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Experimental Study on Use of Corn Cob Ash in Concrete

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Abstract*—Cement is the most utilized construction material, and second most consumed in the world after water. Its demand has increased proportionately with the rise in population in a bid to match the required development. The heavily energy-intensive processes that are involved in its production contribute to about 7-10% of the total global emissions, with potentially adverse environmental implications, and are also economically expensive. This study investigated the ability of Corn Cob Ash (CCA) to be used as partial replacement of cement. CCA was obtained and used to replace cement partially in specified ratios of 10%, 15%, 20%. Results were compared with a conventional concrete, which was made with 100% cement. The potential of corn cob ash CCA as an alternate cementitious material was calculated. The physical, chemical and mineralogical characteristics of CCA were studied and analyzed. CCA can be used as partial replacement for cement in concrete production as well as for walls of building units and other works of mild construction. Impact Test, Crushing Test and Shape Test were conducted on aggregates and found satisfactory results.*

Keywords—Cementitious materials, Compressive strength corncob ash, partial cement replacements, pozzolanas

I. INTRODUCTION

Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens after specific time. For production of concrete the most commonly used material is Portland cement. Concrete technology give information about properties of concrete and its practical applications. Concrete is required for the construction of foundations, columns, beams, slabs and other load bearing elements of the structure. Apart from cement different types of binding material used are lime for lime concrete and bitumen for asphalt concrete which is used for road construction. Required strength is obtained by mixing the materials in required proportions. Strength of mix is given as M5, M10, M15, M20, M25, M30 etc, in which M signifies mix and 5, 10, 15 is their strength is in kN/m2.When water is mixed with materials, hydration reaction starts. This reaction helps ingredients to form a bondthat binds the materials together into a durable stone-like material. Concrete can be casted in any shapeand size. Because it is a plastic material which is in normal state, various types of shapes and sizes of formworks are used to provide different shapes such as rectangular, circular etc. It is said that 7% of the world's carbon dioxide emission is because of Portland cement industry.Because of the significant contribution to the environmental pollution, to the high consumption of natural resources like limestone and the high cost of Portland cement etc., we cannot go on producing more and more cement. There is need to reduce the use of cement. One of the practical solutions to reduce use of cement is to replace cement with supplementary cementitious materials like corn cob ash. So by the research and test we decided to use Corn Cob Ash and replace it partially with cement. Corn cob is the hard thick cylindrical central core ofmaize (on which are borne the grains or kernels of near of corn). It is an agricultural waste product obtained from maize or corn which is the most important cereal crop insub-Saharan Africa.Corn is the third most important food crops after rice and wheat in India. According to the advance estimate, it is cultivated in 8.7 m ha (2010-11) mainly during kharif season which covers 82% area. In India maize contributes nearly 10% the national food basket and more than ₹101 billion to the agricultural GDP at current prices apart from the generating employment to over 100 million man-days at the farm and downstream agricultural and industrial areas. The use

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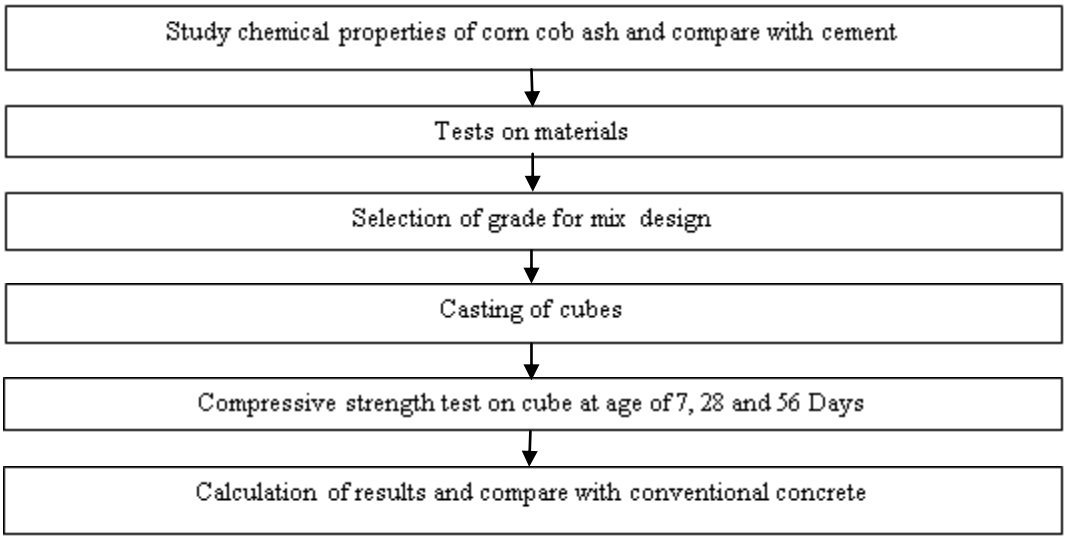
of corncob ash with normal strength is a new innovation of concrete design, and if large-scale applications will reform the construction industry through cost savings. The chemical composition of pozzolanas varies considerably, depending upon the source and the preparation technique. Pozzolanascontains silica, alumina, iron oxide and a variety of oxides and alkalis, each in varyingdegrees. Use of corn cob ash as a pozzolanas, without accounting this chemical CCAsuitable for use as pozzolanas. In this study, it is working to produce CCA mixed cement in afactory controlled environment because it is an ordinary portland cement. The CCA used isproduced by grinding the dried corn mandrel to a diameter of about 4.00 mm to enhancesufficient combustion and reduce the impact pozzolanas properties of CCA.

