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Influence of High Pozzolanic Agro-Wastes on Non-Pozzolanic Agro-Wastes

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Abstract- The rising cost of cement coupled with the release of toxic gases during production has necessitated researching into the pozzolanic potentials agro-wastes that are been indiscriminately disposed thereby constituting environmental nuisance can be used in the construction industry The pozzolanic capabilities of four agro-wastes namely Maize cob ash (MCA), guava leaf ash (GLA), Cocoa Pod ash (CCPA), and Almond pod ash (APA) determined using chemical analysis and X-ray fluorescence. Those that were not pozzolanic were thereafter mixed with those having high pozzolanic potentials and their physical characteristics and chemical composition compared the values stipulated in the ASTM requirements for pozzolans. The percentages of the oxide of MCA among the rest met the 70% requirement and the oxide of its mixture with non pozzolanic GLA gave a value that only satisfied the 50% requirement for the material to be classified as Class C. The results showed that instead of discarding agro-wastes that are not pozzolanic, they can be mixed with those having high pozzolanic capabilities thereby making all agro-wastes potential materials that can be used for construction purposes.

Indexed Terms- Maize cob ash, Guava leaf ash, Pozzolans, Oxide, X-Ray Fluorescence

I. INTRODUCTION

Cement, apart from having its price increasing everyday and according to Akinboboye F.A.O., Ogunfayo I.K., and Dawodu H. 2012 and Cline et al, 2000, cement, also has it production release toxic gases which has adverse effect on the people living around the place where it's been produced Cement is a major component of concrete and construction industry relied so much on it in providing houses units to the people unfortunately as stated earlier, the geometric increase in its price is threatening the provision of affordable housing units to low and middle level income earners. Efforts are therefore been geared towards finding a substitute that will have twin advantages over cement; cost and environment friendly. Agro-wastes have been found to constitute environment nuisance when not properly disposed but can suitably be used as substitute for cement provided they are pozzolanic. Harnessing such in concrete production will not only be cheaper when compared to cement but also rid the environment with its waste.

Pozolans are siliceous and aluminous materials that have slight or no cementitious value but will react with calcium hydroxide ($Ca(OH)_2$) chemically at normal temperature in the presence of water to form compounds with cementitious properties (Cook D.J. 1986). Natural pozzolans comprises Pyroclastic rock (volcanic origin) and clastic rocks (sedimentary) while artificial consists of thermally activated materials and by-products (M.S. Shetty, 2004). Natural pozzolans have a wide range of chemical compositions, with silica (SiO_2) dominating over the other constituents. The second highest mass is alumina (Al_2O_3), followed by iron oxide. (Fe_2O_3). The standard stipulates a minimum of 70% by mass for the sum of the three oxides for it to be used as natural pozzolans in cement and concrete. The use of pozzolans in construction will go a long way in not only reducing the cost to be incurred but also eases the environmental concerns on the eyesore waste disposal culture and greenhouse gas emissions by this means improving sustainability Malhotra V. and Mehta P (1996).

Lots of researches are ongoing on the potential of agro-waste as pozzolans with pozzolanic reaction occurring when pozzolans reacts with calcium hydroxide under moisty condition. While some have pozzolanic potentials, there are some that faltered. Adegbesan O.O. and Ayegbusi O.A. (2020) looked into the use of cocoa pod ash as pozzolans. The chemical composition of the materials and its oxide analysis revealed that the appropriate calcining temperature for the CCPA was 800oC, but the sum of SiO2, Al2O3, and Fe2O3 at that temperature was less than 70%. The results showed that cocoa pod ash (CCPA) did not meet the requirements for cement and agro-based materials, so it cannot be used as a substitute for cement, but it can be used to partially replace cement provided others things are factored. Further work on agro-wastes as pozzolans by According to the work of Adegbesan O.O., Ayegbusi O. A., and Omisande L.A. (2020) on the pozzolanic prospect of ash from guava leaf at the optimum calcining temperature of 600^0C, the sum of the SiO2, Al2O3, and Fe2O3 was 82.33%, which is greater than the 70% required ASTM C 618. Pozzolanic capability of Rice husk ash was experimented by Soyemi O.B. and Adegbesan O.O. (2020) by partially replacing it with cement in concrete. Their findings showed an increase in the flexural strength of the beam considered. They recommended a 10% replacement of cement for structural elements and 20% and 30% for non-structural elements. Another agro-waste considered by Adegbesan O.O., Ayegbusi O. A., and Lawal A.N (2022) was kolanut pod. Kolanut pods waste were collected, sun dried, and then calcined between 600^0C to 800^0C. The results revealed that the sum of all the oxides in KPA; SiO2, Al2SO3, and Fe2O3 at were greater than 70%, as stipulated by ASTM C618. If agro-wastes ash is not pozzolanic in nature, that does not mean they are not of economic value, those that are pozzolanic can probably be used in increasing their chemical composition so as to meet the relevant requirements for them to be classified as having pozzolanic potentials.

