PERFORMANCE OF A LOCAL PROPOSED ECONOMICAL ADDITIVE ON THE CEMENT MORTAR PROPERTIES AFFECTED BY AGGRESSIVE ENVIRONMENTAL CONDITIONS

A. Megahd Ahmed [1], M. M. Rashwan [2] , and Mostafa A.Razek [3,*]

Civil Engineering Department, Faculty of Engineering, Assiut University, Assiut, Egypt

Received 20 January 2012; accepted 5 February 2013

ABSTRACT

Admixtures have long been recognized as an important components of concrete used to improve its performance. The original use of admixtures in cementitious mixtures is not well documented. It is known that cement mixed with organic matter was applied as a surface coat for water resistance or tinting purposes. It would be a logical step to use such materials, which imparted desired qualities to the surface, as integral parts of the mixture. The use of natural admixtures in concrete was a logical progression. Materials used as admixtures included milk and lard by the Romans; eggs during the middle ages in Europe; polished glutinous rice paste, lacquer, Tung oil, blackstrap molasses, and extracts from elm soaked in water and boiled bananas by the Chinese; and in Mesoamerica and Peru, cactus juice and latex from rubber plants. The Mayans also used bark extracts and other substances as set retarders to keep stucco workable for a long period of time. (ACI Education Bulletin E4-03)

Chemical admixtures confer certain beneficial effects on concrete, including reduced water requirement, increased workabi1ity, control led setting and hardening, improved strength and better durability.

Many approaches have been adopted to investigate the role of chemical admixtures. One approach is to determine the state of the admixture in concrete at different times of curing. The admixture may remain in a free state as a solid or in solution, or interact at the surface or chemically combine with the constituents of cement or cement paste. The type and extent of the interaction may influence the physico-chemical and mechanical properties of cement paste.

In this paper an attempt is made to discuss experimentally the performance of a local proposed economical additive on cement mortar affected by aggressive environmental conditions.

1. Introduction

Many approaches have been adopted to investigate the role of chemical admixtures. One approach is to determine the state of the admixture in concrete at different times of curing. The admixture may remain in a free state as a solid or in solution, or interact at the surface or chemically combine with the constituents of cement or cement paste. The type and extent of the interaction may influence the physico chemical and mechanical properties of cement paste.

* Corresponding author.
Civil Engineering Department, Faculty of Engineering, Assiut University, Assiut, Egypt

Also found on several ways, the water is the most important fluid on nature. Among its properties, is noticeable the capacity to penetrate in small pores or cracks, and the capacity of dissolve a large amount of substances.

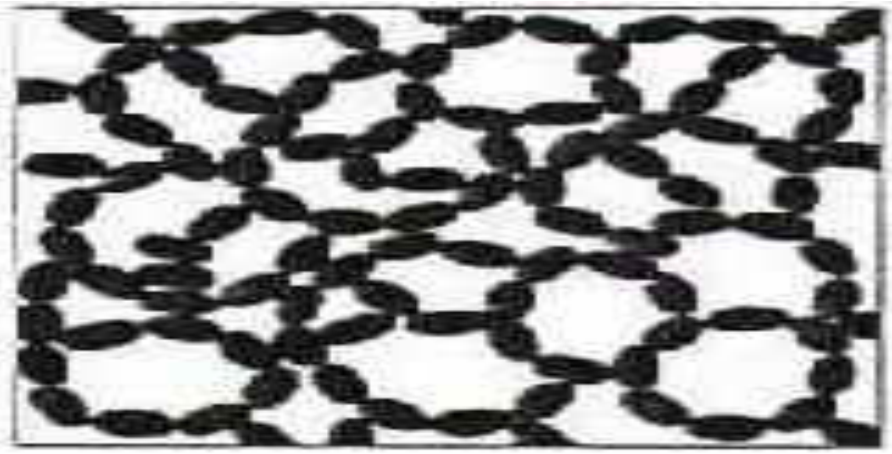
Several researches refer and attest the great importance of the water molecule on the concrete structure, especially on the first ages, caused by the cement hydration and consequent hardening of the concrete. However, the presence of water after the hardening of the concrete and after the reduction, or the ceasing of the hydration reactions, may cause the deterioration of the concrete or of the steel bar embedded in the structure. The water take action as a direct agent (lixiviation) or transporting noxious substances, such as chloride ions, sulfate ions and acid, or components that can activate and propel many chemical reactions that speed up the degradation process of the matrix, proportioning this way a substantial reduction of the durability and the use life of the concrete and reinforced concrete structures.

Some authors emphasize that the permeability of the water is the most important factor to esteem the durability under the most diverse conditions of service of a structure. The permeability regulates the speed of aggressive water penetration for inside of the concrete besides controlling the movement of the water during the ice-thaw process. Therefore concrete must be projected and manufactured for the environment to which it goes to be displayed, because the permeability is related to the porosity that varies in accordance to the composition of the concrete, its factor water to cement, its age and even though with its form of launching. (2)

Many important characteristics of concrete are influenced by the ratio (by weight) of water to cementitious materials (w/c) used in the mixture. By reducing the amount of water, the cement paste will have higher density, which results in higher paste quality. An increase in paste quality will yield higher compressive and flexural strength, lower permeability, increase resistance to weathering, improve the bond of concrete and reinforcement, reduce the volume change from drying and wetting, and reduce shrinkage cracking tendencies (PCA, 1988). (2)

Reducing the water content in a concrete mixture should be done in such a way so that complete cement hydration process may take place and sufficient workability of concrete is maintained for placement and consolidation during construction. The w/c needed for cement to complete its hydration process ranges from 0.22 to 0.25. The existence of additional water in the mixture is needed for ease of concrete placing and finishing (workability of concrete). Reducing the water content in a mixture may result in a stiffer mixture, which reduces the workability and increases potential placement problems.

