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Changing Properties of Self-Compacting Concrete with Different Proportions of Fly Ash

Mohammad Kamran[1], Mudit Mishra[2]

[1]Department of Civil Engineering, Jamia Millia Islamia, Jamia Nagar, New Delhi
[2]Department of Civil Engineering, Manav Rachna International University,
Delhi Surajkund Road, Aravalli Hills, Faridabad, Haryana, India
[1]mteqjmi@gmail.com

Abstract: **Self compacting concrete has been playing vital role in the mass concreting nowadays especially in the structures where reinforcement used is very dense and in narrow tubular sections. This paper talks about its variation in properties on different proportions of fly ash in the mix which were taken as 15%, 25%, and 35% in place of cement. For one proportion, a set of 6 cubes was casted and the same was to be tested at 7 days and 28 days for strength. The temperature of sample cubes was kept constant at 24°C for the whole period. The mix design was done for M25 grade. The W/C ratio was kept constant at 0.45. The proportion of fine aggregates to coarse aggregates was kept at 70:30 and maximum size of aggregates was 20 mm. Total powder content was kept at 530 Kg/m^3. The quantity of super plasticizer was kept at 450 ml for the samples which was 1% of the total volume. The properties were checked by conducting slump test, J-Ring Test, L-Box Test, V-funnel Test, and U-Box Test with compressive strength test after 7 days and 28 days. The slump value was maximum for 35% replacement of cement with fly ash and lowest for 25% replacement. V-funnel value was lowest for 35% replacement. J-ring was lowest for 15% replacement. U-box value was maximum for 25% replacement. L-box value was highest for 35% replacement. The most important compressive strength test showed very surprising results. Only 15% replacement samples showed characteristic strength after 7 and 28 days. 25 % replacement samples gained only 55% of desired strength and 35% replacement samples gained only 33% of desired strength after 7 days and gained 92% and 80% of desired strength after 28 days respectively.**

Keywords: **Self Compacting Concrete, Fly Ash, V-Funnel, Slump Value, Compressive Strength**

1. INTRODUCTION

Self-compacting concrete (SCC) has been described as "the most revolutionary development in concrete construction for several decades"(efnarc, 2002).

Self compacting concrete, a recent innovation has numerous advantages over conventional concrete. it can spread and fill all corners by means of itself weight only, thus eliminating the need of vibration for any type of consolidation effort[1]. originating in Japan[2] with a view to reduce the reliance on skilled workers and to enhance productivity of construction without compromising quality of concrete[3]. also known as self consolidating concrete, super workable concrete, no vibrating concrete[4]. It is flow able and deformable without segregation[1, 4]. In order to maintain deformability along with flow ability in paste, a super plasticizer is an indispensable ingredient for such concrete.

SCC typically has a higher content of fine particles and different flow properties than conventional plasticized concrete. It should have three essential properties: filling ability, resistance to segregation and passing ability. the mixture proportioning is based on creating a high degree of flow ability while maintaining a low w/c ratio. This is achieved by using water reducing admixture combined with stabilising agents such as viscosity modifying admixture to ensure homogeneity of mixture for reasons of achieving better rheological properties, reduction in cost, increase in powder content. A high amount of mineral admixture is typically used. Use of fly ash GGBFS, limestone powder increases fine materials in a concrete mixture[1]

Self compacting concrete can be used in different components of structure even combined with narrow tubular sections. It was done by using different proportions of fly ash at constant temperature condition to see the settling by performing different tests on the samples.

2. EXPERIMENTAL STUDY

Self compacting concrete with constant w/c ratio and quantity of super plasticizer (1%) was prepared as per the mix design. The percentage of 20 mm aggregate was 30% and that of fine aggregate was 70%. The total powder content was kept constant equal to 530 Kg/M^3 in all the trials. Thereafter, to check the effects on strength of SCC, more percentage of fly ash mixed by replacing the quantity of cement by15%, 25% and 35%. The w/c ratio of 0.45 was kept constant . For each concrete mix, 6 cubes of sizes 150x150x150 mm were casted to determine the compressive strength. After casting, the specimens were cured in water tub for 7 days at room temperature. Three out of them were then tested after 7 days compressive strength of SCC and the rest were tested on 28

days. The following tests were conducted to check the specified properties of the concrete sample prepared.

