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Effect of Hydrochloric Acid on the Compressive Strength of Cement-Cassava Peel Ash Concrete

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Abstract: *This research was conducted to investigate the effect of hydrochloric acid on the compressive strength of concrete containing cassava peel ash (CPA). CPA was used to partially replace Portland cement by 0, 5, 10 and 15% by weight of binder in order to prepare CPA concrete. Water to binder ratio was 0.4 and Conplast SP 430 superplasticizer was added to improve workability. CPA concrete was cured for 7 days and thereafter immersed in 10% hydrochloric acid solution for 28 days. All the concrete cubes experienced loss in weight due to leaching with the control concrete recording the least loss.The concrete cubes removed from the HCl acid solution as well the as the ones cured exclusively in water were subjected to compression tests.The loss in compressive strengths of 0, 5, 10 and 15% CPA concrete cubes immersed in 10% HCl solution were 55.7%, 45.9%, 40.8% and 15.2% respectively compared to the concrete cubes cured in water. It is recommended that finer size ash be investigated for possible better results.*

Keywords *-Cassava Peel Ash, Compressive Strength, Concrete, Hydrochloric Acid, Portland Cement*

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I. Introduction

Water is the most important and cheapest ingredient of concrete. It is the most active ingredient of concrete which not only participates in the hydration of cement but also participates in the workability of fresh concrete. Naturally occurring water may not be considered good for making concrete as it may contain impurities like sulphates, chlorides, various acids and salts which may affect the strength and durability of concrete. Various studies have shown that hydrochloric acid is not only a naturally occurring chemical compound but also affects the strength and durability of concrete. The attack of hydrochloric acid on concrete is due to the high alkalinity of Portland cement. The damage to concrete starts at the surface and progresses inwards.

Notable researchers have demonstrated the use of pozzolanic admixtures to improve the properties of concrete (Frias et al. 2007; Cizer et al. 2006; Ketkukah and Ndububa, 2006; Salau et al. 2012; Jaturapitakkul et al. 2007; Weerachart et al. 2007). Research findings have also shown the ability of pozzolanic materials to enhance the resistance of concrete to acid attack.

Nigeria is the world's largest producer of cassava. The crop is produced in 24 of the country's 36 states. In 2013, Nigeria produced 47,607,770tonnes which was 18% of the production in the world.

Cassava Peel is a by-product of the cassava processing industry. Cassava peel constitutes about 20-35% of the weight of tuber (Adesanya et al. 2008). Cassava Peel Ash (CPA) is obtained from cassava when it is calcined at 700◦C for 90 minutes (Salau and Olonade, 2011; Salau et al. 2012). The chemical and physical properties of a typical Cassava Peel Ash (CPA) is shown in Table 1 (Salau and Olonade, 2011).

The aim of this research work is to determine the effect of hydrochloric acid on the compressive strength of cement-cassava peel ash concrete.

II. Materials And Methods

2.1 Materials

Cassava peels were obtained from local cassava processing people in Osogbo, Nigeria. The peels were turned to ash by calcination for 90 minutes at 700◦C. The resulting ashes were sieved using 600µm sieve. Dangote Portland cement was used and it was sourced in Iree, Nigeria. Fine aggregate was sourced from the drains in the compound of Osun State Polytechnic Iree, impurities were removed and the sand was sieved using 5mm size sieve. The coarse aggregate used was 10mm size and it was obtained from Igbajo, Nigeria. Conplast SP 430 superplasticizer was used. Concentrated Hydrochoric acid was also sourced from Osogbo in Nigeria.

2.2 Experimental Procedure

The concrete mix ratio adopted for this research work was cement:fine aggregate: coarse aggregate of 1:1.3:2.6. The water to binder ratio was 0.4 and 1% Conplast SP 430 was applied. Portland Cement was replaced by cassava peel ash at 0, 5, 10and 15% levels. The size of the concrete mould used was 100 x 100 x 100 mm. The casted concrete cubes were demoulded 24 hours after casting and cured in water for 7 days. The cubes were removed from water and weighed after curing and then immersed in 10% Hydrochloric Acid solution for 28 days. Thereafter, the cubes were removed from the acid solution and weighed again. The loss in weight and percent loss in weight of the concrete cubes were determined. After testing the concrete samples in acid solution, the samples were tested for compression to determine the residual strengths. Concrete samples that were continuously cured in water were also tested for compression and compared with the strengths of the corresponding samples immersed in acid.

III. Results And Discussions

The results of the experimental programme on the concrete cubes are shown in Table 2 and 3 as well as Figures 1, 2 and 3. The results revealed all the concrete cubes experienced loss in weight as a result of leaching resulting from the reaction of the hydrochloric acid with concrete. The percentage loss in weight was 2.17%, 2.35%, 3.15%, and 3.31% for 0%, 5%, 10%, and 15% replacement of cement with cassava peel ash (CPA). This revealed that the control concrete had the best resistance towards acid attack. Thus, the incorporation of cassava peel ash did not in any way improve the resistance of the concrete towards acid attack. The loss in compressive strengths of 0, 5, 10 and 15% CPA concrete cubes immersed in 10% HCl solution were 55.7%, 45.9%, 40.8% and 15.2% respectively compared to the corresponding concrete cubes cured exclusively in water. The control concrete cubes experienced the highest strength reduction ratio compared to CPA concrete cubes with the 15% CPA concrete experiencing the least strength reduction ratio.

