Experimental Investigation on Partially Replacement of Cement, Coarse Aggregate by Corn Cob Ash and Steel Slag

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Abstract

In this project experimental investigation carried out in concrete by use of natural waste material where cement replace by corn cob ash and coarse aggregate by steel slag for protect our environment, give better comparative strength than conventional concrete. The corn cob ash used to replace cement partially in specified ratio 5%, 10% and steel slag obtain the replacement aggregate partially in specified ratio 40%, 50% used. The following test were carried out and made comparative study with conventional concrete such as compressive strength , split tensile strength, flexural strength at the age of 7,14,28 days are conducted for the specimen also enclosed results of their replacement.

Keywords: Ordinary Portland cement, corn cob ash (CCA), Fine aggregate, coarse aggregate & steel slag (SS)

I. INTRODUCTION

Concrete is the most versatile heterogeneous construction material and the impetus of infrastructural development of any nation civil engineering practice and construction works around the world depend to a very large extent on concrete. Aggregates and cement play a major role in concrete. In India there is a great shortage of natural aggregate. Apart from this waste Generation has increased considerably and finds no way for disposal. In order to overcome this, industrial slags can be used as alternate building materials.

Steel slag is an industrial by product obtained from the steel manufacturing industry. It is a non- metallic ceramic material formed from the reaction of flux such as calcium oxide with the inorganic, non-metallic components present in the steel slag.

Corn cob ash a low cost material and can be used for the construction of any type of structure. Because cement remains the most expensive ingredient in making a concrete. The use of combination of corn cob ash and steel slag as a partial replacement for cement and coarse aggregate in concrete production is the focus of this study.

Appropriate utilization of the combination of these two materials as a partial replacement for cement and coarse aggregate will bring ecological and economic benefits to the country.

II. MATERIAL PROPERTIES

A. *Material Used*

1) Cement
2) Coarse Aggregate
3) Fine Aggregate
4) Replacement steel slag (partial Replacement of coarse aggregate 40%, 50%)
5) Replacement corn cob ash (Partial Replacement Of cement, 5%, 10%)

6) Water

1) Cement:

The ordinary Portland cement (OPC) 53 grade cement is used in the project work.

– Physical Properties of Cement

The most common cement used is an ordinary Portland cement. The Ordinary Portland Cement of 53 grades conforming. Many tests were conducted on cement; some of them are consistency tests, setting tests, soundness tests.

Table – 1
Physical Properties of Cement

Sl. No	*Physical Properties Of OPC 53 Grade Cement*	*Results*
1	*Specific Gravity*	*3.104*
2	*Standard Consistency*	*30%*
3	*Fineness Test*	*7.3%*
4	*Soundness Test*	*3mm*
5	*Initial Setting Time*	*30 min*
6	*Final Setting Time*	*10Hours*

2) Coarse Aggregates

Aggregates are the important and large used constituents in concrete. They give bond to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Crushed granite of 20mm maximum size has been used as coarse aggregate. Analysis of combined aggregates confirms to the specifications for graded aggregates.

Table – 2
Properties of Coarse Aggregate

Sl.No	*Description*	*Value*
1	*Specific Gravity*	*2.93*
2	*Impact Value*	*28.9%*
3	*Water absorption*	*2.5%*
4	*Bulk Density*	*0.72*
5	*Crushing Test*	*12.4%*
6	*Flakiness Test*	*38.67%*
7	*Elongation Test*	*34.49%*
8	*Abrasion Test*	*13.4%*

3) Fine Aggregate:

Sand collected from nearby river is used for this project. The various properties of sand are tabulated in Table II.

Table – 3
Properties of Fine Aggregate

Sl. No	*Description*	*Value*
1	*Specific Gravity*	*2.71*
2	*Bulk Density*	*0.79*
3	*Sieve analysis*	*Zone iii*

4) Steel Slag

Steel slag is one of the artificial lime stone and silica, commonly used as coarse aggregate in HPC. Slag is a partially vitreous by product of the process of smelting ore. Slag is usually a mixture of metal oxides and silicon dioxides. One of the most beneficial uses for steel slag in concrete.

