M30 cast with magnetic structured water of varying magnetic field strengths.

III. SCOPE OF THE WORK

The scope was limited to following tests:

a) To find the effect of magnetic treatment on properties of water such as Hardness of water (TDS) and pH of water
b) To find out the effect of magnetic structured water on workability of polypropylene fiber reinforced concrete.
c) To determine the effect of magnetic structured water on hardened properties of polypropylene fiber reinforced concrete cast and cured with varying magnetic field intensities of 0.2T, 0.4T and 0.6T and varying percentages of polypropylene fiber of 0%, 0.2%, 0.4%, 0.6%, 0.8% and 1% by conducting Compressive strength test, Split tensile test and Flexural test.

IV. STUDY METHODOLOGY

A. Materials Used

Cement: Cement used in this investigation was Ordinary Portland Cement (OPC) confirming to IS: 12269-1987. The specific gravity of cement found was 2.92 and standard consistency is 32%.

Fine Aggregate: Fine aggregate confirming to Zone- 2 as per IS: 383-1970 which was procured from Manair River in Telangana state. The properties of fine aggregate are shown in Table-I

Coarse Aggregate: Coarse aggregate used here was obtained from local crusher at unit having Crushed granite of size 20mm and 10mm well graded as per IS: 383-1970 is used in this investigation. The properties of Coarse aggregate are shown in Table-I

Table I
Properties of fine aggregate and coarse aggregate

Sl. No	Property	Fine aggregate	Coarse aggregate
1	Specific gravity	2.54	2.86
2	Bulk Density	1.66kg/m	1.5kg/m
3	% of voids and Porosity	34.48%	47.22%
4	Void ratio	0.526	0.8
5	Fineness modulus	3.25% fine	7.32% fine

Polypropylene fibre: Polypropylene fibre of size 12 mm was used in this investigation, the properties of the fibre are shown in Table II.

Table II
Properties of Polypropylene fiber

Sl. No	Description	Results
1	Diameter	38 µ m
2	Flash Point & Ignition Point	2.44
3	Colour and Appearance	White and short cut staple fiber
4	Melting Point	162° C

Water: The water used in this investigation is potable water which is free from suspended solids and dissolved salts and Magnetic structured water, which is potable water subjected to varying magnetic fields (0.2Tesla, 0.4T, 0.6T) for different durations of time(12 Hours and 24 Hours) is used, the properties of normal water and magnetic structured water are shown in Table III.

Table III
Properties of Normal water and Magnetic structured water

Sl. No	Property	Normal water	Magnetic structured water		
			0.2T	0.4T	0.6T
1	pH	7.3	7.6	7.6	7.7
2	Total hardness	575	385	374	322

B. Sample Preparation

In this research, M25 and M30 grades of concrete were used with constant water cement ratio of 0.42 and 0.40 respectively for both ordinary water and magnetic structured water. Cubes of size 150mm X 150mm X 150 mm, Cylinders of size 150mm X 300mm and beams of size 700mm X 100mm X 150mm were cast with varying percentages of polypropylene fibres(0%, 0.2%, 0.4%, 0.6%, 0.8% and 1%)using Ordinary water and magnetic structured water (0.2T, 0.4T and 0.6T subjected to 24Hours)and cured for 28 days with potable water, magnetic structured water and under constant magnetic field of 0.6T.

Preparation of Magnetic structured water:

Ordinary/Potable water which is free from suspended solids and dissolved salts is filled in Borosilicate containers which are placed on Neodymium magnets of varying intensities(0.2T, 0.4T and 0.6T) for 24 Hours. Figure1shows the set up for preparation of magnetic structured water.

Fig 1 Preparation of Magnetic structured water

C. Curing of Test specimens

Immersion curing method is adopted for Cubes, Cylinders and beams cast with both Ordinary water and magnetic structured water which is shown in Figure 2 (a) for the test specimens cured with magnetic water a non ferrous container is used in which the magnetic structured water is replaced for every 24 Hours, the setup used for curing is shown in Figure 2(b) and 2(c).

