EXPERIMENTAL INVESTIGATION OF REPLACING CEMENT WITH CORN COB ASH POWDER

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Abstract: The possible of corn cob ash (CCA) powder as a substitute cementitious material was estimated in this study. The physical, chemical and mineralogical characteristics of CCA were considered and analyzed. The Compressive strength, Split Tensile strength and Flexural strength of the CCA mixed concrete was observed to check on the effect of CCA in concrete. The water to binder ratio of 0.45 is considered and concrete with five different dosage of CSA (OPC, 10%, 20%, and 30%) were casted. Results of Compressive strength, Split Tensile strength and Flexural strength exposed that CCA provides a positive effect in the strength development at later ages and in fact has higher percentage gain in strength than the later because of the excellent pozzolanic effect of CCA in the combined concrete.

Key Words: CCA, concrete, steel, compressive strength, flexural strength, split tensile strength.

1. INTRODUCTION

The history of cementing materials is as old as the history of engineering construction. Concrete is one of the most commonly used building materials today. The adaptability and plasticity of the materials, its high compressive strength and discovery of improved and harried techniques have been generally used. The properties of the concrete in the plastic/hardened state depend on the nature and type of the ingredients used. The alteration of building ingredients has an important impact on the construction engineering. A number of attempts have been made in the building materials industry to use waste products, such as additional cement, for useful and economical items. Some studies have focused on finding alternatives that can be used as alternatives to cement, such as industrial and agricultural disposable and less valuable wastes, and their potential benefits can be achieved through recycling, reuse and renewal programs. These wastes are created in huge quantities (millions of tons) and are wasted every year. They cause environmental problems and leaching of toxic chemical like arsenic, beryllium, boron, cadmium, chromium, cobalt, lead, manganese, mercury, molybdenum selenium, strontium, thallium when landfilled or dumped in lakes and oceans. It is shown in studies that waste materials can be successfully used to replace cement and providing environmentally safe, stable and more durable and low cost construction material.

In India, Corn is the third most important food crops after rice and wheat. According to advance estimate, it is cultivated in 12.7 m ha (2017-18) mainly during Kharif season which covers 80% area. Maize in India donates nearly 9 % in the national food basket and more than ₹100 billion to the agricultural GDP at current prices apart from the producing employment to over 100 million man-days at the farm and downstream agricultural and industrial sectors. The use of corncob ash in concrete with normal strength is a new dimension of concrete anxiety design, and if large-scale applications will reform the construction industry through cost savings. Pozzolana have been used to improve properties of cement mortar and concrete. Pozzolana, by their miscellaneous and varied nature, tends to have widely varying appearances. The chemical composition of Pozzolana varies considerably, depending on the source and the preparation technique. Normally, a Pozzolana will contain silica, alumina, iron oxide and a variety of oxides and alkalis, each in varying degrees.). Use corn cob ash (CCA) as a pozzolana, without considering this chemical CCA suitable for use as pozzolana. In this study, it is working to produce CCA mixed cement in a factory-controlled environment because it is an ordinary portland cement. The CCA used is produced by grinding the dried corn mandrel to a diameter of about 4.00 mm to enhance enough combustion and reduce the impact pozzolana properties of CCA.

2. EXPERIMENTAL INVESTIGATION

The commonly used mix of 20 MPa was used for this study. The concrete mix design was done as per IS 456:2000 and IS 10262:2009. The materials were tested for various properties wanted for the mix design. The cement used for the complete experiment is Ordinary Portland Cement of grade 53 cement. The coarse aggregates were of size 20 mm and downgraded and the fine aggregate used was M-sand.

Water to binder ratio (0.45) and three different replacement percentages (OPC, 10%, 20%, and 30% by weight of cement) were adopted. For each replacement percentage, three samples were casted for the experiments (3 specimens for 28 days) and results have been reported in this paper. The concrete mix was prepared to have a design compressive strength of 20 N/mm2 at 28 days. The waste of concern in this study is corn cob ash (CCA). Use corn cob ash (CCA) as a pozzolana, without considering this chemical CCA suitable for use as pozzolana. Use a local blacksmith furnace using charcoal as a fuel, burning ground coke in the open air.

