The Study Of Compressive Strength On Concrete With Partial Replacement Of Cement With Cassava Peel Ash

Owolabi, T.A[1*], Popoola O.O[2] and wasiu j.[3]

Department of Civil Engineering Afe Babalola University, Ado-Ekiti. Nigeria
[1*]owolabititilayoabimbola@yahoo.com

Abstract: This research work presents the properties concrete using cassava peel ash (CPA) as a partial replacement for cement. Specific gravity, sieve analysis, density test, slump test and cube test were carried out in the concrete laboratory. Concrete cubes were cast, cured and tested at curing ages of 7, 14, 21 and 28 days using 0, 5, 10 15, and 20 percentage replacement levels. The density test showed that CFA has no significant effect on the density of the concrete. The optimum compressive strength of 17.5N/mm^2 was obtained at 5% replacement at 28 days of age compared to the control of 23.6 N/mm^2. The slump test results show that the workability of the concrete decreased as the CFA content increased. Water binder ratios of 0.55 0.6, 0.65 and 0.75 were used for the concrete mix 1:2:4 with varying percentage of cassava peel ash (CPA) as replacement for cement. Water binder ratio of 0.75 was found to be optimum to produce workable blended concrete. This shows that more water is needed to maintain the same uniformity as the percentage of CPA increases. CPA can be used optimally in concrete work by prolonging the curing age. Therefore, the use of agricultural and industrial wastes as pozzolan cementitious materials in concrete production should be encouraged.

[Owolabi, T.A, Popoola O.O and wasiu j. **The Study Of Compressive Strength On Concrete With Partial Replacement Of Cement With Cassava Peel Ash.** *Academ Arena* 2015;7(9):13-18]. (ISSN 1553-992X). http://www.sciencepub.net/academia. 3

Keywords: Cassava peel ash, Compressive strength, Concrete, Slump test

Introduction

Concrete is a composite material composed of aggregate bonded together with fluid cement which hardens over time. In Portland cement concrete, when the aggregate is mixed together with dry cement and water, they form a fluid mass that is easily moulded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix which binds all the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolans or superplasticizers) are included in the mixture to improve the physical properties of wet mix or the finished material (Kosmatka and panarese, 2002). Aggregate in a concrete mix consists of coarse aggregate such as granite or limestone and fine aggregate such as sand. Portland cement is the most common type of cement it consists of a mixture of oxides of calcium, silicon and aluminium. Portland cements are made by heating limestone with clay and grinding the product called clinker with a source of sulphate (gypsum). The use of industrial and agricultural wastes as pozzolan cementitious materials (SCMs) in concrete production is economical and suitable in term of strength, workability and durability. Cassava peel is one of the agricultural wastes which is a by-product of cassava processing, either for domestic consumption or industrial uses. Adesanya et al (2008) described that cassava peel constitutes between 20-35% of the weight of tuber, especially in the case of hand peeling. Cassava peel ash (CPA) has been found to be pozzolanic when it is calcined at 7000C for 90 minutes (Salau and Olonade, 2011). The use of certain additives to improve the quality and performance of concrete had been carried out in many countries like Canada, India, Japan etc (Wahby, 2003; Blaga and Beaudoin, 2004b; Ohama, 2006; Islam et al, 2011). These additives include asbestos, glass, nylon, carbon, polythene, fly-ash, polymer, epoxy, and super plasticizers. These materials offer the advantages of higher strength, improved durability, and resistance to damage from freeze-thaw cycle, high rate of strength gain and high coefficient of thermal movement, outstanding adhesion qualities and low shrinkage (Wahby, 2003; Mason, 2004; Ohama, 2006; Islam et al, 2011). Concrete is a construction material that consists in its most common form of Portland cement, fine aggregates, coarse aggregates and water. Each of these components contribute to the strength their concrete possesses (Gambhir, 2004). Pervious concrete offers the benefit of a rigid pavement design, which overcomes the instabilities of other permeable pavement system such as precast pavers or asphalt systems (Owolabi *et al.,* 2014). The age long form of concrete has a number of limitations; such as low flexural strength, low failure strain, susceptibility to frost damage and low resistance to chemical attack (Blaga and Beaudoin, 2004a).