The essence of this research is to see how to improve non-pozzolanic agro-wastes such as CCPA and APA with those having high pozzolanic tendency. An example of such are MCA and GLA. If the resulting mixture is thus pozzolanic, this will invariably eliminate the nuisance of open and indiscriminate agro-wastes disposal irrespective of their pozzolanic potentials. This will significantly reduce the cost of construction because of the partial substitution of cement with pozzolans

II. METHODOLOGY

Samples of MCA, GLA, CCPA, and APA were weighed and combined physically; MCA + GLA, MCA + CCPA, MCA + APA, GLA + CCPA and GLA + APA. The resulting mixtures were then calcined at temperatures between 600^0C to 800^0C. The Silicon-dioxide, Aluminium oxide, Iron oxide (Fe_2O_3), Calcium oxide, Magnesium oxide, Moisture content and Loss on ignition were determined through X-ray fluorescence (XRF) and Chemical analysis with strict adherence to ASTM C618

III. RESULTS

Table 1: Results chemical analysis of physical mixtures of agro waste relative to ASTM-C618

Oxide composition, %	ASTM-C618 standard	M.C.A	G.L.A.	M.C.A.+ G.L.A.	M.C.A.+ C.C.P.A.	M.C.A+ A.P.A.	G.L.A.+ C.C.P.A.	G.L.A.+ A.P.A.
SiO_2	SiO_2 + Al_2O_3+ Fe_2O_3, min%=70.0	67.70	41.40	44.80	13.90	21.80	16.60	13.20
Al_2O_3		5.70	4.90	4.10	1.20	2.60	3.60	4.00
Fe_2O_3		2.50	1.90	5.00	1.20	4.20	4.62	4.33
CaO		6.80	18.90	8.70	6.12	16.90	8.70	14.30
MgO		3.60	8.40	4.30	5.30	6.50	8.80	1.70
LOI	Max. % = 10.0	18.01	7.10					
MC	Max. %	11.07	38.25					

	=3.00			

Table 2:Results of x-ray fluorescence on chemical mixtures of agro waste relative to ASTM-C618

Oxide composition, %	ASTM-C618 standard							
		M.C.A	G.L.A.	M.C.A.+ G.L.A.	M.C.A.+ C.C.P.A.	M.C.A+ A.P.A.	G.L.A.+ C.C.P.A.	G.L.A.+ A.P.A.
SiO_2	SiO_2 + Al_2O_3+ Fe_2O_3, min%=70.0	58.20 11.02 2.41	9.10 4.60 2.20	22.1 11.10 3.00	10.70 3.20 0.50	11.10 7.80 5.24	10.80 5.67 2.91	11.06 8.30 3.01
Al_2O_3								
Fe_2O_3								
CaO		8.30	12.38	7.85	6.81	7.70	11.34	12.38
MgO		2.00	3.77	3.76	4.03	3.30	4.46	3.79
MC	Max % = 3.0	11.1	38.31					

Table 3: Comparison of the compound in the mixes with that of Control (Control)

Chemical Compound,%	Samples							
	M.C.A	G.L.A.	M.C.A.+ G.L.A.	M.C.A.+ C.C.P.A.	M.C.A+ A.P.A.	G.L.A.+ C.C.P.A.	G.L.A.+ A.P.A.	Cement OPC
C_3S	-525.90	-275.07	-328.83	-116.73	-118.59	-119.43	-74.63	55.6
C_2S	590.82	326.29	376.65	128.24	151.72	135.85	94.69	19.8
C_3A	411.71	220.51	259.21	100.69	96.23	97.68	66.78	6.7
C_4AF	7.47	5.67	15.11	3.65	12.78	14.89	13.18	9.5
Total %	484.11	277.48	321.80	14.98	142.56	132.18	99.78	91.2

IV. DISCUSSION

The chemical analysis results showed that MCA was pozzolanic while GLA was not (table 1). The mixture of MCA and GLA was 53.88% which only met ASTM requirements of 50% thereby making the mixture to be classified as Class C. All other mixtures were below the ASTM requirements. The results of the mixtures using X-ray fluorescence differ from that obtained chemical analysis as that of M.C.A met the ASTM standard (table 2). The results of the compound present in the samples in comparison to that of the cement showed that C_3S of the samples' mixtures have a negative value, this implied that the samples are deficient silicates. Comparing the C3A and C4AF with that of the cement, the values of those of the samples were higher relative to that of the control.

CONCLUSION

The Oxides of MCA determined from the chemical analysis and X-ray fluorescence falls within the minimum of 70% specified for pozzolans by ASTM-C618, therefore, MCA is categorized as pozzolan. While using only chemical analysis method, the mixture of MCA and GLAadded up to a value of 50% thereby making the mixture to be classified as Class C. The percentage of oxides of maize cob ash and guava leaf ash mixed physically was 50%, which is can made the mixture of the pozzolanic and non-pozzolanic materials to be classified as class C in accordance with ASTM-C618. The has given an indication that materials with high pozzolanic potential can be physically mixed with those not having pozzolanic potentials.

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