Water reducers, retarders, and super-plasticizers are admixtures for concrete, which are added in order to reduce the water content in a mixture or to slow the setting rate of the concrete while retaining the flowing properties of a concrete mixture. Admixtures are used to modify the properties of concrete or mortar to make them more suitable to work by hand or for other purposes such as saving mechanical energy.



a) floculated

b) dispersed

Increase of slump is different according to its type and dosage. Typical dosage rate is based upon the Cementnous material content (milliliters per hundred of kilograms). The FIGure below illustrates the influence of dosage of Lignosulfonates and HC (Hydroxy Carboxylic) acid on slump. It is shown in the FIGure that HC acids give a higher slump compared to lignosulfonates with the same dosage.

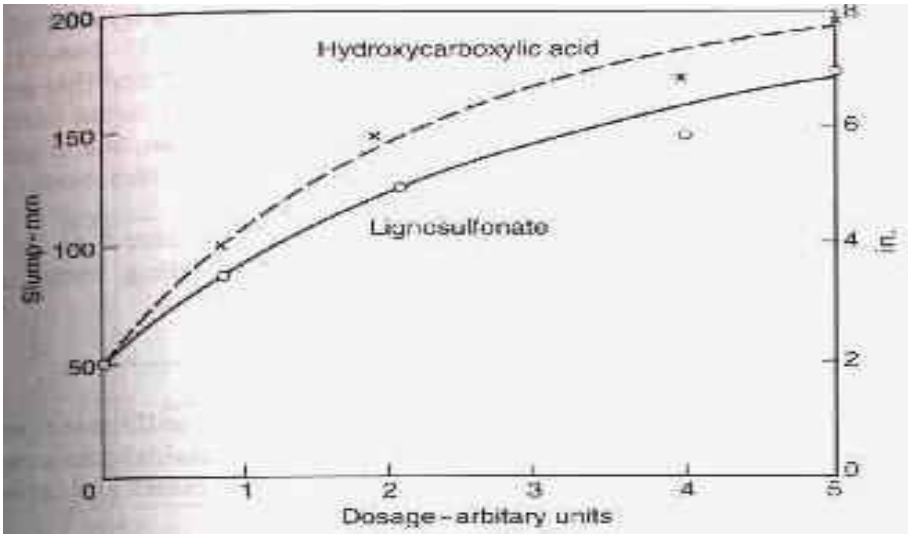


Fig. 1. Influence of dosage of retarders on slump (neville, 1995).

Where a fire occurs in a compartment of a building, the structure of the compartment should be required to contain the fire by continuing to perform those of its normal functions which contribute to the integrity and insulation of the compartment. The fire resistance test of Section Three grades elements of building structures in accordance with the time for which they are capable of fulfilling these functions while subjected to heating conditions representative of an actual fire in a compartment. Although the term fire-resistance has often been used indiscriminately in the past to denote the resistance of materials to ignition or spread of flame, the use of the term in this standard is restricted to the performance of complete elements of building structure without individual regard to the performance of the materials of which they are composed. Materials which perform well in the combustibility) or surface spread of flame tests may not necessarily do so when build into an element of structure and subjected to the fire-resistance test. B.S. 476 : Part 1 : 1953

2. Experimental program

The main aim of this program is to investigate experimentally the local economical additive for producing cement mortar present aggressive environmental conditions for different groups of normal strength mortar specimens modified with this new type of organic admixture. The experimental approaches in this study consist of testing standard cubic mortar specimens under static load. The main variables studied were Different types of admixtures and divided to:

- **Group 1** Suggested an organic local admixture, which was fabricated in the laboratory and contained in their composition wastes from petroleum refining industries and silica fume (is a by-product of melting process used to produce silicon metal and ferrosilicon alloys) and wastes of coke industries (Naphthalene sulfonate) and pure water (BM 2010).
- **Group 2** Control admixture (commercial admixture) (sedrete Wp)
- **Group 3** Control admixture (commercial admixture) (plastmix wp)
- **Group 4** Control sample (without admixes)

All groups of mortar specimens (252 cubes), with and without admixtures, were identical in size, 7x7x7cm. Specimens were cast and hardened in fresh water conditions until testing date. After that, specimens were divided into four groups depending on the type of admixture. Each group consists of 63 cubes as shown in **Table 1**. Then, all groups of cubes were tested under axial compression load.

Table 1

Number of test cubes for groups division

Number of test cubes	(Control)	Suggested (BM 2010)	(Sedrete Wp)	(Plastmix Wp)
Tested after 3 days	21	21	21	21
Tested after 7 days	21	21	21	21
Tested after Dryd in 100 ^{o}C	21	21	21	21

3. Materials

3.1. Technique of preparing and producing the suggested admixtures

The experimental technique for preparing and producing the suggested organic admixtures (BM 2010) was carried out by adding the naphthalene sulfonate to hot pure water in 50 ^{0}C and mix them with mechanical mixer and adding the wastes from petroleum industries and silica fume to the mixer until obtaining homogenous solutions.

The composition and correlation of components of the proposed admixtures by weight from their solid particles are shown in **Table 2. a. , b**.

Table 2. a.

Composition and correlation of components of the organic local admixture

Type of admixture	Components of the admixture	Correlation of components, % by weight
"BM 2010" (Suggested)	1-Wastes from petroleum refining industries (brown liquid solution)	1.62%
	2- Wastes of coke factory (Naphthalene sulfonate)	32.25%
	3- silica fume is a by-product of melting process used to produce silicon metal and ferrosilicon alloys	1.62%
	4- pure water	64.51%

Table 2. b.

