International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.11, pp 131-139, 2017

Effect of Magnetic Water on Mixing and Curing of M_{25} Grade Concrete

R. Malathy, N. Karuppasamy*, S.Baranidharan

Departmentof Civil Engineering Sona College of Technology, Salem, India

Abstract : This study involves the investigation of influence of magnetic water on the workability and compressive strength of concrete. The water is initially magnetized with the help of 0.5hp motor having a 0.8 T magnet at its inlet pipe. Both the physical and chemical properties oh water is to be studied. Concrete samples are then prepared and cured with magnetic water and ordinary water in four different cases. About 48 concrete cubes are casted for M_{25} grade and tested for 7, 14, 21 and 28 days respectively. The main scope of the study is to improve the qualities of water as per standards and reduce the water cement ratio thereby reducing the consumption of cement content and curing days.
Key words : Magnetic Water, Workability, Compressive Strength, Curing Ages.

1. Introduction

The word magnet is derived from the name of an island in Greece called magnesia, where magnetic ore deposit were found as early as 600 B.C. Water passing through a magnetic field with certain intensity is called as magnetic field treated water. Russia and China in last two decades, introduced magnetic water technology for improving the properties of concrete[1].Magnetic Field Treated Water (MFTW) improves the mechanical properties of concrete without addition of any admixture in concrete mix, increase in strength by 10-22% ,Compare to normal water concrete[2].The reason why MFTW 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[3]. Therefore, hydration process will be done efficiently, which in turn improves concrete strength[4]. MFTW surround the cement particles of same electrical charges, which repels each other and thus disperse cement cluster which facilitates the flow of entrapped mixing water. The use of GBFS with magnetized water increase strength by 9-19% in mortar and 10-23% in concrete[5]. Addition of fly ash in concrete, will decrease the waste pollution and accelerate the engineering properties[4].Magnetic water will reduce the hardness caused initially by calcium and magnesium[6].Water exposed in the magnetic field of mixed pole (N+S) will gives good flowability and zero sign of indication for bleeding and segregation[7].Authors reported that, use of super-plasticizer and silica fume will increase the strength by 25% reduce cement by (5 to 7.5%) without decrease in compressive strength[8,9].The effect of magnetic field on water structure, gathered by spectrum technique[10]. In irrigation field, Magnetic treatment has a significant effect on water quality and reduce the hardness upto 5%[11]. New technique are introduced to analyze the mechanical and optical properties of concrete[12,13]. Magnetic water prepared with standard pure water increase compressive strength by 8-9%[12].

1.1 Magnetic Water

Magnetic fields are produced by the motion of charged particles. The magnetic field is present only, when electrical current is passed through the wire coils or by using permanent magnet along the flow of water. The mechanism of magnetic water as shown in figure 1[14].

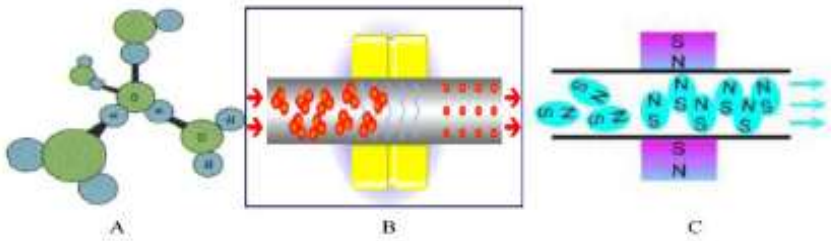


Fig 1:Mechanism of Magnetic Watera) Water Cluster b) Breakage of Cluster c) Orientation

Due to the effect of magnetic field on the water, large water cluster are cut and broken down by external magnetic field to form smaller water cluster, which helps magnetic water to penetrate easily into cement particles and thereby hydration process will takes place more effectively. Effect of hydration process as shown in figure 2[15].

