International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Effect of Magnetic Water on Behavior of RC Beams with Ordinary Portland cement and Raid Hardening Portland Cement

I. Jagith Hassan[1], R. Renuka[2], N. Karuppasamy[3]
[1]*P.G. Structural Engineering,* [2]*Assistant Professor,* [3]*Research Scholar, Department of Civil Engineering, Sana College of Technology, Salem-636005, India.*

Abstract: ***Water is the most important ingredient property on concrete and which is used to form a paste that binds with the aggregate together on mixing of cement. The amount of water used in concrete controls the fresh and hardened properties of concrete. Concrete is the most widely used man-made buildings materials on civil engineering community to produce a structure in harmony with the concept of high-strength concrete at a reasonable cost. In the last two decades, in Russia and China, a new technology, has been used in the concrete industry. from this, water is passed through a magnetic field, the physical properties are changes and so the numbers of molecules in the water cluster decrease from 13 to 5, which cause a decrease in the water surface tensions. This study involves the investigation of the influence of magnetic water on workability, compressive strength, Split tensile strength and flexural strength in RC beams. The concrete samples are prepared with ordinary Portland cement and rapid hardening Portland cement and it is cured with magnetic water and potable water with four different combinations. The scope of this study is to improve the qualities of water and reduce the water-cement ratio thereby reducing the consumption of cement and curing days.***

Keywords: Magnetic water Technology, physical properties, workability, compressive strength, split tensile strength and flexural strength.

I. INTRODUCTION

Concrete is the most widely used man-made building material in the World, owing to its versatility and relatively low cost. In general, adding certain chemicals while mixing concrete is practiced to alter the properties of concrete to obtain a concrete with the desired property. But in most of the cases, these admixtures 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. The corrosion of magnetic water is greatly reduced if the water is passed through an intense magnetic flux which in turn changes the physical structure of water molecules and hard water to soft water. This softening intensity is based on the magnitude of flux induced. In these study, the magnetic water is prepared with a Magnetic device called permanent magnets N406 with the magnetic field (0.8 to 0.9 Tesla), which induce changes and effects on ions and water molecule clusters passing through its magnetic field. A magnetic field has a considerable effect on clusters of water molecules and causes the decrease of such a mass from 13 molecules to 5 or 6 molecules. The usage of magnetic water while mixing concrete will increase compressive strength and also there will be higher workability for the same water-cement ratio. from this study, the potable water is replaced by magnetically treated water by which quantity of cement used in any concrete mix is reduced.

A. Background

Pop Haydn discover the magnetic water effect on water in the year of 1890s. later Magnetic water the treatment machine was first invented in 1945 at Belgium. At the earlier age, this technology was used mainly in many countries which have very little chemical industry, like Russia, China etc., who all reported the successful use of magnets in treating water for irrigation, industry and home use. This new technology was used in concrete industry during the year of 2000 at Taiwan. The magnetic water on the engineering properties of concrete containing some granulated blast- furnace slag. The results show the compressive strength of mortar samples mixed with magnetic water of 0.8 to 1.2 Tesla (T) increased by 9-19% and the compressive strength of concrete increased up to 10-23%. it can improve the concrete structure, making it denser and reducing the occurrence of dry shrinkage [1]. The use of MFTW (Magnetic Field Treated water) could improve the concrete strength as much as 10%. Hence, it can save 5% of cement dosage, decrease the bleeding of concrete and improve resistance to freezing [2]. By using magnetic water the compressive strength is in-

creased 10-20% is achieved at 1.2T and passed through a velocity of 0.71m/s. The water molecules are arranged in one direction and the bond angle decreases to less than 105° When water is subjected to a magnetic field[3]. by using magnetized water in cement mortars, which lead to increase in the compressive strength and decreasing in the consistency of cement mortar, the initial and final setting time and finess. The different W/C ratios were used, in that 0.45 is to be optimum and gave best compressive strength [4]. The magnetic water has higher slump values up to 45% and the compressive strength up to 18% and the cement content can be reduced by 28% [5].