II. MATERIAL AND METHOD

2.1 Methodology



2.2 Materials

2.2.1. Cement: The Ordinary Portland Cement (OPC) 53 grade cement is used in the project work. Table 1 shows the Compressive strength of the cement.

Table 1
Chemical Properties of Cement

Sr. No.	Particular	Value
	Chemical Properties (%)	
1	SiO_2	20.02
2	Al_2O_3	4.7
3	Fe_2O_3	3.0
4	CaO	61.90
5	MgO	2.60
6	Na_2O	0.19
7	K_2O	0.82
8	SO_3	3.9
9	Loss of Ignition	1.9

2.2.2. Coarse Aggregate: Aggregates are important and most used constituents in concrete.
2.2.3. Fine Aggregate: Crushed sand is used as fine aggregate.

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2.2.4. Corn Cob Ash: The CCA used is produced by grinding the dried corn mandrel to a diameter of about 4.00 mm.

Table 2
Chemical Properties of CCA

Sr. No.	Particular	Value
	Chemical Properties (%)	
1	SiO_2	62.30
2	Al_2O_3	6.24
3	Fe_2O_3	4.40
4	CaO	10.56
5	MgO	1.86
6	Na_2O	0.35
7	K_2O	3.89
8	SO_3	1.02

2.3 Mix Design

Table 3
Mix Proportion

Sr. No.	Replacement of CCA with cement	Cement Content (kg/m^3)	Corn Cob Ash Content (kg/m^3)	10 mm Aggregate (kg/m^3)	20 mm Aggregate (kg/m^3)	Crushed Sand (kg/m^3)	Water (kg/m^3)	Admixture (kg/m^3)
1	0%	400	00	472	584	778	211	4
2	10%	360	40	472	584	778	211	4
3	15%	340	60	472	584	778	211	4
4	20%	320	80	472	584	778	211	4

2.4 Experimental Investigation

The commonly used mix of 30 MPa was used for this study. Concrete mix design was done as per IS 456:2000 and IS 10262:2009. Materials were tested for various properties needed for mix design. Three different replacement percentages (OPC, 10%, 15%, 20% by weight of cement) were adopted. For each replacement percentage, three samples were casted for the experiments (3 specimen for 7 days, 3 specimen for 28 days, 3 specimen for 56 days, 3 specimen for 91 days) and the average of the three results has been reported on this paper.

Tests carried on the aggregates are Impact test, Crushing test and shape test. Tests carried on the hardened concrete were compressive strength test (Confirming to IS 516:2000). A compression testing machine was used for compressive strength.

2.5 Results and Discussion

2.5.1 Tests on aggregate:

Aggregate Impact Value was recorded as 15.89%.

Aggregate Crushing Value was recorded as 14.715%.

% Elongation was recorded as14.01% and % Flakiness was recorded as 12.24%.