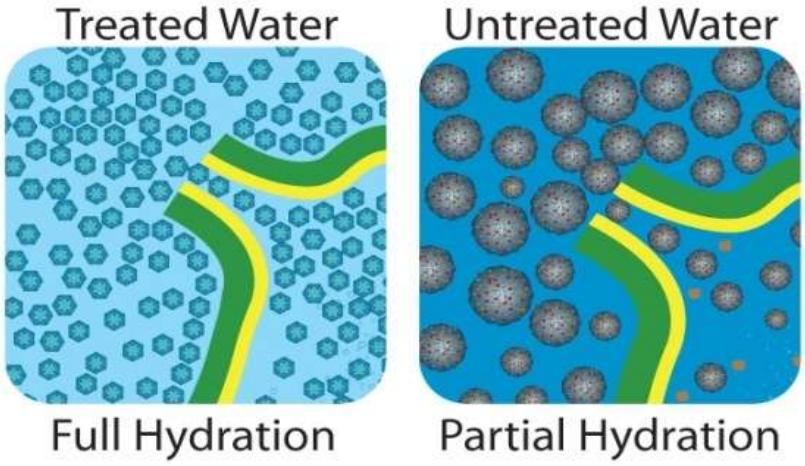


Fig 2:Effect of hydration :Treated water Vs Untreated Water

1.2 Research Significance

The main objective is to improve the workability and strength of concrete using magnetic field treated water and also to reduce the cement content in the concrete mix. magnetic field technology is used for irrigation purposes at many countries. So far in concrete industry ,this technology is not yet to be initiated in many areas. So the main significance of this study the benefits of magnetized water in the concrete mix.

2experimental Investigation on Concrete

2.1 Materials

Ordinary Portland cement of 43 Grade produced in Ultra-tech cement company confirming to IS:269-1976 was used throughout the investigation. Locally available river sand passing through 4.75 mm sieve as per IS: 383 provision were used as fine aggregates. Locally available basal stone chips were used for preparation of concrete . Machines crushed locally available hard basalt, well graded 20 mm and down size were used. Table I depict the physical properties of fine aggregate and coarse aggregate.

Table 1.Physical properties of coarse and fine aggregate

Test	Coarse aggregate	Fine aggregate
Specific gravity	2.90	2.69
Absorption (%)	0.10	1.00
Modules Of Fineness	3.43	4.80

2.2 Chemical Properties of Water

The normal water was used in this experimental study for the purpose of mixing and curing of concrete. The properties of water was tested as per the BIS specifications and shown in table 2.

Table 2. Chemical Properties of Water

Parameter	NormalWater	MagnetizedWater	Allowable Limit
Calcium(ppm)	340	145	300
Chlorides(ppm)	1050	550	1000
Total Dissolved Solids(ppm)	1800	1250	2000
Total Hardness(ppm)	620	380	600
pH	8.9	8.3	6.5-8.5

2.3 Mix Proportions

In with water cement ratio of 0.5. Proportion of concrete should be selected to make the most economical use of available materials to produce concrete of required quality. The mix design of M_{25} grade concrete is 1:1.97:3.05 this present research the effect of magnetized water on workability and strength properties are carried out. The concrete mix design was proposed by using IS 10262:2009. The grade of concrete used was M_{25}.

2.4 Experimental Setup

The specimens were cast and tested as per BIS testing procedures, after they were taken from curing pond and wiped off the surface water, as per IS 516-1959.

Workability Test

Slump test is the most commonly used method of measuring consistency of concrete. Slump test as per IS: 1199:1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod. Bottom diameter of slump cone is 200mm, top diameter is 100mm and height is 300mm. The concrete was filled in cone by three layers; each layer is tamped 25 times by the tamping rod.

Compressive Strength Test

As per IS: 516-1959, 150 mm concrete cubes were casted and specimens was made to cure for 28 days. The 7,14,21 and 28 days compressive strengths were tested using FIE compression testing machine of 100 T Capacity**.**

3 Results and Discussion

3.1 The effect of MFTW on workability

The figure 3 shows that, the workability of fresh concrete prepared with MFTW is higher than that mixed with normal water. Using normal water in concrete, medium slump (75 mm) was achieved in 0.5 w/c ratio, but preparing with magnetic water, medium slump value is achieved for 0.45 w/c ratio. Hence the cement

content is reduced about 11.11% while using magnetic water. The phenomenon behinds the performance of concrete using magnetically activated water, produces lot of polarity as the ingredients of concrete mix and more quantity of smaller water cluster. It will leads to better dispersion of fine cement particulates. Hence, lumps of cement particulates are breaks down and provide maximum surface area. Broken down cement particles provide "Ball Bearing" effect on the concrete mix, hence it will improve the workability and slump better in fresh state concrete.

