INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN: 2278 – 0211 (Online)

Utilization Of Fly Ash And Pond Ash In Self Compacting Concrete

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Abstract:
Self Compacting Concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight, without the need for vibration. The highly fluid nature of SCC makes it ideal for placing in difficult conditions and in sections with congested reinforcement. Mixture proportions for SCC differ from those of ordinary concrete, in that the former has more powder content and less coarse aggregate. Supplementary cementitious materials such as fly ash, silica fume and blast furnace slag, pond ash are normally used as powders to enhance the technology of SCC. In addition, SCC also incorporates chemical admixtures, such as HRWR (High Range Water Reducer), and VMA (Viscosity Modifying Agent). Large amount of fly ash and pond ash is being generated in India annually and hence there is a strong need to use this byproduct from thermal power stations, in large proportions in concrete which is also makes the concrete as cost effective. A SCC mix was arrived based on available EFNAARC guide lines and using various mix combinations. An experimental study is made on the properties of SCC incorporating fly ash and pond ash. Slump flow test, V-funnel test, L-box test were carried out to confirm the self-compact ability of concrete. Compressive strength test, split tensile test, flexural strength test, youngs modulus test were carried out on SCC. Experimental studies confirm that the mixes satisfy the requirement for SCC.

Keywords: *self compacting Concrete, Fly ash, Pond ash, Chemical admixtures, Hardened properties.*

1. Introduction

SCC concept can be stated as the concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedure and curing practices. The SCC is an engineered material consisting of cement, aggregate, water and mineral admixtures like fly ash, pond ash etc and chemical admixtures to take care of specific requirements, such as, high-flowability, high workability, compressive strength, enhanced resistances to chemical or mechanical stresses, lower permeability, durability, resistance against segregation, and possibility under dense reinforcement conditions. The main characteristic of SCC is the higher cement matrix aggregate ratio with respect to an ordinary concrete. In other words, the volume of cement matrix responsible for the mobility of the concrete mixture must be increased in order to push the aggregate under the gravity action or under the pressure of a pumping system. On the other hand, the volume of the aggregate in particular the coarse aggregate must be reduced in terms of both volume and maximum size, to improve the mobility and the segregation-resistance of the fresh mixture.

2. Materials Used

The raw materials used in this experimental studies for manufacturing Self-Compacting Concrete are cement, fly ash, pond ash, fine aggregate, coarse aggregate, Glenium. Ordinary portland cement (Grade 53) was used for the experimental work. Specific gravity of cement is 3.15.Pond ash is collected from Thermal Power Plant, Mettur (Tamil Nadu). The specific gravity of pond ash is 2.31 and the particle size of pond ash ranges between (10-50)µm. Fly ash is obtained from Mettur Thermal Power plant (Tamil Nadu).The specific gravity and particle size of fly ash are 2.72 and (10-50)µm respectively. From chemical composition of Fly ash, CaO content is less than 5%, so the fly ash is classified as class F according to the ASTM C 618. Locally available natural river sand is used as fine aggregate. Crushed stone with 10mm maximum size is used as coarse aggregate . Both fine aggregate and coarse aggregate confirmed to Indian Standard Specification IS: 383-1970.The specific gravity of sand is 2.65 and the fineness modulus of fine aggregate is 2.67.The specific gravity and fineness modulus of coarse aggregate is 2.71 and 7.09. GLENIUM B233 is an admixture of a new generation based on modified Polycarboxylic ether. GLENIUM B233 is free of chloride & low alkali. It is compatible with all types of cements.

3. Mix Proportion

There is no standard method for the mix design of SCC. However, the European guidelines for SCC are useful in the mix design. These guidelines are not intended to provide specific advice on mix design, but indicate the typical range of constituents in SCC by weight and by volume. Table 1 shows the various mix combinations for SCC.

Mix designation	Cement (kg/m^3)	Fly ash (kg/m^3)	Pond ash (kg/m^3)	Water (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Super Plasticizer (% total powder content)
M1	450	100	50	200	550	600	1.1%
M2	400	100	100	200	500	600	1.1%
M3	380	100	120	200	500	500	1.1%
M4	380	60	40	255	900	300	1.1%
M5	375	61	44	255	831	225	1.1%

Table 1: Mix Combinations for SCC

4. Result And Discussion

4.1.Fresh Concrete Properties Of SCC

The fresh properties of SCC consist of workability, flowability, filling ability which can be tested by slump flow test, V-funnel test, L-Box test were carried out as per the EFNAARC guide lines. Table 2 shows the fresh concrete properties of SCC.

