

Sudan University of Science & Technology

College of Graduate Studies

Effects of Magnetized Mixing Water on the Properties of Concrete

آثار مياه الخلط المغنة على خواص الخرسانة

By

Abd Allah Salah Abd Allah

BSc, Civil Engineering

A thesis submitted in partial fulfillment of the requirements of the
degree of Master of Science in Civil Engineering
(Construction Engineering)

Supervisor:

Prof. Dr. Ahmed Eltayeb Ahmed

May 2009

DEDICATION

To my:

*Father's, Mother, Teachers,
Brothers, sisters and friends*

With gratitude and love

Abd Allah, S, A

ACKNOWLEDGEMENT

With sincere respect and gratitude, the author acknowledges his thanks to his supervisor Prof. AHMED ELTAYEB AHMED for his close supervision. Careful reviews, constructive discussion and criticism during the different stage of the study. His assistance and continuous encouragement has greatly improved this work.

Sincere thanks are extended to those in charge of concrete, soil and high way labs of the SUST especially Teaching Assistant Osman Elsir Dublok.

The author's thanks are extended to his colleagues for their assistance and encouragement.

الملخص

تعتمد مقاومة الخرسانة على تفاعل الإماهة ويشكل الماء دوراً مهما بالأخص الكمية المستعملة. عند إستعمال ماء قليل تزيد مقاومة الخرسانة. تفاعل الإماهة في حد ذاته يستهلك كمية من الماء. تخلط الخرسانة بمياه أكثر من التي تحتاجها عملية الإماهة، هذه المياه الإضافية تضاف لكي تعطي الخرسانة تشغيلية كافية، اذ أن إنسياب الخرسانة يكون مرغوباً فيه لتحديد التعبئة وتكون الشكل. إن المياه التي لا تساهم في تفاعل الإماهة سوف تبقى في شكل فجوات تجعل الخرسانة ضعيفة نسبياً للمقاومة الممثلة في روابط إماهة سيليكات الكلسيوم، بعض الفجوات لا تشكل أهمية عندما يتم دمك الخرسانة وإستعمال المياه المغفطة.

أحد الخصائص الأساسية للمياه المعالجة مغناطيسياً التي تشكل أهمية في صناعة الخرسانة هي مشاركتها للجزيئات والمحاليل مثل أيونات المحلول (محلول جزيئات الأسمنت المذاب في المياه المغفطة) التي تحتوى على جزيئات محاطة بطبقة رقيقة وكثيفة من الجزيئات الأحادية الواقعة تحت تأثير المجال المغناطيسي.

هذا البحث يهتم بتنويم عملي لتأثير المياه المغفطة على بعض الخواص الهندسية للخرسانة في الحالة اللمونة والصلبة. لقد أثبتت نتائج إختبارات الخرسانة التي إستعملت فيها مياه مغفطة زيادة ملحوظة في التشغيلية وتحسين المقاومة بنسبة 50% مما يمكن من تخفيض نسبة الأسمنت المستخدم بنسبة 25% غير أن زمن الشك يقل مقارنة بالخرسانة التي أُستخدمت فيها مياه غير مغفطة.

ABSTRACT

The strength of concrete is very much dependent upon the hydration reaction. Water plays a critical role, particularly the amount used. When less water is used to make concrete, strength of concrete increases. The hydration reaction itself consumes a specific amount of water. Concrete is actually mixed with more water than is needed for the hydration reactions. This extra water is added to give concrete sufficient workability. Flowing concrete is desired to achieve proper filling and composition of the forms. The water not consumed in the hydration reaction will remain in the microstructure pore space. These pores make the concrete weaker due to the lack of strength-forming calcium silicate hydrate bonds. Some pores will remain no matter how well the concrete has been compacted and has been used magnetized water.

One of the basic characteristics of magnetically treated water, which has major importance in concrete making, is its pertaining to colloidal particles and solutions. Like ion solution (colloidal cement solution is made with magnetized water), colloidal cement solution will contain colloidal particles, surrounded by a thinner dense layer of water mono-molecules as the number of mono-molecules drops at some regimen of magnetic treatment. Therefore, some reduction of water share in cement mixture is possible.

This investigation deals with the experimental evaluation of the effect of magnetic water on some of the engineering properties of concrete. The properties studied were those of both fresh and hardened states of concrete.

In order to evaluate the effect of the parameters tested alone, without the possible intervention of the other variables might mask the over all picture, it was felt necessary to adopt satiric control over the quality of the materials used through the whole investigation, this minimizes the effect of the variation in materials quality and gives higher confidence when interpreting the result.

The results showed that the workability and strength of concrete mixes made with magnetized water were increased with 50% which may result in a possible reduction of cement by 25%; however the setting time was shortened compared to that of mixes which used local tap water.