Chemical analysis of the organic local admixture
(Tested by Analytical Chemistry Unit – ACAL Assiut University)

Parameter	Description
Chloride	0.0132 % (wt/vol)
Sulfate	0.1416 % (wt/vol)
Calcium oxide	0.1624 % (wt/vol)
Aluminum oxide	0.0560 % (wt/vol)

The system of mixing of the proposed admixtures with the mortar can be achieved as follows: the admixture, in a shape of solution, with different doses must be diluted with the required amount of water of the mortar. After that, the obtaining solution must be mixed with the different components of the mortar mix by using useful method of preparation of mortar. It is necessary to notice that, temperature of the required water for mixing should not be smaller than 25^{o}c to prevent the appearance of sedimentation of organic elements.

Compatibility of initial components of any admixture represents an important requirement for its chemical characteristics. Compatibility of admixture components means their correlation in the ability of producing additional chemical reactions and their common effect on the cement materials properties.

3.2 Mortar mix

Different doses were used for obtaining each admixture on producing cement mortar. These mortar cubes specimens were tested after 3-days & 7-days.

Ordinary Portland cement of specific gravity 3.15,(Assiut cement). Local natural sand which passing from sieve No. 20 and retained on sieve No.30 were used.

Table 3.
Physical and mechanical and chimical Prop. of used Sand

Property	Sand
Volume weight (t/m3)	1.73
Specific gravity	2.63
Finess Modulus	3.00
Cl	0.04
So4	0.26
PH	7.4

Table 4.
Sand sieve analysis

Sieve size	% Passing
4.75mm	100
No. 4	100
No. 8	100
No. 20	100
No. 30	0
No. 50	0
No. 100	0
No. 200	0

3.3 Test procedure

All of the tested cubes (252 cubes 70.6x70.6x70.6 mm) were hardened in fresh water. Each group has:

- **21 specimens tested After 3days** to measure the **compressive strength**
- **21 specimens tested After 7days** to measure the **compressive strength**
- **21 specimens tested After** drying it in an oven of elevated temperature up to 100^{o}c for **1 day** after cured in water for 7 days (to measure the **compressive strength** and **water absorption**

Water absorption was determined by means of the difference in weight of the specimens before and after the heating in the oven.

Standard paste: (reach when Vicat test needle (φ = 10mm) penetrate (0.5 – 0.7 cm) on the specimen).

Table 5
Details and properties of mortar mixes

Mix No.	Cement (gramme)	Sand (Kg)	Additives Dose	Type	Water
1	200	600	without	(Control)	To produce standard paste
2	200	600	Variable (0.2-1.4%)	(BM 2010)	
3	200	600	Variable (0.2-1.4%)	(Sedrete Wp)	
4	200	600	Variable (0.2-1.4%)	(PlastmixWp)	

The testing machine (Control 2000 KN) was used. Each specimen was loaded axially and gradually keeping the rate of loading constant. The mortar specimens were tested under static axial compression loading after 3 & 7 days hardening in fresh water.

4. Test results and discussions

Test results of the all-cubic cement mortar specimens, without admixtures, modified with the suggested admixture and, control admixture, are presented and discussed.

4.1. The optimum dose of the suggested admixture according to compressive strength

Effect of different doses of the proposed admixtures on the compressive strength of mortar specimens having the same workability (standard paste) and hardened in fresh water at different ages was studied. Optimum dose of each admixture, at which maximum values of compressive strength occurred, was determined and the results are shown in **FIG. 2**.

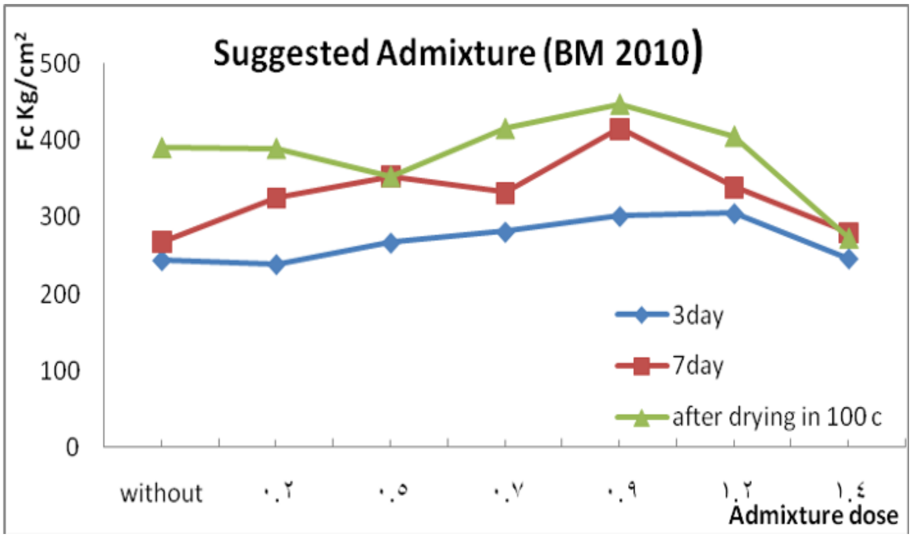


Fig. 2. Effect of different doses of suggested admixture on the cubic compressive strength of mortar specimens hardening in fresh water.

It is Obvious that, optimum dose of the suggested admixtures equals 0.9% by weight of cement. At this dose, compressive strength of concrete specimens modified with the organic admixtures (BM 2010) at age of 7 days increased by about 55% compared to the control specimens without admixtures.

4.2. The optimum dose of the control admixtures (sedrete wp, plastmix wp) according to compressive strength

Effect of different doses of the proposed admixtures on the compressive strength of mortar specimens having the same workability (standard paste) and hardened in fresh water at different ages was studied. Optimum dose of each admixture, at which maximum values of compressive strength occurred was determined and the results are shown in **FIGS. 3.,4.**

Based on FIG. 3, optimum dose of the control admixture equals 0.5% from weight of cement. At this dose, compressive strength of concrete specimens modified with the control admixture (Sedrete wp) at age of 7 days increased by about 24% compared to the control specimens without admixtures.

