Effect Of Melted Clay Brick Powder (MCBP) On Compressive Strength and Drying Shrinkage Cracks of Cement Mortar.

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Abstract

This investigation is conducted to study the effect of addition of melted Brick clay powder (MCBP) on drying shrinkage cracks and compressive strength of cement mortar. Steel moulds having a trapezoidal section, and the end restrained at square shape used to study restrained drying shrinkage of cement mortar. Specimens of compressive strength , density , were cast. The admixture (MCBP) was used with three levels of (2% , 4% , and 8%) by weight of cement. All specimens were cured (7 days). The experimental results illustrate that the adding of this admixture cause a delay in a formation of cracks producted from a drying shrinkage, increase compressive strength at levels of (2%) and (4 %) of admixture , and decrease the density. The increment of compressive strength at level (2%) was about (4.28%) , but at level of (8 %) it was decreased about of (2.62%). The admixture has the clear opposite effect in delay of the information of shrinkage cracks and decrease of numbers.

الخلاصة:

هذه الدراسة تهدف الى دراسة تأثير اضافة (مسحوق الطابوق الطيني المنصهر) على تشققات الجفاف ومقاومة الانضغاط المونة السمنت ، في هذه الدراسة ثم استخدام قوالب حديدية بمقطع على شكل شبه منحرف بطول 2.5 متر ومن نهايتيه قالب بشكل مربع لغرض تقييد النموذج لضمان حدوث (تشققات إنكماش الجفاف) لمونة السمنت وأيضاً تم صب نماذج لغرض تعيين مقاومة الانضغاط والكثافة. استخدمت ثلاث نسب مئوية من مسحوق الطابوق الطيني المنصهر) وهي (% 8 , 4% , 2%) من الوزن الجاف للسمنت تم انضاج النماذج جميعاً بفترة انضاج (7ايام).

أوضحت النتائج العملية أن إضافة هذا المضاف يؤخر حدوث التشققات الناتجة من (إنكماش الجفاف) وتزيد من مقاومة الانضغاط عند النسب (4%, 2%) وتقلل الكثافة وان مقدار الزيادة في مقاومة الانضغاط عند النسبة (2%) هي (4.28 %) ,ولكنها تقلل من مقاومة الانضغاط عند النسبة (8%) بمقدار (2.62%) ولها تأثير أيجابي واضح في تأخير حدوث(تشققات الانكماش)وتقلل من عددها.

Introduction

The melted clay brick is available material , so this investigation is an attempt to study of using it with cement mortar mix's to known the effects on shrinkage cracks for cement mortor , whereas concrete or cement mortar cracks in drying conditions. High fineness of (MCBP) consider as a pozzalanic materials.

(P., sandor., 1982), usually admixtures are classified according to their major purpose of use , They are used to modify the properties of concrete or mortar and make them more suitable for the work by hand , economy or such other purpose as saving energy. In many istances, very high strength , resistance to freezing and thawing , retarding and accelerating. (Cengiz, 2004), stat that Afsin – Elbistan FA reduced drying shrinkage of the mortar by 40%. Therefore it was concluded that Afsin – Elbistan FA can be used as a shrinkage – reducing agent. (Romild D., and et al., 2005), study free, restrained and dry shrinkage of cement mortar composites reinforced with vegetable fibers. Based on the obtained results on drying shrinkage an equation using the recommendation of ACl mode B3 was adjusted and compared well with the obtained experimental data. (Shakir A.S.,2008), State that a significant increasing in spitting tensile, strength with using polypropylene fibers for cement morter containing crushed brick as aggregate, although, a considerable reduction in using high rang water redusing admixture. All mixes show acceptable values for thermal insulation with regards to (AC1 213- 87)Thermal insulation recommendation. (A.Naceria, et al. 2009.) showed that the quantity of pozzalanic

admixture (wast brick) of cement manufactured is the principal parameter who influences on the variation of the physic-chemical properties of the cement tested.

Experimental Works

Materials

Cement:

Ordinary portland cement from Al-kouffa cement factory used for cement mortar mixes. This cement conformed to the Iraqi specification (IOS NO 5-1984). The physical and chemical properties are given in table (3.1) and (3.2).