B. Mechanism and Working Principle Of Permag (N406)

When the 'PERMAG' units are fitted on a pipeline, the water flowing through the pipeline is subjected to the intense, focused magnetic field. The magnetic field, affects the physical structure of the minerals, thereby altering their shapes. The minerals sustain to remain in the water, but, the changed physical state prevents the minerals from exhibit hardness, and the water becomes soft .after Magnetized and the magnetic fields are produced by the motion of charged particles. The magnetic fields generated by moving electrons are used in inducing a magnetic field in the water. It only changes the trajectory of the charged particles movement and not its energy. It works with the principle of MHD (Magneto Hydro Dynamics) creating a strong perpendicular magnetic field to the direction of water flow. The strong magnetic field affects the physical state of the minerals, thereby the number of molecules in water cluster decreases from 13 to 5 or 6, which causes a decrease in the water surface tension.

C. Methodology

The Methodology of this investigation is done with collection of literature and materials and the collecting water samples from the different sources like (sea water, portable water, open well water and treated water) and collected samples were optimized by testing the pH, hardness, chloride, sulphate, and iron etc., then the mix design for M40 grade of concrete is prepared with four different combinations by casting and curing. The specimen was cured for 28days. The sample is then tested with workability, Compressive strength, Split tensile strength and Flexural strength of concrete and the results were obtained and recorded.

II. EXPERIMENTAL INVESTIGATION ON CONCRETE

A. Materials

a) Cement (OPC and RPC)

In this project there are two types of cement were used, Ordinary Portland cement and Rapid hardening Portland cements confirming to the standards of IS: 1498 1991. The Normal consistency in OPC and RHPC were 36% and 38% respectively. The initial and final setting time was under the permissible limits and the Specific gravity of OPC and RHPC cement are 3.10 and 3.12 respectively.

B. Fine and coarse aggregate

Natural sand and coarse aggregate from local quaries are used to prepare the concrete mix, The Specific gravity of the sand and coarse aggregate are 2.71 and 2.85 respectively, The maximum nominal size of the gravel is 20mm.The bulk density of fine and coarse aggregate are 1625kg/m^3 and 1661kg/m^3.

C. Water

In general the different water sample (sea water, treated water, well water, bore water or potable water) were collected and tested on the laboratory as per IS 3025. From that the water sample is optimized and used for the concrete mixing and curing of specimens. the properties of potable water is shown in (Table 1)

Table 1

Test	Potable water	Magnetized water
pH	7.6	8.0
Total Hardness	240 mg/l	68.33mg/l
Chloride (Cl)	77.47 mg/l	67.47 mg/l
Sulphate ($S0_3$)	134 mg/l	115mg/l
Density	0.996kg/l	0.985kg/l
Iron	0.1mg/l	0.1mg/l
Suspended matter	100 mg/l	50mg/l

D. Mix Design

The Mix Proportion of M40 grade of concrete is shown in (Table 2). Mix Design for M40 grade concrete is done as per Bureau Indian standard recommended with the mix design code of IS : 10262-2009.

Table 2

Materials	Cement	FA	CA	water	W/C
Kg/m^3	456	661	1235	174	0.38

III. RESULTS AND DISCUSSION

A. Workability

The slump test is the most commonly used method of measuring the consistency of concrete. slump test as per IS: 1199-1959 is followed. the workability test has been taken with a 0.38 W/C ratio by using both magnetic and potable water for different trails.

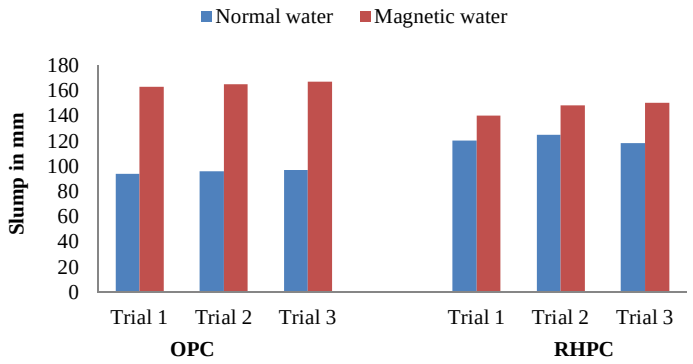

Fig 1

(Figure 1) represents the workability is improved up to 69% in OPC by using magnetic water than normal potable water. In Normal Potable water the workability is increased up to 26% in RHPC than OPC. but the Magnetic water is slightly increased up to 13.70% in OPC than RHPC. Here the cement content can be reduced up to 16% to achieve the target strength of concrete and also formwork can be removed at earlier and the cost is reduced.