Corn Cob powder

Tests carried on the tough concrete were compressive strength test (Conforming to IS 516:2000), flexural strength test (conforming to IS 516:2000) and splitting tensile strength test (conforming to IS 5816:2000). Mechanical tests were performed at, 28 days, on three specimens. A digital compression testing machine (conforming to IS 516:2000) was used for compressive strength and splitting tensile strength. For flexural strength test 3point loading system was employed. The maximum load at failure was taken for strength comparison. Table 1 represent chemical properties of OPC 53 and table 2 represent chemical properties of corn cob ash.

Table 1 chemical properties of the cement

	Particular	Value
	Chemical properties	
1	SiO2 (%)	20.02
2	Al2O3 (%)	4.70
3	Fe2O3 (%)	3
4.	CaO (%)	61.9
5.	MgO (%)	2.60
6.	Na2O (%)	0.19
7.	K2O (%)	0.82
8.	SO3 (%)	3.9
9	Loss of Ignition	1.9

Chart 1 chemical properties of the cement

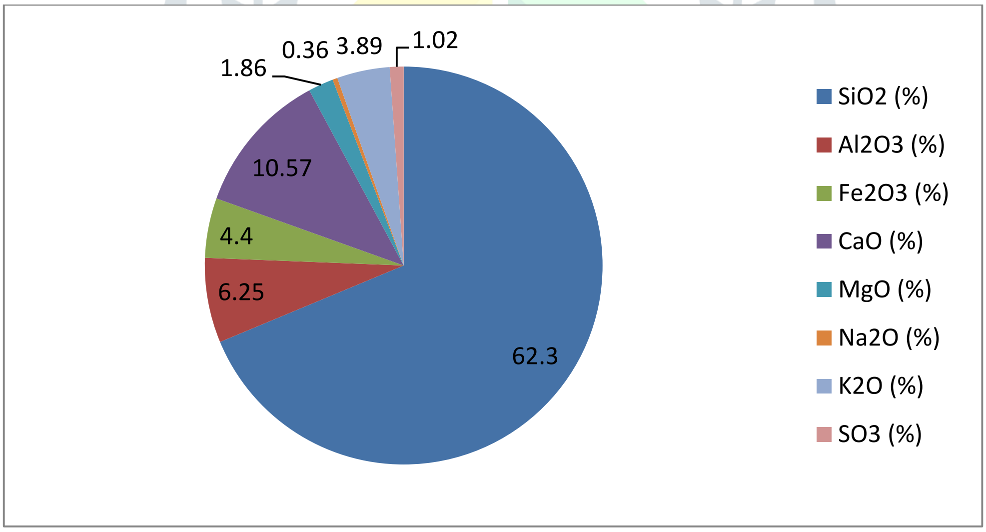
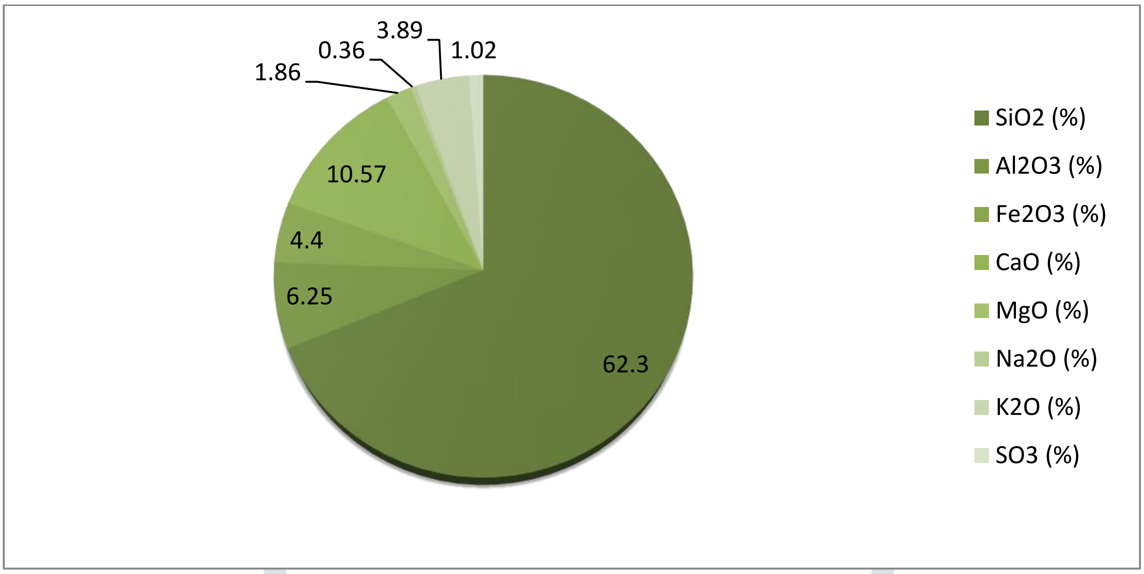