Table (3. 1) : Physical Properties of the OPC used

Physical properties	Test Result	I.O.S.NO5: 1984
Finercss, blain test m^2 /kg	334	$\geq$ 230
Sitting time , Vicat's method Initial hrs:min Final hrs: min	 1: 39 2: 45	 $\geq$ 00:45 $\leq$ 10: 00
Compressive strength of 70 mm Cube (MPa) 3day 7day	 16.8 27	 $\geq$15 $\geq$23
Soundness % (Auto clave) method	0.5	$\leq$ 0.8

Table (3.2) Chemical Properties of OPC Used

Oxide	(%)	I.O.S. NO5: 1984
CaO	70.0	–
SIO2	21.0	–
Al_3O_3	5.5	–
Fe_2O_3	3.36	–
MgO	3.75	$\leq$ 5%
SO_3	2.63	$\leq$ 2.8%
L.S.F	0.87	0.66 – 1.02
L.O.I	1.86	$\leq$ 4%
I.R	0.97	$\leq$ 1.5 %
Compound Composition	(%)	I.O.S. NO5: 1984
C_3S	38.0	–
C_2S	31.8	–
C_3A	9.05	–
C_4AF	10.30	–

Fine Aggregate:

Natural sand form Al- Akhaidur used. It is grading and other characteristics conformed to the Iraqi specification (IOS NO45- 1984) as shown in table (3-3).

Table (3.3) : Properties of the sand used

Sieve size (mm)	Percent passing (%)	(I.O.S.NO45 , 1984)
9.5	100	100
4.75	100	90-100
2.36	97	85-100
1.18	79	75-100
0.6	58	60-74
0.3	13	12-40
0.15	5	1-10
Impurities content	1.9	$\leq$3
Sulphate content SO_3	0.08	$\leq$ 0.05

Admixture :

The admixture (melted clay brick powder (MCBB) was brought form Al – Furat Brick Plant in Hilla. This dust was producted from the crushing and softening of crushed high burnt clay bricks, this dust is yellowish- brown in color.

Moulds:

The moulds used in this study are as follows:

1. Channel shape steel moulds having a Trapezoidal section, (2500) mm in length, dimension of section (80 , 50, 60) mm (top base , bottom base , height) respectively. This frame used to study shrinkage cracking of end – restrained cement mortor specimens.
2. (50 * 50 * 50) mm cube steel moulds of cement mortar specimens for compressive strength test. For the Trapezoidal section steel mould , a layer of polyethylene sheets was put over the mould base after cleaned and carefully oiled to minimize base friction with shrinkage specimens of cement mortor.

Curing :

Wett hassian sheet and polyethylene sheets were used to cover the surface of shrinkage specimens after casting to prevent plastic shrinkage cracking due to rapid evaporation from the upper surface of specimens. The chosen period of curing time is (7 days). Compressive strength specimens put in water at (22^{o}C) for (7 days) after covered with polyethylene sheets.

Testing:

Drying shrinkage Test:

Cement mortor specimens were tested for restrained shrinkage cracking. The end of the mould offers an end- restraint to the web which would be formed as result of the stresses induced from concrete shrinkage. Reading were taken at the occurrence of crack , till when no movement could be recorded. The reading for the crack width were taken in each (7 days) by a crack dial microscope. Results average for two specimens for each mix were taken.

Compressive strength Test:

This test was done according to (BSI: 1881 : part 4) . The specimens tested after taken out from water tank. Their surfaces dried of the axcess water and kept in the laboratory for a few minutes to obtain saturated dry surface specimens. Average for three results were taken for each mix.

Results and Discussion

Shrinkage Cracks test:

From Table (4.1) and Figures (4.1) (4.2) (4.3) and (4.4) it can be seen that the effect of admixture on drying shrinkage cracking was different depending on the admixture content.

The measurement of crack width for all specimens was achieved by portable dialed microscope every (7 days) at early ages and every (12 days) at later ages. The first crack time for each specimen was recorded to evaluate the improvement in cement mortar shrinkage cracking. A clear influence in craking time was caused for admixture at level (8%) compared with control specimence , (AL- Khalaf, 1983) state that, cracking time increase when admixture are used but in other side these admixture have a property they have a high surfactant effect , forming air voids in concrete during the mixing process , and thus the concrete strength is reduced. (Al-Nassar, 2002) Generally, the crack width development is slower with age progress

when admixtures were added compared with control mix. This can be considered as an advantage reflection of using some admixture , as reducing crack width is very important from durability point of view. From the table (4.1) and figures4(1,2,3) it can be seen that the specimens with admixture are delay of occurrence of crack and decreased of Its width. Espically at level of (8 %) for the admixture content. (Al-Rawi , 1985) The position of crack occurred within the middle third of cement mortor specimen rather than at the side thirds . This means that the higher restrained shrinkage strain is at the middle of the specimen rater than at the sides. This behavior is attributed to the growth of a strain gradient at the end which increases the restraint loss and reduces the possibility of cracking , while at interior , higher strain would be developed due to the build up of friction forces and the absence of strain gradient , so cracks would be expected to initiate at the interior regions of member.

