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Strength Characteristics of Self Compacting Concrete Containing Flyash

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Abstract

Self compacting Concrete (SCC) is a new category of concrete which flows under its own weight .It does not require any external vibration for compaction. Due to many advantage of this concrete, it is suitable for the situations where congested reinforcement is used. In this paper self compacting concrete is developed using various percentages of fly ash,10% ,20% and 30% by weight of cement as partial replacement of cement .The rheological strength have been assessed

Keywords: Self compacting concrete, slum flow test, V−funnel fly ash.

Introduction

Self-Compacting Concrete (SCC)[1] has been described as the most revolutionary development in concrete industry .Due to many advantages like faster construction, reduction in site for thinner concrete sections ,improved durability, suitability for congested reinforcement; This concrete becomes popular in civil Engineering construction

The objective of this study is to understand the fresh state properties of SCC containing fly ash in various proportions as partial replacement of cement and small quantity of super plasticizer. An experimental program has been developed to investigate the behavior of self compacting concrete containing fly ash. The fresh state properties like slump flow, T_{50} time, V-funnel and ,L-box blocking ratio have been assessed using the methods as per EFNARC[2] specification .The properties of hardened concrete have also have been evaluated The compressive strength at 7 days and 28 days has also assessed for the mixes containing different percentages of fly ash ie. 0%, 10%, 20% and 30% of the weight of cement.

Methodology

Cement: Birla gold cement (Grade 43) was conforming to is (8112-19890)[3] used. Its physical properties are as given in Table-1.

Flyash: Class F Fly ash obtained from "Thermal Powers Plant BirSinghPur (Pali) India" The physical and chemical properties of fly ash are given in the table-2 and table-3, respectively.

Table-1
Physical Properties of Cement

Physical property	Results obtained	IS: 8112-1989 specifications
Fineness (retained on 90-μm sieve)	9.0	10mm
Normal Consistency	30%	-
Vicat initial setting time (minutes)	90min	30second min
Vicat final setting time (minutes)	300min	600second max
Compressive strength 3-days (MPa)	22Mpa	22.0 Mpa min
Compressive strength 7-days (MPa)	35Mpa	33.0Mpa min
Compressive strength 28days(MPa)	45 Mpa	43.0 Mpa min
Specific gravity	3.14	

Table-2
Physical Properties of Fly Ash

Sr. No.	Physical Properties	Test Results
1.	Colour	Grey (Blackish)
2.	Specific Gravity	2.21

Table-3
Chemical composition of fly ash

S.NO.	Characteristic	Percentage by weight
1.	Silica, SiO_2	53.14
2.	Alumina l_2O_3	25.88
3.	Fe_2O_3	3.14
4.	TiO_2	1.51
5.	CaO	0.34
6.	Mgo	1.13
7.	NaO_2	1.19
8.	K_2O	1.22
9.	SO_3	0.53
10.	P_2O_5	1.65

Admixtures: In the present investigation Polycarboxylic ether based super plasticizer FAIRFLO RMC is used as water reducing admixture.

Aggregates: Locally available fine and coarse aggregates are used in this study and conformed to Indian standard specifications (IS 383-1970)[4].

Fine aggregate: In the present investigation natural fine aggregate from local market is used. The physical properties of fine aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with (IS :2386)[5] are given in table-4.

Table-4
Physical properties of Fine aggregates

Property	Results
Fineness modulus	2.71
Specific gravity	2.60
Bulk density (Kg/m3) Loose state Compact state	1.60 1.70

Coarse aggregate: The crushed coarse aggregate obtained from the local crushing plant is used in the present study. The physical properties of coarse aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS ; 2386 are given is table-5.

Mix Design with Data: The trial mixes taken for development of self compacting concrete are summerised[6] in table 6. **S** stands for Self Compact Concrete having water binder ratio as 0.40. S stands for concrete having water binder ratio as 0.45.

Suffix after S or S´ indicates % Fly ash used in the mix as partial replacement of cement.

Table-5
Physical properties of Coarse aggregate

Property	Result
Fineness modulus	6.14
Specific gravity	2.62
Bulk density (Kg/m^3) Loose state Compact state	1475 1690

Test Methods: The rheological characteristics have been found out using the following tests as per EFNARC Guide lines. Slump flow test, V-Funnel test, L-Box blocking ratio test

Strength of 150mmx150mmx150mm size cubes is also found at 7days and 28dayes age.

