

Experimental Investigation on Self Compacting and Self Curing Concrete with Various Admixtures for M30 Grade Concrete

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ABSTRACT: Curing of concrete is maintaining satisfactory moisture content in concrete during its early ages in order to develop the desired properties. It also plays a major role in developing the concrete microstructure and pore structure, and hence improves its durability and performance. Self-Curing Concrete reduces the water evaporation from concrete. It increases the water retention capacity (WRC) the concrete compared to the conventionally cured concrete. Self-Compacting Self-Curing concrete (SC-SCC) has been studied using Polyethylene Glycols (PEGs) and Glenium B233. The current trend is incorporating Self-Compacting agents in Self- Curing Concrete. So, a study may be conducted on self - compacting self- curing concrete. The workability properties of Self-Curing Self-Compacting Concrete with partial replacement (20%) by weight of cement by Quartz powder, Fly-Ash were studied with 1% Addition of PEG for all the tests. Workability studies such as Slump flow test, V- Funnel test and L- Box method were performed and Strength related tests such as Compressive test and Split tensile test for 3, 7 & 28 days were performed in this study. Flexural strength of beams size (1500x150x230mm) has been studied.

KEYWORDS: Self Compacting Self Curing Concrete, Fly Ash, Quartz Powder, Poly Ethylene Glycol, Glenium B233.

I. INTRODUCTION

Curing of concrete is maintaining satisfactory moisture content in concrete during its early ages in order to develop the desired properties. Curing of concrete plays a major role in developing the concrete microstructure and pore structure, and hence improves its durability and performance. Good curing is not always practical in many cases due to the non-availability of good quality water. Water resources are becoming valuable every day. Each one cubic meter of concrete requires about 3m³ of water for construction, most of which is used for curing. It reduces the water evaporation from concrete. Increases the water retention capacity (WRC) the

Concrete compared to the conventionally cured concrete. It has been found that water soluble polymers (Poly Ethylene Glycol) can be used as self-curing agent in the concrete. On the other hand Glenium B233 has been primarily developed for applications in high performance concrete where the highest durability and performance is required. The current trend is incorporating self-curing agents in Self Compacting Concrete. So, a study may be conducted on self-compacting self-curing concrete.

II. MATERIALS

A. Cement

Cement is one of the important constituents of mortar it is the binding material in mortar which is used for all building elements. Most important benefit is the faster rate of development of strength. Ordinary Portland cement 53 grade is used for casting the mortar cubes. Cement properties are evaluated as per the IS methods.

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B. Coarse Aggregate

Uncrushed gravel or stone which is the result of natural disintegration and crushed gravel or stone are usually called the “Coarse Aggregates”. As mentioned earlier, coarse aggregates are stones that are retained on 4.75mm sieve. Nearly all natural aggregates originate from bed rocks. Fine aggregate properties are evaluated as per the IS 2386-1963 methods.

C. Fine Aggregate

Sand is either round or angular grain and is often found mixed in various grading of fineness at different zones. According to size the fine aggregate may be described as coarse sand, medium sand and fine sand. IS specifications classify the fine aggregate into four types according to its grading as fine aggregate of grading Zone-1 to grading Zone-4. The four grading zones become progressively finer from grading Zone-1 to grading Zone-4. 90% to 100% of the fine aggregate passes 4.75 mm IS sieve and 0 to 15% passes 150 micron IS sieve depending upon its grading zone. Fine aggregate properties are evaluated as per the IS 383-1970 methods.

C. Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. The quantity and quality of water is required to be watched in to carefully so that it can form the strength giving cement gel. Portable water is used for making mortar. The pH value of water lies between 6 and 8 that indicate the water is free from organic matters.

E. Fly Ash

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds.



Figure 1. Fly Ash

F. Quartz Powder

Quartz is the main crystalline mineral form of silica. White or milky quartz is an opaque white, greasy-looking and sharply angular very hard rock. Natural deposits of relatively pure quartz are plentiful and it is found in most rocks, it is the most abundant mineral on earth and a fascinating study in the importance of considering the mineralogy of materials used in ceramics. For example, quartz and fused silica glass have the same chemistry, SiO₂, but dramatically different physical properties (e.g. thermal expansion, hardness, specific gravity). From a theoretical perspective, quartz is a mineral. However in ceramics it is also considered a material, huge quantities of quartz powder are used in bodies and glazes. We used a very snow white color, a grade Quartz Powder where silica content is more than 96%.