Table (4.1) Crack development of crack width for cement mortor specimens made with and without of admixture (MCBP) at drying period (140 days) .

Control Specimement (CMO)	Drying period (days)	7	14	21	28	40	52	64	76	100	140
	Crack width (mm)	0.28	0.41	0.51	0.60	0.64	0.659	0,664	0.668	0.668	0.668

Specimement with admixture contain (2%)(CM2)	Drying period (days)	10	17	24	31	43	55	67	79	100	140
	Crack width (mm)	0.27	0.44	0.56	0.63	0.65	0.659	0.66	0.665	0.665	0.665

Specimement with admixture containt (4%)(CM4)	Drying period (days)	35	42	49	56	68	80	92	100	140
	Crack width (mm)	0.27	0.40	0.51	0.62	0.65	0.658	0.659	0.661	0.661

Specimement with admixture containt (8%)(CM8)	Drying period (days)	81	88	95	102	114	140
	Crack width (mm)	0.21	0.31	0.38	0.395	0.397	0.396

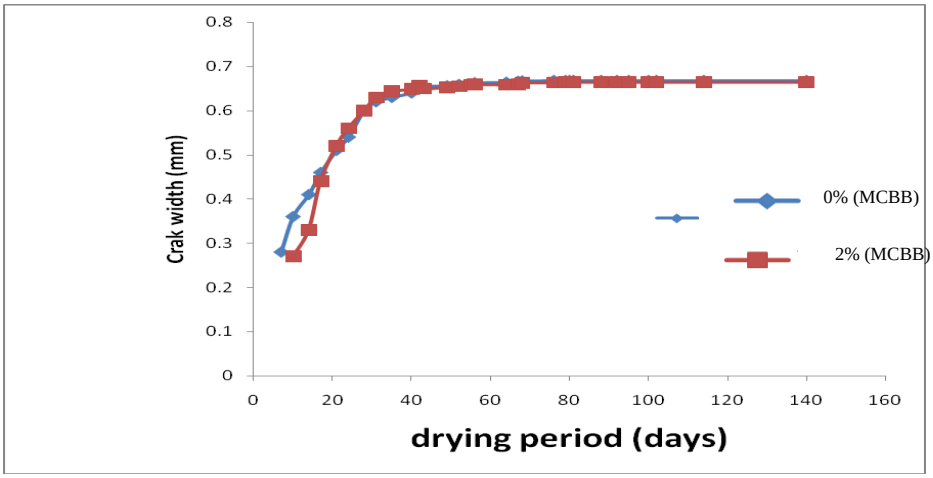

Fig.(4.1) : Crack width development for speciemence with admixture (MCBP) at level (2%)

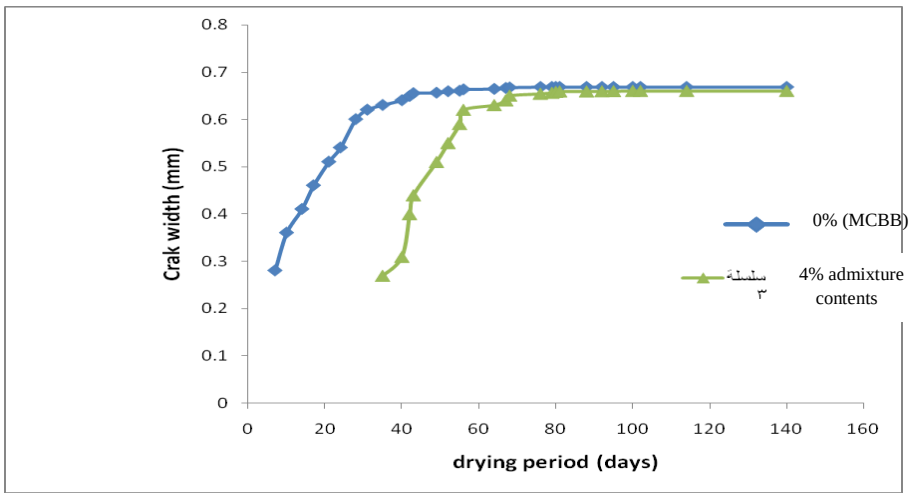

Fig.(4.2) : Crack width development for speciemence with admixture (MCBP) at level (4%)

