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Influence of Treatment Tarot Kaolin by Thermal Method on Hard and Fresh Properties of Cement Mortar

Mohamed A Aboubakar, Eshmaiel Ganjian, Homayoon Pouya, A M Akash, H M Abdussalam

Abstract :-In the last year at Libya the cost of the cement going up and lack has impacted unenthusiastically on the delivery of reasonably priced accommodation and infrastructural growth, for solve this problem we looking for new material for replacement with cement. This paper investigated the use of natural clay (kaolin) from Tarout town in south Libya, after treatment by thermal method, as partial replacement of Portland cement in the production of concrete. By The Scanning Electron Microscope (SEM) imaging and particle size distributions (PSD) to understand the mechanism of pozzolanic improvement of the Libya clay after treatment by thermal method (calcined at 800 OC for 2 hour).The Mortar mixes cubes measuring 50mm x 50mm x 50mm were made by using treated Tarout natural clay to replace 0%, 10%, 15%, and 20% of Portland cement by mass. The workability of the fresh cement mortar mixes were evaluated using the slump test ,while compressive strengths of cement mortar cubes were evaluated at 3, 7 and 28 days. The maximum compressive strength at all ages of testing was obtained at 10% replacement, corresponding to an increase of 11% compared to 28-day compressive strengths. The result show Workability decreased with an increase in replacement percentage. Pozzolan can be used to partially replace ordinary Portland cement in the production of concrete without compromising strength.

Keywords: thermal treatment, pozzolan, mortar, compressive strength, slump.

I. INTRODUCTION

Cement or selected form of cementing material is an essential ingredient of building materials. Cement is the vital binding agent in concretes and mortars. Since its invention in the first half of the 19th century, Concrete is the world's greatest utilized building material [1]. The want for infrastructural advance in both the developing and developed the world's has placed a Despite the advantages of concrete as a construction material, the making of cement comes at a great cost to the environment [1, 2, 3, and 4].

Unlimited demand on ordinary Portland cement (OPC), traditionally, the main binder in the manufacture of concrete

In view of environmental and sustainability concerns associated with the production of cement, the use of Pozzolan to replace part of Portland cement is receiving a lot of attention.

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A.PhD student in Civil, Architecture and Building Department, Coventry University UK.

B.Reader In Civil Engineering Materials, Department of Civil, Architecture and Building, Faculty of Engineering & Computing, Coventry University.

C.Research Fellow, Department of Civil, Architecture and Building, Faculty of Engineering & Computing, Coventry University.

D.Professor at Civil Engineering Department Sebha University Libya.

E. Research Department of Civil Engineering, Sebha University, Libya.

Substituting Portland clinker either partially or entirely is also being examined as an alternative to carbon dioxide emissions [2]. More than 70% of Portland cement can be substituted by using materials such as primarily silica fume fly ash, natural pozzolan, slag and rice-husk ash, and agricultural products ash [5].Artificial pozzolan used in modern commercial cement are derived from fly ash produced by coal burning plants [6].

Pozzolanic materials do not have any cementing properties of their own, but they contain silica and alumina in reactive form Ancient Romans produced excellent cement by mixing pozzolanic materials with lime to build constructions some of which are standing now [6]. Pozzolanic materials chemically react with calcium hydroxide in the presence of water to form compounds possessing cementitious properties [6].

The pozzolanic reactions are silica reactions in the presence of calcium hydroxide and water to produce calcium silicate hydrates(C-S-H) [7, 8].

The partial Additional of ordinary Portland cement by Pozzolan is known to improve the resistance of concrete to sulphates [9].

As additives in modern cements pozzolan improve mechanical strength and provide resistance to physical and chemical weathering [6].

The addition of pozzolan reduces pore sizes and porosity leading to increased strength [10]. Clays and shales after some treatment like heat are also used as pozzolanic materials and show adequate pozzolanic activity of the products.

The aim of the study is to investigate experimentally the effects of partial replacement of OPC with pozzolan on the workability and compressive strength of concrete. This study seeks to contribute to efforts to make use of locally available materials in infrastructural development in line with the Libya Government's objective of using at least 50% of local building materials in government infrastructural projects. This paper investigated, the site use of natural clay (kaolin) from Tarout town in south Libya around Sebha city shown in figure (1)