Slump flow test: Primarily to assess filling ability, suitable for laboratory and site use.

U-Box test: The test is used to measure the filling ability of self compacting concrete.

L-box test: The L-box test is used to assess the passing ability of self-compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking.

V-funnel test: The V-funnel test is used to assess the viscosity and filling ability of self-compacting concrete.

J-ring test: Primarily to assess filling ability, suitable for laboratory and site use.

Compressive strength test: The compressive strength of concrete was measured using AIMIL compression testing machine with a loading capacity of 2000 KN confirming to IS: 14858 (2000). The compressive strength test was carried out on cubes at the 7 and 28 days.

3. OBSERVATIONS

Observation 1: Mix with 15% fly ash of total powder was prepared as shown in the table 1:

Observation 2: Mix with 25% fly ash of total powder was prepared as shown in the table 1:

Observation 3: Mix with 35% fly ash of total powder was prepared as shown in the table1:

Table 1: Mix Design for Observation 1, Observation 2, Observation 3

Temp: 24 °C		w/c ratio: 0.45	
	15% Fly Ash	**25% Fly Ash**	**35% Fly Ash**
Components			
Cement (Kg)	20.05	17.8	15.35
Fly Ash(Kg)	3.53	5.78	8.23
Fine aggregate(Kg)	38.53	38.53	38.53
C.Aggregate 20 mm(Kg)	12.46	12.46	12.46
C.Aggregate 10 mm(Kg)	23.14	23.14	23.14
Water (lit.)	10	10	10
Super plasticiser (ml.)	450	450	450

The various properties of the mix were observed as tabulated in table 2:

Table 2: Different Properties of Mix

Test	15% Fly Ash	25% Fly Ash	35% Fly Ash	Range
Slump flow	630 mm	610 mm	670 mm	550-800 mm
Time	4.23 sec	3.2 sec	5 sec	2- 5 sec
V-Funnel	10 sec	10 sec	7.45 sec	7-12 sec
J-ring	6 sec	7.50sec	6.6 sec	4-8 sec
J-ring flow	580	600	630	500-700
U-box	27 mm	30 mm	28 mm	< 30 mm
L-box	0.82	0.789	0.85	0.8- 1.0

The most important property was checked by performing compressive strength test on samples and calculated data is shown in table 3:

Table 3: Compressive strength of samples at 7 days and 28 days

	Cube	1	2	3	4	5	6
	Days	7	7	7	28	28	28
15%FlyAsh	Comp Strength (MPa)	16.25	16.80	16.11	27.33	28.12	27.66
	Avg Strength (MPa)	16.34			27.70		
25%FlyAsh	Comp Strength (MPa)	9.288	10.2	9.73	24.27	24.46	24.12
	Avg Strength MPa	9.74			24.28		
35%FlyAsh	Comp Strength (MPa)	5.45	5.81	4.91	21.56	21.33	21.94
	Avg Strength (MPa)	5.39			21.61		

4. RESULTS AND DISCUSSIONS:

- The experimental study showed that the only change in the mix lied with quantity of cement and fly ash, so the results were dependent on the compatibility of these two matters with each other. The type of cement that was used belonged to PPC which has some percentage of fly ash

already in the composition. Any addition in fly ash content was going to result in even higher percentage of the same actually present in the mix.

- The observations showed that the results were always within permissible range, anytime in any mix, the critical value was not exceeded. Though the results of different tests did not show any trend or pattern in nature. The results were randomly varied for different experiments and different proportions.
- The compressive strength results showed that after 7 days, the mix with least fly ash content gained maximum strength which was desired as per 67% of total characteristic strength. The remaining samples gained very less strength in first 7 days but started gaining after this time to 28 days time mainly because of secondary hydration of lime which generally occurs in fly ash but the overall strength gained even after 28 days was maximum least fly ash percentage content than the rest. So it can be deduce that quantity of fly ash should be kept around 15% of total powder content in the given temperature and atmospheric conditions at the above specified w/c ratio.

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