Table – 5
Physical Properties of Steel Slag

Sl.No	*Description*	*Value*
1	*Specific Gravity*	*2.97*
2	*Impact Value*	*40%*
3	*Water absorption*	*4.5%*
4	*Bulk Density*	*0.71*
5	*Crushing Test*	*21.73%*
6	*Flakiness Test*	*33.90%*
7	*Elongation Test*	*32.05%*
8	*Abrasion Test*	*23.7%*

5) Corncob Ash (CCA);

The corncob was collected from Salem, a major corn cob producing rural community in Tamilnadu state. The corn cob was dried thoroughly and burnt using open air burning.

Table – 5
Physical Properties of Corn Cob Ash

Sl. No	Physical Properties Of Corn Cob Ash	Results
1	Specific Gravity	2.798
2	Fineness Test	8.2%

6) Water
Water is the important ingredient of concrete as it actively participates in the chemical reaction with cement. Potable water with pH value 7 is used for mixing and curing throughout the experiment.

III. EXPERIMENTAL INVESTIGATION

A. Mix Proportioning

The grade of concrete M30 is used further proportion of 1:1.105:2.87respectively.
Characteristic compressive strength required at the end of 28 days is 30 N/mm^2

B. Slump Cone Test

To determine consistency of concrete, Slump test was conducted with varying water content and a particular w/c is fixed according to the slump of 85mm from graph plotted. The various w/c for different proportions of cement with corn cob ash and coarse aggregate with steel slag.

C. Casting of Specimen

As the aggregate of size less than 20 mm and greater than 12.5 mm are used, cubes mould of 150x150x150 mm are used. Cylindrical mould of size 150 mm diameter and 300 mm height and beam mould of size 500x100x100mm are used for casting specimen.

D. Production of Concrete;

Cube Moulds, Cylindrical mould and beam mould of were used. They were lubricated with engine oil in order to reduce friction and to enhance removal of cubes from the moulds. They were then filled with concrete in three layers and each layer was tamped 25 times. The moulds containing the cubes were left for 24 hours under a room temperature for the cubes to set before removing the mould. The cubes were removed after 24 hours and were taken to curing tank

E. Curing of Cubes;

The method use for curing in this work is the total immersion of the cubes in water for specific age of 7, 14, and 28 days from the day of casting.

F. Compressive Strength Test

The compressive strength of concrete is one of the most important properties of concrete. Comparative strength if M_{30} grade of concrete for the partially replacement of cement and coarse aggregate by crushed was found. In this test 150x150x150mm concrete cubes were cast, by using 30 N/mm^2 concrete. The mixing was done by cubes were remolded and placed under water and cured for 28 days. Then the cubes were tested for their crushing strength at 7, 14 and 28 days.

G. Split Tensile Strength Test

The test is carried out in a cylindrical specimen of 150mm diameter and 300mm length. The cylindrical specimen is placed horizontally between the loading surface of a compression testing machine and the load is applied until failure of cylinder, along the vertical diameter.

H. Flexural Strength Test

Flexural strength is a measurement that indicates a material's resistance to deforming when it is placed under a load. The values needed to calculate flexural strength are measured by experimentation, with rectangular samples of the material placed under load in a Two-point testing setup.

