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Management the Use of Cement Dust to Improve the Quality of Concrete Mixtures

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Abstract— Cement manufacturing is a critically important industry in Iraq and throughout the world. These industrial by-product and waste materials must be managed responsibly to achieve two aims; the first is reduction the cost of cement product in addition to the cost of construction building, the second aim is insuring a clean and safe environment.

Cement kiln dust (CKD) is a significant by-product material of the cement manufacturing process. Over the past several years dramatic advances have been achieved in the management and use of cement kiln dust, thus reducing its dependency on landfill disposal.

This paper study physical and mechanical properties of cement mortar and concerts which produced by replacing the CKD instead of cement. So an experimental tests and practical applications have been carried out mix contains different percent (10, 20, 30, 40%) of CKD. The experimental results shows that a concrete mix with acceptable compressive strength based on Iraqi standard specifications (ISS) can be obtained by mixing 30% of CKD with cement. While the practical applications results show that (cement and CKD mortar have shrinkage less than the cement mortar, and cement plaster with free cracks obtained by mixing 20% of CKD with cement.

Keywords—Cement Kiln Dust (CKD), Compressive Strength, Iraqi Standard Specifications (ISS).

I. INTRODUCTION

It is well known that the disposing of industrial wastes is one of the major worldwide environmental problems. Furthermore, as a consequence of environmental and financial considerations, there is a growing demand for wastes to be re-used or recycled. and one of these wastes materials is CKD which considered as a byproduct of cement production. So the researchers try to availing from CKD through use of it as additive materials to improve the following mechanical and physical properties of concrete, and cement mortar;

Physical properties include [2]:

- Shrinkage,
- Cracks,
- Setting time, and
- Slump.

Mechanical properties include:

- Bonding strength,
- Compressive strength, and
- Flexural strength.

II. THE MAIN ADVANTAGES OF STUDYING THE USE OF CEMENT KILLEN DUST

Large quantity of cement kiln dust CKD is produced during cement production. CKD is a fine powdery material similar in appearance to Portland cement. The principal constituents of CKD are compounds of lime, silica, and alumina, and iron. The physical and chemical characteristics of CKD depend on the raw materials used and the method of its collection employed at a particular cement plant [6]. The primary related air pollution of cement is dust and the landfill areas, so it's make risk on (people, animals and plants) [3]. In addition to the environmental CKD problems, there are financial problems, due to the cost of storage, CKD as industrial wastage, but recently it is emphasized for its application, because a considerable amount of energy has been to be paid for its preparation, calcinations and so discarding it, bring out wastage of energy and cost. On the other hand, due to consideration of high volume of the collected dust, a lot of costs were allocated by collection and destroying it, due to have some special chemical compound which, has adverse environmental effects [1]. Thus this study aims to achieve the following:

1. Economical advantage, by reducing the quantity of cement use, in addition to reduce the cost of storage and disposing CKD in the land filled by replacing the CKD instead of

Cement in the pre casting construction members such as, concrete bricks, tiles, and columns which did not require low sitting time such as that casting in site. Thus these construction members can be used in rural building and building with low cost.

2. Maintain the environment from the pollution of disposing large quantities of CKD.

3. Improve some of mechanical and physical properties of concrete and cement mortars.

4. Reduces the need for limestone and other raw materials, and thus saves natural resources and helps conserve energy.

III. Experimental Work

The materials used in this composite are consists of Cement, CKD, Aggregate, Water, and Sand. The experimental work includes:

1. Chemical composition for cement that use in this study according to the Iraqi standard specification (ISS) NO.7,while the comparison carried out according to ISS No.5 as shown in table (I) .

2. Chemical composition for CKD according to ISS No.7 as shown in table (II).

3. CKD graded test to determine its particles size, the range was (106-150) Mm. as shown in table (III).

4. Preparing many original mixtures to get a suitable mixture in compressive strength and slump. The quantities have been determined to produce 1m³ of concrete as shown in table (IV).

5. Preparing four experimental concrete mixtures by replacing the CKD instead of cement with different ration (10, 20, 30, 40 of CKD as a percent of cement weight. While the quantity of other material (sand, grave) is constant.

TABLE I. Cement Chemical Composition

Constituent	The Result	ISS NO.5
SiO2	21.6	-
Al2O3	4.12	-
Fe2O3	5.58	-
CaO	61.88	-
MgO	3.3	Not more than 5%
C3A	1.5	Not more than 3.5%
SO3	2.1	Not more than 2.5%
Unsoluble materials	0.38	Not more than 1.5%
Loss on Ignition	0.86	Not more than 4%
Lime Saturation Factor	0.876	(0.66-1.02)

TABLE II. CKD Chemical Composition

Constituent	The Result
SiO2	17.05
Al2O3	3.73
Fe2O3	5.27
CaO	52.67
MgO	3.71
C3A	12.25
Lime Saturation Factor	0.978
Loss on Ignition	0.792

TABLE III. CKD Graded Test

Sieve Size	Accumulative Passing Percent
100	0.3
98	0.212
95	0.18
90	0.15
36	0.106
20	0.09
19	0.08
17	0.075
6	0.063
1	0.045

TABLE IV. Material Quantities of Referred Mixture

Cement (Kg/m³)	Sand (Kg/m³)	Gravel (Kg/m³)	Water (l/m³)	Average Compressive Strength in (28 days) (N/mm²)	Slump (cm)
400	675	950	240	25	17

IV. Practical Applications

Practical application included;

1- Making a concrete footing .(100×100×5 cm) included CKD as a percent of cement weigh , then after treatment and setting operation it subjected to pass people where it was good in the bearing strength.