B. Compressive strength of concrete

The compressive strength results of M40 grades of concrete at the age of 28 days were observed. The compressive strength of concrete was determined based on IS : 516 -1959. The Compressive strength for M40 grade of concrete at 28 days is shown in (Figure 2).

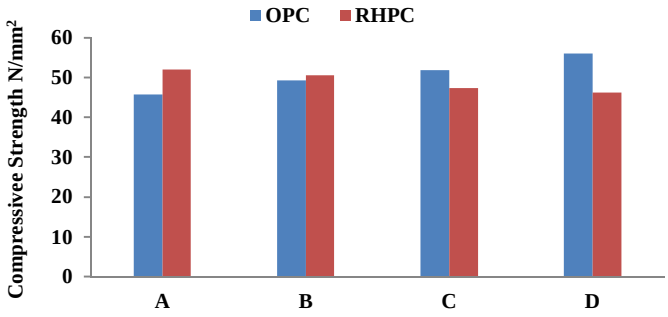

Fig 2

In these study ordinary Portland cement (OPC) and rapid hardening Portland cement (RHPC) are used. similarly, the samples made with OPC and RHPC were both cast and cured under four different combinations and are represented as A, B, C and D. The sample A - with Normal water only, The sample B with the Normal and Magnetic water. The sample C with the Magnetic and Normal water. and the sample D with only on the Magnetic water. The compressive strength of the concrete at the end of 28 days is observed

that the compressive strength of concrete in Sample A is increased by 13.80% in RHPC than OPC concrete. The sample B and sample c are slightly increased by 7.5% and 13.12% in OPC than sample A, but the same samples in RHPC are decreased than sample A. and sample D is increasing by 22.37% than sample A in OPC concrete. The RHPC is not much effective with the usage of magnetic water in concrete.

C. Split tensile strength

The split tensile strength results of M40 grades of concrete at the age of 28 days were observed. The tensile strength of concrete was determined based on IS : 5816 -1970. The splitting tensile strength for M40 grade of concrete at 28 days is shown in (Figure 3).

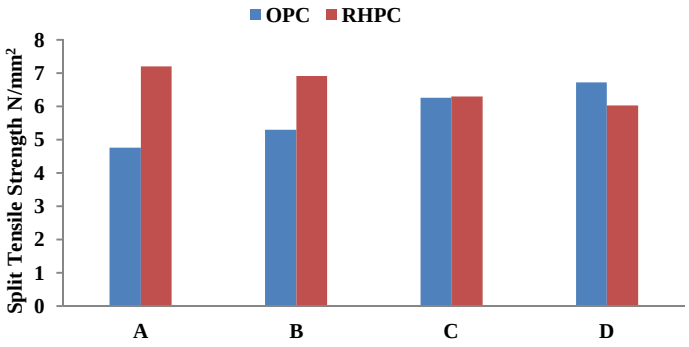

Fig 3

The sample is represented as same as above, It is observed that the tensile strength of concrete in sample A is increased by 51% in RHPC than OPC concrete. The sample B and sample c are slightly increased as 10% and 31.5% in OPC than sample A, but the same samples decreases in RHPC than sample A. and the sample D is increasing up to 41.47% than sample A in OPC concrete. The RHPC is not more effective on the magnetic water.

D. Beam Details

In this study, Totally 8 beams were cast with a size of 1200mm X 100mm X 150mm and Two numbers of 10mm diameter bar are provided in Top and Bottom of the beam and stirrups of 8mm diameter bar are provided at 150mmc/c spacing are shown in (Figure 4) and cured with normal room Temperature. The beams cast were de-molded and kept for 28 days of curing under four different combinations. The effective length of RC beams is the L/3 distance from each end of the beam and the loading is applied. The loading is gradually increased in Universal Testing Machine and deflection for each was noted through the dial gauge placed at the middle of the load setup are shown in (Figure 5). The following results like Load carrying capacity, Load Vs Deflection, Ductility and Energy absorption was studied.