IV. Conclusion And Recommendations

The following conclusion can be drawn from this research work:

Cassava peel ash possesses pozzolanic properties.

The incorporation of CPA in concrete could not mitigate the effect of acid attack where higher strength concrete is to be used.

The following recommendations can be drawn from this study:

Finer size CPA should be investigated.

Resistance of CPA concrete to other types of acids should be investigated.

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 *SaccharamycesCereviasiae* from cassava peel hydrolysate. The Internet Journal of Microbiology. Vol 5 No 1: 25-35.

[2]. Cizer, O., Van Balen, K., Elsen, J. and Van Gemert, D. (2006). Carbonation and hydration of calcium hydroxide and calcium silicate binders with rice husk ash. 2nd International Symposium on Advances in Concrete through Science and Engineering 11-13 September. Quebec City. Canada.

[3]. Frias, M., Villar Cocina, E. and Valencia-Morales, E. (2007). Characterisation of sugar cane straw waste as pozzolanic material for construction: Calcining temperature and kinetic parameters. Journal of Waste Management. 27: 533-538.

[4]. Jaturapitakkul, C., Kiattikomol, K., Tangchirapat, W. and Saeting, T. (2007). Evaluation of the sulfate resistance of concrete containing palm oil fuel ash. Construction and Building Materials. 21(7): 1399-1405.

[5]. Ketkukah, T.S. and Ndububa. E.E. (2006). Groundnut Husk Ash (GHA) as a Pozzolana Material in Mortar. International Journal of Science and Technological Research. Vol 3 No 2: 209-214.

[6]. Salau, M.A. and Olonade, K.A. (2011). Pozzolanic Potentials of Cassava Peel Ash. Journal of Engineering Research. Vol 16. No 1: 10-21.

[7]. Salau, M.A., Ikponmwosa, E.E. and Olonade, K.A. (2012). Structural Strength Characteristics of Cement-Cassava Peel Ash Blended Concrete. Civil and Environmental Research. Vol 2. No 10: 68-74.

[8]. Weerachart, T., Tirasit, S., Chai, S., Kraiwood, K. and Anek, S. (2007). Use of waste ash from palm oil industry in concrete. Waste Management. 27(1): 81-88.

Table 1: Chemical and Physical Properties of Cassava Peel Ash (CPA)

Chemical Constituents	Percentage (%)
SiO_2	58.02
Al_2O_3	12.80
Fe_2O_3	1.41
CaO	8.53
MgO	5.02
SO_3	2.18
K_2O	7.67
Na_2O	0.03
LOI	4.18
Physical Properties	
Specific gravity	0.32
Fineness (m^2/kg)	330

source: Salau and Olonade, 2011

Table 2: Results of Immersion of Concrete Cubes in Hydrochloric Acid Solution

Percentage CPA (%)	Weight of Concrete Cubes before immersion in acid (g)	Weight of Concrete Cubes after immersion in acid (g)	Loss in Weight of Concrete Cubes (g)	Percentage loss in Weight of Concrete Cubes (%)
0	2425.6	2373.0	52.6	2.17
5	2335.6	2280.7	54.9	2.35
10	2216.9	2147.1	69.8	3.15
15	2090.8	2021.6	69.2	3.31

Table 3: Bulk Densities and Compressive Strengths of Concrete Cubes

Percentage CPA (%)	Density of Concrete Cubes before immersion in acid (g/cm^3)	Density of Concrete Cubes after immersion in acid (g/cm^3)	Compressive Strength of Concrete Cubes immersed in water (N/mm^2))	Compressive Strength of Concrete Cubes immersed in acid (N/mm^2)
0	2.43	2.37	48.05	21.29
5	2.34	2.28	36.32	19.66
10	2.22	2.15	26.65	15.78
15	2.09	2.02	20.43	17.32