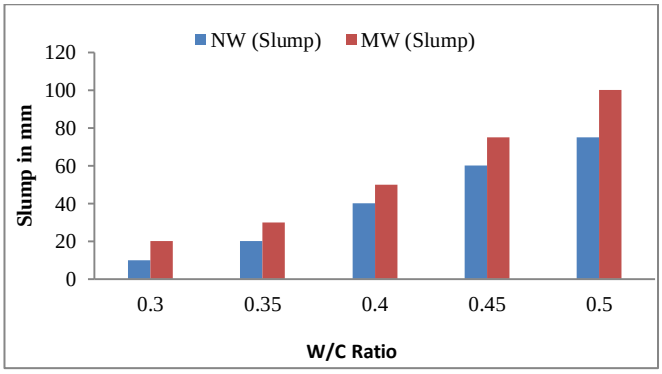


Fig 3:Slump Flow for M_{25} Grade Concrete with Different W/C Ratios (Using NW And MW)

3.2 The effect of MFTW on compressive strength with different curing ages

3.2.1 Compressive Strength of Concrete at 7th Day Curing

The Figure 4 shows the compressive strength development in normal water and magnetized water concrete. It is observed that the addition of magnetic water showed that significant increase in compressive strength by around 10.25% at 7 days of concrete cured with normal water and 21.33% at 7 days of concrete cured with magnetic water.

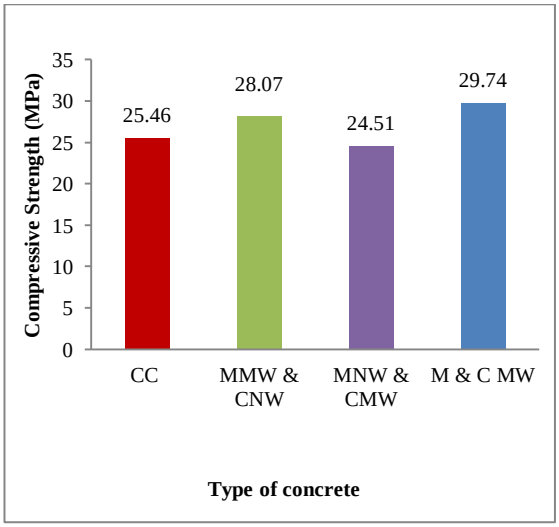


Fig 4: Compressive Strength of Concrete at 7th Day Curingat

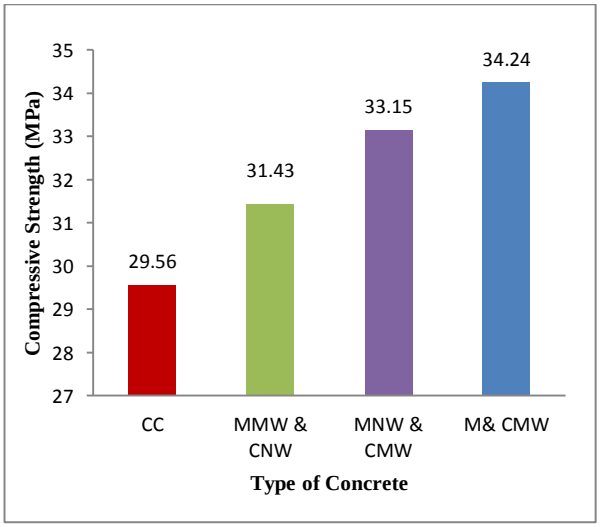


Fig 5: Compressive Strength of Concrete 14th Day Curing

3.2.2Compressive Strength of Concrete at 14th Day Curing

Figure 5 show the compressive strength development in normal water and magnetized water concrete. It is observed that the addition of magnetic water showed that significant increase in compressive strength by around 6.33% at 14 days of concrete cured with normal water and 8.29% at 14 days of concrete cured with magnetic water. The Target mean strength is achieved at 14 days, for the concrete type ,mixed with normal water and cured with magnetic water.