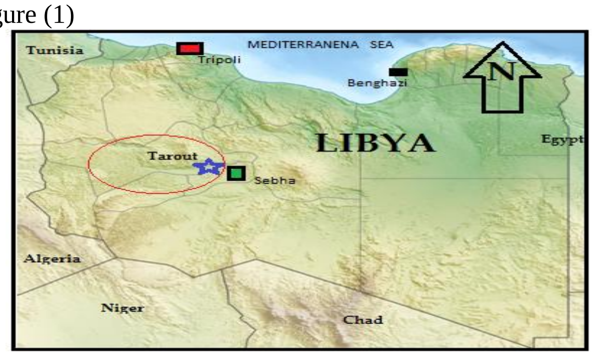


Figure 1 the site Tarout town in south Libya

II. MATERIALS AND METHODS

1-MATERIALS

A- Cement

The cement used was ordinary Portland cement of strength class CEM 52.5 N. The cement conformed to BS 12 and Libya stranded 340/97. [11] Table 1 shows the chemical compositions of cement

Table 1: Chemical composition of Cement CEM-1according BS EN 197-1

Binder	Chemical composition [%]										
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3	LOI
OPC*	19.7	---	4.9	2.4	---	2.1	63.3	0.2	0.6	---	2.7	2.7

(*according to the producer)

B-Natural Clay

Tarout Kaolin The clay soils (kaolin) were collected from the Tarout site in the south of Libya, around Sebha city at northern regions as shown in Table 2 and in Figs. 1 and 2. Most of the experimental work was carried out in laboratory of concrete technology, according to procedures as per BS, ASTM and Libyan standards.

Natural clay as pozzolan we used is of ASTM C618-03 Type N after treated by calcined method. Figure 2 shown shapes and colour and Table 2 shows the chemical compositions of natural clay before and after treated from Tarout site. And the particle size distributions (PSD) show in figure 3, Scanning Electron Microscope (SEM) imaging showed the shape change before and after treatment in figure 4.

All chemical composition before and after calcined clays fully comply with the ASTM C618-03 which represents good pozzolanic materials, as silica, alumina and iron oxide total is greater than 70%.

Table 2: Chemical composition of Tarout Natural clay before treated (A) and after calcined (B) according ASTM C618-03

Oxides	natural clay A	Calcined clay B
SiO_2	54.52	71.88
Al_2O_3	24.89	20.2
Fe_2O_3	2.50	1.84
Total ($SiO_2+Al_2O_3+Fe_2O_3$)	**81.91**	**93.1**
MgO	0.29	0.35
CaO	0.58	0.163
K_2O	1.14	1.06
Na_2O	0.83	0.93
SO_3	0.51	0.319
TiO_2	1.30	0.966
MnO	0.03	0.028
P_2O_5	0.41	0.36
Cr_2O_3	----	----
SrO	0.034	0.036

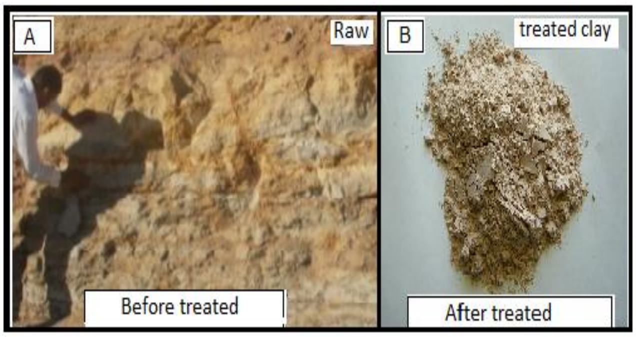


Figure 2 shown shapes and colour the natural clay (kaolin) from Tarout town in south Libya before (A) and after (B) calcined

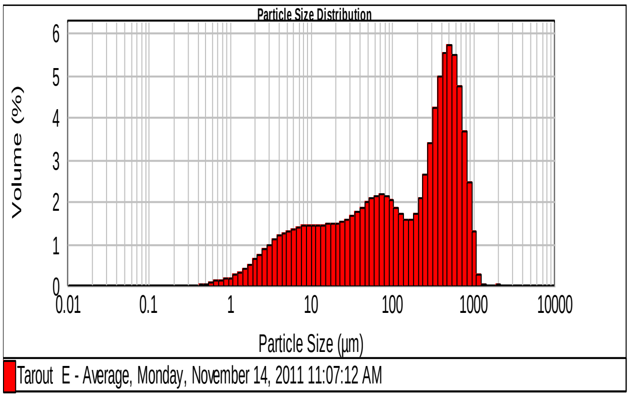


Figure 3 shown particle size of natural clay from Tarout site before treated (A)