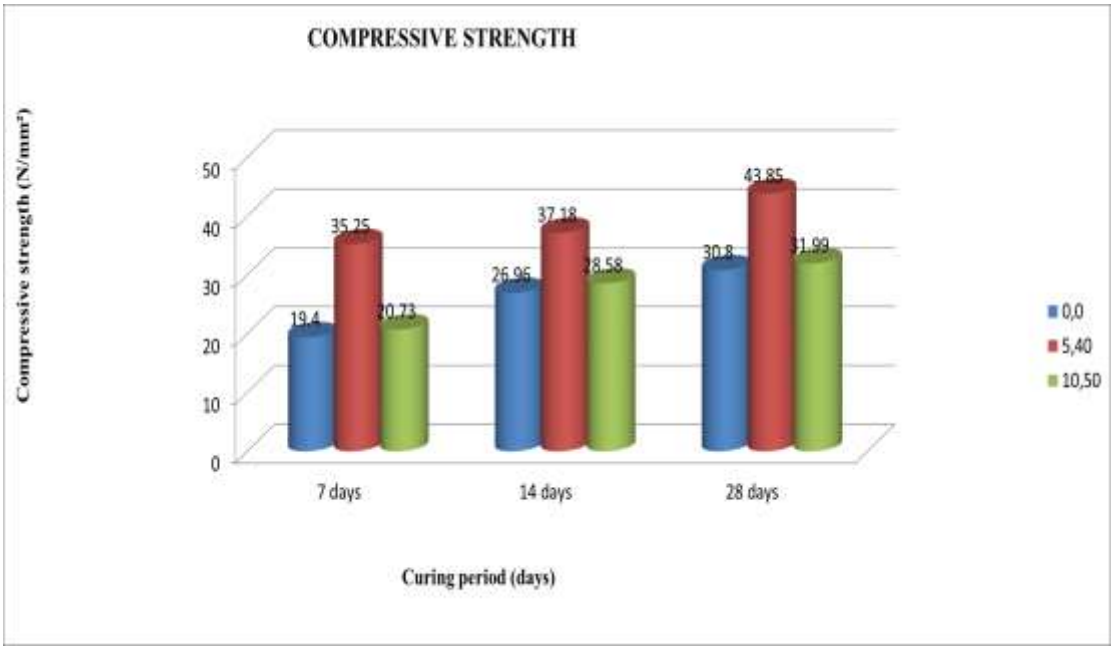
I. Test on Hardened Concrete

1) The Compressive Strength
2) The Split Tensile Strength
3) The Flexural Strength

IV. RESULT AND DISCUSSIONS

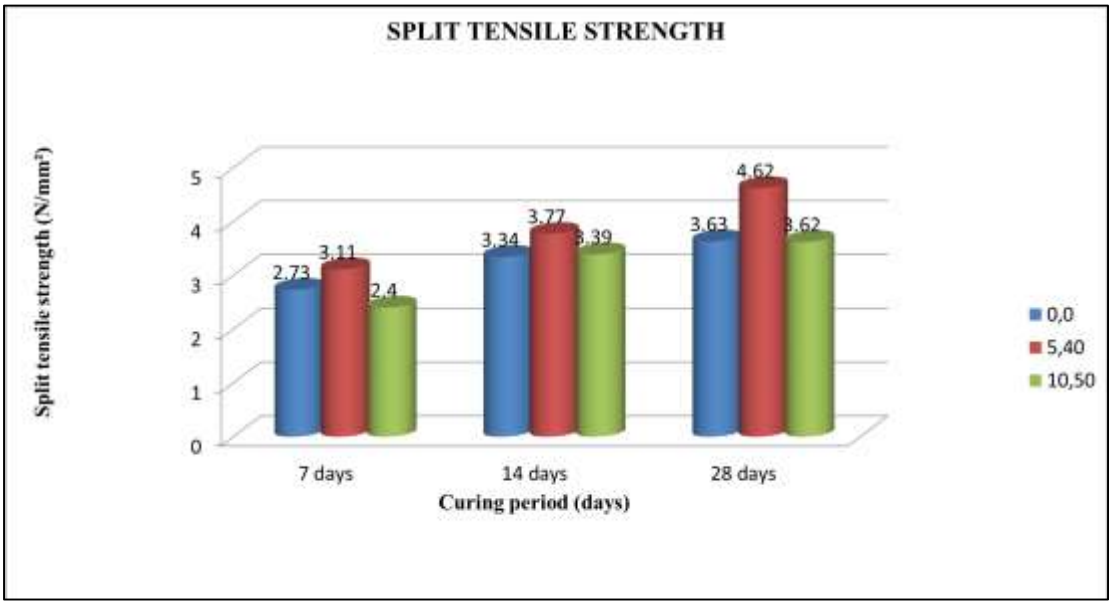
A. The Compressive Strength on Cubes

Sl. No	Mix CCA &SS (%)	Average compressive strength in N/mm^2		
		7days	14days	28days
1	0,0	19.40	26.96	30.80
2	5,40	35.25	37.18	43.85
3	10,50	20.73	28.58	31.99