3.2.3 Compressive Strength of Concrete at 21st Day Curing

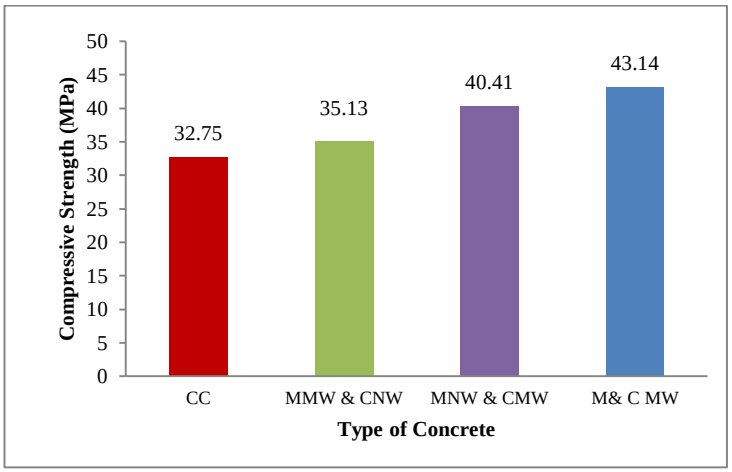


Fig 6: Compressive Strength of Concrete at 21st Day Curing

Figure 6 show the compressive strength development in normal water and magnetized water concrete. It is observed that the addition of magnetic water showed that significant increase in compressive strength by around 7.27% at 21 days of concrete cured with normal water and10.26% at 21 days of concrete cured with magnetic water.

3.2.4Compressive Strength of Concrete at 28th Day Curing

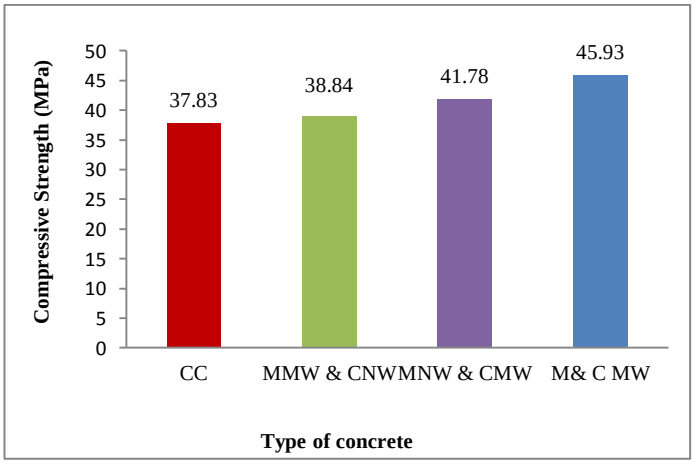


Fig 7: Compressive Strength of Concrete at 28th Day Curing

Figure 7 show the compressive strength development in normal water and magnetized water concrete. It is observed that the addition of magnetic water showed that significant increase in compressive strength by around 1.34% at 28 days of concrete cured with normal water and 9.93% at 28 days of concrete cured with magnetic water.

Figures 4 to 7 show that compressive strength of concrete samples prepared with magnetic water shows encouraging results than that of normal water. The concrete samples prepared and cured with magnetic water shows higher compressive strength than other combinations. As the curing ages increases, compressive strength also increases respectively. It shows that ,while hydration of cement particles is in progress, the MFTW can penetrate the core region of cement particles more. Hence ,hydration can be done more efficiently which in turns to improves concrete strength. Also shows that percentage increase of concrete sample prepared with magnetic water and cured with normal water, decreases slowly as the curing ages increases.

