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Effect of Using Magnetized Water on Concrete Properties

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ABSTRACT

The magnetic water has been used in different fields like agriculture, health care, constructions, dairy production, and oil industries. Concrete mixes designed were prepared using tap water (TW) and another set of concrete mixes designed of the same proportions were also prepared using magnetized water (MW) in the laboratory to prepare the testing specimens. Assessment of the Concrete strength was performed to determine the effect of using magnetized water. The compression parameters included the mechanical properties and the consistency of fresh concrete. The change in water surface tension and the positive results of the concrete evaluation is evidence of the positive effect of using magnetized water in preparing concrete.

Keywords. magnetic water, consistency, surface tension.

INTRODUCTION

Recently, magnetized water (MW) has been used in several applications including health, environment, agriculture, construction industry. The main target of this project is to study and evaluate concrete produced using MW. An experimental laboratory plan has been established to investigate the physical and mechanical properties of this concrete. Magnetized water is obtained by passing tap water through a magnetic field. Special apparatus to generate the magnetic field has been purchased and assembled with immerse-able water pump, for the laboratory study. The test variables include the magnetic strength of the water, the curing age of the concrete, the MW to cementations material ratio (w/c), and the constituents of the concrete mix usually used in Kuwait. The technology of using MW has been introduced in concrete production. A proposed program was developed to evaluate the feasibility of using MW in concrete by tune down the level of magnetizing to the optimum, and characterizing the concrete produced by MW in both fresh and hardened

stages. Various mixes design produced by MW and compared with the control mixes produced by normal water.

BACKGROUND ON MAGNETIC WATER

Magnetic water is the water that results when it is passes through a magnetic field with the purpose of changing its structure (Nan Su, et al., 2000). After water passes through a magnetic field of a certain strength, it is called magnetic field treated water (MFTW). Or magnetic water (MW). The estimated improvement to the concrete strength is 10 %, saving 5 % of the cement dosage in addition to improving other characteristics (Nan Su and Chea-Fange Wu, 2002). Where the structure of any substance appreciably determines its physical, chemical and thermo-physical properties (Fig. 1).

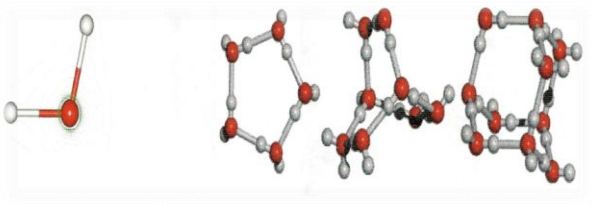

Fig. 1. Structure of water.

The process of magnetizing water does change its mechanical properties. As seen in Fig. 2 it only changes the trajectory of the charged particles movement, and not its energy (Nan Su and Chea-Fang Wu, 2002).

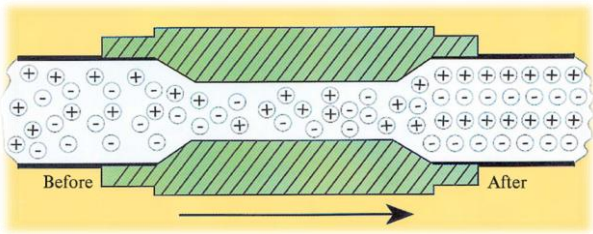

Fig. 2. Trajectory of charged particles movement, before and after the magnetizing process.

Workability plays an important role in the concrete quality in the short and long term. It is anticipated that the use of MW would have an effect on the fresh concrete quality that will lead to better quality of the hardened concrete, due to a change in the surface tension (viscosity) of the water used in the mix. moreover, more water is required for the concrete to be mixed well. Adding more water in concrete will make it workable, but unfortunately

adding water will scarify the concrete density. The reduction in water surface tension causes the water molecules to be more dynamic and fluid (Fig. 3). This in turn allows much better bonding between the other materials added to the water (Lazarenko and Zhuravlev 1985).

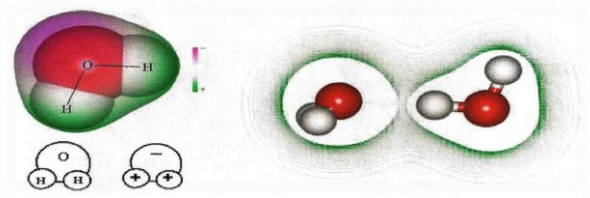

Fig. 3. Change in surface tension (viscosity) of the water.