Fig 2 (a) Curing of test specimens in potable water

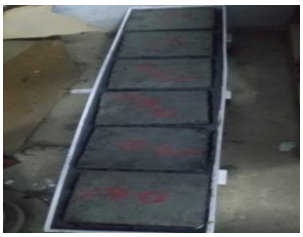

Fig 2(b) curing of test specimens with magnetic structured water

Fig 2(c) curing of beam in with magnetic structured water

D. Tests

1) Workability of fresh polypropylene fiber reinforced concrete:

Slump cone test is carried out to determine the workability of fresh polypropylene fiber reinforced concrete cast with ordinary water and magnetic structured water . The highest workability is obtained for specimens cast and cured with magnetic structured water with 0.6T magnetic field intensity was found to be 162mm and 140mm respectively for M25 and M30 grades.

2) Tests on hardened polypropylene fibre reinforced concrete:

The Compressive strength on cubes, Split tensile strength on cylinders and Flexural strength of beams are determined after curing for 28 days as per IS 516 1959. The test results are shown in Table IV, Table V, Table VI below.

E. Results

1) Workability of fresh Polypropylene Fiber reinforced concrete:

The maximum slump obtained in case of specimens cast and cured with potable water is 60mm and 52mm. The maximum slump obtained in case of specimens cast with magnetic water and cured with potable water is 80mm and 60mm for M25 and M30 grades of concrete. The maximum slump obtained in case of specimens cast and cured with magnetic structured water is 162 mm and 140mm for M25 and M30 grades of concrete respectively. Hence, as water is magnetized the workability may increase

1) Properties of Hardened Polypropylene Fiber reinforced concrete:

TABLE IV

COMPRESSIVE STRENGTH OF CONCRETE

Sl. No	Polypropy leneFiber (%)/ Magnetic strength	Compressive strength of cubes Cast with Normal water and Cured in Normal water (MPa)		Compressive strength of cubes Cast with Magnetic water and cured in Normal water						Compressive strength of cubes Cast in Magnetic water and cured with magnetic water					
		M25	M30	M25			M30			M25			M30		
				0.2T	0.4T	0.6T	0.2T	0.4T	0.6T	0.2T	0.4T	0.6T	0.2T	0.4T	0.6T
1	0	29	30.2	34	35.1	40	35	37.1	41	38	39.8	42	38	39.8	42
2	0.2	32.1	33	36.2	36.5	40.8	36.8	38.1	41.5	37.7	38.7	41.6	39.1	41.5	44
3	0.4	35.6	34.5	40.3	44.2	46.5	42.8	44.5	47	42.8	45.3	47.1	44.5	46.1	49.5
4	0.6	37.9	39.4	44.6	46.2	46.7	44	45.1	46.8	46.8	45.1	46.9	42	46.2	48.4
5	0.8	41.8	42.4	38	33.5	28	39	32.1	30.8	39	32.2	35.4	40	38.1	36
6	1	35.1	36.6	32	29	42.9	41.5	44.2	46.2	34.5	32	42.8	43.1	45.3	45.6

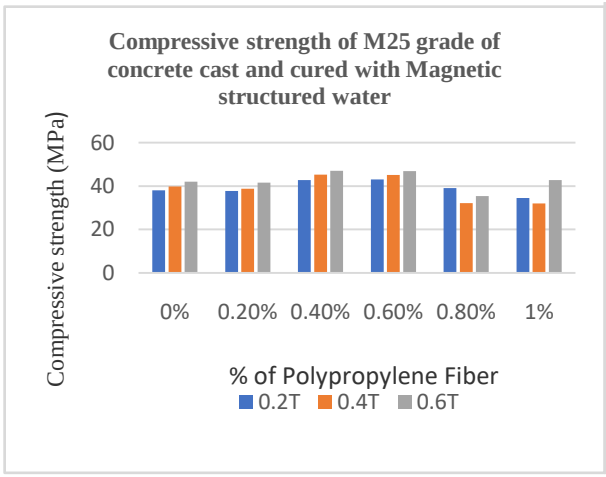

Fig 4 (a) Graphs showing compressive strength of M25 grade Grade of concrete cast and cured with magnetic structured water