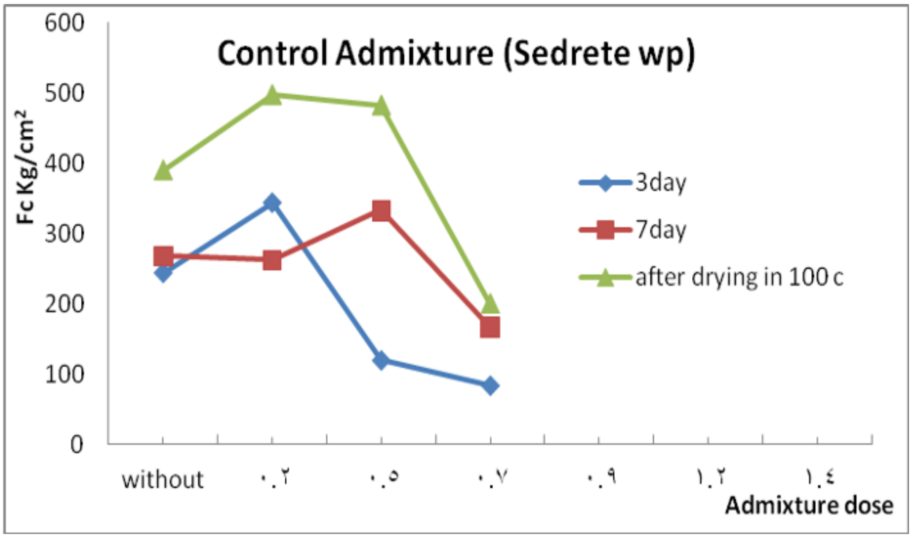


Fig. 3. Effect of different doses of Control admixtures (Sedrete wp) on the cubic compressive strength of mortar specimens hardening in fresh water.

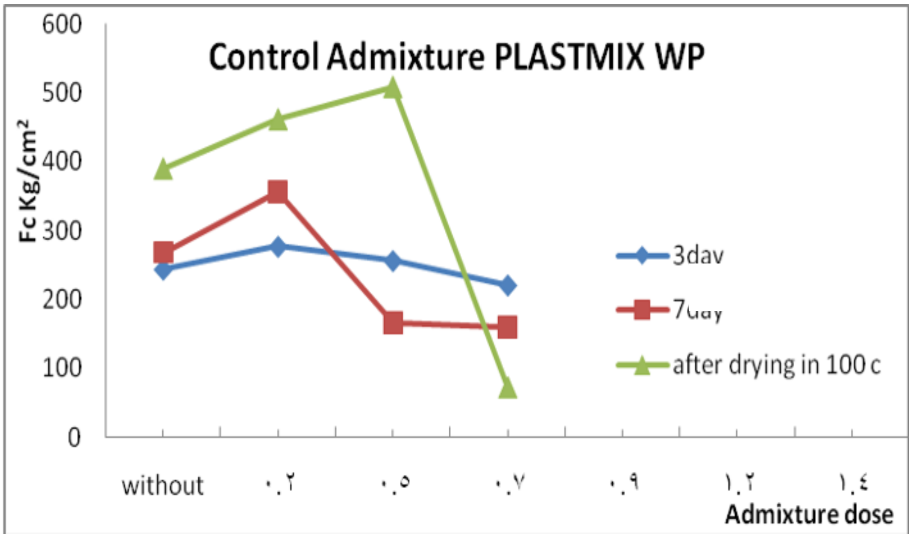


Fig. 4. Effect of different doses of control admixtures (Plastmix wp) on the cubic compressive strength of mortar specimens hardening in fresh water.

FIG. 4 shows that, optimum dose of the suggested admixtures plastmix wp equals 0.2% from weight of cement. At this dose, compressive strength of concrete specimens modified with the organic admixtures (Plastmix wp) at age of 7 days increased by about 32% compared to the control specimens without admixtures.

4.3. The Optimum dose of Admixtures according to water absorption of mortar specimens

The effect of dose of each admixture on the water absorption of mortar specimens was investigated compared with the control specimens. The results were determined and shown in **FIGs. 5,6,7**.

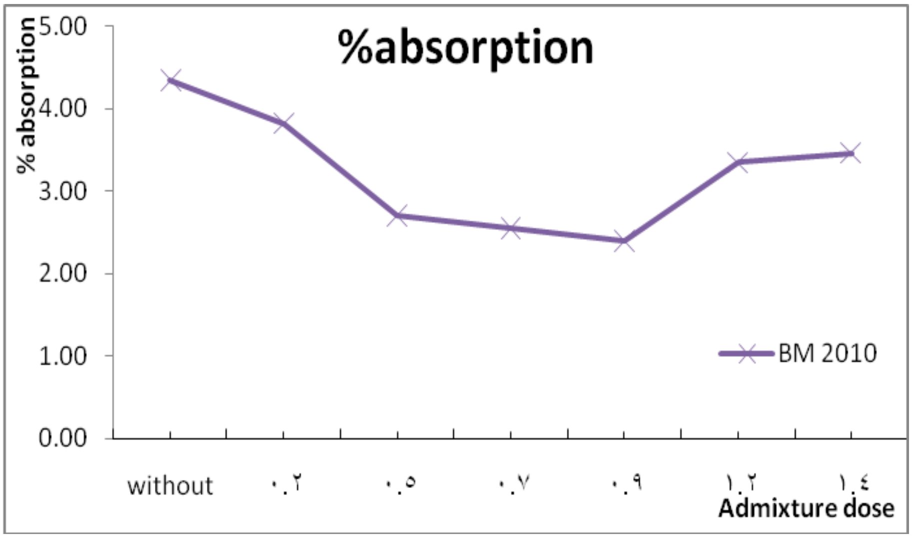


Fig. 5. Effect of admixture (BM 2010) dose on the water absorption of mortar specimens.

On the light of FIG. 5, it is obvious that, optimum dose of the suggested admixtures BM2010 equals 0.9% from weight of cement. At this dose, the water absorption of mortar specimens modified with the organic admixtures (BM 2010) at decreased respectively by about 41% compared to the control specimens without admixtures.

