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Application of Industrial Waste in the Manufacturing of Self Compacting Concrete

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Abstract: To provide a better structural efficiency and adequate durability to meet the special architectural configuration, the production of workable concrete, which has the capability to fill concrete in moulds ad closely spaced reinforcement without any mechanical vibration. The popularity of the use of self-compacting concrete (SCC) in cement concrete construction has increased in most countries because SCC effectively reduces the need for skilled workers on the construction and reduces human errors or negligence in concrete compaction. Nowadays, the purpose of sustainability of environmental resources it is necessary to limit the use of natural raw materials as construction materials. The reduction in use of natural resources increases interest in the use of alternative materials in various industrial wastes (bi-products), which represents significant financial, economic and environmental benefits. Industrial waste is such a fly ash that shows pozzolanic properties. This paper explores the fresh and rigid properties of self-compacting concrete (SCC) prepared by blending fly ash in concrete as a replacement for cement and studied the mechanical properties of cement concrete. The SCC is designed on specification of EFNARC, in which cement is replaced by Fly ash in the percentage for M40 grade concrete, 10%, 20%, 30% and tested.

Keywords: Self-compacting concrete, fly ash, super plasticizer, strength properties, Nan-su method for mix proportions.

I. INTRODUCTION

Self-compacting concrete is concrete whose ingredients are proportioned in such a manner that it can be placed and compacted into any shape of the formwork, Improved Practice and performance combined with the construction Health and safety benefits make SCC a very attractive solution Precast for both concrete and civil engineering construction. Increasing population industrialization and urbanization increased the demand for basic infrastructure. In most studies it has been found that concrete performance can be increased significantly by using mineral mixture and by the use of certain industrial products. Fly ash is one of the most effective mineral products due to cementation or pozzolanic properties used in cement or concrete. Generally there is high cement content in the self-compacting concrete mix, which increases the heat of hydrations and can lead to increased contraction, which can lead to cracking and less durability.

A. Advantage of Self Compacting Concrete (SCC)

- Faster construction
- Reduction in site manpower
- Better surface finish
- Easy placing
- Reduces equipment wear
- Absence of vibration, reduced noise levels
- Thinner concrete section

B. Fly Ash

Fly-ash also known as 'Pulverized Fuel Ash' is one of the coal combustion products, compost of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom ash in modern coal fired power plants; fly-ash is usually captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler it is known as coal ash. Fly-ash can significantly improve the workability of concrete recently; the techniques have been developed to replace particles in high volume fly-ash.

II. MATERIAL

A. Cement

Ordinary Portland cement 53 grade conforming to IS: 12269 having specific gravity 3.15

B. Fine Aggregate

All type of aggregate is suitable. Normal adopted size ranged 16 to 20mm. having specific gravity of 2.17 and fineness modulus of 4.4 has been used as fine aggregate for this study.

C. Coarse Aggregate

Coarse aggregate obtained from local quarry unit has been used for this study; maximum size of aggregate used is 20mm with specific gravity of 2.87

D. Admixture

High Range Water reducing Admixture called as super plasticizer are used for improving the workability for lower water- cement ratio with sacrifice in the compressive strength. PERMA PLAST PC-101 has been used as super plasticizer.

E. Water

Ordinary potable water is used.

III. METHODOLOGY

Effect of fly ash on following properties of self compacting concrete

A. Fresh Properties

The self-compaction properties of the trial mixes were determined by using slump flow test, V-funnel test, and L-box test. The tests were conducted in following order:

Slump flow test

V-funnel flow test.

L-box test

1) *Filling Ability*: The property of SCC to fill all corner of a formwork under its own weight is known as filling ability

2) *Passing Ability*: The property of SCC to flow through reinforcing bars without segregation or blocking.

3) *Resistance to Segregation*: The property of SCC to flow without segregation of the aggregates.



Fig. 1: Slump Flow, V-Funnel, l-Box Test

Table I- Quantities Of Materials Required for 1m³ of SCC using Fly Ash

Cement (kg/m ³)	Fine Aggregate (kg/m ³)	Coarse Aggregate (kg/m ³)	Water (kg/m ³)
436.32	881.34	703.28	172.64
1	2.09	1.61	0.4

The mix proportion was based on the Nan-Su method. The mix design was carried out for M40 grade of SCC with Fly ash as partial replacement of cement with a fraction of 0%, 10%, 20% & 30%.