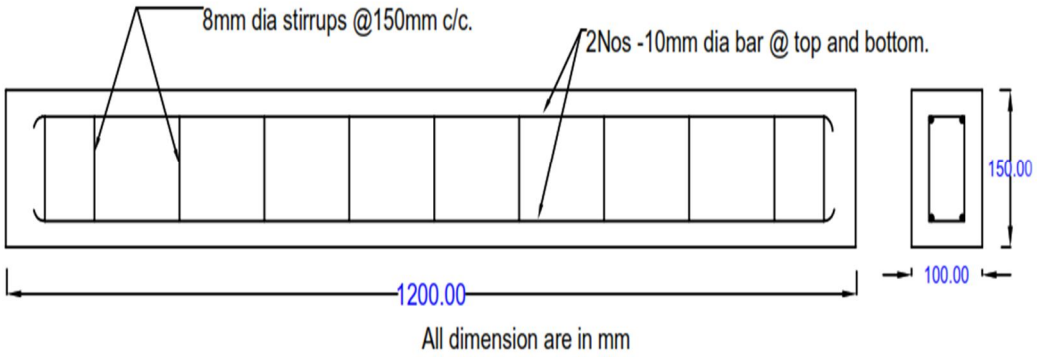

Fig 4

Fig 5

E. Flexural Strength of RC Beams

1) Load carrying capacity

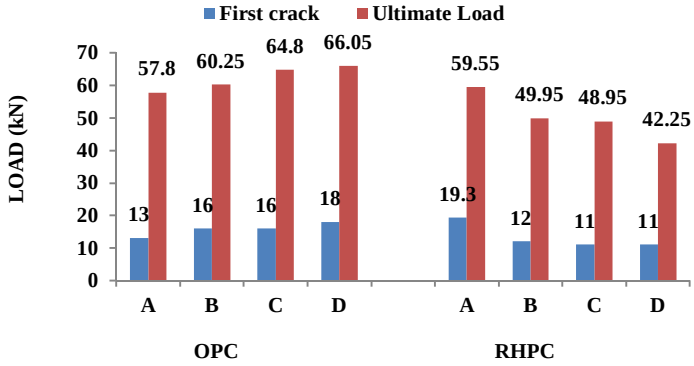

Fig 6

(Figure 6) shows the First crack load and Ultimate load details and the sample are represented as same as above, It was observed that the performance of concrete with magnetic water in terms of the First crack load was increased up to 38% and ultimate load were increased up to 16% in OPC than RHPC.

2) Load Vs Deflection

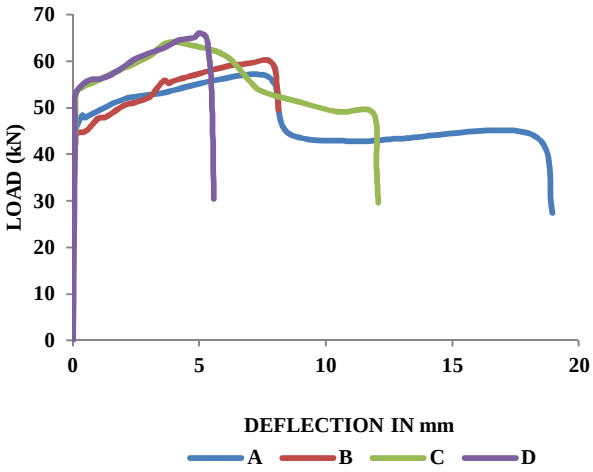

Fig 7(a)

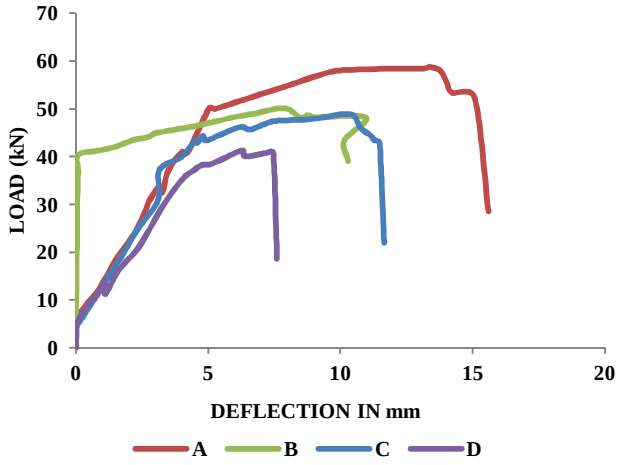

Fig 7(b)