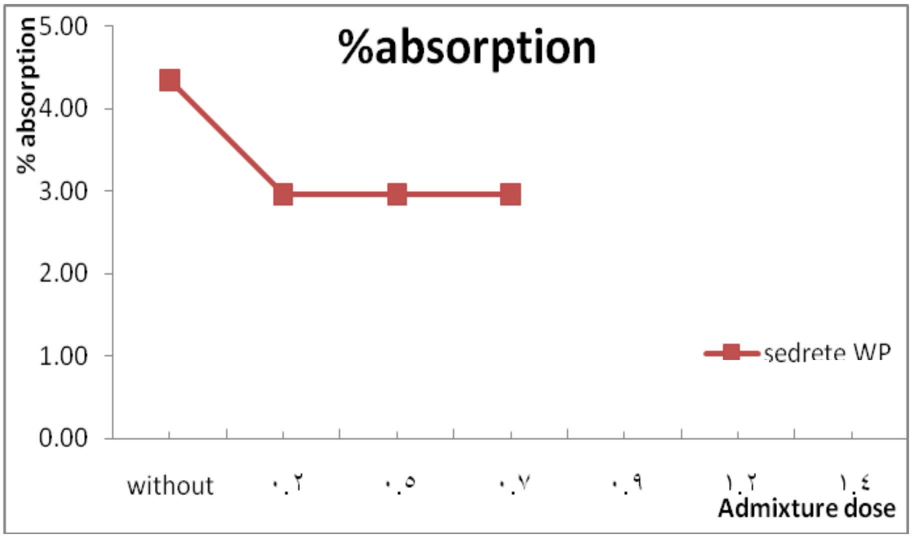


Fig. 6. Effect of admixture (Sedrete wp) dose on the water absorption of mortar specimens.

FIG. 6 shows, optimum dose of the suggested admixtures sedrete wp equals 0.2% from weight of cement. At this dose, the water absorption of mortar specimens modified with the control admixture (Sedrete wp) decreased by about 31% compared to the control specimens without admixtures.

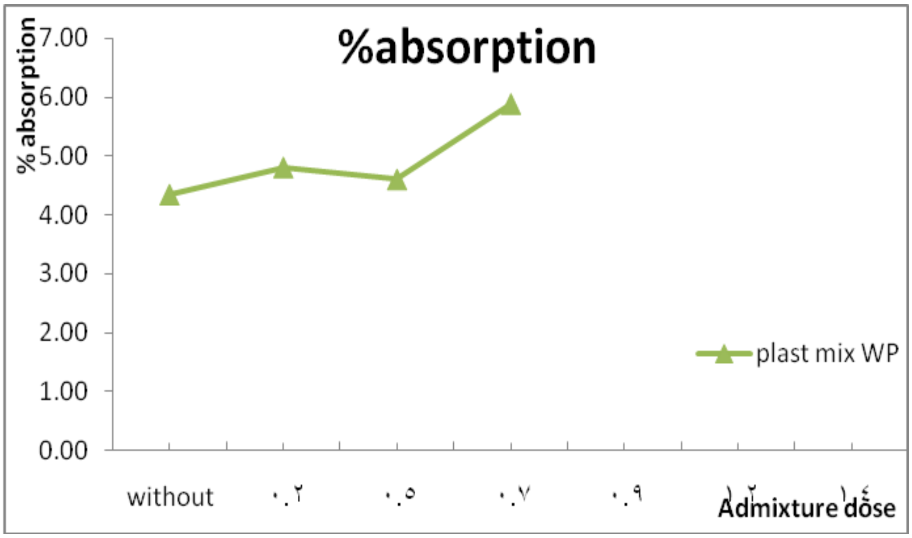


Fig. 7. Effect of admixture (Plastmix wp) dose on the water absorption of mortar specimens

A first glance on FIG. 7 it is Obvious that, optimum dose of the suggested admixtures equals 0.5% from weight of cement. At this dose, the water absorption of mortar specimens modified with the control admixtures (Plastmix wp) increased by about 6% compared to the control specimens without admixtures.

4.4. Comparison between the suggested, control aamixtures according to compressive strength

It is necessary to notice that the suggested admixtures (BM 2010) using dose 0.9% increased Compressive Strength after 3 days by about 60% compared with the control specimen with admixture (Sedrete wp) & by about 8% compared with the control specimen with admixture (Plastmix wp) as shown in **FIG.8** .

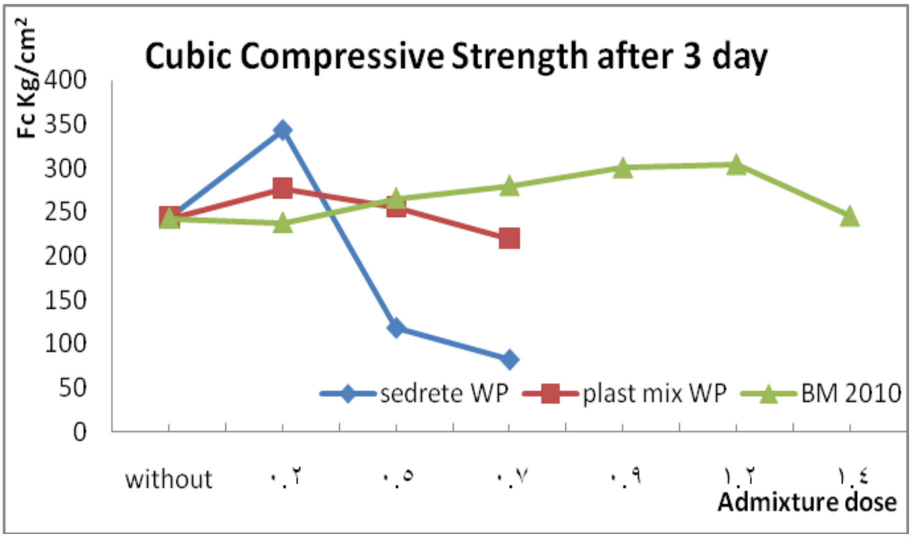


Fig. 8. Effect of different doses of admixtures on compressive strength after 3 days

It can be noticed that the suggested admixtures (BM 2010) using dose 0.9% increased compressive strength after 7 days by about 19% compared with the specimen with control admixtures (Sedrete wp) & by about 14% compared to the control specimen with control admixtures (Plastmix wp) as shown in **FIG.9** .