Table 2 chemical properties of the CCA

S.No	Particular	Value
	Chemical properties	
1	SiO2 (%)	62.30
2	Al2O3 (%)	6.25
3	Fe2O3 (%)	4.40
4.	CaO (%)	10.57
5.	MgO (%)	1.86

6.	Na2O (%)	0.36
7.	K2O (%)	3.89
8.	SO3 (%)	1.02

Chart 2 Chemical properties of the CCA



3. RESULTS AND DISCUSSION

Physical and chemical analysis of CCA and cement

The physical properties of cement and CCA are given in Table 1 and Table 2. The specific gravity and mean size of CCA was found to be less than that of cement. Chemical composition data for the cement and CCA is also presented in Table 1 and Table 2. This particular specimen of CCA contains 62.30% of silica as related in Table 2. The total percentage of Iron Oxide, Silicon Oxide and Aluminium Oxide when added together was greater than the minimum 70% specified by for pozzolanas (ASTM 618, 2005). The high percentage of silicon oxide is beneficial in pozzolanic reaction with time.

Compressive strength

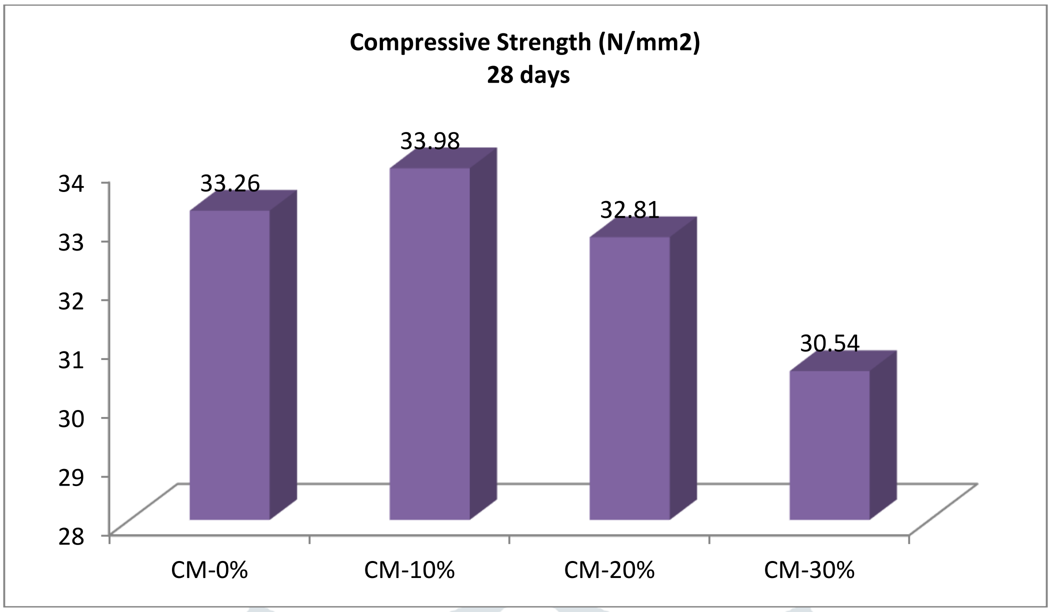
Table 3 presents the results of compressive strength of CCA blended cement concrete. The test was achieved at age of 28 days. This observation is also reported by many researchers alike as Adesanya A, Raheem A, (2009) who reported that compressive strength of concrete having variable replacement percentage of CCA was lower than that of control specimen at 28 days compressive strength of concrete with variable replacement percentage of CCA was higher than the corresponding concrete mixtures without CCA.