Slump flow test **V-funnel test**

L-Box test

Figure2: Fresh concrete properties of SCC

Mix proportion / **Tests**	**M1**	**M2**	**M3**	M4	M5	**Acceptable limit**
Slump flow (mm)	710	667	656	670	620	600 to 800mm
L – box(H2/H1)	2.6	1.9	1.2	1.0	0.9	0.8 to 1.0
V- funnel (sec)	25	21	17	12	10	6 to 12sec

Table 2: Test Results on Fresh Concrete Properties of SCC

Slump value varies between 620 to 710 mm for the mix M5 to M1 .In V-funnel test the concrete passes from 10 to 25 secs for the mix M5 to M1.In L-box test value varies from 0.9 to 2.6. Based on EFNAARC guide lines, M4 and M5 satisfy the acceptable limit for SCC concrete. Hardened concrete tests proceed for the mix combination M5.

4.2.Hardened Properties Of SCC

Hardened properties of SCC such as Compressive strength test, Flexural strength test, Split tensile test, Young's modulus test were carried out for mix combination M5. The

compressive strength of concrete cubes of 150mm X 150mm X 150mm size which was tested in compression testing machine. The compressive strength is equal to the ultimate load by the cross sectional area. The split tensile strength of SCC of diameter 150mm and the length of the specimen is 300mm and the test was conducted in the compression testing machine. The split tensile strength is equal to (2p) / (πDL). The Flexural strength test is conducted for a beam of size 500mm X 100 mm X 100mm. Single point load is applied to the beam specimen. The Young's modulus test is also carried out for the cylinders of size 150mm X 300mm.The young's modulus and flexural strength test is tested using universal testing machine. Table 3,4,5,6 shows the test results of compressive strength test, flexural strength test, split tensile strength test, young's modulus test. Figure 3,4,5,6 shows the graphical representation of compressive strength test, flexural strength test, split tensile strength test, young's modulus test.

Sample No.	**Compressive Strength (N/mm^2)**	
	7 day	**28 days**
A	14.44	31.70
B	14.65	32.80
C	14.16	31.12
Mean	**14.41**	**31.87**

Table 3: Test results of Compressive strength

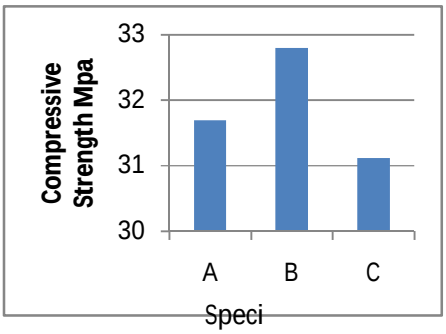

Figure3: Compressive strength test

Specimen	**Load(N)**	**Split Tensille Strength (N/mm^2)**
A	15900	2.25
B	15800	2.23
C	16200	2.3
Average		2.26

Table 4: Test results of Split Tensile strength

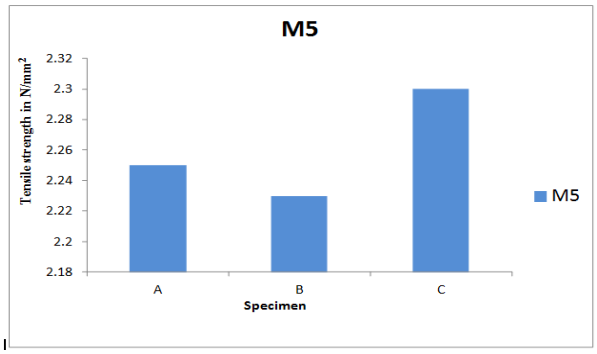

Figure 4: Split Tensile strength test

Specimen	Load(N)	Flexural Strength (N/mm^2)
A	12600	5.04
B	12200	4.88
C	13500	5.40
Average		5.106