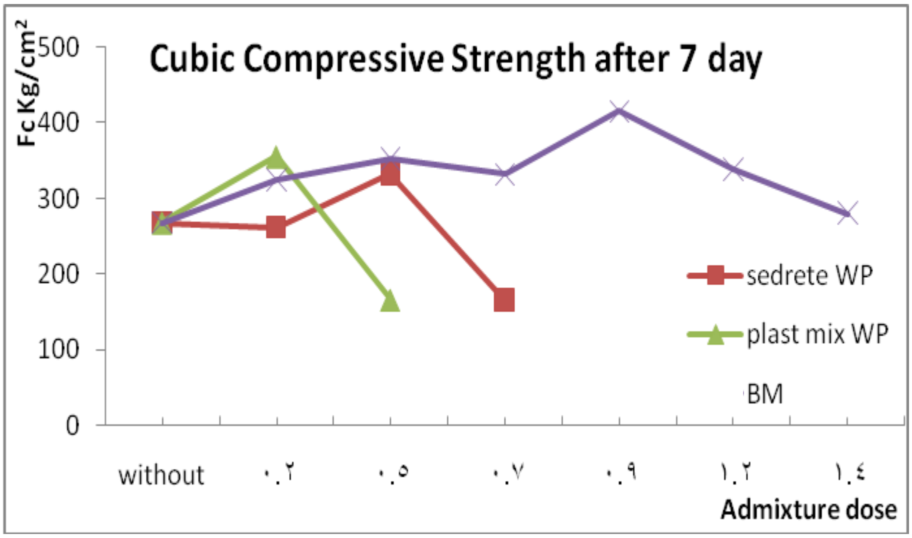


Fig. 9. Effect of admixture on compressive strength after 7 days.

4.5. Comparison between the suggested and control admixtures according to water absorption

It is necessary to notice that the suggested admixtures (BM 2010) using dose 0.9% decreased water absorption by about 23% compared with the control specimen with admixture (Sedrete wp) & by about 100% compared to the control specimen with admixture (Plastmix wp) as shown in **FIG.10** .

4.6. Comparison between the suggested and control admixtures according to compressive strength after hardening in an oven of elevated temperature up to 100^{o}c

After Hardening the mortar specimen in an oven of elevated temperature up to 100^{o}c it was noticed that the suggested admixtures (BM 2010) decreased compressive strength by about 8% compared to the control specimen with control admixtures (Sedrete wp) & by about 3% compared to the control specimen with control admixtures (Plastmix wp) as shown in **FIG.11** .

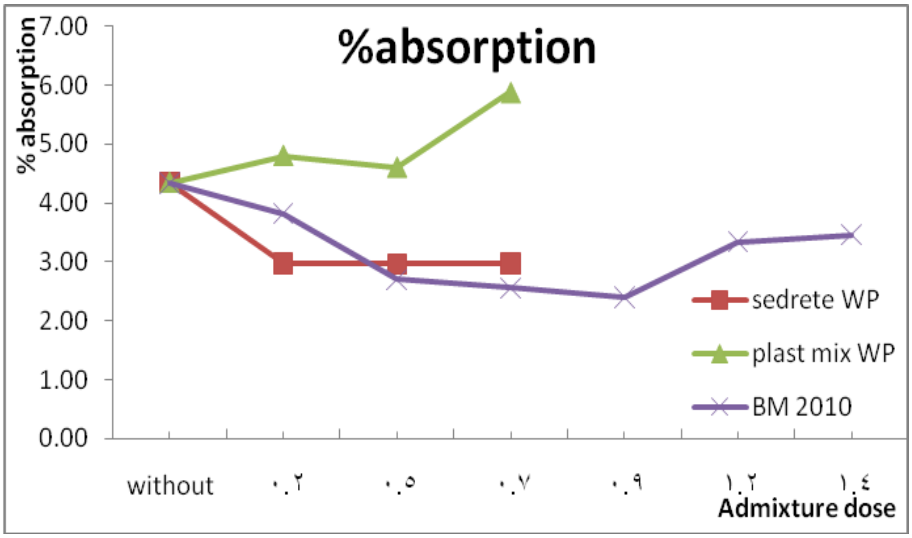


Fig. 10. Effect of admixture on water absorption

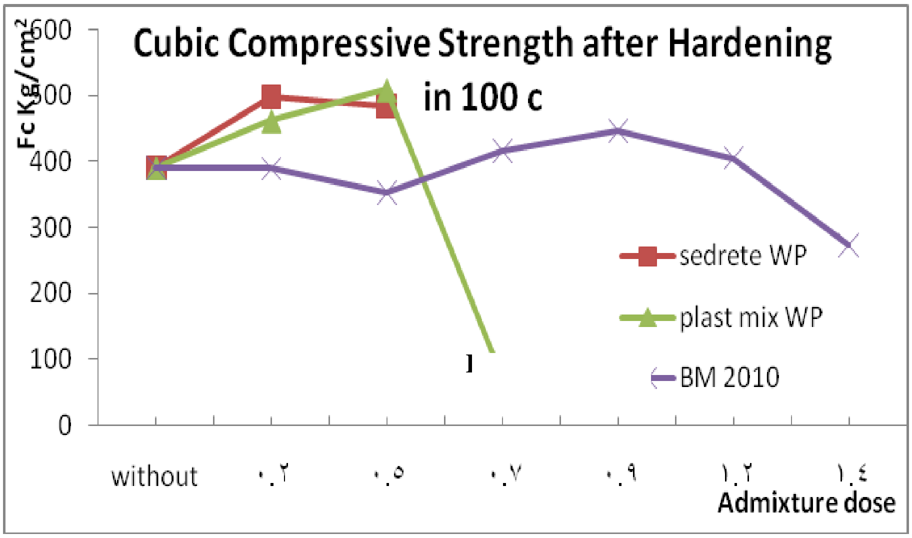


Fig. 11. Effect of hardening the mortar specimen in an oven of elevated temperature up to 100^{o}c

