Compressive strength Study of Self-Compacting Concrete (SCC) by addition of fly ash in different proportion.

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ABSTRACT-- Concrete is the most widely used construction material because of its mould ability into any required structural form and shape due to its fluid behavior at early ages. Thorough compaction, using vibration, is normally essential for achieving workability, the required strength and durability of concrete. Inadequate compaction of concrete results in large number of voids, affecting strength and long-term durability of structures. Self-compacting concrete (SCC) provides a solution to these problems. As the name signifies, it is able to compact itself without any additional vibration or compactive effort. However, wide spread applications of SCC have been restricted due to lack of standard mix design procedure and testing methods. Self-compacted concrete was used as a special concrete in place of standard concrete due to lack of mix design procedure. Generally, the SCC was prepared by using Ordinary Portland Cement (OPC) with mineral and chemical admixtures. Portland Pozzolana Cement (PPC) itself contains some amount of fly ash, thus given the motivation to prepare the SCC using PPC only.

***Keywords*:** Portland Pozzolana Cement, fly ash, Ordinary Portland Cement

1. INTRODUCTION --Self-compacting concrete (SCC) is a type of highly flowable concrete that fills entirely each corner of congested formwork without the need of mechanical vibration as it is placed by means of its own weight. It has a low value of yield stress, high deformability, good segregation resistance and moderate viscosity. Chemical admixture used is CAC Hyperfluid Plus G. This super plasticizer comes under the category of poly - carboxylic ether.

The common concrete having ingredients aggregate, water and cement only is known as normal concrete. It is also called Normal strength concrete. It has a setting time of 30-90 minutes depending upon the various factors such as moisture in atmosphere, fineness of cement etc.

2. Materials-

The physical properties of cement, fine aggregates, coarse aggregates, fly ash and water used for mix design of M20, M25 and M30 grade of concrete were tested in laboratory and mentioned below.

2.1 CEMENT-

2.1.1. Portland puzzolona cement was used in this study. All properties of cement were in accordance with IS269:1976. The physical properties of the cement used are as listed in table below.

S.No.	Test Particulars	Test Values	Permissible Limits
1	Normal Consistency (%)	32%	-
2	Initial Setting Times(minutes)	48	≥ 30 minutes
3	Final setting Times(minutes)	410	≤ 600 minutes
4	Specific Gravity	2.92	-

Table-1- Physical Properties of Portland puzzolona Cement.

2.1.2. Fine Aggregates-The sand that was locally available and passing through 4.75mm IS sieve size was used as fine aggregate. The physical properties of the fine aggregates are as listed in table below:

Table-2- Physical Properties of Fine Aggregates.

S.No.	Properties	Numerical Value
1.	Specific Gravity	2.65
2.	Water absorption	1.2
3.	Fineness Modulus	2.24

2.1.3. Coarse Aggregates-The coarse aggregates with nominal maximum size of aggregates as 20 mm. (60%) and 10 mm. (40%) as per Indian standard were used. The physical properties of the coarse aggregates are as listed in table below:

Table-3- Physical Properties of Coarse Aggregates.

S.No.	Properties	Numerical Value	
		C20	C10
1.	Specific Gravity	2.68	2.67
2.	Water absorption	0.35	0.33
3.	Fineness Modulus	7.2	6.61

2.1.4. Fly Ash- The fly ash used was of class F with specific gravity of 2.20.

2.1.5. Water-The water used for experiments was potable water.

3. METHODOLOGY-

The aim of the present study was to study the effect of fly ash on compressive strength of concrete by partial replacement of cement with 4%, 8% and 12 % of fly ash. The concrete mix of M20, M25and M30 grade was prepared as per IS10262:2009 having mix design ratio as 1:1.4:2.96 and w/c ratio of 0.52. To carry out the experimental investigation total 30 cubes of size 150mm x 150mm were casted. 6 cubes were casted to determine the compressive strength of normal concrete with no fly ash. Similarly, each set of 6 cubes were casted to determine the compressive strength for 4%, 8% and 12% replacement of cement with fly ash respectively. From these 6 cubes, 3 cubes were utilized to determine the compressive strength of concrete after 7 days of curing and rest 3 cubes were used to determine the compressive strength of concrete at 28 days. Compression Testing Machine of 2000kN capacity was used to determine the total compressive load taken by concrete at different ages.

4. RESULTS AND DISCUSSIONS

Each set of 6 cubes of M20, M25 and M30 grade of concrete were tested in Compression Testing Machine with 4%, 8% and 12% replacement of cement with fly ash to determine the compressive strength after 7 and 28 days. Average value of these 6 readings gives the average compressive

strength of concrete. The average compressive strength of cubes with admixture and fly ash and without admixture with fly ash at the age of 7 days and 28 days were calculated.

Table 4. Compressive Strength of concrete at 4% fly ash.

Type of Concrete	Grade of Concrete	At the age of 07 days (N/mm^2)	At the age of 28 days (N/mm^2)	Target Strength days (N/mm^2)
SCC with4% fly ash	M20	23.45	32.56	26.60
	M25	24.11	28.11	31.60
	M30	20.33	29.18	38.25
NC without admixture with 4% fly ash	M20	18.44	24.56	26.60
	M25	21.22	26.55	31.60
	M30	19.56	27.22	38.25
NC with admixture with 4% fly ash	M20	20.89	30.33	26.60
	M25	22.44	35.07	31.60
	M30	24.33	37.11	38.25

Table 5. Compressive Strength of concrete at 8% fly ash.

Type of Concrete	Grade of Concrete	At the age of 07 days (N/mm^2)	At the age of 28 days (N/mm^2)	Target Strength days (N/mm^2)
SCC with 8% fly ash	M20	24.04	34.56	26.60
	M25	25.11	30.11	31.60
	M30	22.33	31.18	38.25
NC without Admixture with 8% fly ash	M20	19.44	23.56	26.60
	M25	22.22	24.55	31.60
	M30	24.56	26.22	38.25
NC with Admixture with 8% fly ash	M20	22.89	31.33	26.60
	M25	24.44	32.07	31.60
	M30	26.33	36.11	38.25

Table 6. Compressive Strength of concrete at 12% fly ash.

Type of Concrete	Grade of Concrete	At the age of 07 days (N/mm^2)	At the age of 28 days (N/mm^2)	Target Strengthdays (N/mm^2)
SCC with 12%	M20	25.45	34.56	26.60

fly ash	M25	26.11	32.11	31.60
	M30	27.33	30.18	38.25
NC without Admixture with 12% flyash	M20	20.44	25.56	26.60
	M25	22.22	27.55	31.60
	M30	23.56	28.22	38.25
NC with Admixture with 12% flyash	M20	21.89	31.33	26.60
	M25	23.44	36.07	31.60
	M30	25.33	37.11	38.25

CONCLUSIONS-

From the experimental work carried out for M20, M25 and M30 grade of concrete by partial replacement of cement with 4%, 8% and 12 % of fly ash, the following conclusions were drawn.

1. The compressive strength of normal concrete increases with increase in fly ash content. The compressive strength of self-compacting concrete having M20 grade at the age of 28 days was found to be increased with addition of fly ash having different proportion of 4%, 8% and 12% respectively.
2. For M25 grade concrete, the SCC using PPC and different amount of fly ash is slightly difficult to achieve but it may be possible with a little change in water content and amount of admixture.
3. For M30 grade concrete, the SCC using PPC and different amount of fly ash is very difficult to achieve as the segregation of coarse aggregate may start and target strength may not be achieved.
4. The NC with admixture and fly ash showed very good compressive strengths

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