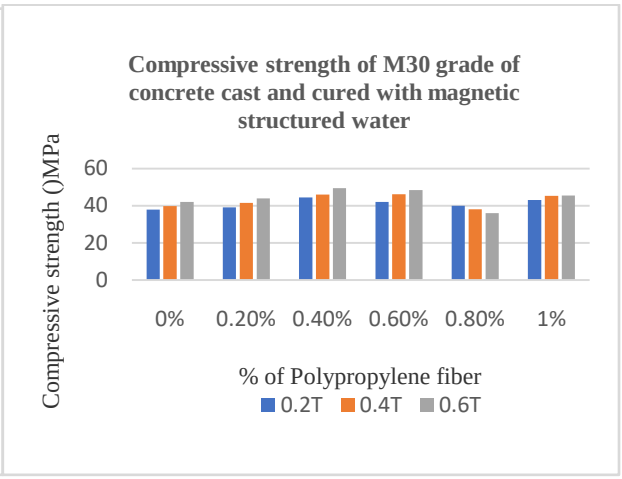

Fig 4 (b) Graphs showing compressive strength of M30 concrete cast and cured with magnetic structured water

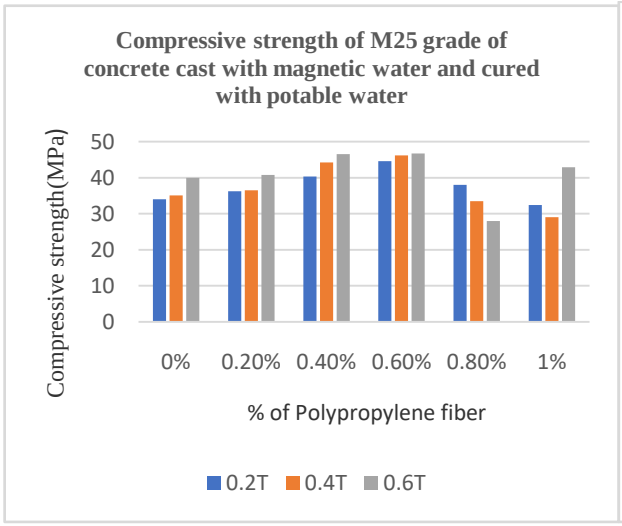

Fig 4 (c) Graphs showing compressive strength of M25 grade concrete of M30 Grade concrete cast with magnetic structured water and cured with potable water

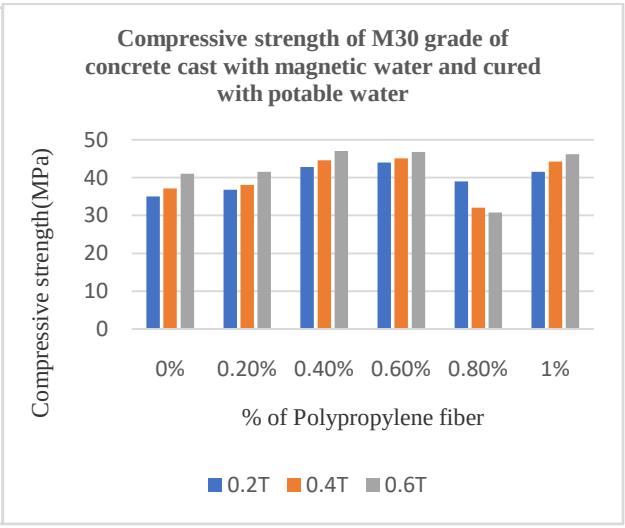

Fig 4(d) Graphs showing compressive strength cast with magnetic structured water and cured with potable water

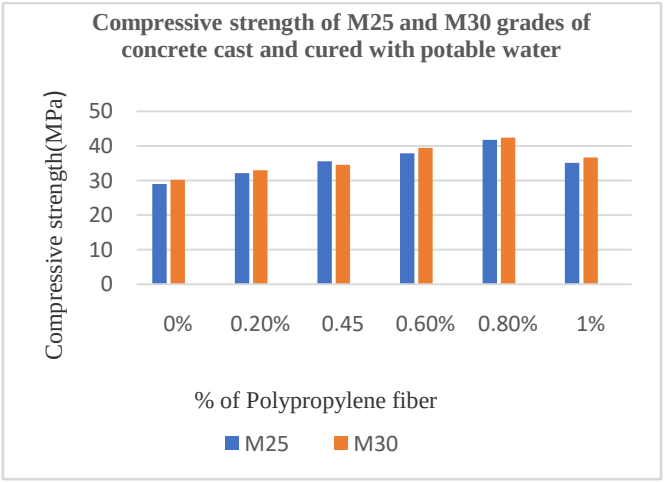

Fig 4 (e) Graphs showing compressive strength of M25 and M30 grade concrete Cast and cured with magnetic structured water