Materials And Methods

The materials used for the research are cassava peel ash, ordinary Portland cement, water, coarse and fine aggregate. Cassava peels were collected at garri processing factory in akure, Ondo State. The cassava peel were air-dried for few days and burnt to ashes. It was sieved using 75µm sieve size to produce fine ash. The concrete was of mix ratio 1:2:4 (cement and cassava peel ash: sand: granite) with water/binder ratios of 0.50, 0.60, 0.65 and 0.75 to prepare concrete cubes of size 150x150x150 mm. The cassava peel ash were used to replace cement by weight in varying proportions of 0%, 5%, 10%, 15%,and 20%. Specific gravity and sieve analysis test were carried out on the materials in accordance with British standard code of practice (BS1377:1990). Slump test were conducted on the concrete in accordance with BS 1881-102: 1993 to determine the workability of the concrete. Cube test were done to determine the compressive strength of concrete after curing ages which was done in accordance with BS 1881: Part 116: 1983. The density test of the hardened CPA concrete were also carried out in accordance with BS1881- 114: 1993. The Concrete cubes were cast and cured for 7, 14, 21 and 28days. Energy dispersive X-ray spectroscopy (EDS) were carried out on the cassava peel ash powder in SHESTCO (Sheda Science and Technology Complex Federal Ministry of Science and Technology) for elemental analysis and chemical characterisation of the sample.

Result And Discussion

Specific gravity

The result of specific gravity of the material is given table 1.

Table 1: Specific gravity of the material

Materials	Specific gravity
Sand	2.55
granite	2.47
cement	3.13
Cassava peel ash	1.21

Elemental Composition Of The Material

The evaluated values of the chemical composition of cassava peel ash are given in table 2. It is observed that SiO2 has the highest composition. CaO is the main source of binding and hardening compound in cement when reacted with water (hydration reaction) which is very low in CPA. But the SiO2 in CPA reacts with $Ca(OH)_2$ (by product of cement hydration) to produce more binding property (Pozzolanic reaction) (Kolawole *et al.,* 2014).

Table 2: Chemical composition analysis of cassava peel ash

Chemical constituents	% Composition
CaO	8.37
SiO_2	55.20
MgO	6.80
Na_2O	0.41
Al_2O_3	13.06
Fe_2O_3	2.83
SO_3	2.96
K_2O	9.70

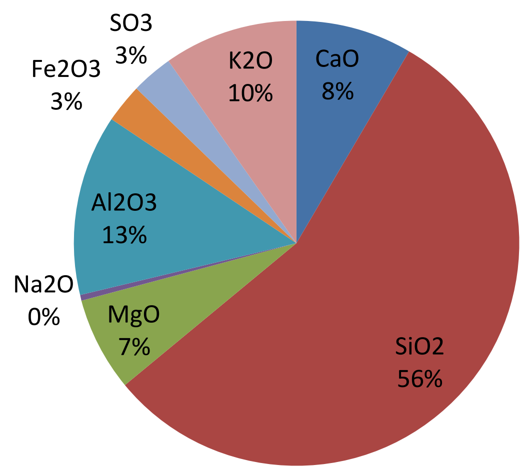

Figure 1: Chemical composition analysis of the cassava peel ash

Sieve Analysis

The particle size analysis conducted on the sharp sand, shows that the percentages passing number 200BS sieve is 2.40%. The soil material contains 2.40% silt and clay, 79.6% of sand and 18% of gravel. This result indicates that the material is sharp sand. The graph is shown in figure 2.