3.3 Compressive Strength of Conventional Concrete and Magnetic water concrete cured with Normal water and magnetic water

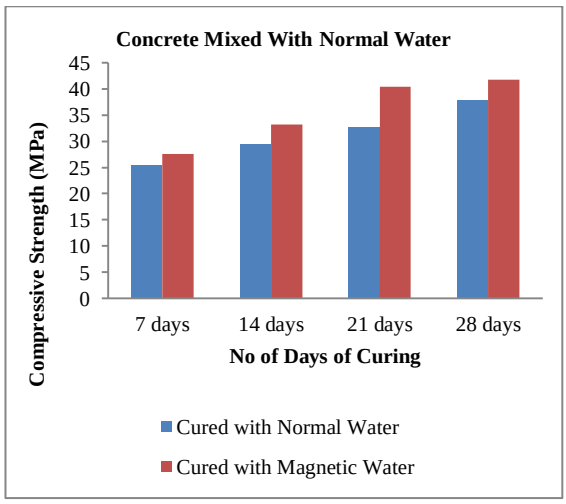


Fig 8: Compressive strength of conventional concrete cured with NW and MW water

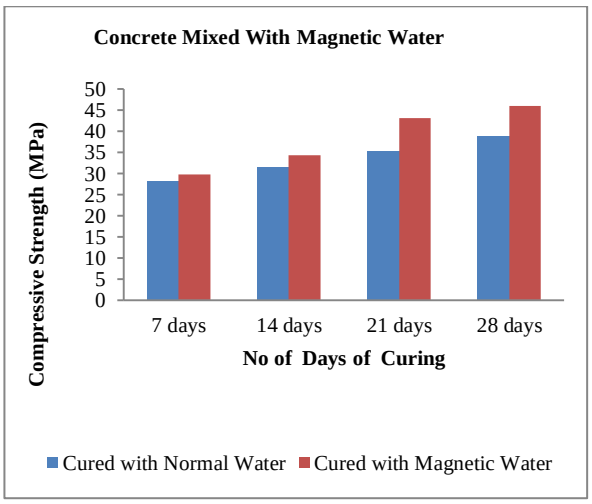


Fig 9: Compressive strength of magnetic concrete cured with NW and MW

Figures 8& 9 show the concrete sample prepared with both normal water concrete and magnetic water concrete cured with magnetic water gives higher compressive strength than normal water curing. As curing promoting hydration of cement by control of temperature and moisture movement in the concrete. The main objective of curing is to keep the concrete in saturated condition until, the water fill the space in fresh concrete paste has been filled to the desired extent by the products of cement hydration and this hydration takes place only in water filled capillaries[16].

3.4 Compressive Strength of Concrete Mixed With Normal Water and Magnetic Water

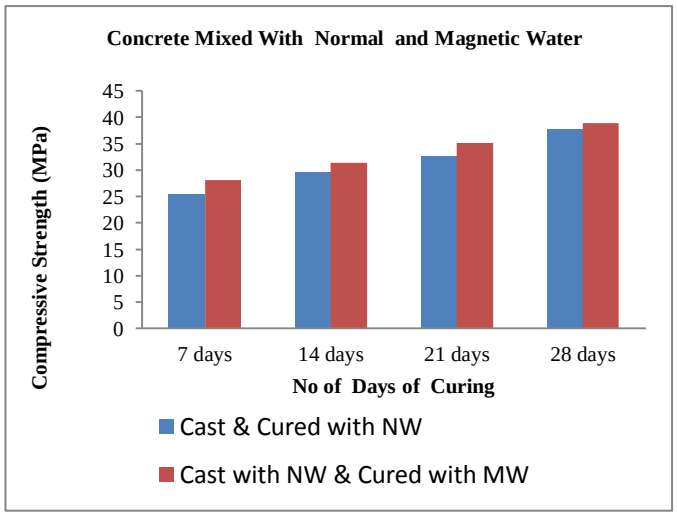


Fig 10: Compressive strength of concrete mixed with normal water & magnetic water

Figure 10 shows that, concrete sample prepared with magnetic water and cured with normal water showing encouraging results, than concrete sample prepared and cured with normal water. Target mean strength is achieved with concrete sample prepared and cured with magnetic water at 21 days period itself. This results shows that, action of cement hydration initially takes places on the surface of cement particles and formation of gel film layer type on the surface of the cement, which reduce tension on the surface of the magnetic water and improves the activity of cement. Therefore, magnetic water can make the cement hydration more completely and the structure more compactly [13] .Magnetic Water play an important role on casting yard of an precast units.

