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Suitability of Pulverized Burnt Clay/Calcium oxide in Concrete Production

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Abstract:**With the increasing building activities in both developed and developing countries, the utilization of supplementary cementing materials will continue to increase in the years to come because of their technical, economical and ecological advantages. One of such pozzolanic materials is pulverized burnt clay (PBC) which has been identified to be a good cement substitute in mortar and concrete mixes. This paper highlights some laboratory test results on the fresh properties and strength characteristics of concrete made with pulverized burnt clay and calcium oxide. Chemical properties as well as consistency limits were tested. Concrete specimens containing 90/10, 80/20, 70/30 and 60/40% PBC/CaO by proportion were made using 150 mm cube mold and tested for compressive strength at 7,14, 21 and 28days. The results of chemical composition show over 70% of combine effect of silicon, iron and aluminum. The consistence and slump performance of the constituent material demonstrated good flow. The compressive strength indicate that up to 21N/mm^2 of concrete can be produce with 70/30% of PBC/CaO at 28days.**

Keywords:*Pulverized Burnt Clay, Calcium Oxide, Consistency, Pozzolan*

1. INTRODCUTION

One of the most influential building materials is cement the high cost of cement in the recent time has led to increase in the price of concrete production and it is almost becoming unaffordable, this calls for the sourcing of alternative binding materials that will be readily available and affordable to reduce the over dependency on cement as binder.

According to Shetty (1999) cement is the backbone for global infrastructural development and it was estimated that global production of cement is about 1:3 billion tones in 1996. Production of every ton of cement emits carbon dioxide (CO_2) to the tune of about 0.87ton, it can therefore be said that 7% of the world's carbon dioxide emission is attribute to cement industry.

However, due to this significant contribution to the environmental pollution and high cost of cement production, there is the need to find a viable replacement that will have little or no negative environmental consequences and cost. One of such practical solutions is to partially or wholly replace the use of cement with industrial or agricultural waste that possesses pozzolanic qualities. This study therefore, focuses on the use of pulverized burnt clay and lime in concrete production.

The term "Pozzolana" is used to describe naturally occurring and artificially silicious or aluminum materials, which in themselves possess little or no cementations value but in finely divided form and in the presence of moisture, chemically react with calcium oxide at ordinary temperature to form compound possessing cementations properties (Neville and Brooks, 1997).

Matawal (2005) and Hassan (2006) highlighted that the application or use or various pozzolanic materials as potential replacement of cement in mortar and concrete production has attracted the attention of researchers in the literary world because of their prospect to decrease or totally eliminate waste materials polluting environment. Additionally, for economy by reducing the quantity and consequently cost of cement applied in concrete works.

Experiment conducted by day (2006) also confirms the calcium oxide deficiencies when he added one quarter of lime to pulverized burnt clay. The pulverized clay behaves like Portland cement pozzolana and lime can be produce with much less sophisticated technology than pozzolana cement, however, it takes two to three times. The volume of pozzolana required to make a concrete with the same strength. The strength normally improves with age since pozzolana reacts somewhat slowly as compared to the Portland cement and at one year, about the same strength is obtained.

The utilization if lime as an admixture has several advantages such as excellent resistance to water penetration, whilst allows vapour penetration, high open porosity high ductility to joint and massive masonry excellent plasticity and hydraulic properties. Thus inherent properties of lime combines very well with pozzolanas such as calcined clay thereby facilitating improved workability improved water retention/reduction bleeding, improved sulphate resistance to alkali aggregate reaction and lower heat of hydration (Magerate 2005)

Nigeria like many developing countries has being facing a number of inter-related problems in the area of housing delivery, the situation has been worsened by the economic depression, allied with low income growth rate, severe shortage of foreign exchange earnings, increased debt repayment burden, rapidly increasing population and increasing cost of building materials, consequently, effort have been made over the past few years to partially substitute cement with locally available materials which are referred to as pozzolanas. It is in this regard that this research work is intended to focus on the utilization pulverized Burnt Brick/lime as a replacement of cement.

2 MATERIALS AND TEST METHOD

2.1 Materials and Mix Proportion

Pulverized burnt clay used in this study was obtained from urban shelter brick factory along Chanchaga Suleja road in Minna. The bricks were crushed into smaller particle which were further grinded into fine powder with the aid of Los-angles machine. The grinded materials were additionally sieved using BS standard sieve. Materials passing 150mµ were used for the study.