Workability results of CPA cement concrete

The slump test show that the workability of the concrete decreased as the cassava peel ash content increased which implies that the concrete became less workable (stiff) as the CPA percentage increased. It was observed that the slump values increases consequently with increase in water- binder ratio. This shows that the workability of CPA cement concrete can be improved by addition of more water as CPA content is increasing. The optimum workability was achieved at water-binder ratio of 0.75. The slump values is shown in table 3.

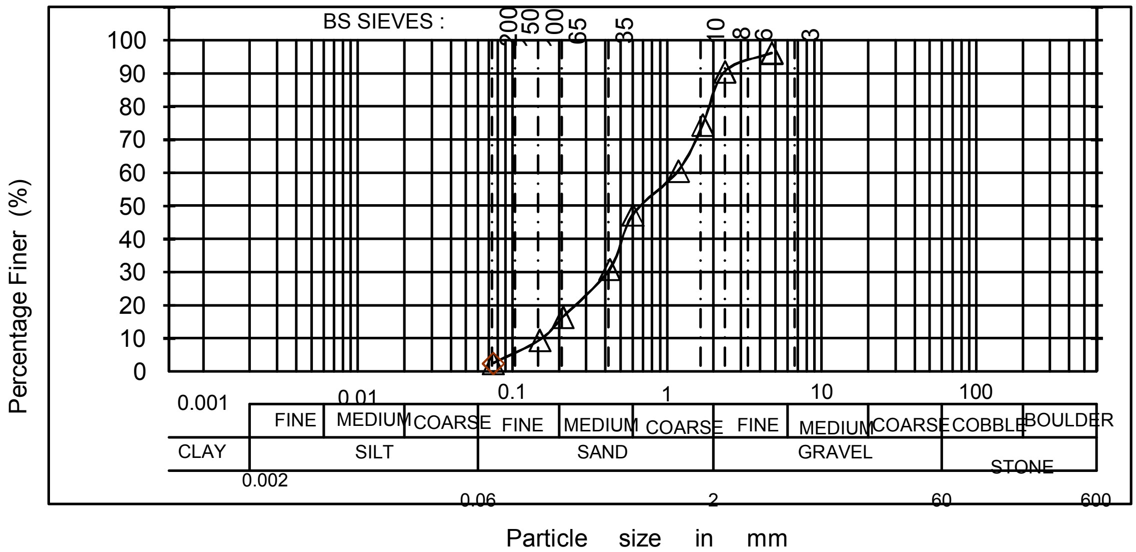

Figure 2: Particle size distribution for the sharp sand

Table 3: Slump values (mm) of the Cassava peel ash concrete

Water-binder ratio	% Replacement				
	0	5	10	15	20
0.55	29	20	17	3	0
0.60	38	33	26	6	0
0.65	62	47	35	29	24
0.75	96	80	73	70	66