Table 3 Result of compressive strength

Water binder ratio	Replacement %Age	Compressive Strength (N/mm^2)
0.45		28 days
	CM-0%	33.26
	CM-10%	33.98
	CM-20%	32.81
	CM-30%	30.54

But irrelevant development in strength was observed for CCA mixed concrete at lower ages. This can be credited to the fact that pozzolanic reaction is slow at early age's strength.

Chart 3 Comparison of Compressive Strength of cubes after 28 days



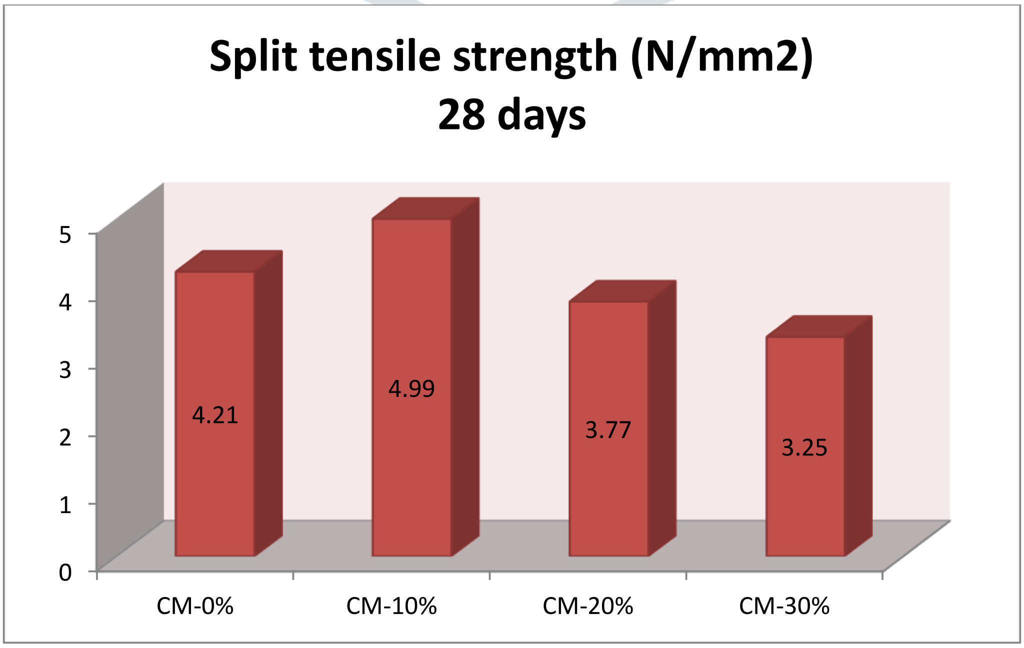
Split tensile strength:

The split tensile strengths of CCA blended concrete at 28 days, is presented in Table 4. Split tensile strength also showed the same trend of higher strength in CCA blended concrete having higher age (28 days) as compared to control specimen however the increased was less marked as compared to compressive strength. Chart 5 present values of split tensile strength increases at 10% replacement of cement at 28 days.

Table 4 Result of Split tensile strength

Water binder ratio	**Replacement %Age**	**Split tensile strength (N/mm^2)**
		28 days
0.45	CM-0%	4.21
	CM-10%	4.99
	CM-20%	3.77
	CM-30%	3.25

