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STUDIES ON THE FRESH AND HARDENED PROPERTIES OF BINARY BLENDED GREEN CONCRETE BY USING FLY ASH

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ABSTRACT

The February 2007 report issued by the international panel on climate change (IPCC) has stated in no uncertain terms that global warming is no longer an issue that has to be debated. According to the report, global warming is here, and drastic actions are needed for the long term sustainability of our environment. It is in this context that this paper discusses the roll of supplementary cementing materials as partial replacements for cement in concrete for reducing green house gas emissions. Due to growing interest in sustainable construction, engineers and architects are motivated to choose the materials which are more sustainable. Green concrete capable for sustainable construction is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of the environment. Replacement of materials over nominal concrete is what makes green concrete more environmental friendly concrete. Marble sludge powder, quarry rocks, crushed concrete and fly ashes are some of the materials used for making green concrete, a sustainable construction. Now a day's OPC is widely used and it is the costly ingredients in the production of concrete. The manufacture of OPC is expensive and skill intensive process, besides polluting the environment heavily production is associated with the emission of carbon dioxide which is a significant source of global warming. Pozzolanic materials are widely used in concrete and mortars for various reasons particularly for reducing the amount of cement required for making concrete which lead to a reduction in construction cost. In the present experimental investigation an attempt is made to study the workability and strength properties of M30 grade green concrete by using supplementary cementing materials (SCMs) as partial replacement of cement.

KEYWORDS: Compressive Strength, Fly Ash, Green Concrete, Superplastisicer, Workability

INTRODUCTION

Concrete has played significant role in the key development of the world for last one and half century. Concrete became widely popular material due to its versatility, excellent resistance to water, low cost, and availability of ingredients across the world [1].

Global warming is a key challenge for our planet and reducing the amount of energy intensive building materials such as Portland cement in the concrete is desirable as the Portland cement industry is one of the largest producers of carbon dioxide [2].

The production of one ton of Portland clinker produces approximately one ton of carbon dioxide. The use of fly ash from the combustion of coal as a partially replacement of Portland cement can offset the emission of green house gas [3].

Extensive research on the replacement of Portland cement by fly ash has been conducted worldwide. In the last fifteen years, many researchers investigated the use of High Volume Fly Ash (HVFA) in concrete to decrease the level of green house gases and to promote sustainability in concrete construction, presented two case histories wherein 70% cement was replaced by class C fly ash to pave a 254 mm thick road way [4, 5].

The SCMs such as flyash, Blast furnace slag, silica fume and metakaolin which are generally very fine, may be finer than cement, when added to concrete in right proportion can improve the strength and durability of concrete drastically and high strength and high performance concrete is obtained in this manner. One major concern about the concrete is its sustainability. Every tone of cement produces equal amount CO_2 through consumption of fuel in burning and decomposition of $CaCO_3$ thus control of green house gas emission is major issue in the context of sustainable concrete. Use of SCM, especially other industrial by-product such as blast furnace slag, flyash in concrete to reduce OPC clinker consumption is currently being considered as a major step towards achieving sustainability of concrete. Composite cements containing more than one SCM can be used where ever appropriate [6].

The use of high volume fly ash system for sustainable development resulting in production of such concrete with reasonable cost with the lowest possible environmental impacts In view of the global sustainable development, it is imperative that SCM be used to replace large proportion of cement in the concrete industry, and the most available SCM worldwide is fly ash [7].

An experimental investigation on the effect SCMs on strength and durability of concrete cured for a short period of time 14 days. This work primarily deals with the characteristics of these materials, including strength, durability, and resistance to wet and dry and freeze and thaw environments [8].

In the present experimental program fly ash at 0%, 25% and 50% is partially replaced with cement for the development of green concrete to study the workability characteristics and strength properties of M30 grade concrete.

MATERIALS AND METHODS

Cement

Ordinary Portland cement Zuari-53 grade conforming to IS: 12269-1987 [9] was used in concrete. The physical properties of the cement are listed in Table 1.

Table 1: Physical Properties of Zuari-53 Grade Cement

Sl. No.	1	2	3	4	5		
Properties	**Specific Gravity**	**Normal Consistency**	**Initial Setting Time**	**Final Setting Time**	**Compressive Strength(Mpa)**		
Values	3.15	32%	60 min	320 min	3 days	7 days	28days
					29.4	44.8	56.5

Aggregates

A crushed granite rock with a maximum size of 20mm with specific gravity of 2.70 was used as a coarse aggregate. Natural sand from Swarnamukhi River in Srikalahasti with specific gravity of 2.60 was used as fine aggregate conforming to zone- II of IS 383-1970 [10]. The individual aggregates were blended to get the desired combined grading.