Results and Discussion

The results of the SCC mixes prepared are summarized in Table-6. The rheological characteristics results are given in table- 7.

In the present analysis the cement is replaced by Fly ash up to 30% (10%, 20% and 30%) by weight of cement and quantities of the fine aggregates and coarse aggregates are kept constant i.e. 890 kg/m^3 and 810 kg/m^3 respectively. The fine aggregate is kept approximately 37% by weight of concrete. The coarse aggregate is kept approximately 34% of weight of concrete.

The water powder ratio is kept 0.40 and 0.45 by weight. For this, the total powder content is taken as 480 kg/m^3 and 450 kg/m^3 respectively. The mixes thus prepared to follow the EFNARC guidelines. The mix proportions are shown in Figure-1.

As the quantity of Flyash increase from 0 to 30% , the quantity of super plasticizer reduces significantly from 13.30 kg/m^3 to 9.40 kg/m^3, 2.77% to 1.96% of weight of powder (for W/B ratio 0.4) and 9.25 kg/m^3 to 4.8 kg/m3 for i.e. 2.05% to 1.06% of weight of powder (for W/B ratio of 0.45) as shown in Figure-2. The Rheological characteristics were found well within the limits as specified in EFNARC Gudelines.

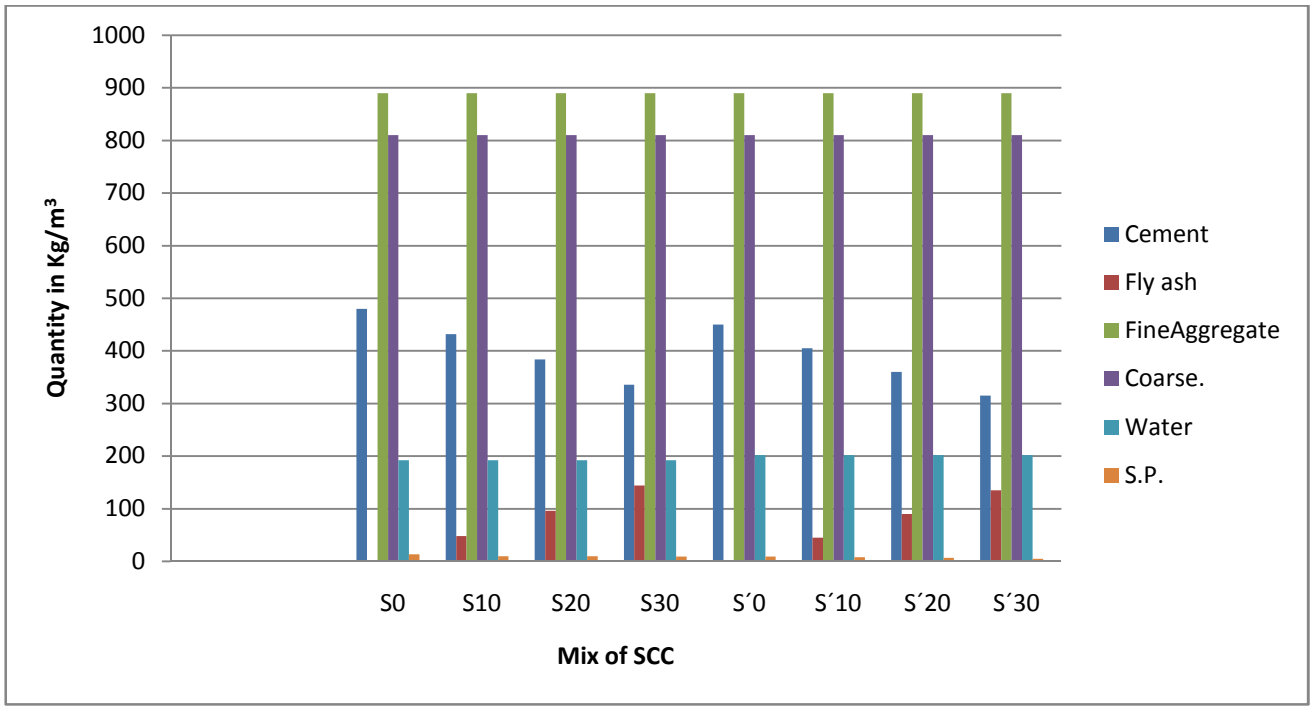
Strength characteristics: Both 7 days and 28 days compressive strength decrease the Fly ash content increase, For a water winder ratio 0.4, the decrease in 7 days strength is 36 MPa to 24 MPa and decrease in 28 days strength is 52 MPa to 40 MPa. Similarity for a water winder ratio 0.45, strength decrease from 32 to 22 MPa in 7 days and 50 MPa to 39 MPa in 28 days. The variation in strength is shown in Figure-3.