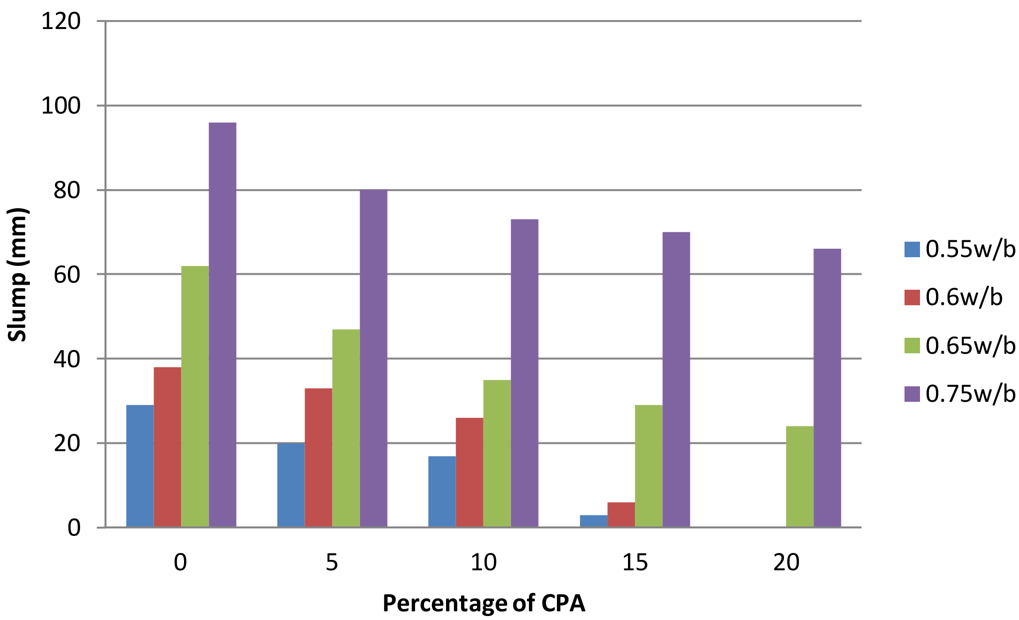

Figure 3: Slump values of CPA concrete at different water binder ratio

The Density Result Of The Cpa Concrete

The cassava peel ash has no significant effect on the density of the concrete compare with the control mix. The densities range between 2.391 and 2.485 g/cm^3. The densities values are shown in table 4.

Table 4: Densities of the CPA Concrete (g/cm^3)

% Replacement	7 days	14days	21days	28days
0	2.485	2.424	2.405	2.441
5	2.395	2.401	2.399	2.395
10	2.431	2.426	2.389	2.391
15	2.422	2.394	2.403	2.395
20	2.411	2.400	2.392	2.390