As illustrated in Fig. 4 when water is magnetized, it becomes anti-magnetized and inhibits the mineral in concrete from bonding, which causes the minerals of the concrete and additive to repel each other. This fact plays a major role in of mixing, forming, and curing stages which all contribute in producing better concrete. All that will contribute in producing a high-quality concrete which can overcome its lack of ability to resist deterioration.

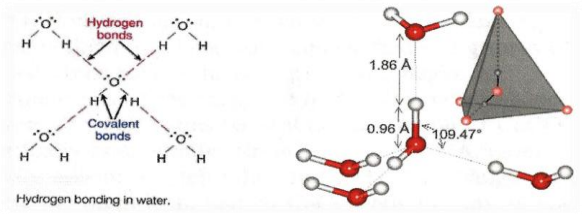

Fig. 4. The advantage of using anti-magnetized water on mineral additives.

Thus, the main target of this project is to study and evaluate concrete produced using MW. An experimental laboratory plan was established to investigate the physical and mechanical properties of concrete specimens. The magnetic treated water was obtained by passing tap water through a magnetic field.

MAGNETIC DEVICE

The type of magnet which is used in many household appliances, automobiles, and industrial machines. This type of magnet can be used to produce a magnetic field and has the advantage control of the magnetic field strength by controlling the voltage of the electric current passed through the coil wire. Figure 5 shows the line magnetic field which is generated from the coil.

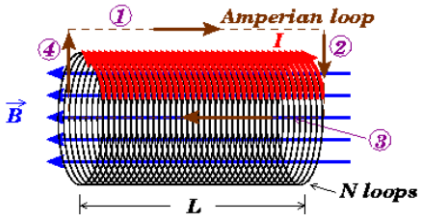

Fig. 5. Magnetic field generator.

However, the type of magnetizer used in the first stage is known as permanent magnets, where magnet strength is a result of mutual alignment of very small magnetic fields produced by each atom in the magnet. Permanent magnets are composed mainly of ferromagnetic materials such as iron, cobalt, and nickel. The magnetic field is then a result of charged particles. The inner line is distributed uniformly and this is referred to as the uniform field, thus each field between rolls of coil ignores other than the filed out of coil is so weak and not uniform. Therefore, the length of the coil is much greater than the its radius. The Ampere's function used to find the magnetic field inside the coil is as follows (Reitz, 1971):

$$\beta = \mu_o \, (N \, x \, I)/L \qquad (1)$$

where:

β : magnetic field, measured in teslas.

μ_o : magnetic constant (known as the permeability of vacuum has the exact value $4\pi*10^{-7}$ N/A^2, (Newton per ampere squared, or in henrys per meter) in SI units).

N : total number of rolls in the coil (nondimensional).

I : current in wire, measured in amperes.

L : length of the coil , measured in meter.

The strength of a magnet is given by its magnetic flux density, which is measured in unit of gauss, (1 gauss = 10^{-4} teslas = 100 microteslas (μT)), the strength of the magnet which is used in the present study was (1.2)Tesla, and in SI units of tesla, 1 T = 1 $kg{\cdot}s^{-2}{\cdot}A^{-1}$. An equivalent, but older, unit for 1 Tesla is $Weber/m^2$. The magnetizer used in this study is made for domestic use. It is a set of permanent series of ring magnet materials arranged in a certain manner in a Poly Venial Chloride (PVC) body to form of magnetic field with length greater than its radius. Figure 6 shows the water magnetizer used in this study. Its output is up to 90 m^3/hr, it is made of PVC body, and is used without preliminary filtration of water with high salt content.

Fig. 6. Permanent magnets field (water magnetizer

Testing Procedures

WATER TREATMENT (MAGNETIZING)

This study aims to investigate the affect of using magnetized water on concrete properties. Therefore, prior to the proportion of each mix, water is prepared for that specific concrete mix. The water was simply treated by passing it through magnetic field (magnetizer). MW was prepared by passing it through magnetic field, using an im-merseable pump to circulate the water through the magnetic field for 45 min (figure 7), with a velocity of 9 m^3/h. As a result the surface tension of water decreased by 7.4 mN/m.

Fig. 7. Immerse-able pump used to circulate water through the magnetic field (Magnetizer).

A hand-held electronic surface tension meter (Tensiometer) was used to measure the surface tension of the treated water. The device used is a very useful tool for quick and easy determination of the dynamic surface tension by the bubble method (fig. 8). This report covers the results of a comparative evaluation conducted in the laboratory between some selected concrete mixes prepared using normal water (tap water) and other mixes of the same proportions prepared using MW. In the present study, MW is prepared by passing it through a magnetic field of strength of about 12,000 gauss and with a velocity of 9 m^3/h.