Chart 4 Comparison of Split tensile strength of cubes after 28 days



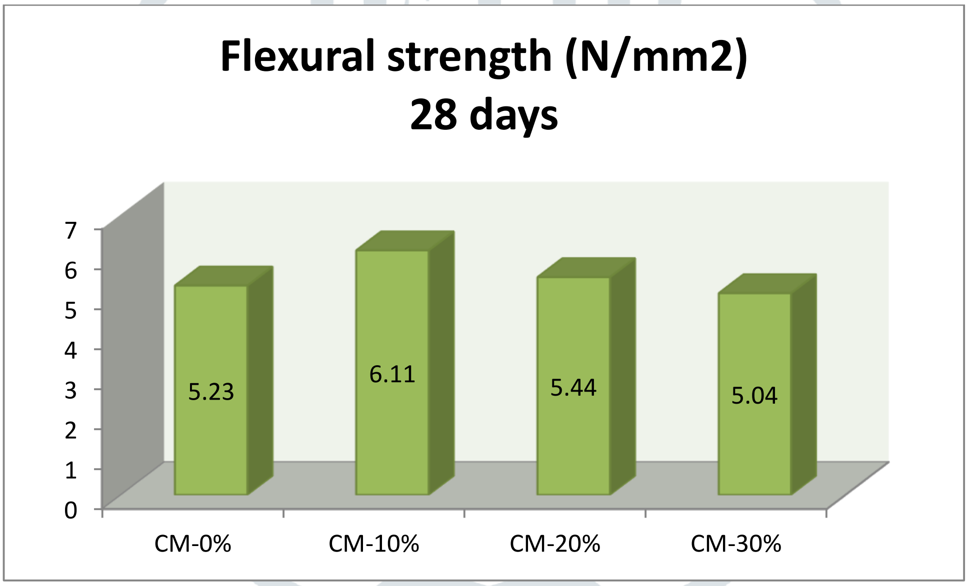
Flexural strength

The flexural strength of CCA mixed concrete at 28 days, days is existing in Table 5. Flexural strength result presents a difficult result pattern. Flexural strength also showed the same trend of higher strength in CCA blended concrete having higher age (28 days) as compared to control specimen however the increased was less pronounced as compared to compressive strength. It shows that pozzolanic activity was continued after curing period at 28 days. Chart 4 present values of flexural strength increases at 10% replacement of cement at 28 days.

Table 5 Result of Flexural strength

Water binder ratio	Replacement %Age	Flexural strength (N/mm^2)
		28 days
0.45	CM-0%	5.23
	CM-10%	6.11
	CM-20%	5.44
	CM-30%	5.04

Chart 5 Comparison of Flexural Strength of cubes after 28 days



4. CONCLUSIONS

Following are conclusions drawn on the basis of the results obtained from the experimental works:

1. The CCA can be used to replace 10% of the concrete in concrete production because this alternative reduces the strength of the concrete beyond the control.
2. A considerable improvement in the flexural strength and split tensile strength was seen at 10% replacement of cement
3. CCA is pozzolanic and is consequently suitable for concrete production.
4. Utilization of CCA for production of concrete will reduce overall concrete cost and also reduces the amount of waste in the environment.
5. Strength of concrete rises with curing age and declines as percentage replacement of CCA increases.

5. REFERENCES

I. ApriantEi,ShafighP,BahriS,Farahani J (2015) Supplementary cementitious materials origin from agricultural wastes – A review Construction and Building Materials 74 (2015) 176–187.
II. Antonio P, Yeargin R, Fini E and Abu-Lebdeh (2014)- investigating effects of introduction of corn cob ash into Portlandcementconcrete:mechanical and thermal properties- American Journal of Engineering and Applied Sciences 7 (1): 137-148, 2014
III. A S Alkali. 2016, Optimization of Activated Carbon Preparation from Corncob Wastewater Treatment, Ph. D. Dissertation.
IV. Department of Chemical Engineering, Faculty of Engineering Ahmadu Bello University, Zaria, Nigeria
V. D A Adesanya and A A Raheem. A study of the permeability and acid attack of corn cob ash blended cements. Construction and Building Materials. 2010; 24, 403 – 409.
VI. E E Ikponmwosa, M A Salau and W B Kaigama. Evaluation of Strength Characteristics of Laterized Concrete with Corn Cob Ash (CCA) Blended Cement. IOP Conf. Series: Materials Science and Engineering. 2009; 96, 1-9.

VII. F Faleschini,, P De Marzi, and C Pellegrino. Recycled concrete containing EAF slag: environmental assessment through LCA. European Journal of Environmental and Civil Engineering. 2014; 18, 1009-1024

VIII. RAHEEM A, OYEBISI S, AKINTAYO S and OYENIRAN M (2010) Effects of Admixtures on the Properties of Corn Cob Ash Cement Concrete- Leonardo Electronic Journal of Practices and Technologies 13-20

IX. T M Toryila. Partial Replacement of Cement with Corn Cob Ash. International Journal for Innovative Research in Multidisciplinary Field. 2016; 2(7), 159-169

X. K Saini, V Chaudhary, A Bisnohi, H Agarwal, M Ram, S Saraswat. Effect on strength properties of concrete by using waste wood powder as partial replacement of cement. SSRG International Journal of Civil Engineering (SSRG-IJCE). 2016; 3(5), 172-176.