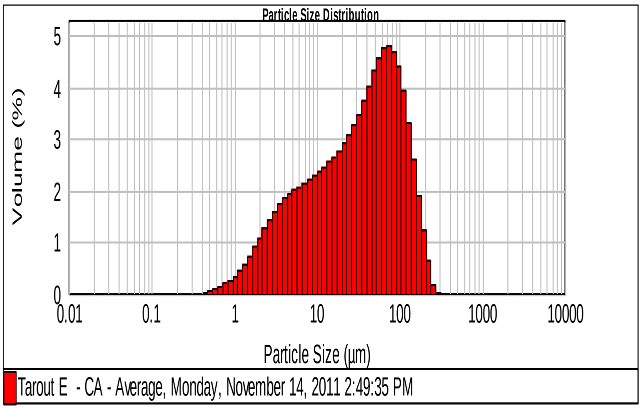
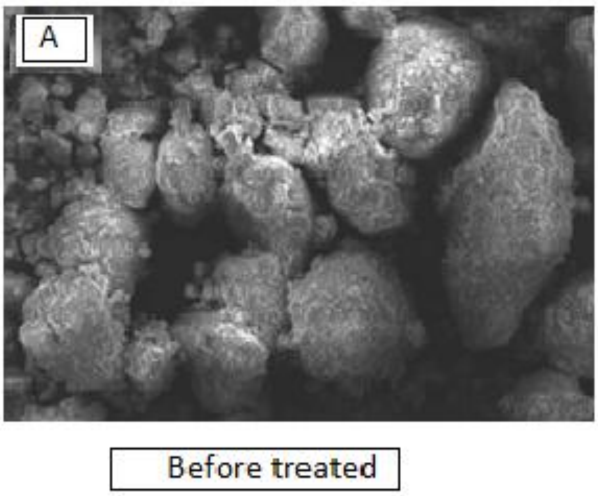


Figure 4 shown particle size of natural clay from Tarout after calcined (B)



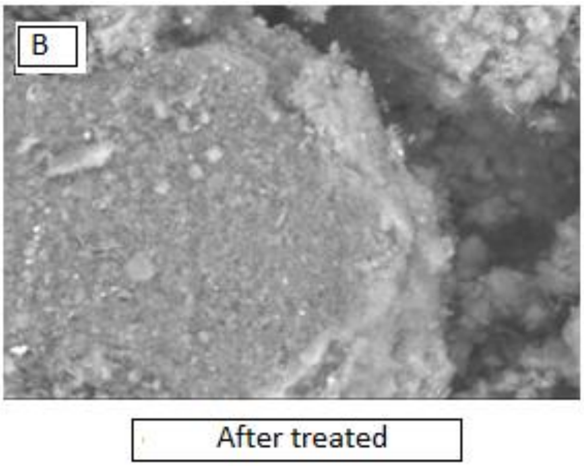


Figure 4 shown Scanning Electron Microscope (SEM) imaging of natural clay (kaolin) from Tarout site before (A) and after (B) treated

C-Sand

Natural river sand with a specific gravity of 2.53 and a bulk density of 1561kgm-3 was used.

D-Water

The water used in mixing looked clean and free from any visible impurities. It conformed to the requirements of [12].

2-METHODS

Four different mixes were used for the study. A control mix of ratio was (1 cement: 3 sand) batched by mass using a water-binder ratio of 0.50

The control mix was produced using OPC only as binder while in other mixes; pozzolan was used to replace 10%, 15%, and 20% of the mass of ordinary cement in the control mix. The details of mix proportions mortars are shown in Table3.

Table3 .cement mortar Concrete mix details

Percentage replacement (%)	Cement(gm.)	Treated natural clay Pozzolan(gm.)	Sand	water
0	450	0	1350	225
10	405	45	1350	225
15	382.5	67.5	1350	225
20	360	90	1350	225

The slump test [13] and compacting factor test [14] were used in assessing the workability's of the fresh mortar concrete mixes. No test measures workability directly, but there are tests that measure properties related to workability. Workability is related to the compatibility, mobility and stability of fresh mortar concrete [15].

A-The cast

Casting of concrete was done in cast iron moulds measuring 50mm × 50mm × 50mm internally. A total of 48 cubes were made The specimens were made in accordance with [16]

B-The curing

After casting, the moulds were covered with plastic sheet to prevent water loss through evaporation. Demoulding was done after 24 hours and the specimens immersed in a curing tank to cure for strength gain. Curing improves both the physical and mechanical properties of concrete.

The compressive strengths were determined by crushing concrete cubes at 3, 7 and 28days of curing using a 1000 KN compression testing machine.

Before crushing, the mortar concrete cubes were removed from the curing tank and placed in open air in the laboratory for about two hours. The results presented are the average of three tests. All tests were conducted at the Materials Laboratory of the Department of Civil Engineering.

III. RESULTS AND DISCUSSION

A-Workability

The results of workability tests are presented in Table 4.

Table 4 Results of workability tests

Workability	Cement Replacement (%)			
Percentage replacement (%)	0	10	15	20
Slump (mm)	19	17	12	10

From the results it can be seen that as the percentage replacement of OPC with pozzolan increases, the workability of cement mortar concrete decreases. Replacing cement by an equal mass of pozzolan causes an increase in volume since the density of cement is higher than that of pozzolan.