Table-6
Mix Proportions

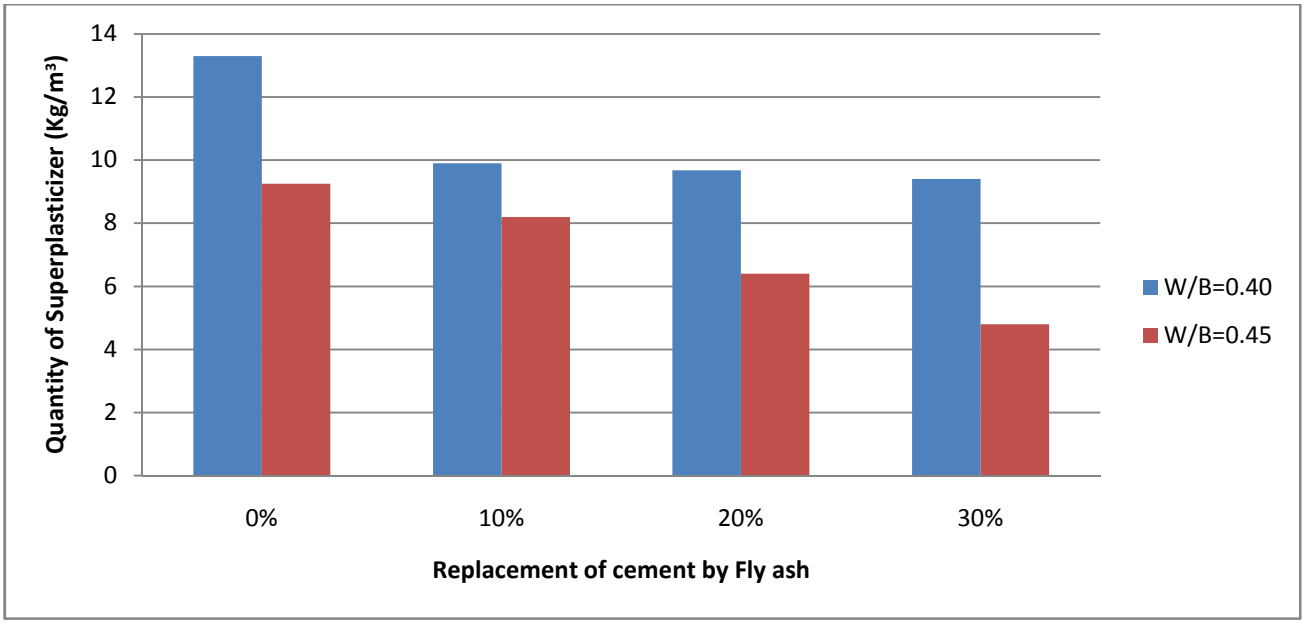
S. No	Mix	Cement Kg/m^3	Fly ash Kg/m^3	Fine Aggregate Kg/m^3	Coarse Aggregate Kg/m^3	Water Kg/m^3	S.P. Kg/m^3	W/B ratio
1	S0	480	0	890	810	192	13.30	0.40
2	S10	432	48	890	810	192	9.90	0.40
3	S20	384	96	890	810	192	9.68	0.40
4	S30	336	144	890	810	192	9.40	0.40
5	S´0	450	0	890	810	202	9.25	0.45
6	S´10	405	45	890	810	202	8.20	0.45
7	S´20	360	90	890	810	202	6.40	0.45
8	S´30	315	135	890	810	202	4.80	0.45