3.5 Compressive Strength of Concrete Mixed and Cured withNormal Water and Magnetic Water

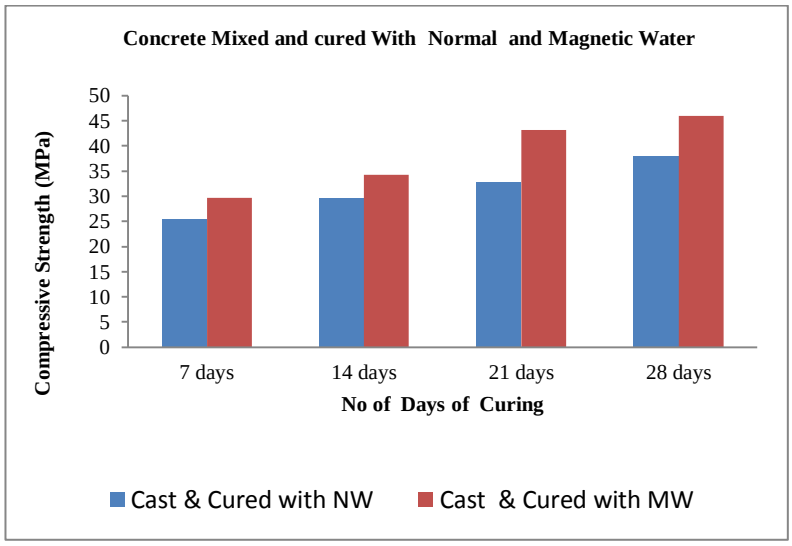
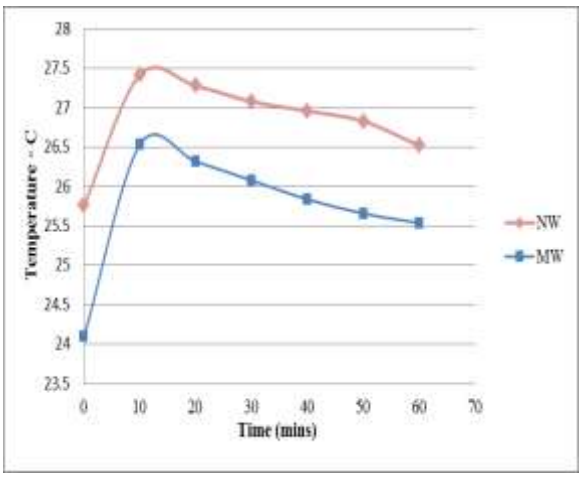


Fig 11: Compressive strength of concrete mixed and cured with normal water & magnetic water

Figure 11shows that, concrete samples mixed and cured with magnetic water shows higher result than mixed and cured with normal water. The percentage difference in compressive strength of conventional concrete with respect to magnetic water concrete goes on increasing, respectively with the increase in ages of curing. The higher difference ratio is achieved at 10.38% at 21 days concrete strength. Thus, water when exposed to magnetic field has better dispersion. As the more water available for hydration, the more number of cement particles are hydrated and results leads to better quality and density of hydration products of cement. This increase in hydration may leads to increase in compressive strength of the concrete. It increase the efficiency of cement used in concrete.

3.6 Heat Of Hydration

The end result of exothermic reaction between cement and water is known as heat of hydration. The temperature of concrete raises due to the hydration of cement. As per ASTM C186, standard est method for heat of hydration of hydraulic cement, uses a heat of solution producer. The 7 and 28 days, hydration of cement is measured using BS 4550.



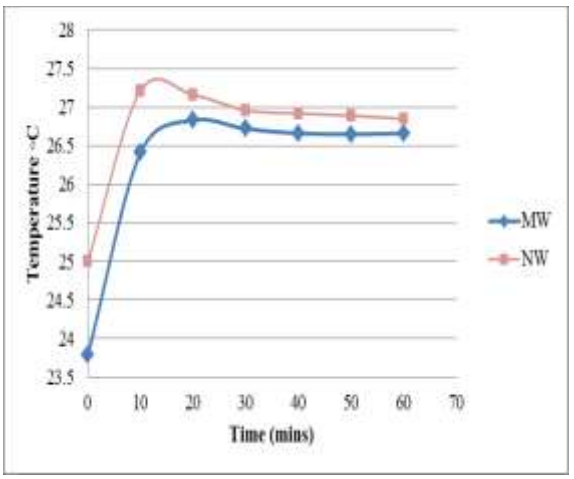


Fig 12 Time Vs Temperature at 7 days. **Fig 13 Time Vs Temperature at 28 days.**

Figure 12&13 shows the relationship between time and temperature during heat liberated in the process of hydration .At the end of 7 and 28 days, liberation of heat in the hydration process mixed with magnetic water is low compared to normal water. The cement mixed with magnetized water, produces heat as 99.39 Cal/gm,

within the specified limits. This low heat of liberation reduce the thermal stress and to avoid the cracks at early ages in concrete.

4. Conclusion

From the experimental results reported in this paper, the following conclusion are made:

1. The strength properties are found higher in concrete with magnetized water and the same in workability
2. The concrete prepared and cured with magnetic water shows higher percentage of compressive strength than normal water concrete.
3. The percentage efficiency of concrete samples cast and cured with magnetic water gives 20 % efficient than the conventional one.
4. The main advantage of using magnetized water in concrete is that increment in the strength properties and also reduction in the cement content up to 11% compared with an conventional concrete.
5. With the same mixture proportioning , concrete samples prepared with magnetic water will have a higher degree hydration of 20.14^0 C and 21.26^0C than samples prepared with normal water.
6. The magnetic field effects of water increases with increasing magnetizing time after which the properties of MW was constantly increased.
7. The strength properties shows that, magnetic water concrete producing high strength than normal water concrete at the earlier curing ages, as the curing ages increases. At the later curing ages, strength is not increased ideally , due to the decrease in effect of magnetic field intensity on the water properties.
8. The concrete prepared by using magnetized water will be cost effective, environmentally accepted and required low maintenance for the devices.