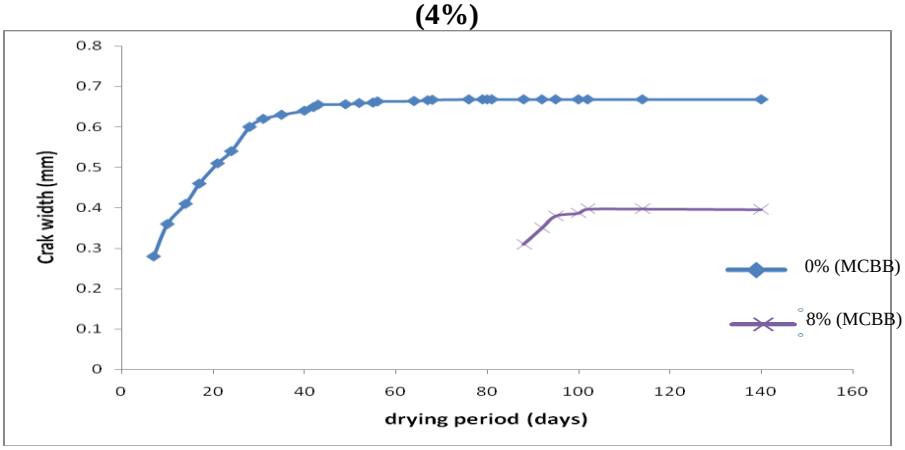

Fig.(4.3) : Crack width development with admixture (MCBP) at level (8%)

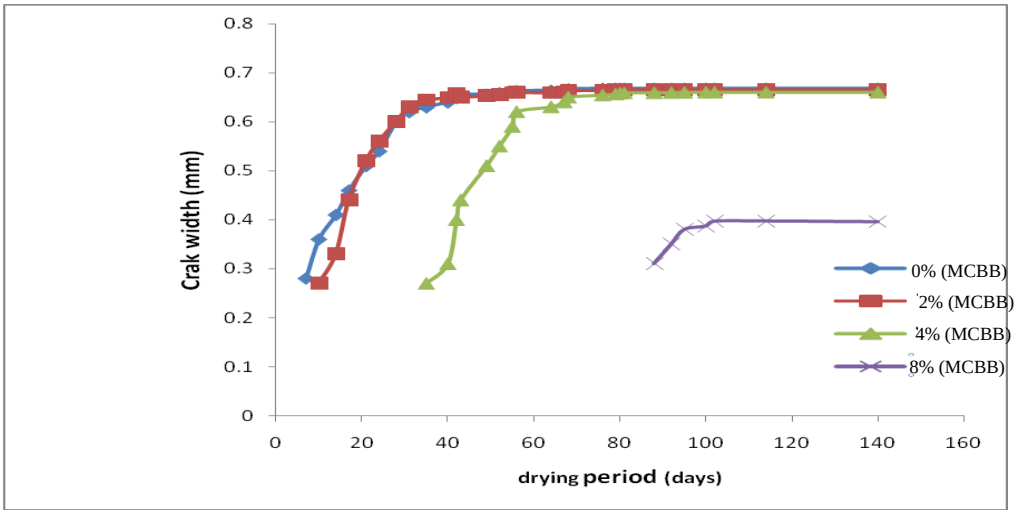

Fig.(4.4) : Crack width development for specimennt with and without admixture contents (MCBP)

Compressive Strength Test.

The results of the compressive strength of specimens with and without admixtures are given in table (4.2) and fig. (4.5). Results illustrate that the increase of admixture (MCBB) addition increases the compressive strength except at level (8 %) , There was a reduction of about (2.62 %). The increasing in compressive strength at level (2%) admixture content was about of (4.28%). (AL-Khalaf,1983), The reduction of water powder ratio (W/P) can be attributed of the increasing of compressive strength , that due to to absorption of these fine particle to water content , and the effect of their fineness and large surface area, cement mortar density. Especially at early age , and that can be attributed to the accelerated hydration cement paste. The cause of the reduction in compressive strength at level (8%) was due to the high fineness- high absorption of water and the large a mount of this admixture , which leads to lack in hydration action and presence of air voids in cement mortar structure.Table (4.3) and Figure (4.6) showed that, no high obvious influence on the density of specimens .