TABLE V
SPLIT TENSILE STRENGTH OF CONCRETE

Sl. No	Polypropylene Fiber (%)/Grade Magnetic strength	Split Tensile strength of cylinders Cast and Cured in Normal water (MPa)		Split Tensile strength of cylinders Cast with Magnetic water and cured in Normal water (Mpa)						Split Tensile strength of cylinders Cast in Magnetic water and cured with magnetic water (MPa)					
		M25	M30	M25			M30			M25			M30		
				0.2T	0.4T	0.6T	0.2T	0.4T	0.6T	0.2T	0.4T	0.6T	0.2T	0.4T	0.6T
1	0	2.5	2.6	2.98	3.01	3.1	3.1	3.92	3.98	3.2	3.22	3.3	3.6	4.18	4.2
2	0.2	2.65	2.7	3.18	3.22	3.46	3.98	4.0	4.12	3.42	3.64	3.8	4.01	4.2	4.11
3	0.4	2.8	2.83	4.31	3.95	4.95	4.52	3.98	5.1	4.4	4.1	5.10	5.1	5.14	5.25
4	0.6	2.62	2.85	4.59	3.74	4.60	3.91	4.2	4.75	4.6	3.97	4.70	4.55	4.7	4.95
5	0.8	2.85	2.95	3.39	2.82	4.03	4.10	2.91	4.21	3.4	3.1	4.66	4.2	3.2	4.1
6	1	2.7	2.76	5.16	5.10	5.19	5.12	5.21	5.32	5.21	5.26	5.34	5.34	5.4	5.45

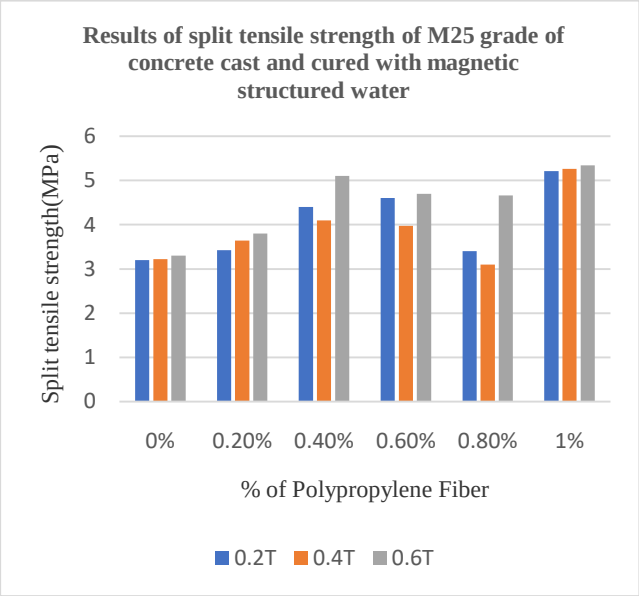

Fig 5 (a) Graphs showing Split tensile strength of M25 Grade concrete cast and cured with magnetic structured water

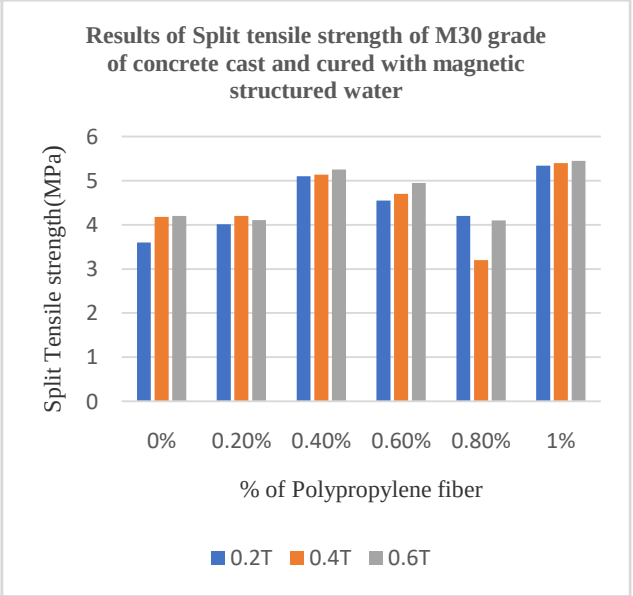

Fig 5 (b) Graphs showing Split tensile strength of M30 Grade concrete cast and cured with magnetic structured water