2- Making a mortar (1 cement: 3 sand) with suitable amount of water for suitable workability of mortar is suitable in bonding and finishing bricks wall. So

many mortar mixtures have been made with different percent of CKD (10,20,30,40%) for the following application ;

a- Finishing a brick wall to observe the cracks may be occurring.

b- Preparing prism mold (4, 4, and 16 cm) to measure the flexural strength in 7days age.

c- Preparing prism mold (2.5, 2.5, and 25 cm) to measure the shrinkage in 7days age.

d- Bonding two bricks in crusader form by cement mortar contain CKD to measure the bonding strength in 14days age.

After comparing the result of the above four applications the optimum percent of CKD is 20% for better result.

V. THE RESULTS

The results of experimental work are:

1- The cement used in this study is Resistance Sulphate Portland cement, and it is correspondent to ISS NO.5, while the comparison between the chemical composition of cement (table I) and CKD (table II) illustrates a reduction in the percent of (Fe2O,CaO, C3A, and lime saturation factor) so that's lead to decrease the bearing strength of concrete. In return, this causes increasing the expansion and decreasing the shrinkage.

2- The particle size of CKD is very fine as shown in table (III) which represents the result of sieving CKD. The fine particles lead to increase the surface area of concrete mixture, in return that causes increasing water amount required to reach to the same slump of referred a concrete mixture.

3- The compressive strength (Б)of experimental concrete mixture have been increased as the percent of CKD are increased until (30%), while more that percent the compressive strength are decreased as shown in table (V) and figure (1, 2, 3, 4, and5).

4- Decreasing the slump value (€) as CKD percent is increased due to increase the surface area of mixture as shown in table (V).

5- Concrete density (ɣ) decreased as CKD percent increased in return the dead load will decrease.

6- The setting time (T) , the initial (IT) to final time (FT) are decreased as CKD percent increased, although the quantity of SO3 increased as illustrated in table (II), which caused increased the sitting time. The decreasing in sitting time occurs due to decrease the slump.

TABLE V. THE RESULT OF REFERRED AND EXPERIMENTAL TEST

CKD (%)	Б (N/mm²) Days			€ (cm)	ɣ (gm/cm³)	T(Hr:min)	
	7	28	56			IT	FT
0	20	26	32	17	2.46	5:00	14:00
	17	24	28				
	17	25	30				
	18	25	30				
10	14	19	25	16	2.44	4:15	13:00
	12	18	21				
	13	20	23				
	13	19	23				
20	11	22	27	15	2.43	3:30	11:30
	11	18	24				
	8	20	24				
	10	20	25				
30	8	25	28	14	2.42	2:00	10:15
	9	21	31				
	7	20	28				
	8	22	29				
40	7	10	19	13	2.40	1:15	8:30
	5	13	21				
	6	13	20				
	6	12	20				

While the practical application illustrated the following:

1- Very little cracks occur in the cement plaster contain CKD that used as a finishing coat for bricks wall.

2- The bonding strength less than its value of referred mixture by 30%.

3- The flexural strength of cement mortar contained CKD less than its value of referred mortar by 20%.

4- The shrinkage less than its value of referred mortar by 40%.