5. Conclusions

Based on the results of the experiments carried out on mortar specimens containing in their compositions wastes from petroleum refining industries & wastes of coke industries and hardened in different conditions exposed to static load, the following conclusions can be drawn out:

1- The suggested organic admixture (BM 2010) were prepared and produced by adding coke industries wastes with petroleum industries wastes with silica fume to hot pure water in 50 ^{0}C obtaining homogenous solutions and give good results on the behavior of mortar specimens comparison with the control specimens without admixture and with the two control commercial admixtures specimens.

2- Optimum dose of suggested admixture, at which occurs maximum values of compressive strength and minimum values of water absorption was determined and equals 0.9% from weight of cement. At which, compressive strength of concrete specimens modified with the organic admixtures (BM 2010), at age of 7 days hardening in fresh water, increased respectively by about 55% compared to the control specimens without admixtures. But, it increased by about 19%,14% compared to specimens modified with the control admixture (Sedrete wp, Plastmix wp)

3- The suggested admixture (type BM 2010) increased cubic compressive strength of mortar specimens hardened on Oven Of Elevated Temperature up to 100^{o}c by about 14% respectively compared to the control specimens hardened in the same conditions.

4- The suggested admixtures (BM 2010) decreased water absorption respectively by about 41% compared to the control specimens without admixtures. but, water absorption decreased by about 23%,100% compared with specimens modified with the control admixtures (Sedrete wp, Plastmix wp)

5- The specimens modified with the control admixture (Sedrete wp, Plastmix wp) having dose more than 0.7% was dissolved during curing in water. But The specimens modified with the suggested admixture did not dissolv until dose 1.4%.

6- The suggested admixture showed a better influence compared with the control admixtures (Sedrete wp, Plastmix wp).

References

[1] Permeability of Concrete: A Study Intended for the "in situ" Valuation Using Portable Instruments and Traditional Techniques Abdias Magalhäes Gomes, Dr. Prof. Universidade Federal de Minas Gerais, Brazil. Juliana Oliveira Costa, Universidade Federal de Minas Gerais, Brazil 2003.

[2] Komatska, S. H. and Panarese, W. C., Design and Control of Concrete Mixtures, PCA, 1988.

[3] Chemical Admixtures for Concrete, ACI Committee 212.3R-91 (1991) Report.

[4] Chemical and Air Entraining Admixtures for Concrete, ACI Education Bulletin No. E4-95 (1995).

[5] Ramachandran, V. S., Concrete Admixtures Handbook, Properties, Sciences, and Technology, 2nd edition, 1995

[6] M.D. Cohen, "Theories of expansion in sulfoaluminate - type expansive cements", Cement and Concrete Research 13, 1983, pp. 809-818.

[7] D. Bonen and M.D. Cohen, "Magnesium sulfate attack on Portland cement paste: I. Micro structural analysis ", Cement and Concrete Research 22, 1992, pp. 169-180.

[8] M. Santhanam, M.D. Cohen and J. Olek, " Mechanism of sulfate attack: A fresh look", Part 1: Summary of experimental results, Cement and Concrete Research 32, 2002, pp. 915.

[9] Powers, T.C., Copeland, L.E., Hayes, J.C., and Mann, H.H., "Permeability of Portland Cement Pastes", ACI Journal proceedings, Vol.51, 1975.

[10] M.D. Cohen, A. Bentur, "Durability of Portland Cement, silica fume pastes in magnesium sulfate and sodium sulfate solutions", ACI Material Journal, Vol. 85, 1988, pp. 148-157.

[11] R.S. Gollop, H.F.W. Taylor, "Micro structural and micro analytical studies of sulfate attack: I. Ordinary Portland cement paste", Cement and Concrete Research 22, 1992, pp. 1027.

[12] J. W. Wang, "Sulfate attack on hardened cement paste", Cement and Concrete Research 24, 1994, pp. 735.

[13] P.K. Mehta, "Magnesium sulfate attack on Portland cement concrete another look", Cement and Concrete Research 13, 1983, pp. 401.

[14] P.J. Tikalsky, R.L. Carrasquillo, "Influence of fly ash on the sulfate resistance of concrete", ACI Structural Journal, Vol. 89, 1992, pp.69.

[15] K. Torii, M. Kawamura, "Effects of fly ash and silica fume on the resistance of mortar to sulfuric acid and sulfate attack", Cement and Concrete Research 25, 1995, pp. 759-768.

[16] N. Smaouia, M. A. Bérubé, B. Fournierc, B. Bissonnetted and B. Durand, Effects of alkali addition on the mechanical properties and durability of concrete", Cement and Concrete Research, vol. 35, ISSUE 2, February 2005, pp. 203-212.

[17] Saeed Ahmad, Attaullah Shah and Karamet Ali, " Effect of water reducing concrete admixtures on the properties of concrete ", 29th Conference on our world in concrete and structures, Singapore, 25-26 August 2004.

[18] Hegerovitsh, M.E., soloviev, V.E., and Tomashpolske, A.D., "Complex admixture for concrete mixes", A.C. No. 769212, USSR, Pub in B.E., No. 2, 1981.