2.5.2 Compressive Strength of concrete

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Table 4
Results of Compressive strength

% added sugarcane liquid	Compressive strength (f'c) (MPa)		
	7 days	28 days	56 days
Convention Concrete	i. 27.48	i. 38.7	i. 43.40
	ii. 29.33	ii. 39.3	ii. 44.02
	iii. 28.69	iii. 41.7	iii. 43.68
	Avg = 28.50	**Avg = 39.9**	**Avg = 43.70**
10% CCA 90% Cement	i. 26.43	i. 38.6	i. 42.50
	ii. 27.30	ii. 37.23	ii. 41.98
	iii. 25.56	iii. 40.08	iii. 43.47
	Avg = 26.43	**Avg = 38.65**	**Avg = 42.65**
15% CCA 85% Cement	i. 25.20	i. 37.43	i. 39.89
	ii. 26.21	ii. 37.20	ii. 40.88
	iii. 24.22	iii. 37.06	iii. 42.2
	Avg = 25.21	**Avg = 37.23**	**Avg = 40.99**
20% CCA 80% Cement	i. 24.70	i. 37.20	i. 39.82
	ii. 24.19	ii. 36.27	ii. 40.20
	iii. 23.76	iii. 36.21	iii. 39.59
	Avg = 24.05	**Avg = 36.56**	**Avg = 39.87**

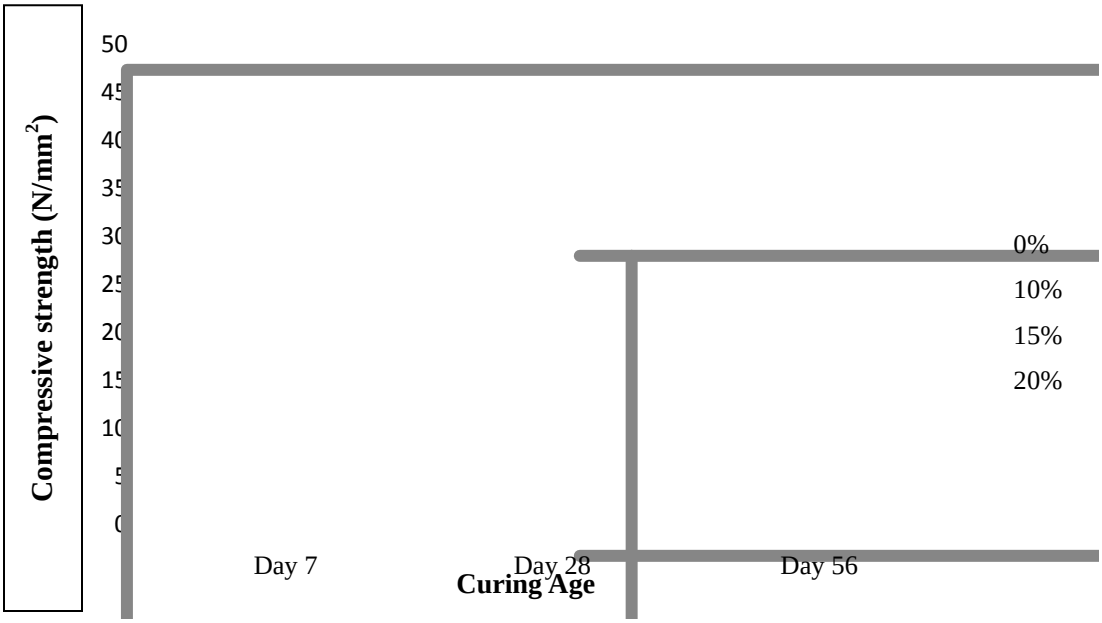

Figure 1: Compressive strength of cubes at age of 7 Days and 28 Days

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TABLE 5
COMPARISON BETWEEN MAIN METHOD

Sr. No.	Paper Name	Advantages	Disadvantages
01.	Experimental study on corn cob ash powder as partial replacement of cement in concrete.	Corn cob ash (CCA) is a suitable pozzolanic material.	Rebound hammer value decreases.
02.	Investigating effects of introduction of corncob ash into Portland cement concrete: mechanical and thermal properties.	Workability time of CCA blended cements increases with the increase of CCA percentage.	Increasing the percentage of CCA more than 10% reduces the bonding.
03.	Suitability of corncob as a supplementary cementitious material.	CCA can be used as a supplementary cementitious material to mitigate on the cost of cement and its impact on the environment.	When percentage of CCA were increased to above 10%, the overall concrete compressive strength was decreased.
04.	Strength properties of corn cob ash concrete.	The use of locally available material in construction will be met with the corn cob ash as a construction material.	Concrete with the presence of corn cob ash required 90 days of curing for gaining max strength.

III. CONCLUSION

I. CCA is a suitable pozzolanic material.
II. These results show that CCA can be used as a supplementary cementitious material to mitigate on the cost of cement and its impacts on the environment.
III. Strength of CCA blended concrete is lower than that of plain cement concrete at early curing ages.
IV. Replacement of 10% of CCA gives satisfactory result and increased strength.

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