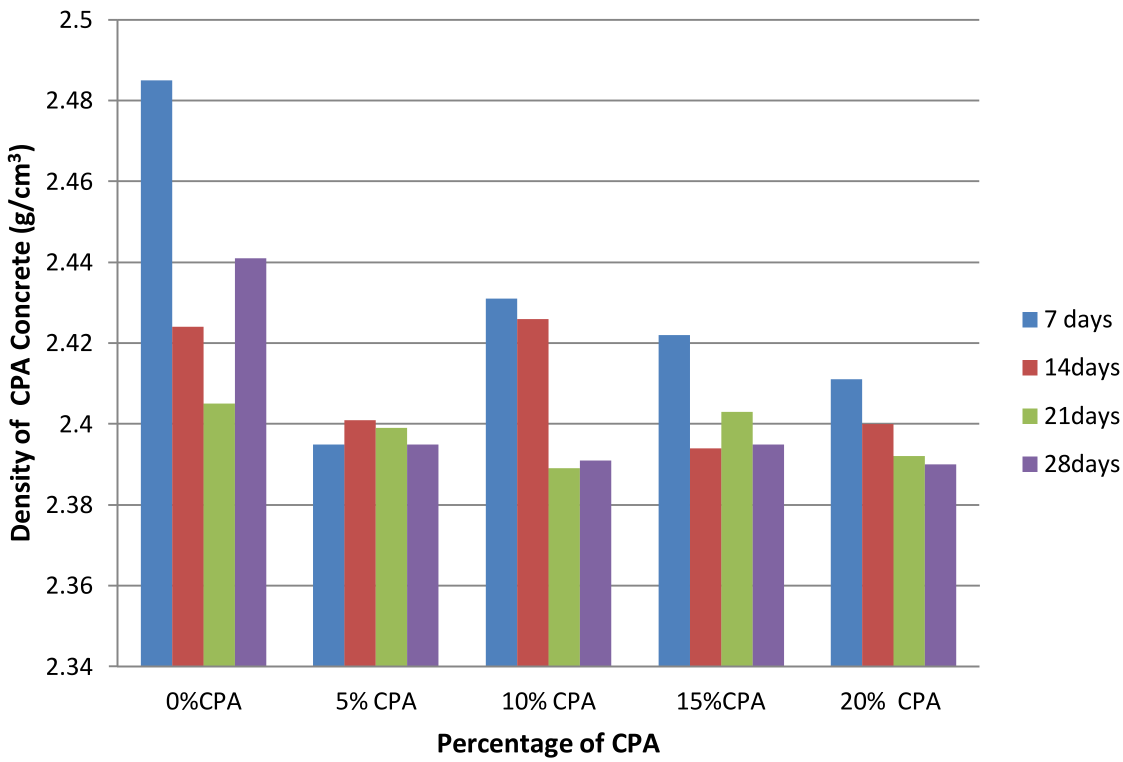

Figure 4: Density of CPA concrete at different curing days

Compressive Strength Result of CPA Concrete

There is an increasing trend in the strength of CPA concrete as the days of curing increases. The strength of CPA concrete reduces as the percentage replacement of cement with CPA increases. This strength improvement is believed to continue as long as the curing period is prolonged to allow completion of hydration. The optimum compressive strength of 17.5 N/mm^2 was achieved at 5% replacement at 28days of age.

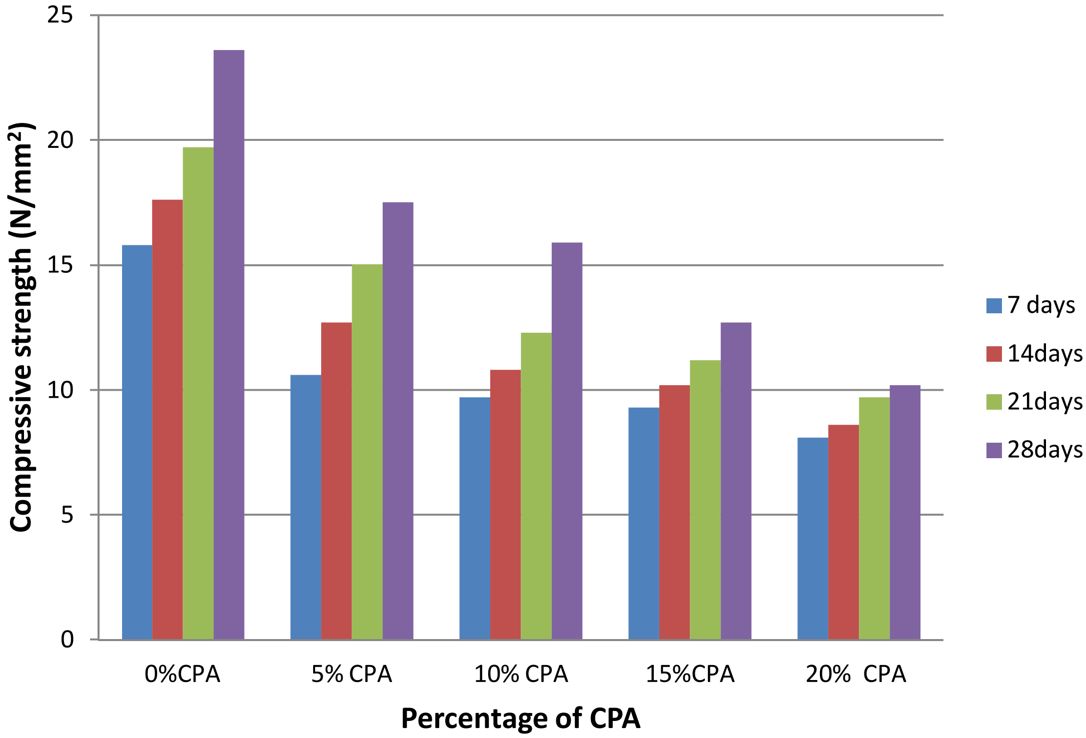

Figure 5: Compressive strength of CPA concrete at different curing days

Table 5: Compressive strength (N/mm^2) of CPA concrete at different ages

% Replacement	7 days	14days	21days	28days
0	15.8	17.6	19.7	23.6
5	10.6	12.7	15.02	17.5
10	9.7	10.8	12.3	15.9
15	9.3	10.2	11.2	12.7
20	8.1	8.6	9.7	10.2

Conclusion And Recommendation

From the studied CPA concrete, the following conclusion and recommendation can be made:

- The workability of fresh CPA concrete measured by slump test reduces as the CPA content increases. The CPA became workable as the water binder ratio increases.