The RC beam is tested with two point loading and the values of the deflection are noted for each 1kN interval. it is observed that load vs Deflection curve of RC beams with ordinary Portland cement are shown in (Figure 7(a)). The sample A can carry an ultimate Load up to 57.80 kN with 7.2mm Deflection. sample B carry a load increment by 2% more than sample A with 7.6mm deflection. Similarly, for the sample C, the load is increased by 12.11% with less deformation of 3.7mm. On comparing of all others samples, sample D has high load carrying capacity of 66.05kN (15%) higher, with a lesser deflection of 5.1mm than sample A.
(Figure 7(b)) shows the load vs Deflection curve of RC beams with Rapid Hardening Portland cement, The sample A can carry an ultimate load up to 59.55kN with a maximum deflection of 13.1mm. similarly, the sample B, C, and D gradually decreased with the load carrying capacity and deflection than sample A. The load carrying capacity is found to be higher in concrete by using magnetic water, which results in withstanding higher loads only in OPC.

3) Ductility Characteristics

Ductility is one of the most important parameters to be considered in the design of structures subjected to a large amount of inelastic deformations due to various loading conditions such as wind, seismic or impact loading. It is defined as the ability of a member to undergo inelastic deformations beyond the yield deformation without significant loss in its load carrying capacity. The ductility of a flexural member can be obtained from its load-deflection curve. The ratio of ultimate deflection to the deflection at first crack is known as ductility factor (μ) and is shown in (Figure 8). The ductility factor was calculated for M 40 grades of R.C beams.

$$\text{Ductility factor } (\mu) = \frac{\text{Ultimate Deflection}}{\text{Deflection at first crack}}$$

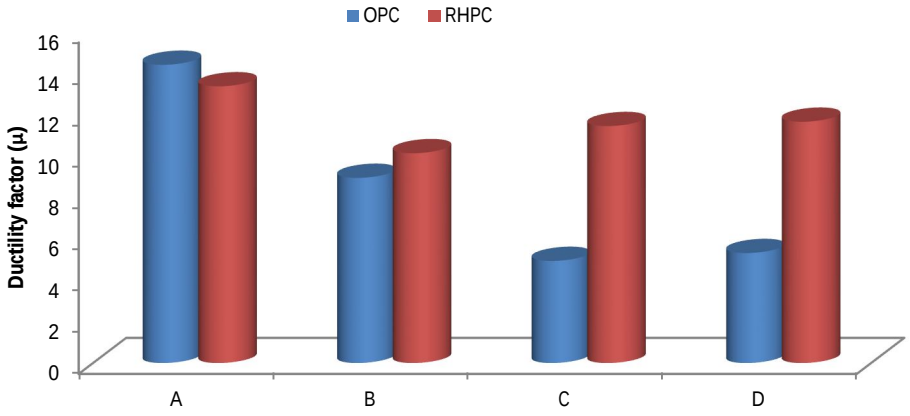

Fig 8

It is observed that the results of ductility factor of RC beams is improved on the sample A and B by 66% and 45% than sample C in OPC due to higher Energy dissipation with less void ratio. The sample C and D achieved less ductility factor compared to other samples, because of energy stored in concrete with large void ratio for OPC. The sample B, C, and D are gradually decreased up to 25%, 14.37%, and 12.80% than the sample A in RHPC, this is due to the energy storage capacity of RC beams.

4) Energy Absorption Capacity

Energy absorption capacity was calculated from the load-deflection curve by using linear and logarithmic method formula. The area under the load-deflection curve was considered for calculating the energy absorption capacity. (Figure 9) shows the energy absorption capacity of M_{40} grade concrete of RC beam.