TABLE II- Mix Proportioning for 1m³ of SCC with Fly Ash

Mix	Cement	Fly ash as replacement	Fine aggregate(k	Coarse aggregate(k	Water	S.P
	(kg/m ³)	(kg/m ³)	g/m ³	g/m ³)	(kg/m ³)	(kg/m ³)
mix-A	436.32	0	881.34	703.28	172.64	3.92
mix-B	392.68	43.632	881.34	703.28	172.64	3.92
mix-C	349.06	87.26	881.34	703.28	172.64	3.92
mix-D	305.42	130.89	881.34	703.28	172.64	3.92

Mix-A: - 0% Replacement of Cement with Fly ash.

Mix-B: - 10% Replacement of Cement with Fly ash.

Mix-C: - 20% Replacement of Cement with Fly ash.

Mix-D: - 30% Replacement of Cement with Fly ash.

IV. RESULT AND DISCUSSION

A. Effects on Fresh Property of Self-Compacted Concrete using Fly Ash

Fly ash was used to replace the cement content by three various percentages (0, 10, 20 and 30%). The partial replacement with Fly ash was carried out for M40 grade of concrete. The tests were Slump flow, L-box, and V-funnel. The acceptance criteria for SCC and results of workability tests on SCC are shown in Table III and IV respectively.

TABLE III SCC - Acceptance Criteria

Method	Properties	Range of values
Flow value	Filling ability	650-800mm
V-funnel	Viscosity	6-12 sec
L-box	Passing ability	0.8-1.0

TABLE IV Test Results for Self-Compatibility

Mixes	Mix-A	Mix-B	Mix-C	Mix-D
Slump flow test	680	670	655	650
V-funnel test	10	9.5	8	7.5
L- box test	0.98	0.90	0.89	0.88

B. Effects on Hardened Properties of Self-Compacted Concrete using Fly Ash

C. Compressive Strength

In order to study the effect of compressive strength, when fly ash was added into high strength SCC as replacement of cement, the cube containing different proportion of fly ash (0%, 10%, 20% & 30%) were prepared and kept for curing for 7, 28 days. It was observed that for replacement up to 20%, strength was increased and after that strength decreased. The 20% replacement level has given maximum strength for M40 grade of concrete.



Compressive Strength

TABLE V Results of Compressive Strength of SCC With Fly Ash for 7, 28 Days

COMPRESSIVE STRENGTH (MPa)		
Mixture no.	7 days	28 days
MIX-A	27.4	40.20
MIX-B	28.10	44.88
MIX-C	30	45.20
MIX-D	29.2	40.22

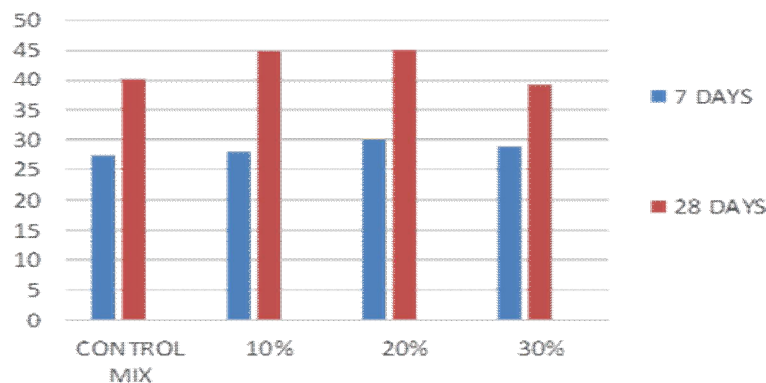
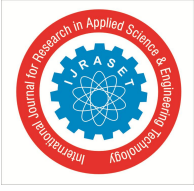


CHART 1. Compressive Strength for 7 & 28 Days



V. CONCLUSIONS

- A. The use of mineral admixtures improves the performance of SCC in fresh state and also avoids the use of VMAs.
- B. SCC with fly ash has exhibits satisfactory results in workability, because of small particle size and more surface area.
- C. At the water/ cement ratio of 0.4, slump flow test, funnel test, and L-Box test results were found satisfactory, i.e. passing ability, filling ability and segregation resistance are well within the limits as per the EFNARC.
- D. The SCC mixes with the addition of 20% Fly ash gives an optimum strength for M40 grade.
- E. Compressive strength at 7 days and 28 days are found satisfactory.

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