This therefore increases the water demand and as the pozzolan content increases the workability reduces since the quantity of water remains the same for all mixes. The results also showed the interrelationship between the results of the compacting factor test and the slump test

B-Compressive strength

The variation of compressive strength of cement mortar concrete is presented in Fig 5. And table 5 It seen that the variation of strength shows similar trends with respect to pozzolan replacement. The results of the compressive strength tests are presented in Table 5 and figure 5

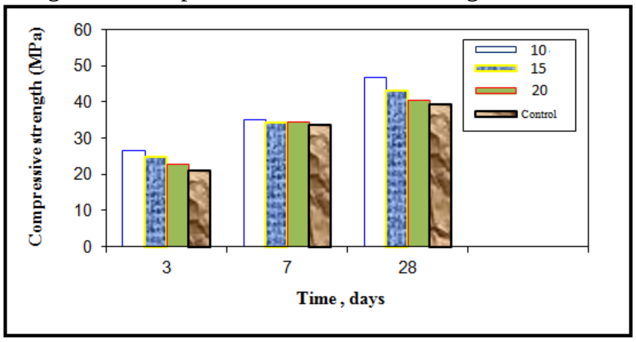


Figure 5. Variation of compressive strength with age

Table 5. Compressive Strength (Nmm^{-2})

Mix	Days	10(%)	15(%)	20(%)
Average strength (MPa)	3	26	23	18
	7	35	33	25
	28	44	42	32

In general, after 3 day curing the compressive strength for

20% replacement reduced from the control mortar concrete but 10% and 15 % replacement after 3 day start increase.

A further rise in replacement increased the compressive strength until a maximum strength was reached at 10% replacement of OPC with treated clay Pozzolan. On further increase, the strength reduced as percentage replacement increased.

Pozzolanic reaction begins immediately after hydration of cement and continues for a long time thereby increasing strength. Concrete attained its maximum strength at a treated clay Pozzolan replacement of 10%**;** corresponding to an increase of 11% in the 28-day strength compared to the control concrete.

Similarly, the 3-day, and 7-day compressive strengths respectively show increases compared to the compressive strength of the control concrete Fig 5.the result show in Fig 6

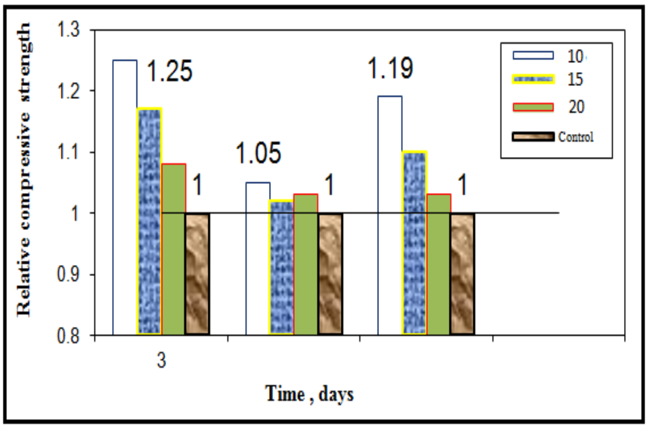


Figure 6. Relative compressive strength of concrete

From Fig 6, it is seen that the average rate of strength growth is constant for the first seven days, after which, the average rate of growth reduces to a constant, but relatively lower rate. The rate of strength gain with respect to time is highest for cement mortar concrete with 10% replacement of OPC by treated natural clay pozzolan.

This is due to optimum reactions which take place at 10% replacement of OPC by pozzolan.

The variation of the relative compressive strength of mortar concrete with is presented in Fig 6. It can be seen that, with the exception of mortar concrete with 10% treated natural clay replacement, as the age increases the strength ratio decreases even though the strength of concrete increases with age. This is due to the rate of increase of the compressive strength of control concrete, which is higher than concrete at all treated natural clay replacement levels with the exception of 10% replacement.

IV. CONCLUSION

At the end of the study, the following conclusions are drawn:

- All chemical composition before and after calcined clays fully comply with the ASTM C618-03 which represents good pozzolanic materials, as silica, alumina and iron oxide total is greater than 70%.
- The result show particle size decreased with increase the surface area and the shape change it is finer after treatment.
- Replacement of cement with natural clay pozzolan significantly increased the strength of mortar concrete.
- Replacement of 10% of the mass of cement with treated clay pozzolan achieved the maximum value of compressive strength.
- The 3day, day, 7-day and 28-day compressive strengths at 10% replacement respectively showed increases compared to the compressive strength of the control concrete at those ages.
- Increase in pozzolan replacement decreased the workability of concrete.

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