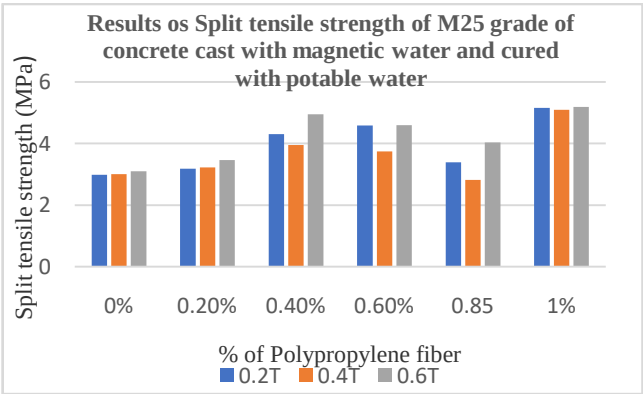

Fig 5 (c) Graphs showing Split tensile strength of M25 Grade concrete cast and cured with potable water

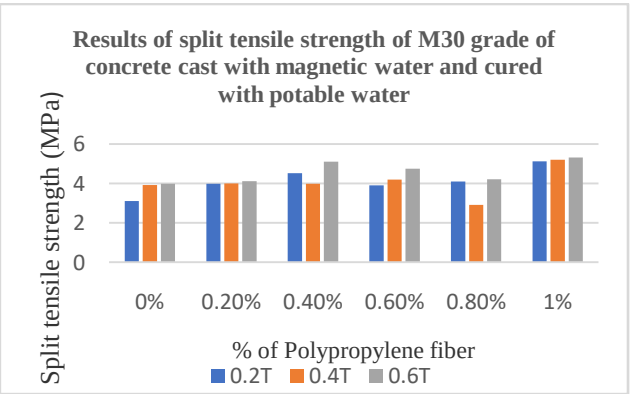

Fig 5 (d) Graphs showing Split tensile strength of M30 Grade concrete cast and cured with potable water

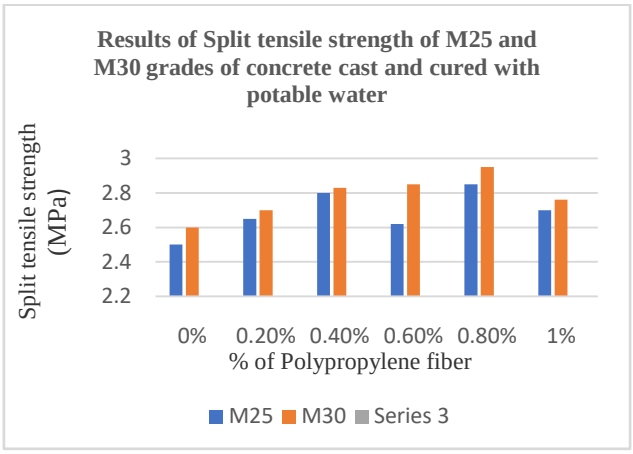

Fig 5(e) Graphs showing Split tensile strength of M25 and M30 grade concrete Cast and cured with potable water

TABLE V FLEXURAL STRENGTH OF CONCRETE

Sl. No	Polypropylene Fiber (%)/Magnetic strength	Flexural strength of beams Cast and Cured with Normal water		Flexural strength of concrete Cast with Magnetic water and cured in Normal water						Flexural strength of concrete Cast in Magnetic water and cured with magnetic water					
		M25	M30	M25			M30			M25			M30		
				0.2T	0.4T	0.6T	0.2T	0.4T	0.6T	0.2T	0.4T	0.6T	0.2T	0.4T	0.6T
1	0	2.6	2.7	2.85	3.15	3.2	2.92	3.22	3.35	3.1	3.19	3.22	3.1	3.38	3.42
2	0.2	2.7	2.95	3.12	3.24	3.68	3.02	3.18	3.72	3.1	3.26	3.77	3.11	3.27	3.91
3	0.4	2.5	3.01	4.40	4.51	4.48	4.22	4.68	4.82	4.6	4.71	4.78	4.9	5.12	5.45
4	0.6	2.7	2.8	4.10	4.2	4.32	4.1	4.25	4.56	4.1	4.16	4.19	4.67	4.7	4.86
5	0.8	2.8	3.2	3.18	3.21	3.98	3.22	3.17	3.54	4.0	3.54	4.1	4.1	3.99	4.6
6	1	2.2	2.34	4.08	4.12	4.15	4.1	4.15	4.28	4.2	4.99	5.12	5.01	5.13	5.28