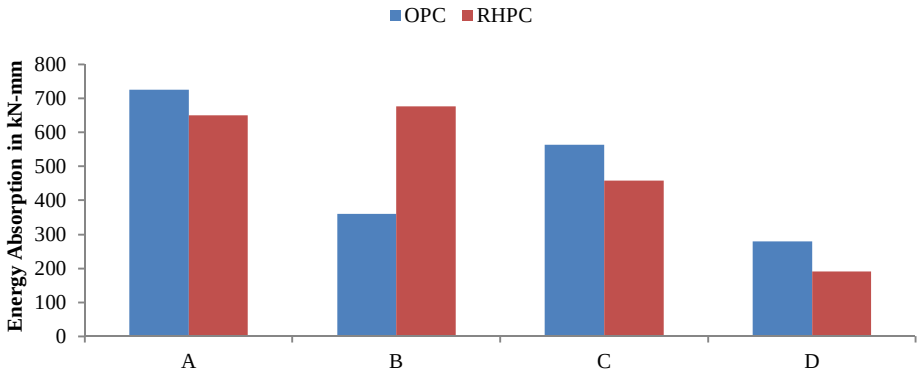

Figure 9

It is seen that energy absorption, on sample A is increased by 11% for OPC than RHPC. In sample B, the energy absorption is higher for RHPC than OPC. similarly, for the sample C & D, the energy absorption is higher in OPC due to less load carrying capacity & maximum deflection. with the usage of RHPC in concrete, the sample C and D are gradually decreased only on magnetic water due to the less load carrying capacity and large deformation. The sample A is slightly decreased to 4% than sample B. from this study magnetic water on concrete the strength is improved.

IV. CONCLUSIONS

From the above experimental investigation,

1) The magnetic water improves some of the physical properties such as pH, Total Hardness, density, chloride, sulphate, and Iron than the normal potable water.
2) The slump value is increased by 69% with 0.38 W/C ratio in OPC by using magnetic water and compared to potable water.
3) Here the Compressive strength is increased by 23% and split tensile strength is increased by 42% by using magnetic water, compared to normal potable water.
4) The cement content can be reduced to 16% to achieve the target strength of concrete and also formwork can be removed at earlier days.
5) The initial crack is delayed for RC beams with magnetic water in OPC when compared to potable water.
6) The load carrying capacity is 38% higher for magnetic water beam in OPC when compared to potable water.
7) The Ductility factor and energy absorption capacity was improved by using magnetic water.

REFERENCES

[1] Adnan Flayih Hassan(2008), " Effect of Magnetized Water On the Properties of Cement Mortars At the Earlier Ages", Al- Qadisiya Journal For Engineering Sciences, Vol.1, No.1 (95-108).
[2] Afshin .H, M. Gholizadeh and N. Khorshidi (2010), " Improving Mechanical Properties of High Strength Concrete by Magnetic Water Technology", Archive of Scientia Iranica, Vol 17, No. 1, February (74-79).
[3] Ali S. Faris, Riadh Al- Mahaidi, Awad Jadooe (2014), "Implementation of Magnetized Water to Improve the Properties of Concrete", International Journal of Civil Engineering and Technology (IJCIET), Vol 5, Issue 10, October (43-57.
[4] Ali Shynier, Mezher Abed and Zaineb Fouad (2014)," Improving Some of Mechanical Properties of Concrete by Magnetic Water Technology", Ministry of Science and Technology.

[5] Banejed .H and E. Abdosalehi (2009), " The Effect of Magnetic field on Water Hardness Reducing", Thirteenth International Water Technology Conference (IWTC), Vol (117-128).

[6] Fujimura Y and Lino M (2009)," Magnetic Field Increases the Surface Tension of Water", 3rd International Workshop on Materials Analysis and Processing in Magnetic Fields, doi : 10.1088/1742-6596/156/1/012028, pp (1-Gholizadeh M and H Arabshahi (2011), " The Effect of Magnetic Water on Strength parameters of Concrete", Journal of Engineering and Technology Research, Volume 3(3), March (77-81).

[7] Hassan Karam and Osama Al-Shamali (2014), " Effect of using Magnetized water on concrete properties", Third International

[8] Conference on Sustainable Construction Materials and Technologies. 1, December (93-95).

[9] Huinan Wei, Youkai Wang (2017)," Influence of magnetic water on early-age shrinkage cracking of concrete ", journal of Construction and Building Materials 147 (2017) 91–100.

[10] Iman Abavisani, Omid Rezaifar, Ali Kheyroddin (2017), " Alternating Magnetic Field Effect on Fine-aggregate Concrete Compressive Strength ", Journal of Construction and Building Materials 134 83–90.

[11] Ju Chen , Jun Wang, Wei-liang Jin (2016)," Study of magnetically driven concrete ", journal of Construction and Building Materials Vol 121 (2016) 53–59.

[12] Masoud Rasoolian, Reza Takhsha, Omid Sarani, Yahya Saravani (2014), " Evaluation of magnetic field on water hardness and some characteristics of concrete", International Research Journal of Applied and Basic Sciences, Vol, 8(11):1889-1890.