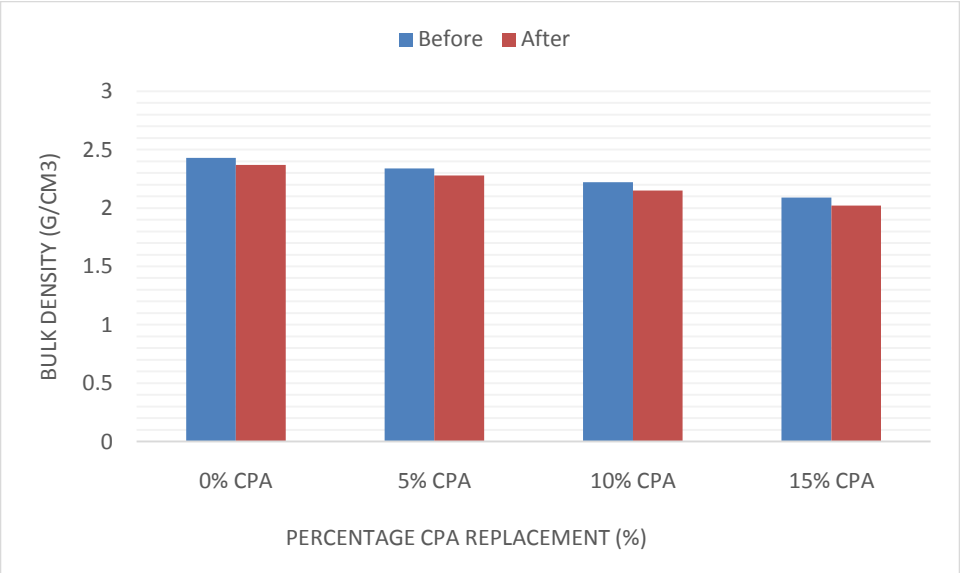

Figure1: Bulk Densities of Concrete Cubes Before and After Immersion in Acid solution

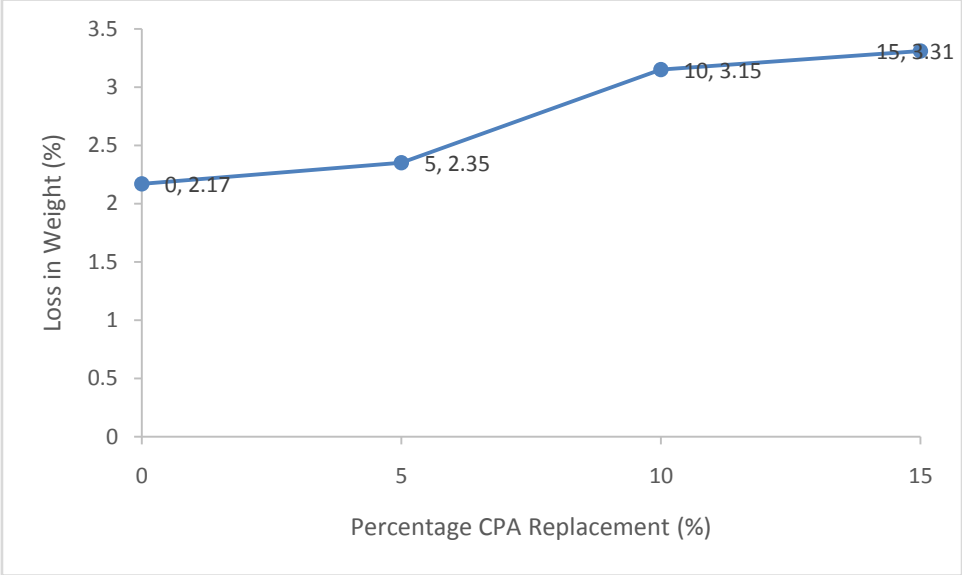

Figure 2: Results of Immersion of Concrete Cubes in Hydrochloric Acid

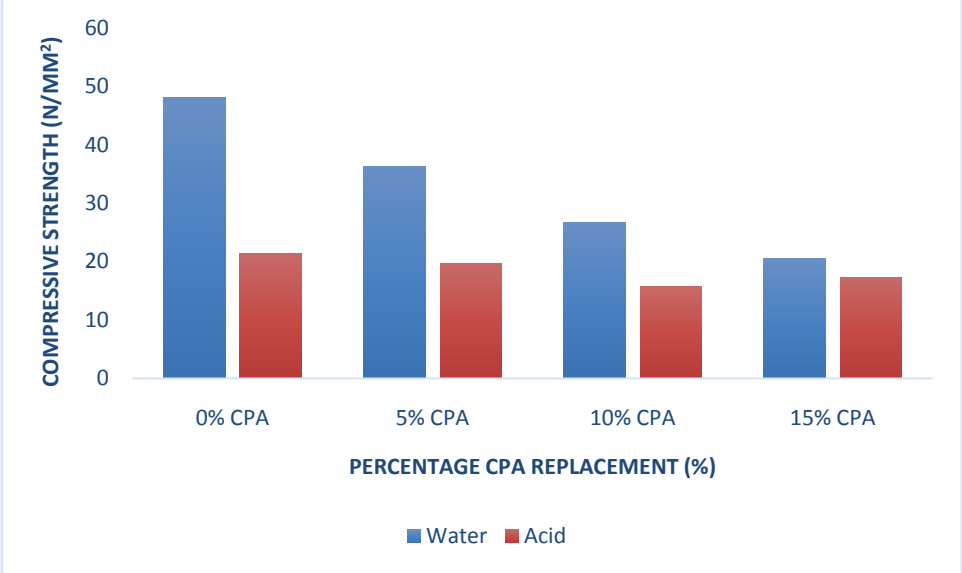

Figure 3: Compressive Strengths of Concrete Cubes immersed in water and acid

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