Fig. 8. Hand-held electronic surface tension meter (Tensiometer).

As a result the surface tension of water decreased by 7.4 mN/m Compressive strength testing results were obtained for curing periods of 7,14 and 28 d. The splitting tensile strength testing results were obtained for curing periods of 28 d. Flexural strength testing results were obtained for curing periods of 28 d. The study covered a number of tests on fresh concrete which reflects the density of the concrete as well as hardened concrete testings.

Mix Proportions. A set of three mixes were mixed using TW and another set of the same proportion were mixed using MW in the laboratory to prepare the testing specimens.

- TW06 is the normal concrete which is prepared with normal water with a water cement ratio of 0.6 %.
- MW06 has the same proportions as the control mix prepared by magnetized water.
- TWSF has the same proportion as the control mix with Silica Fume added as mineral admixture and prepared with normal water.
- MWSF has the same proportion as the TWSF and is prepared with normal water.
- TWFA has the same proportion as the control mix, with Fly Ash added as mineral admixture and prepared with normal water.
- MWFA has the same proportion as the TWFA and is prepared with normal water.

Different testing specimens of each mix and its equivalent control mix were used. Compression was made to assess the effect of using MW. The compression included the mechanical properties and the consistency of fresh concrete. Table 1 shows the details of concrete mix proportions used.

Table 1. Concrete Mixes Proportion

Mix	Admixture	Cement (kg)	Aggregate (kg)			Admixture (kg)	w/c Ratio (%)
			Sand	10 (mm)	20 (mm)		
TW06	No	375.00	705.00	348.48	707.52	00	0.6
MW06	No	375.00	705.00	348.48	707.52	00	0.6
TWSF	Silica Fume	460.00	620.00	396.00	804.00	40.00	0.48
MWSF	Silica Fume	460.00	620.00	396.00	804.00	40.00	0.48
TWFA	Fly Ash	350.00	620.00	396.00	804.00	150.00	0.48
MWFA	Fly Ash	350.00	620.00	396.00	804.00	150.00	0.48

w/c: is the water cement ratio.

RESULTS AND DISCUSSION

Concrete sample prepared with MW, achieved better performance. That is shown from the comparison of concrete properties of the sample of concrete prepared with normal water and those prepared with MW. Properties of concrete in its fresh and hardened states, are compared to evaluate the effect of using MW.

Unit Weight. Density is an important fresh concrete property. Unit weight is the reflection of the concrete density, where higher the unit weight of concrete, the more dense it would be. Table 2 presents the unit weight of all mixes prepared.

Table 2. Unit Weight of Fresh Concrete

Mix.	Unit Weight (kg/m^3)	Change (kg/m^3)	Change (%)
TW06	2358	56.29	2.33
MW06	2415		
TWSF	2390	157.96	6.20
MWSF	2548		
TWFA	2373	161.57	6.38
MWFA	2534		

It can be seen that unit weight increased by 2.0 % for the concrete mixes prepared with MW without admixture and increased by 6.0 % for the concrete mixes with admixture, compared with two unit weight of those prepared with normal water.

Slump of Concrete (Workability). Table 3 shows that an increase between 10 to 35 % was achieved in slump when MW is used. It can be explained by the fact that a more

homogeneous lattice of new formations of hydrated cement minerals is developed when mixed with MW. Plasticity levels depend on the quality of cement glue used and since magnetic treatment influences glue qualities, the level of concrete's plasticity change, as shown in Figs. 14 and 15, when using MW for kneading of cement.

Table 3. Slump of Fresh Concrete

Mix	Slump (mm)	Change (mm)	(%)
TW06	70	10	14.29
MW06	80		
TWSF	70	25	35.71
MWSF	95		
TWFA	100	10	10.00
MWFA	110		

A. Concrete prepared using normal water.

B. Concrete prepared using magnetized water.

Fig. 14. Change in the plasticity level (slump) in fresh concrete.

Compressive Strength of Concrete. The results show that the concrete prepared with MW has a compressive strength higher than that of the mix with normal water, although the same mix proportions were used for all mixes, Fig. 15, and Table 4. Apart from the increase in compressive strength observed, the workability (consistency) of fresh concrete also increases significantly in all magnetic mixes specially in mixes, with admixture that is prepared with normal water and same curing condition. This means that the consistency of fresh concrete is enhanced when using magnetic water. The three mixes MW6, MWSF, and MWFA, that were prepared using MW show that the compressive strength increased (4 to 16 %) when using MW as compared to those prepared using ordinary water. Increased compressive strength of concrete by this process leads to an extra effect of saving cement,

additives, and thermal energy when MW is used in concrete, for which compressive strength is vital. although compressive strength is the main factor for concrete, statistically relevant confirmation of increasing cement's plasticity was obtained when it is prepared using MW. Of all mixes, mix MWFA gained the highest compressive strength increase (16.62 %). That can be explained by the fact that mix MWFA, with Fly Ash contains more minerals that are affected by the MW.