References

1. Afshin H.Gholizadeh M. and Khorshidi.N., Improving Mechanical Properties Of High Strength Concrete by Magnetic Water Technology, Archieve of SID, 2010,17:74-79.
2. Ali Shynier Abed, ZainabFouad, AkeelKazim.,Improving some of Mechanical Properties of Concrete by Magnetic Water Technology ,Ministry of Science and Technology,2012,1-11.
3. Siva Konda Reddy B. Vaishali G Ghorpade, Sudarsana Rao.H., Influence of magnetic water on strength properties of concrete, Indian Journal of Science and Technology,2014, 7:14-18.
4. Nan Su,Chea-Fang Wu,Effect of Magnetic Field Water on Mortar and Concrete Containing Fly Ash, Cement and Concrete Research, 2003, 25:681-688.
5. Nan Su ,Yeong-HwaWu,Chung-Yo Mar, Efeect of Magnetic Water on the Engineering Properties of Concrete Granulated blast-furnace slag, Cement and Concrete Research, 2000, 30:599-605.
6. AdnanFlayih Hassan, Al-Qadisiya,Effect of Magnetized Water on the Properties of Cement Mortars at the Earlier Ages,Journal For Engineering Sciences, 2008,1:97-108.
7. Siva Konda Reddy B,Vaishali G Ghorpade, Sudarsana Rao.H, Effect of magnetic field exposure time on workability and compressive strength of magnetic water concrete, International Journal Of Advanced Engineering Technology, 2013,120-122.
8. Yasser R.Tawfic and Wabel Abdelmoez, The influence of water magnetization on fresh and hardened concrete properties, International Journal Of Civil Engineering and Technology(IJCIET),2013, 4:31-43.
9. Ali S.Faris,Riadh, Al-Mahaidi , Award Jadoe, Implemenation Of Magnetization Water To Improve The Properties Of Concrete,International Journal Of Civil Engineering and Technology(IJCIET), 2014, 5:43-57.
10. Xiaofeng Pang and Bo Deng, Investigation Of Magnetic-Field Effects On Water,International Conference on Applied Superconductivity and Electromagnetic Devices, 2009,25-27.
11. Banejad.H and Abdosalehi.E, The Effect of Magnetic Field on Water Hardness Reducing, International Water Technology Conference(IWTC),2009,13:117-128.
12. Pang Xiao-Feng and Zhu Xing-Chum, The Magnetizational of water Arising from a Magnetic-Field and Its applications in Concrete Industry, Institute of Life Science and Technology, University Science and Technology,2013, 3:1541-1552.
13. Yixin Wang, Xiaoping Yao and HuaGao, Analysis on Microstructure of Impermeability of Magnetized Water Concrete,Journal of Chemical and Pharamaceutical Research,2014, 6:189-199.

14. Manjupriya T, Malathy R., Experimental Investigation On Strength and Shrinkage Properties of Concrete Mixed With Magnetically Treated Water,International Journal of Engineering and Advanced Research Technology(IJEART),2016, 2:46-50.
15. Pang Xiaofeng , Deng Bo, Investigation of changes in properties of water under the action of a magnetic field,Science in China Series G: Physics, Mechanics & Astronomy,2008,51:1621-1632.
16. Siva Konda Reddy B, Vaishali G Ghorpade, SudarsanaRao H.,Use Of Magnetic Water For Mixing and Curing of Concrete,International Journal of Advanced Research and Studies, 2014,1:93-95.
17. IS: 2386 (Part I) – 1963: Methods of Test for Aggregate in Concrete- Particle Size and Shape.
18. IS: 2386 (Part III) – 1963: Methods of Test for Aggregate in Concrete- Specific Gravity, Density, Voids, Absorption and Bulking.
19. IS: 2386 (Part IV) – 1963: Methods of Test for Aggregate in Concrete- Mechanical Properties.
20. IS: 383 – 1970: Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

*****