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A Study on the Strength Behavior of Concrete by Partial Replacement of Cement with Cotton Plant Ash

Asst. Prof. M. Bhuvaneswari
Department of Civil Engineering
Roever College of Engineering and Technology
Perambalur.
Email ID:rmba88@gmail.com

Abstract – **Cement is widely noted to be the most expensive constituents of concrete. The entire construction industry is in search of a suitable and effective waste product that would considerably minimize the use of cements and ultimately reduces the construction cost. This paper describes the research into use of agricultural wastes in concrete through the development of concrete in corporation cotton plant ash(CPA) as a partial replacement for ordinary Portland cement(OPC). It gives the scope to utilize CPA for civil construction works as a partial replacement for cement so as to keep the environment green and also seeks to optimize the benefits of using CPA in concrete as a replacement for large proportions of cement. Different cotton plant ash (CPA) concretes were developed by replacing 10%, 20%, 30% and 40% by weight of ordinary Portland cement with CPA for M_{20} grade concrete. The results indicated that the substitution of cement with CPA in Concrete production was relatively possible not exceeding 10% having good compressive strength, Performance and durability. There was a sharp decrease in compressive strength beyond 10% of CPA substitution. The test results indicate that replacing proportions of cement with 10% CPA would provide improved strength and a most cost effective solution.**

Keywords – **Cotton Plant Ash, Cement, Fine Aggregate, Coarse Aggregate, Compressive Strength, Flexural Strength, Split Tensile Strength.**

I. INTRODUCTION

The cost of construction materials is increasing day by day because of high demand, scarcity of raw materials and high price of energy. From the stand point of energy saving and conservation of natural resources the use of alternative constituents in construction materials is now a global concern. For this, the extensive research and development works towards exploring new ingredients are required for producing sustainable and environment friendly construction materials. The present study investigates the potential use of agro solid waste in the production of construction materials. During different industrial,mining,agrucultural and domestic activities, huge quantity of solids wastes are being generated as by products which major environmental problems as well as occupy a large area of land for their storage and disposal. During production of cement about 7% of carbon-di-oxide(CO2) is released into the atmosphere and this leads to cause the environmental pollution. The gives negative influence on ecology and healthy survival of human being. According to industrial ecology concept for sustainable development by product of one industry may be a raw material for other industry.

During manufacturing of one tonnes of ordinary Portland cement, we about 1.1 tonnes of earth resources like limestone.etc. Further during manufacturing of 1 tonnes of ordinary Portland cement, and equal amount of carbon di oxide is released into the atmosphere. Thus, is the need to search for local materials as alternatives for the construction of functional but low cost buildings in both the rural and urban areas.

Cotton plant is the waste from the agricultural fields. The cotton fibre is removed from the cotton plant and this plant becomes a waste product. These plants are burnt in the fields and the ash is disposed off. This produces huge amount of solid wastes being generated and thus affects the environment. The huge amount of ash produced occupies large areas of lands and also caused environmental pollution. The present study considered both fresh and hardened properties of the normal concrete in which cotton plant ash is incorporated as the point of mix. This study examined the use of cotton plant ash (CPA) as a partial replacement for ordinary Portland cement in concrete. It involves the determination of the chemical composition of the ash and evaluation of the workability and strength of the hardened concrete.

II. LITERATURE REVIEW

Researchers are continuously being conducted to find a suitable waste product that would supplement the normally used construction materials. Each waste product has its specific effect on the properties of fresh and hardened concrete. Some industrial wastes have been studied for use as supplementary cementing materials such as fly ash, ground nut shell ash, egg shell powder, Rice husk ash, saw dust and corn cob ash. Literature is however scarce on the use of cotton plant ash.