Table (4.2) Compressive strength test results for the cement mortor specimens made with and without of (MCBP)

Specimen symbol	Admixture content (by weight of cement) %	Compressive strength at a Age (7 days) MPa	change in compressive strength for specimens containing of (MCBB) the compared with control specimen %
CM_0	0	17.5	-
CM_2	2	18.25	+ 4.28
CM_4	4	17.93	+ 2.45
CM_8	8	17.04	- 2.62

Table (4.3) Density test results for the cement mortor specimens made with and without of (MCBP)

Specimen symbol	Admixture content (by weight of cement) %	Compressive strength at a Age (7 days) MPa	change in density for specimens containing of (MCBB) the compared with control specimen %
CM_0	0	2.25	-
CM_2	2	2.241	- 0.40
CM_4	4	2.236	- 0.62
CM_8	8	2.230	- 0.89

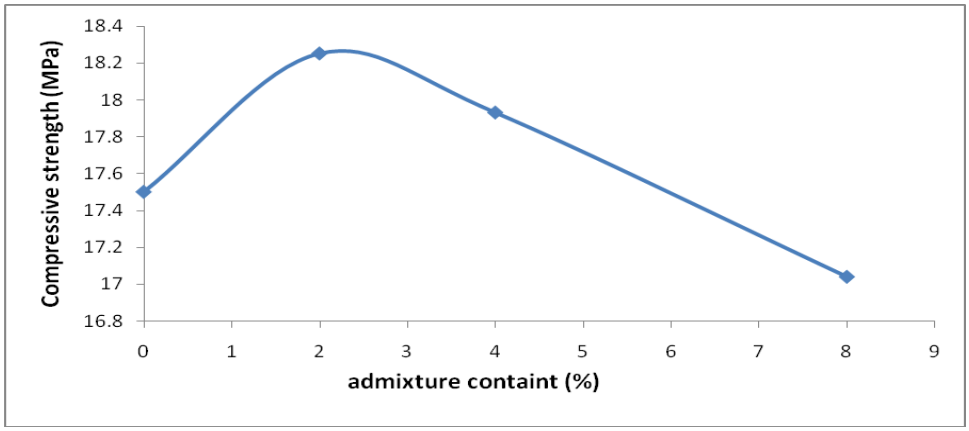

Fig.(4.5) : Effect of admixture contents (MCBP) on compressives strength of cement mortar specimens

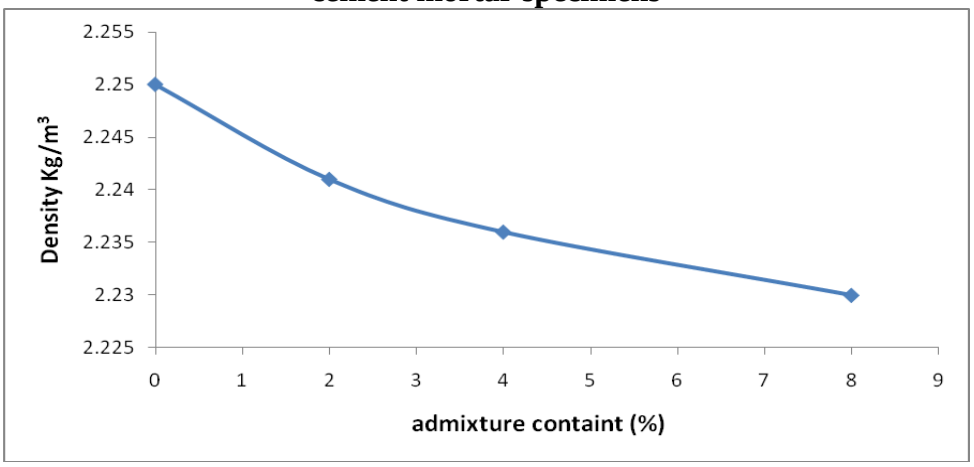

Fig.(4.6) : Effect of admixture contents (MCBP) on density of cement mortar specimens

Conclusions

1. The drying shrinkage cracking development of cement mortar is attacted by amount of (MCBP).
2. For all cement mortar specimens containing different contents of (MCBP) , First crack width is lower than of the control specimens .
3. The cracking time increases with increase of the (MCBP) content epically at highest admixture content .

4. The development of crack width for specimens with (MCBP) is lower that of control specimen.
5. Adding of (MCBP) content increase of compressive strength , but a high contents for (MCBP) decreased it.
6. The addition of (MCBP) for cement mortar specimen is delayed of occurrence of cracking
7. No obvious effect on cement mortor specimens density when the (MCBP) admixture was added at any quantity.

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