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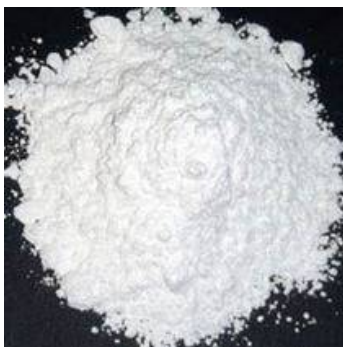


Figure 2. Quartz Powder

G. Glenium B233

Glenium B233 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. Master Glenium B233 is free of chloride & low alkali. It is compatible with all types of cements.



Figure 3. Glenium B233

H. Polyethylene Glycol

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula $H(OCH_2CH_2)_nOH$, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odourless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals. The PEG-200 use in the investigation have Molecular Weight 200, Appearance Clear liquid, pH 5-7, Specific Gravity 1.1

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Figure 4. Polyethylene Glycol

III. MIX PROPORTION OF SCC

There is no standard method for SCC mix design and many academic institutions, admixture, ready- mixed, pre cast and contracting companies have developed their own mix proportioning methods. Our design was based on EFNARC specifications.

Water	Cement	Fine Aggregate	Coarse Aggregate
191.6 lit	445.5 kg/m ³	484.8 kg/m ³	1185.9 kg/m ³
0.43	1.00	1.09	2.66

Table: 1 Final Mix Proportions for M30 Grade

IV. RESULTS AND DISCUSSIONS

Slump flow, V-Funnel and L- Box tests are done with 20% of Replacement of Fly Ash and Quartz Powder with Cement and results for workability properties of SCC are mentioned below.

Table: 2 For 20% Replacement of Cement by Quartz Powder

S.NO	L-Box	V-Funnel	Slump flow
Units	(h ₂ /h ₁)	Sec	Mm
Quartz Powder	0.90	8 Sec	670
Quartz Powder	0.88	8 Sec	680

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Table 3: For 20% Replacement of Cement by Fly-Ash

S.NO	L-Box	V-Funnel	Slump flow
Units	(h ₂ /h ₁)	Sec	Mm
Fly ash	0.84	7 Sec	660
Fly ash	0.86	7 Sec	650

A. Compressive Strength Results:

For cube compression tests on concrete, cube of size 150mm were employed. All the cubes were tested in saturated condition after wiping out the surface moisture from the specimen. For this present investigation, cubes were tested by HEICO compression testing machine as per IS: 516 – 1959 at an age of 7 days and 28 days. The tests were carried out at a uniform stress after the specimen has been centered in the testing machine. Loading was continued till the dial gauge needle just reverses its direction of motion. The reversal in the direction of motion of the needle indicates that the specimen has failed. The dial gauge reading at that instant was noted which is the ultimate load. The ultimate load divided by the cross sectional area of the specimen is equal to the ultimate cube compressive strength.

B. Split Tensile Tests for cylinders:

This is an indirect test to determine the tensile strength of the specimen. Splitting tensile tests were carried out on 150mm x 300mm sized cylinder specimens at an age of 7 days and 28 days using 400 Tonne capacity Heico compression testing machine as per IS: 5816 – 1970. The load was applied till the specimen split and readings were noted.

Table: 4 Compressive Strength of Concrete Cube for M30 Grade of Concrete with Fly Ash as Admixture:

Curing Days	Compressive Strength of concrete cube (N/mm ²) for				
	Self-Curing Self Compacting	Self-Compacting	Self-Curing	With only Fly Ash	N
3 Days	24.46	25.90	25.56	23.60	22.83
7 Days	27.305	29.28	28.78	26.50	26.33
28 Days	34.35	36.77	36	33.71	31.97