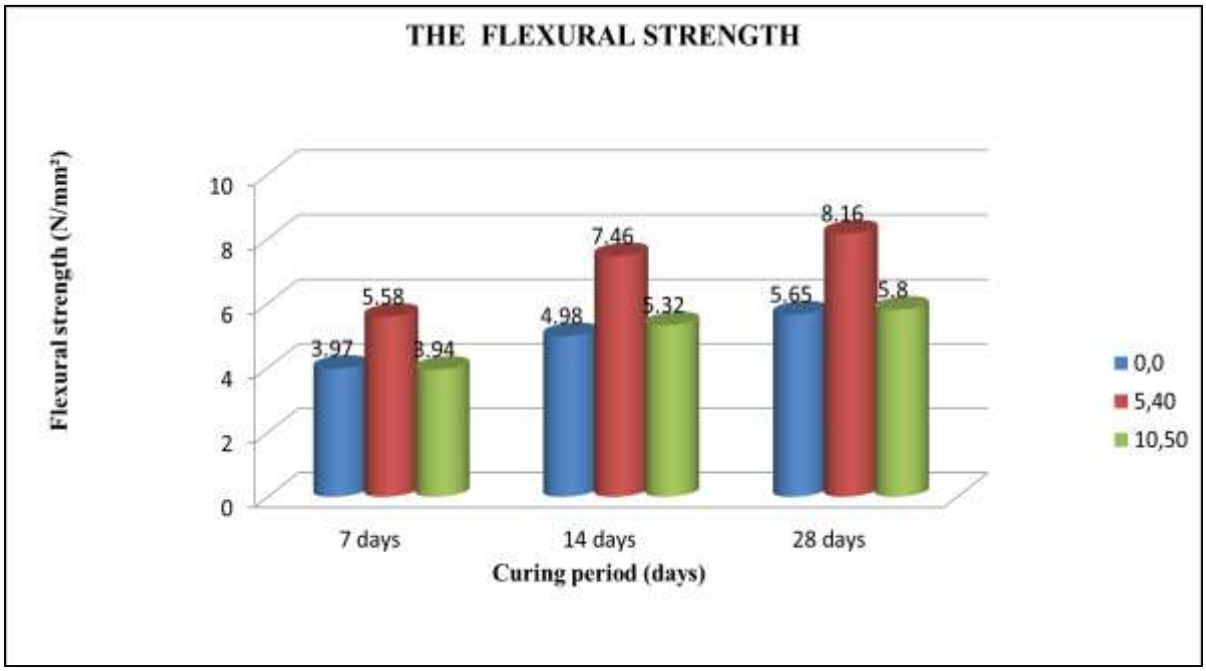
B. The Split Tensile Strength on Cylinder

Sl. No	Mix CCA &SS (%)	Average Split Tensile strength in N/mm^2		
		7days	14days	28days
1	0,0	2.73	3.34	3.63
2	5,40	3.11	3.77	4.62
3	10,50	2.40	3.39	3.62



C. *The Flexural Strength on Beam*

Sl.No	Mix CCA &SS (%)	Average Flexural strength in N/mm²		
		7days	14days	28days
1	0,0	3.97	4.78	5.65
2	5,40	5.58	7.46	8.16
3	10,50	3.94	5.32	5.80



V. CONCLUSION

From the above discussion it is concluded that:

Concrete acquires maximum increase in strength of concrete at 5% replacement of cement by corn cob ash and 40% coarse aggregate replacement by steel slag. When compared to mix proportions conventional concrete and special concrete 10% replacement of cement by corn cob ash and 50% coarse aggregate replacement by steel slag.

The increase in strength of special concrete 5% replacement of cement by corn cob ash and 40% coarse aggregate replacement by steel slag. The compressive strength increase the percentage 1.42 compared to conventional concrete and flexural strength increase the percentage1.44 compared to conventional concrete same as spilt tensile strength increase the percentage1.27 compared to conventional concrete.

Moreover with the use of corn cob ash and steel slag, the weight of the concrete reduces, thus making the concrete lighter which can be used as a light weight construction materials.

Water absorption of steel slag concrete up to 50% replacement decreased with the increased in grade of OPC.

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