ABSTRACT

Increasing the compressive strength of concrete is an aim which most researchers are looking for, using various methods like fiber reinforcement in concrete mixture and usage of certain admixtures including super plasticizers to produce high strength concrete. The cost of these methods are not comparable with their advantages, thus most researchers concentrate their attention on producing economical concrete with higher strength using new philosophies in design methods and through modern techniques.

One such technique is using magnetic water (MW) for manufacturing of concrete. In this technology, by passing water through a magnetic field, some of its physical properties change and as a result of such changes, the number of molecules in the water cluster decrease from 13 to 5 or 6, which causes a decrease in the bond angle in water molecular structure and increases the surface area of water in unit volume and which enhances the hydration of cement. Using magnetized water in concrete mixtures causes an improvement in the workability and compressive strength of concrete. Also, this processed water causes a reduction in the cement content required for the specified compressive strength value.

In this research, the effects of magnetic water on mechanical and durability of concrete properties such as workability, strengths and porosity in concrete have been studied. The results of tests showed that, concrete made with magnetic water (MWC), has higher compressive strength values than those of control concrete (up to 50%). Also the other strengths and durability properties of concrete were improved by using this magnetic water in concrete. Present research also investigated that harmful salt water and treated waste water which is not suitable for mixing water in concrete can be magnetized to suit this water for mixing in concrete and tests showed that this magnetized salt water is same as normal water in imparting strength and durability to concrete.

The present research work is carried out to investigate the effect of MW in mixing of concrete ingredients on the mechanical and durability properties of ordinary grade concrete of M20. The experimental programme is briefed below:
1. To develop the method of production MW to be used in concrete and to study the influence of Magnetic field exposure time on structure of water. To find out
optimum exposure time of water to be used in mixing and curing of concrete.

2. Nano studies are conducted on Normal water and MW to the explore the structure of water before and after magnetizing the water and to develop and establish the theory for strength improvement in MWC.

3. Examine the effect of MW as mixing water in concrete on compressive strength, split tensile strength, flexural strength, impact strength and an attempt is made to understand the basic elastic behavior of MWC by obtaining the stress-strain behavior of MWC experimentally to appraise different parameters like Modulus of elasticity, Toughness or Energy absorption capacity.

4. Investigations on pores in concrete using radiography test and to establish the resistance of MWC to chloride ion penetration, Rapid chloride permeability test was conducted. The test also presents the studies on chloride diffusion of MWC.

5. To study the permeation properties like water absorption, water permeability and air permeability on MW incorporated concrete to understand volume of permeable voids and their interconnected pore space.

6. Resistance to freezing/ thawing cycles on the compressive strength and weight loss of MWC is studied.

7. Pore structure analysis and characterization of MWC is done by some Nano studies like TA/TGA, XRD, SEM and using Brenauer-Emmett-Teller’s (BET) Nitrogen (N2) nitrogen adsorption method. Porosity of concrete in terms of specific surface area and pore volume ratio, was examined using the BET nitrogen adsorption test.

8. Investigation on the use of MW for curing of concrete samples is carried out.

9. Possibility of use of Magnetized salt water and Magnetized treated water as mixing water in concrete is investigated by studying the long term compressive strength of the concrete with and without Magnetic salt and treated water

From the above extensive investigations carried out to evaluate the mechanical and durability characteristics of concrete mixed and cured with Magnetic water and use of Magnetic salt & treated waste water, the following conclusions are drawn:

1. A New method of production of MW inspired by magnetic therapy for producing MW as mixing water and curing water in concrete is proposed.

2. Nano studies conducted on water which is exposed to magnetic field indicated
that the exposure of water to magnetic field alters the internal molecular structure of the water.

3. When water is exposed to different poles of the magnet. The Mixed pole water (i.e 50% of North pole water +50% of South pole water) is showing improvement in workability and compressive strength compared to normal water concrete.

4. For usage of MW as mixing water in concrete, 24 hours of magnetic field exposure time to water is found to be optimum.

5. The addition of MW to concrete, concrete gains very high strength in early ages of hydration (up to 28 days) like NWC.

6. The addition of MW increases the 28 days compressive strength of concrete by 55% than NWC. Similar observations are made in split tensile, flexural strength and impact strength of concrete, which increased 28 days strengths by about 12%, 21% and 45% respectively. This improvement in strengths is due to enhanced hydration in MWC, making the concrete dense by modifying the pore structure.

7. The MWC mixes have shown improved stress values for the same strain levels compared to that of NWC concrete mixes.

8. Toughness or energy absorption capacity of MWC mixes has shown an increase of 45% when compared to NWC mixes.

9. Reduction in chloride permeability values in Rapid chloride penetration test indicates that MWC has shown between 78% to 80 % higher resistance against the chloride ion movements in MWC as compared to the chloride movements in NWC because of microstructure becoming dense due to more hydration causing interconnecting voids to be minimum. MWC at all ages have high electrical resistivity compared to NWC.

10. Auto clam Water permeability test shows that MWC is less permeable than the NWC the reason is that the MWC has improved pore structure due to more hydration subsequently reduction in the porosity of the concrete which substantially reduces the permeability of the concrete. Water permeability index reduces in MWC by nearly 80 % in comparison to NWC.

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12. Auto clam Air permeability and sorptivity values of MWC is reduced by nearly 65 to 76% as compared to NWC specimens. MW added concrete samples gave the lower sorptivity and porosity values compared to NW concrete. This means that the time taken for the water to rise by capillary action in MWC are longer and thus proved that these concrete is less porous compared to the NWC.

13. The resistance to freezing/thawing on the compressive strength loss and weight loss of MWC is found to be considerably superior than NWC.

14. Radiography test conducted on the concrete specimens with and without MW shows that the Pores/flaws are less in MW concrete specimens.

15. Pore structure analysis using BET Nitrogen adsorption test designate that there is significant decrease in total pores in in MWC also the specific surface area increased in MWC which indicates more hydration occurred in MWC.

16. Scanning Electron Micrograph (SEM) analysis indicates that the structure of MWC is very dense compared to that of NWC at all ages of curing.

17. XRD analysis was employed to determine the crystalline form and size of the crystals, it showed that the MWC sample had more size compared to that of NWC indicating more hydration in MWC.

18. Nano characterization done using TG & DTA shows that the microstructure of MWC is very strong compared to that of NWC.

19. The compressive strength of cubes cured in MW showed an increase at very early age and at later ages the increase in compressive strength was very less. This increase in compressive strength in concrete, when MW is cured for curing of concrete is due to ingress of small sized MW clusters deep in to the C-S-H structure which enhances the hydration process.

20. The use of Magnetized chlorine and sulphate water in concrete mixing increased the 28 days compressive strength of concrete cubes by 26.62% & 42.63% respectively compared to that of non magnetized salt water concretes.
21. Magnetized treated waste water (i.e., Primary, secondary and tertiary treated water) concrete specimens exhibited increase in the 28 days compressive strength compared to that of non Magnetized treated waste water by 37.5%, 19.5% and 16% respectively.

In summary, use of magnetic water as mixing water in concrete is effective in enhancing the mechanical and durability properties of concrete and also on magnetization of salt and treated waste water, water behaves like a normal water in achieving strength of concrete. However, a method is to be developed for producing the MW in large sale to take this new technology to in-situ concrete works with a cost-effectiveness.