B.A Alabadam.et,al., this paper the use of OPC and Bambara groundnut shell ash concrete. The utilization of BGSAC will promote waste management at little cost, reduce pollution by these waste and increase the economic

base of the farmer when such waste are sold thereby encourages more production. Also, BGSAC production required less energy demand compared with cement production and safe the needed foreign exchange spent on importation of cement. The main objective of this study is to investigate the suitability of BGSAC as partial replacement for cement in concrete.
Dr. Amarnath this paper describes research into use of poultry waste in concrete through the development of concrete incorporating egg shell powder. Different ESP concretes were developed by replacing 5-15% of ESP for cement. The results indicated that ESP can successfully be used as partial replacement of cement in concrete production. The data presented cover strength development and transport properties. The results further show that addition of fly ash along with ESP is beneficial for improved performance of concrete.

D.Gowsika.et.al this paper to find the strength of concrete to partial replacement of egg shell powder in cement. The result in compressive strength decrease in beyond 5% egg shell powder substitution.

A A Raheem.et..at This research consider the use of saw dust as a pozzolana in the production of concrete. The need to convert this waste product into a useful by product is the focus of the study. This study examined the use of saw dust ash as partial replacement for ordinary Portland cement in concrete. The results showed that SDA is a good pozzolana with combined Sio2, Al2 O3 and Fe2o3 of 73.07%. It was concluded that 5% SDA Substitution is adequate to enjoy maximum benefit of strength gain.

Malik batayneth et.,al This study tackles the problem of the waste that is generated from construction fields, such as demolished concrtete,glass and plastic. In order to dispose of or at least reduce the accumulation of such wastes, it has been suggested to reuse some of these wastes to substitute a percentage of primary materials used in the ordinary Portland cement (OPC) concrete. Such recycling not only helps conserve natural resources, but also helps solve a growing waste disposal crisis.

III.METHODOLOGY AND MIX DESIGN

Constituent Materials

Table 1 Material Test Results

Properties	Results
Fineness Test on Cement	6.7%
Specific Gravity of Cement	3.1
Specific Gravity of Coarse Aggregate	2.75
Specific Gravity of Fine Aggregate	2.7
Zone	II
Specific Gravity of CPA	3.12
Standard Consistency test	32%
Initial Setting time	30minutes
Slump Cone atest	75mm
Compaction Factor Test	0.8
Fineness of Fine aggregate	1.71
Fineness of Coarse aggregate	2.41

Mix design

Water cement ratio **0.5**, weight of cement is **372 kg/m^3** , weight of Fine aggregate is **600.53 kg/m^3** and weight of Coarse aggregate is **1241.845kg/m^3**. A mix ratio is **1:1.6:3.3:0.5**

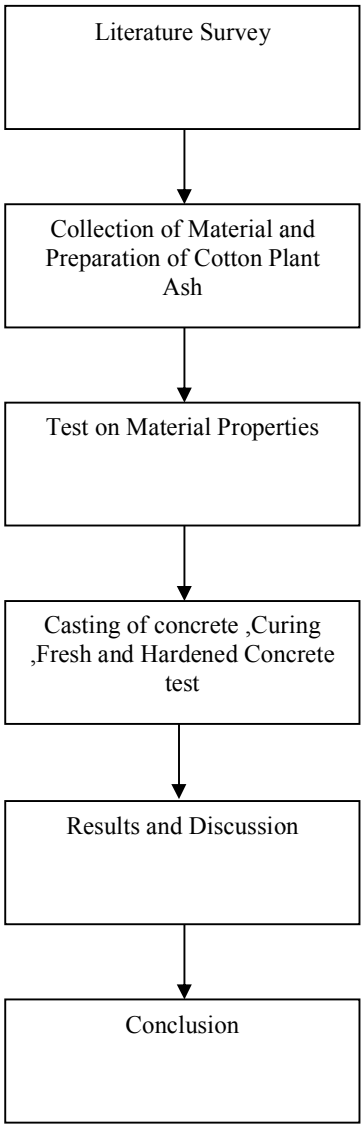

Figure 1 Mix Design.

IV RESULT AND DISCUSSION

1. Hardened Concrete Test

Table 2 Compression test in 7, 14& 28 days.