A saturated surface dry river sand with fineness modulus of 2.9 passing through 4.75mm ASTM sieve with specific gravity and water absorption of 2.6 and 0.7% respectively was used as fine aggregate. The coarse aggregate used was crushed granite of 10mm maximum size with specific gravity of 2.7 and water absorption of 0.5%. The mix proportion of the test materials is shown on Table 1.

Table 1: Mix proportion of test materials

Replacement level (%)	PBC (Kg)	CaO (Kg)	Water required (Kg)
10	13.6	1.5	9.72
20	12.1	3.0	9.52
30	10.5	4.5	9.52
40	9.0	6.1	9.52

2.2 Setting Time

Initial and final setting time of PBC and CaO paste at various replacement level were determined using Vicat apparatus in accordance with ASTM C191 (2005) specification. The initial set is said to have taken place when the needle (1.13 mm dia.) of the Vicat apparatus is at 25 mm above the bottom of paste taken in the Vicat mould. Final set is said to have occurred when the needle penetrates the cement paste to a maximum depth of 1 mm. In both cases, the setting time is reckoned from the moment when mixing water is added to the cement.

2.3 Workability

Workability of the concrete was evaluated in terms of slump and compacting factor to obtain an estimate of concrete ease of handling in fresh state. This test method was characteristically used to ensure a consistent workability. The procedure followed, in measuring the slump and compacting factor is in accordance with BS 1881: part 102 (1983). Slump readings are obtained as soon as the concrete was mixed.

2.4 Compressive Strength

Compressive strength test was conducted in accordance with BS 1881: Part 116 (1983) stipulation. Prior to the testing, the specimens are duly prepared, the machine cleaned and the digital unit of the machine programmed with the required sample information. A constant loading rate was selected and applied until failure of the specimen. The following stress equation was also used to calculate the result for compressive strength.

$$fc = \frac{F}{Ac}$$

Where:

f_c = the compressive strength, in newtons per mm^2

F = the maximum load at failure, in newtons

A_c = the cross sectional area of the specimen, in mm^2

3. Results

3.1 Chemical analysis

The chemical properties of PBC are shown in Table 2. From the analysis it can be observed that the combine proportion of Silicon Oxide (SiO_2), Aluminum Oxide (Al_2O_3) and Iron Oxide (fe_2O_3) in PBC sample was 83.36%.

Table 2: Chemical properties of PBC

Chemical composition	PBB (%)
SiO_2	54.78
$AL_2\ O_3$	19.66
Fe_2O_2	8.92
Na_2O	0.26
K_2O	1.50
CaO	0.10
MgO	1.07
P_2O_5	2.04
LOI	8.82

This satisfies the ASTM 618-78 requirement for chemical composition of pozzolan which stipulates a minimum combined proportion of 70%. Similarly, the MgO and LOI compostion of 1.07 and 8.82% where observed respectively. These values are below the maximum of 5.0% and 12.0% allowable by ASTM 618-78 standard.

3.2 Consistency and setting time

It is well known that the use of CaO influence retardation action of setting time of cementitious materials. Table 3 shows the setting time behaviour of PBC and CaO paste. The setting time was measured at the needle penetration of 25 mm and 1 mm into the paste for initial and final setting time respectively. As was expected, the higher retardation times were obtained for mixture with the higher CaO substitutions. For example, the initial settings for PBC and CaO paste were 200, 227, 245 and 270 minutes, for 10, 20, 30 and 40% respectively. While the final setting times are 290, 332, 362 and 410 minutes. This performance of these mixtures might have been influenced by the level of their fineness, Bouzoubaa and Lachemi, (2001) shared a similar view in high volume fly ash concrete.

Additionally, mixture containing high volume fly ash had both initial and final setting time longer than the specimen containing 100% OPC (Bentz and Ferraris, 2010).

Table 3. Consistency and setting time results

Replacement level (%)	PBC (g)	CaO (g)	Water content (g)	Initial setting time (Minute)	Final setting time (Minute)
10	360	40	124	200	290
20	320	80	128	227	332
30	280	120	132	245	362
40	240	160	140-	270	410

3.3 Workability

The result of workability interms of slump and compaction factor is shown in Table 4. It can be observed that the slump values at 10, 20 and 30% replacement are in a close range, and decreases as the value of PBC replacement with CaO increases.