Table of contents

	Page
Dedication	i
Acknowledgement	ii
الملخص	iii
Abstract	iv
Table of contents	v
List of table	vii
List of figures	viii
List of plates	ix
CHAPTER ONE: Literature Review	
1.1 Background.	1
1.2 Application of magnetic technologies in construction industry.	4
1.2.1 Brief description of the results, which are possible to obtain using magnetic technologies.	5
1.2.1.1 Properties of cement.	5
1.2.1.2 Cement mortar production.	6
1.2.1.3 Impact on concrete mixture.	9
1.2.2 Theoretical model of impact of water, treated by magnetic, on concrete mixing	10
1.2.3 Mechanism of magnetic field impact on water dispersed system	11
1.3 Research objective.	13
CHAPTER TOW: Experimental Program	
2.1 Research methodology	14
2.2 Experimental program	15
2.3 Material properties and mix Design	16
2.3.1 Ingredient	16
2.3.1.1 Ordinary Portland cement (OPC)	16
2.3.1.2 Coarse aggregates (Gravel)	16
2.3.1.3 Natural Sand	19
2.3.1.4 Water	20

2.3.2 Mix design	22
CHAPTER THREE: Results	
3.1 Introduction	24
3.2 Fresh concrete properties	24
3.2.1 Workability	24
3.2.1.1 Temperature of magnetized mixing water	24
3.2.2 Density (unit mass or unit weight in air) of fresh concrete	25
3.3 Properties of hardened concrete	27
CHAPTER FOUR: Analysis and Discussion of Results	
4.1 General	33
4.2 Effect of magnetized water on setting time	33
4.3 Effect of magnetized water on workability of concrete	33
4.4 Effect of magnetized mixing water in improving the strength of concrete by reduction of water	36
4.5 Effect of magnetized mixing water in improving strength	37
CHAPTER FIVE: Conclusions and Recommendations	
5.1 General	40
5.2 Conclusions	41
5.3 Recommendations	41
References	43

List of Tables

Table no	Table Name	Page
Table 1.1	Composition of Portland cement with chemical composition and weight percent	1
Table 1.2	Impact of magnetized water on concrete compressive strength	9
Table 1.3	Impact of magnetized water on concrete tensile strength	9
Table 2.1	Results for Physical Cement Tests	16
Table 2.2	Sieve Analysis for Course Aggregate that obtained from ALRida quarries	17
Table 2.3	Sieve Analysis for Course Aggregate that obtained from Petro Delta quarries	18
Table 2.4	Results of physical properties of both aggregates	19
Table 2.5	Test result of Sieve Analysis of Fine Aggregate	19
Table 2.6	Proportions of concrete mixes (Group A)	23
Table 2.7	Proportion of concrete mixes (Group B)	23
Table 3.1	Properties of fresh concrete mixes of Group (A)	26
Table 3.2	Properties of fresh concrete mixes of Group (B)	26
Table 3.3	Compressive strength test results of Group A	28
Table3.4	Compressive strength test results of Group B	30

List of Figure

Figure no	Figure Name	Page
Fig.1.1	A plot of concrete strength as a function of the water to cement ratio.	2
Fig.1.2	Influence of magnetic treatment of water on the increase of strength in cement rock.	5
Fig.2.1	Sieve Analysis for Coarse Aggregate (ALRide quarries)	17
Fig.2.2	Sieve Analysis for Coarse Aggregate (Petro Delta quarries)	18
Fig.2.3	Sieve Analysis for Fine Aggregate	20
Fig.2.4	Simple flow chart for the design of concrete mix	22
Fig.3.1	Influence of temperature of magnetic water on workability	25
Fig.3.2	Variation of concrete strength at 3 days for mixes of Group A	28
Fig.3.3	Variation of concrete strength at 7 days for mixes of Group A	29
Fig.3.4	Variation of concrete strength at 14 days for mixes of Group A	29
Fig.3.5	Variation of concrete strength at 28 days for mixes of Group A	30
Fig.3.6	Variation of concrete strength at 3 days for mixes of Group B	31
Fig.3.7	Variation of concrete strength at 7 days for mixes of Group B	31
Fig.3.8	Variation of concrete strength at 14 days for mixes of Group B	32
Fig.3.9	Variation of concrete strength at 28 days for mixes of Group B	32
Fig.4.1	Influence of magnetized water in improving the compressive strength of mixes of group A	35
Fig.4.2	Influence of magnetized water in improving the compressive strength of mixes of group B	35
Fig.4.3	Influence of reduction of magnetized mixing water for improving the strength at similar workability of mixes of Group A	36
Fig.4.4	Influence of reduction of magnetized mixing water for improving the strength at similar workability of mixes of Group B	37
Fig.4.5	Influence of magnetized mixing water in improving the compressive strength by reduction of cement content (mixes of Group A)	38
Fig.4.6	Influence of magnetized mixing water in improving the compressive strength by reduction of cement content (mixes of Group B)	39

List of Plates

Plate no	Plate Name	Page
Plate 1.1	Structure of a 3-day-old cement rock seen under electric microscope.	6
Plate 1.2	Change in the plasticity level of cement.	7
Plate 1.3	Samples of cement after repeated freezing and de-freezing	7
Plate 1.4	Change in the appearance of cement sea parapet after 5 years since it was installed. Black Sea, Sochi, Russia.	8
Plate 1.5	Highway precast pavement, 3 years old. Rostov- na-Donu, Russia.	8
Plate 1.6	Cement slabs on the highway, exposure to a wide range of temperature changes (summer - up to 40 C, winter - up to -40 C). One year after laying, Siberia, Russia.	8
Plate 1.7	Change in the structure of cement pavements, 5 years after it was made, Moscow, Russia.	9
Plate 1.8	Effect of magnetic field on water molecules regulation	12