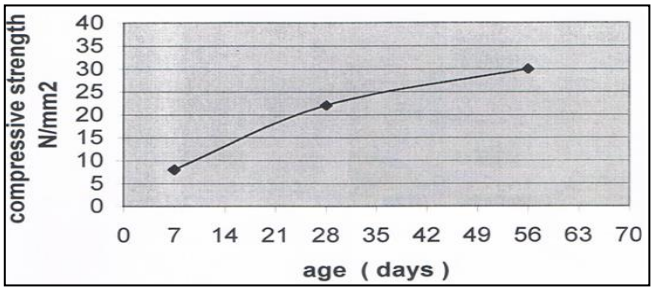

Fig. 1. *Compressive Strength for Concrete Contain 10% of CKD*

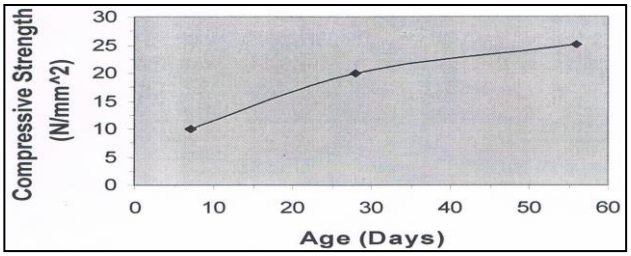

Fig. 2. *Compressive Strength for Concrete Contain 20% of CKD*

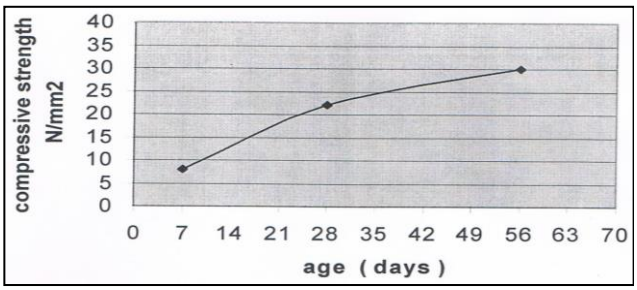

Fig. 3. *Compressive Strength for Concrete Contain 30% of CKD*

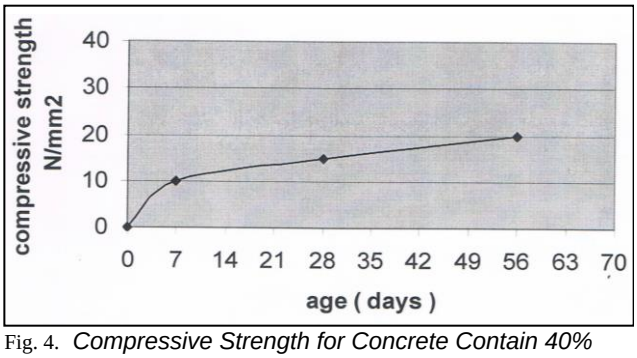

Fig. 4. *Compressive Strength for Concrete Contain 40% of CKD*

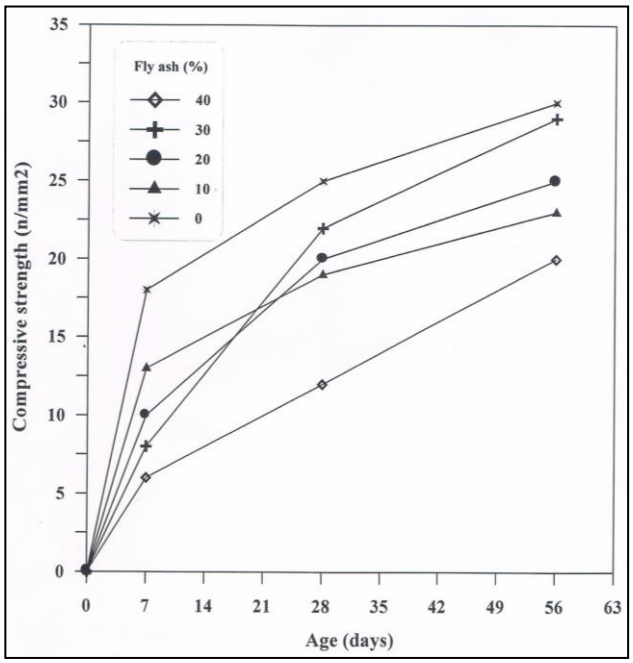

Fig. 5. *Compressive Strength for Referred Concrete Mixture and Four Experimental Mixture*

VI. CONCLUSION AND RECOMMENDATIONS

1. CKD can be used in 30% as a percent of cement weight to obtain a concrete mixture with acceptable compressive strength.

2. CKD can be used in producing pre casting concrete unite, which can be remained longer in treatment stage before marketing and using such as concrete bricks and tiles.

3. CKD can be used with 20% percent in cement mortar, and plasters then use it for bonding and finishing bricks wall.

4. The specific gravity of concrete contains CKD less than the specific gravity of concrete free of CKD therefore the dead load will decrease. So concrete with CKD can be used in building required light weight like multi story building

VII. FURTHER STUDIES

1. Further study to CKD, and its influenced on concrete resistance to bases and acids.

2. Study the permeability, water absorption, durability of concrete contains CKD.

3. Study the influence between reinforcement steel and CKD in concrete.

REFERENCES

[1] F. Mohsenzadeh , J. Nouri, A. Ranjbar, M. Mohammadian Fazli, and A. A. Babaie, " Air Pollution Control Through Kiln Recycling by-Pass Dust in a Cement Factory", Journal of Environmental Health Sciences,Engineering, Iran, Vol. 3, No. 1, pp. 5-8, 2006.

[2] Moaied N. ALkhalaf, Hana'a A. Yousuf "Concrete Technology", University of Technology, Iraq, 1984.

[3] Mohamed H. Ghazaly, Mohammednoor N. Almaghrabi, and Ebrahiem E. Ebrahiem " A Study on The Reuse of Cement Kilen Dust in The Production of Cement Concrets", Minia Journal of Engineering and Technology, (MJET), KSA, Vol. 31, No 2, pp. 63-68, 2012.

[4] The Iraqi standard specification NO.5, 2015

[5] The Iraqi standard specification NO.7, 2015.

[6] Tarun R. Naik, Fethullah Canpolat, and Yoon-moon Chun, "Uses of CKD Other Than for Flue Gas Desulfurization" Report No. CBU-2003-35, University of Wisconsin _Milwaukee, USA, pp. 1-33, 2003.