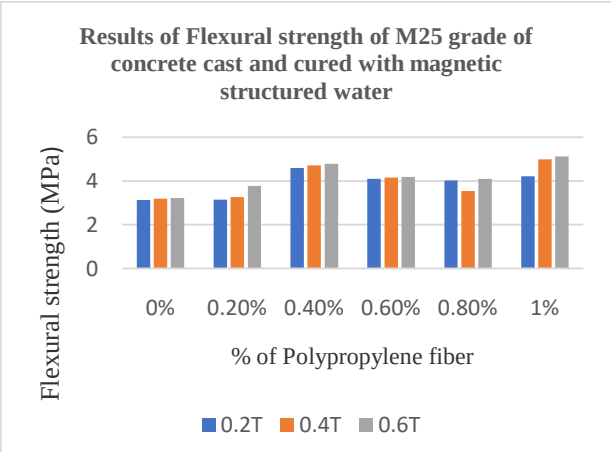

Fig 6(a) A graph showing results of Flexural strength of M25grade Cast and cured with magnetic structured water

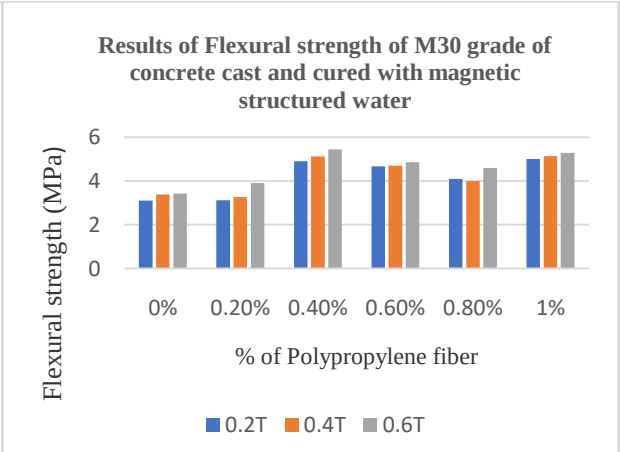

Fig 6(b) A graph showing results of Flexural strength of M30 grade concrete Cast and cured with magnetic structured water

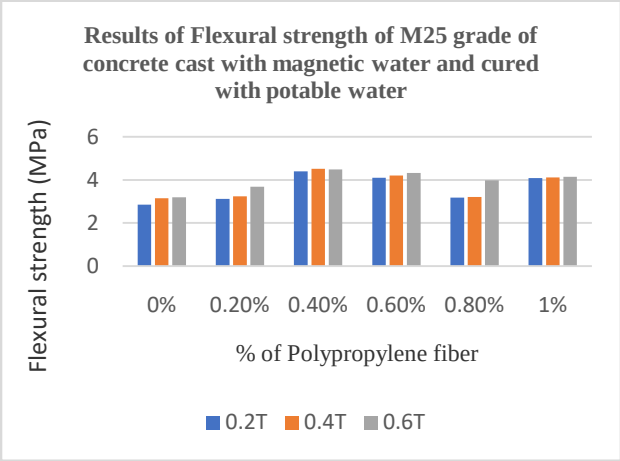

Fig 6(c) A graph showing results of Flexural strength of M25grade Cast with magnetic structured water and cured with potable water