% of CPA mix	Compressive Strength (N/mm²) 7 Days	Compressive Strength (N/mm²) 14 Days	Compressive Strength (N/mm²) 28 Days
0	14.69	18.45	23.42
10	13.08	18.06	24.42
20	11.27	12.87	17.92
30	8.71	9.09	13.55
40	2.99	6.01	10.08

Compressive strength in 7,14 &28 days

The cube compressive strength of concrete in determined by conducting tests on 150mm x 150mm x 150mm cube in specimen at 7 ,14and 28 days test shown in figure 2 . The cubes are placed in the Universal Testing Machine.

The Compressive Strength of Concrete in 7, 14 and 28 days for with 0%,10%,20%,30% &40% Cotton Plant ash with partial replacement of cement .

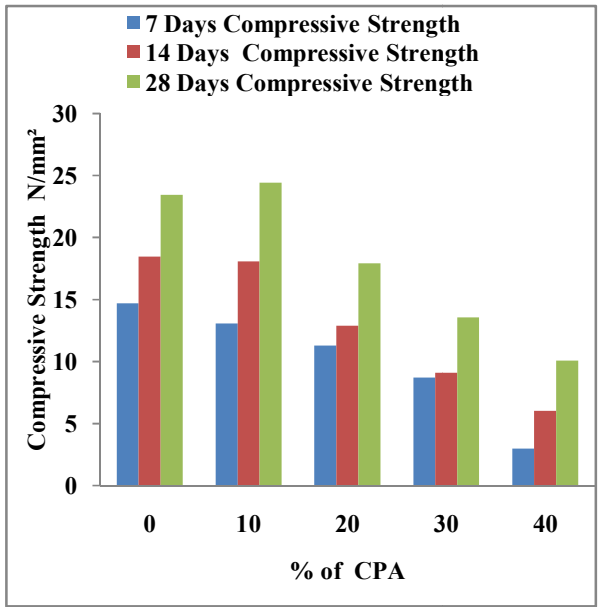

Figure 2 Compressive Strength in 7,14 &28 days.

The Compressive Strength of Concrete by using partial replacement of 10% CPA shows 4.26% increase when compared to Conventional Concrete. The Compressive Strength of Concrete by using partial replacement of CPA 20% shows 23% decrease when compared to Conventional Concrete.

The Compressive Strength of Concrete by using partial replacement of CPA 30% shows 42% decrease when compared to Conventional Concrete. The Compressive Strength of Concrete by using partial replacement of CPA 40% shows 56% decrease when compared to Conventional Concrete

2. Split Tensile Strength

The split tensile strength of concrete in7,14 & 28 days for 0%,10%,20%,30% &40% Cotton Plant ash with partial replacement of cement . The specimen will be cylindrical in shape in 150mm diameter and 300mm long.

The Split Tensile Strength of Concrete by using partial replacement of CPA 10% shows 5.45% decrease when compared to Conventional Concrete. The Split Tensile Strength of Concrete by using partial replacement of CPA 20% shows 10.15% decrease when compared to Conventional Concrete.

Table 3 Split Tensile strength in 7,14 & 28 days.

% of CPA mix	Split Tensile Strength (N/mm²) 7 Days	Split Tensile Strength (N/mm²) 14 Days	Split Tensile Strength (N/mm²) 28 Days
0	1.665	1.932	2.126
10	1.648	1.824	2.016
20	1.482	1.575	1.93
30	1.37	1.537	1.713
40	1.27	1.344	1.526