Table 5: Test results of Flexural strength

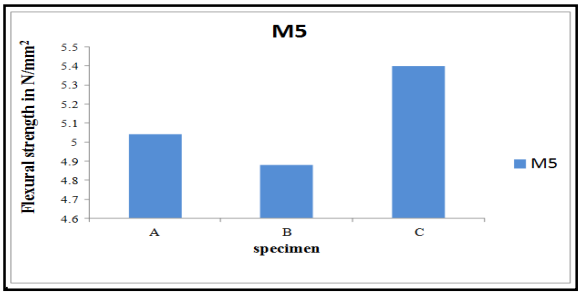

Figure 5: Test results of Flexural strength test

Specimen A		**Specimen B**		**Specimen C**	
Stress (N/mm^2)	**Strain**	**Stress (N/mm^2)**	**Strain**	**Stress (N/mm^2)**	**Strain**
1.13	0.00003	1.13	0.00003	1.13	0.00003
2.26	0.00006	2.26	0.00008	2.26	0.00006
3.40	0.00010	3.40	0.00012	3.40	0.00008
4.53	0.00014	4.53	0.00016	4.53	0.00011
5.66	0.00017	5.66	0.00019	5.66	0.00014
6.79	0.00022	6.79	0.00023	6.79	0.00017
7.92	0.00028	7.92	0.00027	7.92	0.00022
9.05	0.00031	9.05	0.00031	9.05	0.00026
10.19	0.00035	10.19	0.00036	10.19	0.00032
11.32	0.00039	11.32	0.00040	11.32	0.00037
12.73	0.00043	12.73	0.00046	12.73	0.00042
14.15	0.00048	14.15	0.00050	14.15	0.00048
15.56	0.00054	15.56	0.00057	15.56	0.00053
16.98	0.00059	16.98	0.00063	16.98	0.00057
18.39	0.00065	18.39	0.00068	18.39	0.00060
19.81	0.00070	19.81	0.00074	19.81	0.00070
Young's Modulus in MPa					
31133		**28488**		**34186**	

Table 6: Test results of Modulus of Elasticity

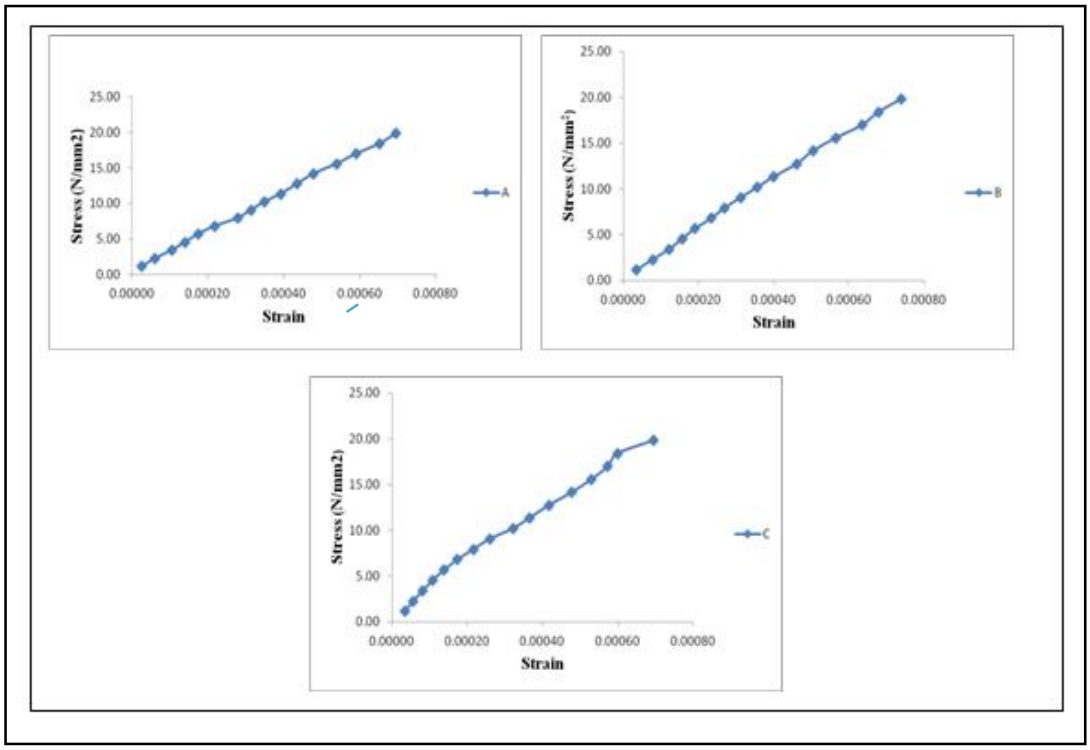

Figure 6: Test result of modulus of elasticity for 28 days

From table 3 and figure 4 the compressive strength varies between 31.12 to 31.70 Mpa. The average compressive strength is 31.87Mpa.Therefore it satisfies the M30 grade of concrete.

From table 4 and figure 4 the split tensile strength varies from 2.25 to 2.3N/mm^2.The average split tensile strength is 2.26N/mm^2 .From table 5 and figure 5 the flexural strength was varies from 5.04 to 5.4 N/mm^2 and the average flexural strength was 5.106N/mm^2 .From table 6 and figure 6, the modulus of elasticity of concrete is varies between 28488 N/mm^2 to 34186 N/mm^2.

5. Conclusion

The polluting materials like fly ash and pond ash are effectively used in Self compacting concrete. Fresh and hardened properties of self compacting concrete for M30 grade of concrete is carried out. The mix M4 and M5 satisfies the fresh properties of Self Compacting Concrete. Reduction in cost can be achieved due to the utilization of fly ash and pond ash in the development of SCC .SCC can be used for any structural applications especially when there is heavy congestion of reinforcement, without any vibration.

6. Reference

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