Table 4. Average Compressive Strength (%)

Mix.	Average Increase After 7,14, & 28 days		
	7	14	28
TW06	11.66	11.10	4.00
MW06			
TWSF	5.26	4.10	11.44
MWSF			
TWFA	0.26	5.77	15.62
MWFA			

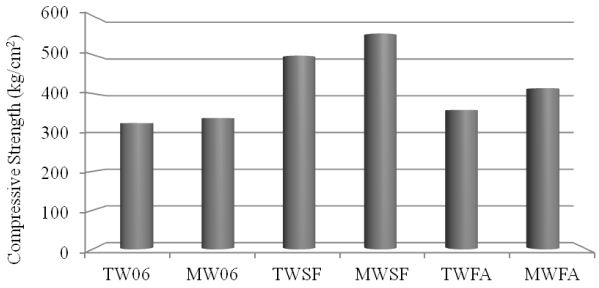

Fig. 15. Average compressive strength of all mixtures at 28 days.

Split Tensile Strength of Concrete. Figure 16 and Table 5 show the results for split tensile testing of different concrete mixes after 28 days. Again the results show an increase of 7 to 28 % in the splitting tensile strength of all the concrete samples.

Table 5. Average Splitting Tensile Strength after 28 d

Mix.	Splitting Tensile (Mpa)	Change (Mpa)	Increase (%)
TW06	24.82		
MW06	27.39	2.56	10.33
TWSF	34.38		
MWSF	36.95	2.56	7.46
TWFA	26.98		
MWFA	34.66	7.68	28.46

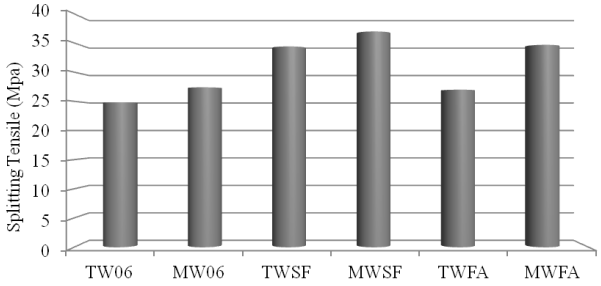

Fig. 16. Average splitting tensile strength.

Flexural Strength (Ductility of Concrete). Concrete prepared with MW, shows brittle behaviour as can be clearly seen from Fig. 17. This implies that it is advantageous to use MW to enhance the quality of concrete. This is further supported by the fact that mixes which contained more minerals like Fly Ash displayed higher split tensile strength than other mixes (Table 6 and Fig. 17). The introduction of MW to concrete was found to increase its ability to resist flexural strength (10 to 22 %).

Table 6. Average Flexural Strength of Concrete Beams After 28 d.

Mix	Flexural (Mpa)	Change (Mpa)	Increase (%)
TW06	4.77		
MW06	5.82	1.05	21.95
TWSF	3.50		
MWSF	3.87	0.37	10.44
TWFA	5.05		
MWFA	6.16	1.11	22.04

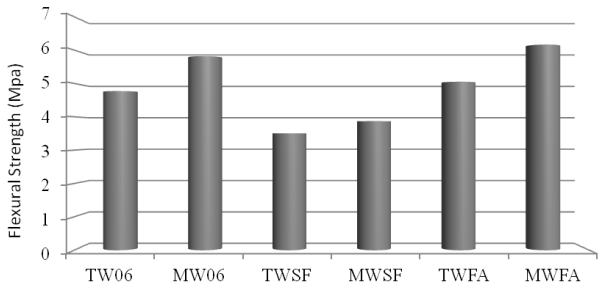

Fig. 17. Average flexural strength of concrete beams after 28 days.

CONCLUSION

Concrete mixes were prepared using both TW and MW. The following conclusions were found:

- The strength of concrete prepared with MW increased by 10 to 15 %.
- Other mechanical properties such as tensile strength and flexural increased by 7 to 28 % for concrete prepared using MW.
- The use of MW increased the workability of concrete that eventually led to enhanced quality of concrete without adding water.
- he enhancement of concrete quality is an evidence of the effect of using MW in preparing concrete.

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