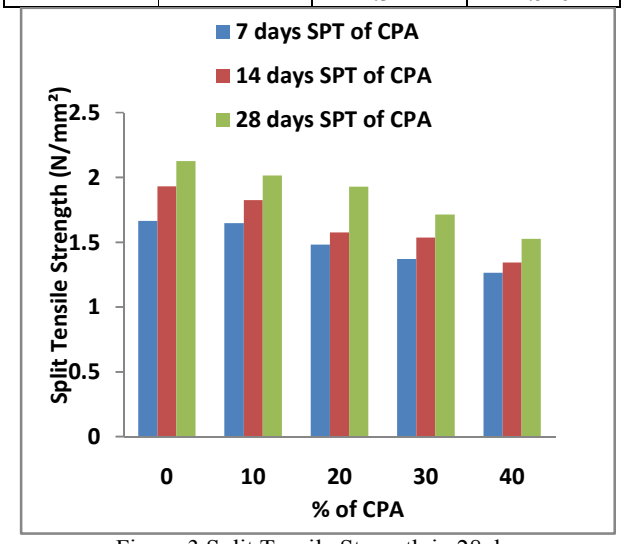

Figure 3 Split Tensile Strength in 28 days

The Split Tensile Strength of Concrete by using partial replacement of CPA 30% shows 24.10% decrease when compared to Conventional Concrete. The Split Tensile Strength of Concrete by using partial replacement of CPA 40% shows 39.31% decrease when compared to Conventional Concrete.

III. Flexural Strength

The Flexural strength of concrete in 7,14 &28 days for for 0%,10%,20%,30% &40% Cotton Plant ash with partial replacement of cement. The prism size is 100mmx100mmx500mm.

Table 4 Flexural strength in 7,14& 28 days.

% of CPA mix	Flexural Strength (N/mm²) 7 Days	Flexural Strength (N/mm²) 14 Days	Flexural Strength (N/mm²) 28 Days
0	6.57	6.925	7.18
10	5.935	6.045	6.645
20	4.815	5.415	5.72
30	4.60	5.085	5.615
40	3.97	4.52	5.185

The Flexural Strength of Concrete by using partial replacement of CPA 10% shows 8.05% decrease when compared to Conventional Concrete .The Flexural Strength of Concrete by using partial replacement of CPA 20% shows 25.52% decrease when compared to Conventional Concrete .

The Flexural Strength of Concrete by using partial replacement of CPA 30% shows 27.81% decrease when compared to Conventional Concrete .The Flexural Strength of Concrete by using partial replacement of CPA 40% shows 38.47% decrease when compared to Conventional Concrete.

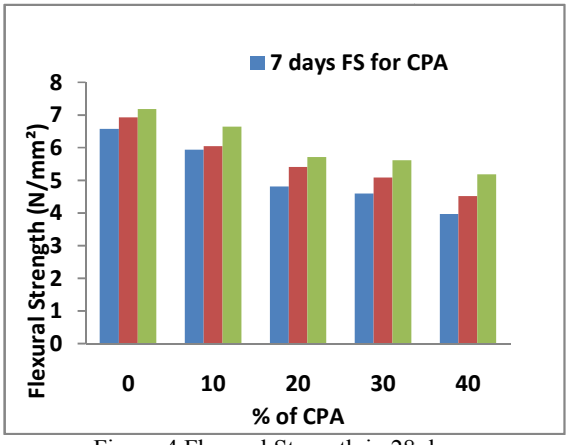

Figure 4 Flexural Strength in 28 days.

V. Conclusion

The results of the various tests and analysis carried out in this study, the following conclusion can be drawn. Cotton plant ash obtained from agricultural wastes is added in various ratios for cement (OPC) replacement. CPA is a suitable material for use as a pozzolana, since it satisfies the requirement for such a material by having a c combined (SIO_2+ Al_2o_3+Fe_2o_3) of more than 65%. There exists a high possibility for partial replacement of cement with cotton plant ash in concrete. However, percentage of CPA replacement has influence on concrete properties. It was found that replacement of 10% CPA substitution is adequate to enjoy maximum benefit of strength gain. CPA replacement greater than 10% had lower strength than nominal concrete. Though the strength of OPC/CPA concrete was lower than that of 100% cement, it can be used for light load bearing elements. People can be educated to utilize this material as building material so as to remove the disposal problem and keep the environment green.

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