[19] Batrakov V.G., Falekman V.R., and Venogradof U.M., "Perspective of producing and using admixtures for concrete and reinforced concrete", Journal of concrete and Reinforced concrete, No., 4, Moscow, 1989.

[20] Rashwan, M.M., "Improvement of the properties of concrete with hydrophopizing admixtures in hot and dry weathering conditions", Ph.D. thesis Eng – Akad. Alma-Ata, 1995.

[21] 16.Rashwan, M.M., "Study of the possibility of producing new complex hydrophobizing admixtures for improvement of the cement materials properties ", Bulletin of the faculty of Engineering, Assiut University Vol .24, No.2, July 1996.

[22] Mahmoud, H.A., Rashwan, M.M., Aly, G.A., and Abu El-fadel, M.M., "Effect of using complex non-traditional admixtures on the mechanical properties of cement mortar" 8th International Exhibition & Conference for Building & Constructions, Cairo, Egypt, June 2001.

[23] Mahmoud, H.A., Rashwan, M.M., Aly, G.A., and Abu El-fadel, M.M.," Durability of cement mortar affected by complex non-traditional admixtures", Journal of Engineering Sciences, Assiut University, Vol. 30, No. 3, pp. 631-645, July 2002.
[24] B.S. 476 : Part 1:1953

تأثير إضافة محلية إقتصادية مقترحة علي خواص المونة الأسمنتية المعرضة لظروف بيئية

ملخص:

باتت الحاجة ماسة وضرورية لحماية العناصر الخرسانية باستخدام المونة الأسمنتية فأصبح من الواجب أستخدام إضافات فعالة واقتصادية والتي تتعرض بدورها لظروف بيئية قاسية مثل التعرض لدرجة حرارة عالية.

إن استخدام مخلفات من المنتجات الثانوية لبعض المصانع في تكنولوجيا إنتاج وتصنيع إضافات كيميائية ملدنة ومحسنة لخواص المونة الأسمنتية يمثل دراسة علمية وعملية شيقة خاصة من الناحية الاقتصادية والبيئية.

ولهذا فإن الغرض الرئيسي من هذا البحث هو عمل دراسة معملية لإمكانية إنتاج وتصنيع إضافات اقتصادية وفعالة وذلك من مخلفات مصانع تكرير البترول ومصانع فحم الكوك ومصانع السبائك الحديدية. ثم دراسة ميكانيكية تأثير الجرعة المثلي لهذه الإضافات علي خواص المونة الأسمنتية المصنعة بهذه الإضافة والمعرضة لظروف بيئية قاسية مثل التعرض لدرجة حرارة عالية.

إن المتغيرات الرئيسية التي تمت دراستها في هذا البحث علي عدد 252 عينة من المكعبات المونة الأسمنتية القياسية مقاس 7.06 × 7.06 × 7.06 سم هي:

1. ثلاثة حالات مختلفة من إستخدام الإضافات :
   - بدون إضافات كعينة للتحكم والمقارنة.
   - باستخدام نوعين إضافة ملدنة معروفة بالسوق المصري (نوع Sedrete Wp ونوع Plastmix wp) كعينات للتحكم والمقارنة.
   - باستخدام الإضافة المقترحة من مخلفات المصانع (نوع BM2010) .
2. تم عمل الإختبارات بعد 3 يوم و بعد 7 يوم من المعالجة بماء الشرب.
3. تم عمل الإختبار بعد التجفيف بفرن درجة حرارته 100 درجة مئوية

لقد أوضحت نتائج الإختبارات المعملية أنه قد تم بنجاح تحضير إضافة جديدة من مخلفات مصانع تكرير البترول ومصانع فحم الكوك ومصانع السبائك الحديدية وأن ميكانيكية تأثير هذه الإضافة بجرعتها المثلي علي عينات المونة المتصلبة في ظروف بيئية قاسية وبينت أن مقاومة الضغط للعينات المختبرة تتأثر بوضوح بالإضافة المقترحة و درجة الحرارة المحيطة بها كما يلي :

❖ الجرعة المثلى من الإضافة المُقترحة التي تحقق أقصى مقاومة للضغط و أدنى قيم لنسبة الإمتصاصِ للماءِ هيَ 0.9 % مِنْ وزنِ الإسمنتِ. مقاومة الضغط لعينات المونة المحتوية على الإضافة المقترحة (نوع BM2010) بعد عمر 7 يوم من التصلب بمياه الشرب زادت بنسة 55 % مقارنة بالعينات التي تم إعدادها بدون إضافات. لكن مقاومة الضغط زادَت

حوالي 19 %14,% مقارنة بالعينات التي تم إعدادها باستخدام إضافات (Sedrete wp، Plastmix wp) على التوالي .

- ❖ مقاومة الضغط لعينات المونة المحتوية على الإضافة المقترحة (نوع BM2010) بعد التعرض لدرجةِ حرارة مرتفعةِ 100درجة مئوية زادَت بنسبة 14 % مقارنة بالعينات التي تم إعدادها بدون إضافات والمعرضة لنفس الظروف.
- ❖ نسبة إمتصاص الماء لعينات المونة المحتوية على الإضافة المقترحة (نوع BM2010) تناقصة بنسة 41 % مقارنة بالعينات التي تم إعدادها بدون إضافات. لكن نسبة إمتصاص الماء تناقصت حوالي 23 %100,% مقارنة بالعينات التي تم إعدادها باستخدام الإضافات المعرفة محليا (Sedrete wp، Plastmix wp) على التوالي .
- ❖ عينات المونة الأسمنتية التي تم إعدادها باستخدام الإضافات المعرفة محليا (Sedrete wp، Plastmix wp) المحتوية على جرعة إضافة أعلى من 0,7 % حدث لها إنهيار وزوبان بماء المعالجة أما عينات المونة المحتوية على جرعة الإضافة المقترحة (نوع BM2010) حتى 1,4 % لم يحدث لها هذا الأنهيار .