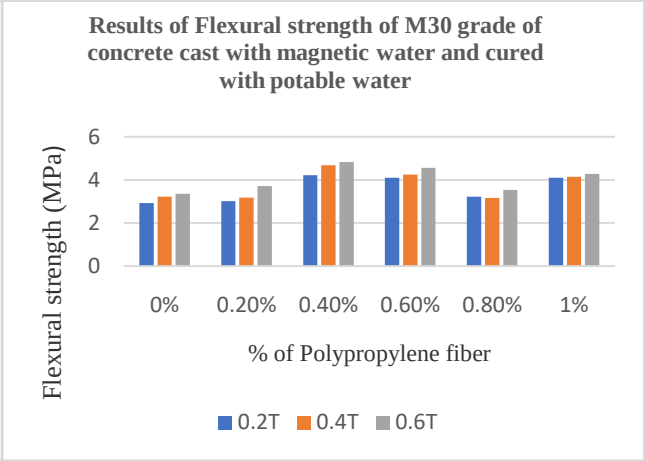

Fig 6(d) A graph showing results of Flexural strength of M30grade Cast with magnetic structured water and cured concrete with potable water

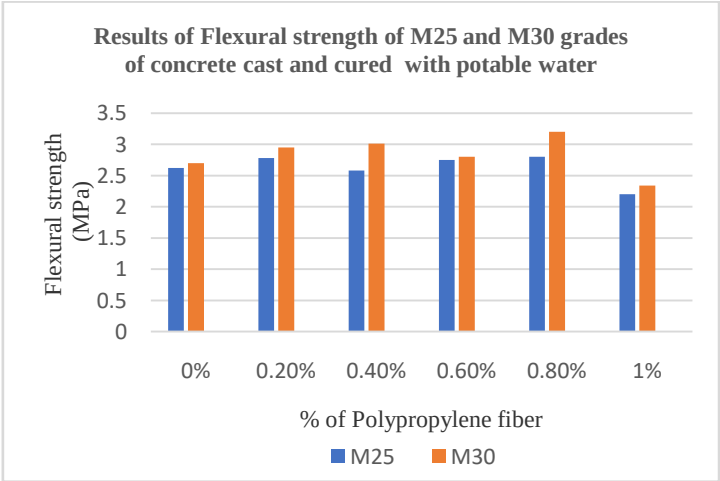

Fig 6 A graph showing results of Flexural strength of M25 and M30 grade concrete cast and cured with potable water

V. CONCLUSIONS

1. The pH value of normal water and magnetised water are almost same. The effect of hardness of water is decreased after magnetisation of water.
2. There is slight increase in workability by increasing the magnetic field strength of water. The workability of Magnetic water concrete is higher than Normal water concrete. The highest workability is obtained for specimens cast and cured with magnetic structured water for 0.6T magnetic field intensity of 16.2cm and 14cm for M25 and M30 grades.
3. The optimum compressive strength of cubes cast with M25 and M30 grades of concrete with 0.4% of polypropylene fiber and cured with 0.6T magnetic field intensity are 47.95MPa and 49.5MPa respectively for cubes cast and cured with magnetic structured water. It is 2.99% and 5.05% greater than cubes cast with magnetic water and cured with potable water(at 0.4% addition of polypropylene fiber reinforced concrete and 0.6T magnetic structured water) and 16% and 17% greater than cubes cast and cured with potable water (at 0.8% addition of polypropylene fiber and 0.6T magnetic structured water) for M25 and M30 grades of concrete .
4. At 1.0% addition of polypropylene fiber and 0.6T magnetic structured water gave an optimum split tensile strength of 5.34MPa and 5.45MPa for M25 and M30 grades of concrete respectively in case of cylinders cast and cured with magnetic structured water. It is 2.8% and 3% greater than cylinders cast with magnetic structured water and cured with potable water (at 0.4% addition of polypropylene fiber and 0.6T magnetic structured water) and 88% and 84.7% greater than cylinders cast and cured with potable water (at 0.8% addition of polypropylene fiber and 0.6T magnetic structured water).

5. At 0.4% addition of polypropylene fiber and 0.6T magnetic structured water showed optimum flexural strength of 4.78MPa and 5.45MPa for M25 and M30 grades of concrete in case of beams cast and cured with magnetic structured water. It is 6.62% and13% greater than beams cast with magnetic structured water and cured with potable water (at 0.4% addition of polypropylene fiber and 0.6T magnetic structured water) and 68.9% and 70.7% greater than beams cast and cured with potable water (at 0.8% addition of polypropylene fiber and 0.6T magnetic structured water).

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