Water

Potable water was used for mixing and curing of concrete cubes.

SUPPLEMENTARY CEMENTING MATERIALS

Fly ash Class – C

The fly ash is supplied from M/S. Sri Srinivasa Minerals Chennai. The chemical properties are presented in Table 2.

Figure 1: Flyash Class - C

Table 2: Chemical Properties of Flyash-C

S. No	Chemical Composition	Percentage (%)
1	Silica(SiO_2)	49-67
2	Alumina(Al_2O_3)	16-29
3	Iron oxide(Fe_2O_3)	4-10
4	Calcium oxide(CaO)	1-4
5	Magnesium oxide (MgO)	0.2-2
6	Sulphur(SO_3)	0.1-2
7	Loss of ignition	0.5-3

Superplasticizer

Varaplast PC 432 is a chloride free, superplasticising admixture based on selected synthetic polymers. It is supplied as a brown solution which is instantly dispersible in water and also it can provide very high level of water reduction and hence major increase in strength can be obtained coupled with good retention of workability to aid placement.

Table 3: Properties of Superplasticizer

Supply forms	Liquid
Colour	Brown
Specific gravity	1.08
Chloride content	Nil

MIX PROPORTION

In the present work, a proportion for concrete mix design of M30 grade was carried out according to IS: 10262-2009 [11] recommendations. The mix proportions are presented in Table 4.

Table 4: Mix Proportion for M30 Concrete

Trial mix	Cement	Fine Aggregate	Coarse Aggregate	Water	Secondary Cementing Materials	Super-Plasticizer
Composition in Kg/m^3	298	706	1117	186	115	7.7
Ratio in %	1	2.369	3.748	0.624	0.385	0.0258

RESULTS AND DISCUSSIONS

The compression tests were carried out as per IS: 516-195 [12]. The 150mm size cubes of various concrete mixtures were cast to test compressive strength. The cubes specimens after de-moulding were stored in curing tanks and on removal of cubes from water the compressive strength were conducted at 7 days, 28 days. The test results were compared with controlled concrete and are represented in Figure 2. The workability test results are presented in Table 5.

Table 5: Workability Results of Concrete

Replacement of Cement with Fly Ash	Workability (Slump in cm)
100% OPC	25
75%OPC+25%FA	29
50%OPC+50%FA	27

Table 6: Compressive Strength Results for Different Trail Mixes

Percentage of Replacement	Compressive Strength in MPa	
	7 Days	28 Days
100% OPC	20.56	33.78
75%OPC+25%FA	26.78	39.27
50%OPC+50%FA	24.26	36.43

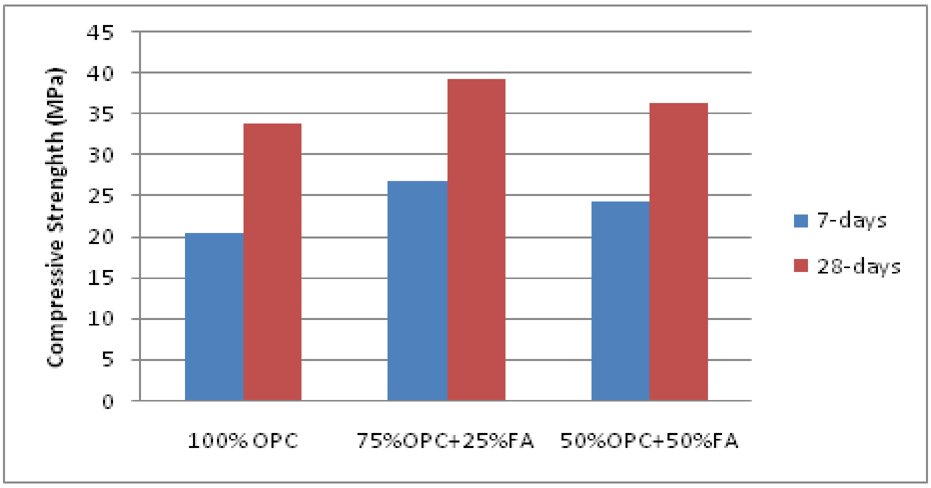

Figure 2: Variation of Compressive Strength of Concrete

CONCLUSIONS

In the present investigation as the w/c ratio is insufficient to provide the good workability, super plasticizer with suitable dosage is necessary for the development of standard concrete.

The experimental results show that the maximum compressive strengths for seven and 28 days curing period achieved are 19.73 and 30.75 N/mm^2 respectively with 25% replacement of cement by class c flyash.

Use of industrial by-products like fly ash which are otherwise hazardous to the environment may be profitably used as a partial replacement of cement, which leads to economy and durability of the structure.

Utilization of industrial wastes in this manner enhances the protection of the environment to a large extent.

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