This shows that more water is needed to maintain the same uniformity as the percentage of CPA increases

- Cassava peel ash has no significant effect on the density of the concrete.
- Compressive strength increases with curing age and decreases with increase in CPA content. This shows that CPA can be used optimally in concrete work by prolonging the curing age.
- The use of agricultural and industrial wastes as pozzolan cementitious materials in concrete production should be encouraged.

References

1. Adesanya, O.A, Oluyemi, K.A., Josiah, S.J., Adesanya, R.A., Shittu, L.A.J., Ofusori, D.A., Bankole, M.A. and Babalola, G.B. (2008). "Ethanol Production by Saccharomyces Cereviasiae from cassava peel hydrolysate", The Internet Journal of Microbiology, Vol.5 No. 1. pp. 25-35.
2. Aderinola O.S., Olofinsae T.O. and Owolabi T.A. Investigating the suitability of pervious concrete in improving environmental qualities. Sci-Afric Journal of Scientific Issues, Research

and Essays 1st Academia Publishing London. Vol. 2 (4), Pp. 166-172, April, 2014. (ISSN 2311-6188).
3. BS1377:1990. Methods of test for soils for civil engineering purposes British standards Institute, London.
4. British Standard Institution (1993). Method for determination of density of hardened concrete BS1881- 114: 1993. British Standard Institution, London.
5. British Standard Institution (1993). Method for determination of slump BS 1881-102. British Standard Institution, London.
6. British Standard Institution (1983). Methods for Determination of Compressive Strength of concrete cubes BS 1881, Part 116, British Standard Institution, London.
7. Blaga, A and Beaudoin, J.J (2004)''Polymer Modified Concrete'' in Canadian Building Digest, CBD-242 on http:.www.CBD-241-polymer Concrete Building Digest.htm.
8. Gambhir, M. L. (2004): Concrete Technology, Tata McGraw – Hill Publishing Company Limited, New Delhi, pp. 352 - 448.
9. Islam, M.A., Rahman, M.M., and Ahmed, M. (2011) '' World Experience and Potential for Bangladesh'', The Indian Concrete Journal.
10. Kolawole A. O. Akinropo M.O., Ayoade O. O. and Funso A. O. (2014) *Construction Materials and Structures IOS Press, The authors and IOS Press. All rights reserved. doi:10.3233/978-1-61499-466-4-764.*
11. Kosmatka S.H and panarese W.C (2002). Design and control of concrete mixtures. Protland cement association, Pp 17-184. ISBN 978-0-89312-087-0.
12. Mason '' Application in Polymer Concrete ''A. Blaga, and J.J. Beaudoin, (2004) '' Polymer Modified Concrete'' in Canadian Building Digest, CBD-241 on http:#www.CBD-241-polymer Concerete Building Digest. Htm.
13. Ohama, Y., (2006) '' Recent Trends in Research and Development in Polymer Mortar and Concrete in Japan'' in Proceedings of the 6th International Symposium on Cement & Concrete, Contributing to Global Sustainability, Volume 3, XI'AN, China, Pp. 1651-1655.
14. Salau, M.A. and Olonade, K.A. "Pozzolanic Potentials of Cassava Peel Ash" *Journal of Engineering Research*, 16(1) 2011, 10-21.
15. Wahby W.S. (2003) '' Fifty years' history of polymer in concrete in Review, ACI International, Publication-SP 214-2, Pp. 13-14.

9/1/2015