Table 4 Workability

Replacement level (%)	Slump (mm)	Compacting Factor
10	26	0.87
20	24	0.86
30	22	0.86
40	10	0.80

3.4 Compressive Strength

Figure 1 shows the compressive strength development of PBC and CaO concrete at various replacement level. From the figure, it can be observed that the entire specimen demonstrate somewhat a similar behavior, ie their strength increases has the duration of the curing increases.

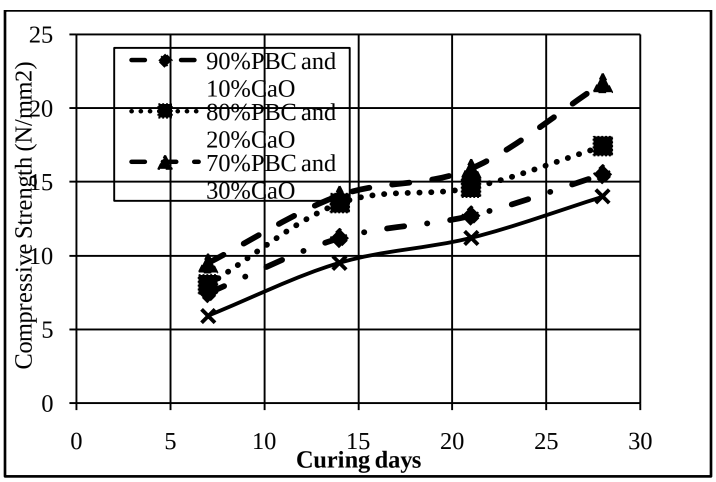

Figure 1:Strength development of PBC and CaO concrete

At 7 days for example, specimen of 10, 20, 30 and 40% developed a compressive strength of 7.45, 8.03, 9.50 and 5.9N/mm^2 respectively. Whereas, at 14 days the strength increases of 11.18, 13.55, 14.08 and 9.5N/mm^2 was observed. Similarly, at 28 days an increase of 15.5, 17.4, 21.7 and 14.0 were obtained for 10, 20, 30 and 40% specimen respectively. These strengths increase may be attributed to the pozzolanic reaction that takes place between the PBC and CaO. It is generally believed that pozzolanic action of pozzolan materials starts somehow belately in the presence of moisture. It is interesting to note that, although the strength of PBC/CaO concrete was generally lower than the the requirement of structural concrete at 28 days, the strength is good enough to allow for early removal of form work at the same age during construction.

4. Conclusion

This paper highlights the potential benefits of combined pulverized burnt clay and Cao as supplementary cementing material in concrete in terms of consistency, workability and compressive development. The results obtained and the observation made in this study conclude that Pulverised Burnt clay combine with proportion of Calcium oxide of 30% can be used in concrete with satisfactory strength gain for insulation purposes.

References

Matawal, S.M. (2005). Application of Ash as Pozzolana in Motar and concrete Production, 1st National Academy Conference, 31st August -2nd September.

Hassan I.O. (2006). Strength Properties of Concrete Containing Volcanic Ash in Partial Replacement of Ordinary Portland Cement. Unpublished M.ScThesis, University of Jos.

Margeret, T. (2005).Properties of lime Motar.Structures Magasine.

Neville A.M and Brooks J.J (1997). Concrete technology, @nd Edition, London Longman Publisher.

ASTM C618 (2005). Standard specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in Portland cement concrete. Annual Book of ASTM Standards, American Society for Testing and Materials.

ASTM C191 (2005). Standard test method for time setting of hydrulic cement by Vicat Needle. Annual Book of ASTM Standards, American Society for Testing and Materials.

British Standard Institution (1983). Testing concrete: method for determination of slump. BS 1881 Part 102:1983.

British Standard Institution (1983). Testing concrete: method for determination of compressive strength of concrete cubes. BS 1881 Part 116:1983.

Bouzoubaâ, N. and Lachemi, M. (2001). Self-compacting concrete incorporating high volumes of class F fly ash: Preliminary results. Cement and Concrete Research. 31(3), 413-420.

Bentz, D. P. and Ferraris, C. F. (2010). Rheology and setting of high volume fly ash mixtures. Cement and Concrete Composite. 32, 265-270.

Shetty, M.S. (1999): concrete technology, thepry and practice. Ram Nagar, New Delhi 11005, Chand and Company Ltd