Table-7
Work ability and compressive strength results

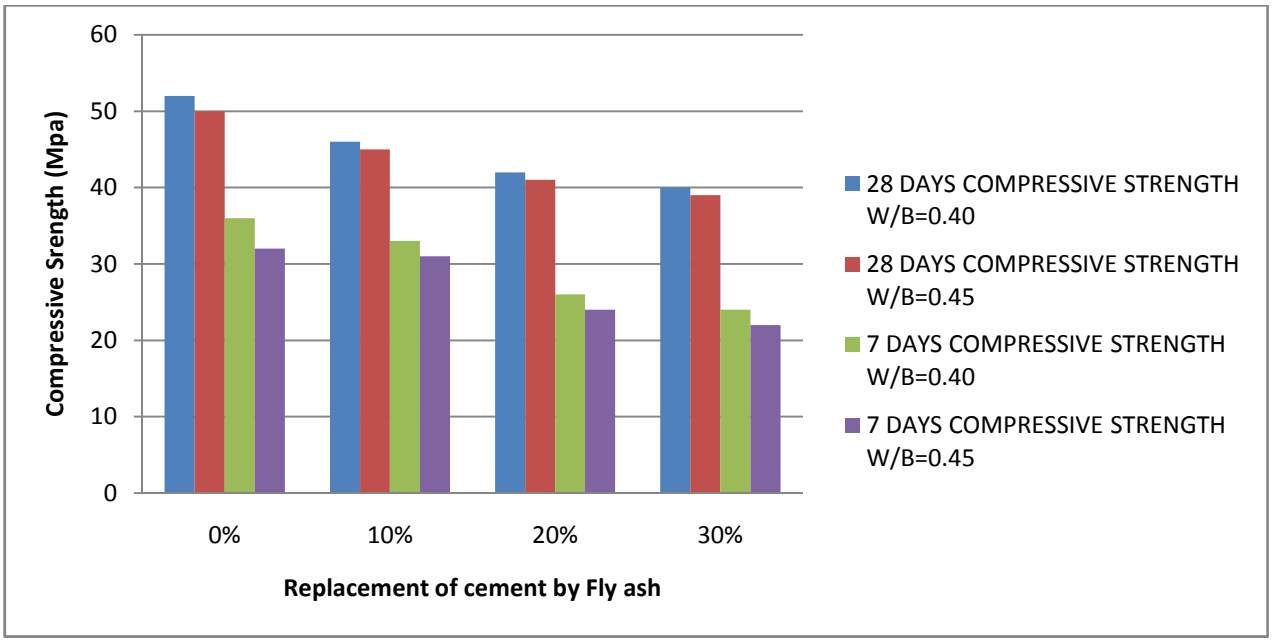
Sr. No.	Mix	Slump Flow (mm)	T50 cm (sec)	V-funnel (sec)	L-Box Blocking ratio (H_2/H_1)	7-days (MPa)	28-days (MPa)
1	S0	650	5.0	12	0.88	36	52
2	S10	665	4.0	9.0	0.85	33	46
3	S20	685	3.6	8.4	0.82	26	42
4	S30	680	3.0	8.1	0.80	24	40
5	S´0	687	4.1	9.0	0.80	32	50
6	S´10	689	3.5	8.6	0.79	31	45
7	S´20	690	3.0	8.0	0.78	24	41
8	S´30	695	3.0	8.0	0.78	22	39



Figure–1
Mixes of SCC showing quantity of ingredients



Figure–2
Variation in quantity of super plasticizer with replacement of cement by Flyash



Figure–3
Variation in 7 days and 28 days compressive strength with replacement of cement by Flyash

Conclusion

i. Series of tests were performed on the self compacting concrete developed using Flyash produced from thermal power plant Birsinghpur Pali of Madhya Pradesh, The rheological and strength characteristics have been assessed. The test was performed on no. of specimens for two types of mixes having water binder ratio as 0.40 and 0.45. The cement replacement was, 10% 20% and 30% by weight of Flyash quantities. The fresh state properties were assessed as per EFNARC guidelines such as slump flow test, L-Box test, V-funnel test. The hardened state compressive strength at 7 days and 28 days were also evaluated. Based on the above investigations the following conclusions have been drawn. ii. The addition of Fly ash resulted in a decreases of super plasticizer content for same or better workability. iii. The addition of Fly ash resulted as decrease in 7 days and 28 days compressive strength. The 28 days compressive strength decrease to 22-23 % as the Fly ash

content is increased to 30%. The reduction in 7 days strength is more as compared to 28 days strength. However all the mixes have good 28 days compressive strength 39 MPa or more. The results of this study show that it is possible to produce a good performing SCC using locally available Fly ash. iv. The fresh state properties for different mixes are as per EFNARC Guidelines better with the increase in flyash content flow ability and passing ability is obtained.

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