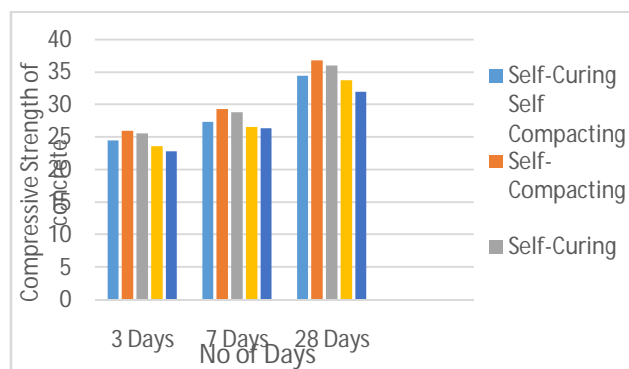


Fig.1 Compressive Strength of Concrete Cube for M30 Grade of Concrete with Fly Ash as Admixture

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Table: 5 Split Tensile Strength of Concrete Cylinder for M30 Grade of Concrete with Fly Ash as Admixture:

Curing Days	Split tensile test of concrete cylinder(N/mm ²) for				
	SC-SCC	SCC	SC	NF	N
3 Days	2.404	2.569	2.573	2.367	1.943
7 Days	2.609	2.731	2.765	2.543	2.447
28 Days	3.414	3.667	3.53	3.371	3.103

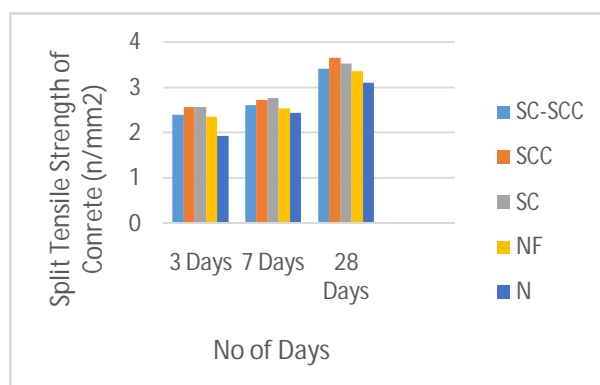


Fig.2 Split Tensile Strength of Concrete Cylinder for M30 Grade of Concrete with Fly Ash as Admixture

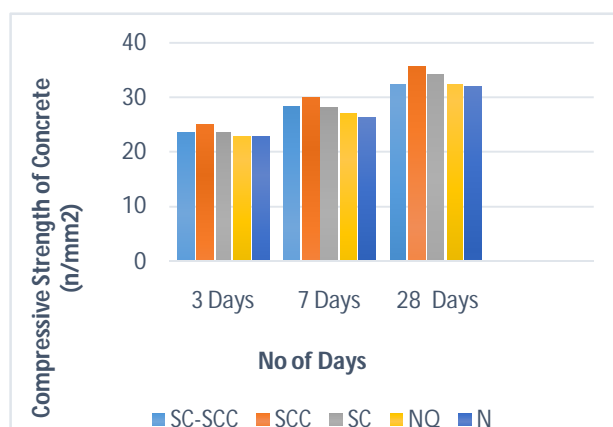


Fig.3 Compressive Strength of Concrete Cube for M30 Grade of Concrete with Quartz Powder as Admixture

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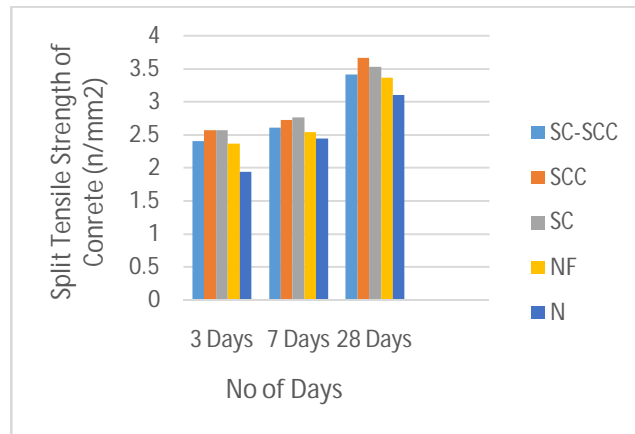


Fig.4 Split Tensile Strength of Concrete Cylinder
for M30 Grade of Concrete with Quartz Powder as

Table: 6 Compressive Strength of Concrete Cube for M30 Grade of Concrete with Quartz Powder as Admixture:

Curing Days	Compressive Strength of concrete cube (N/mm ²)				
	SC-SCC	SCC	SC	NQ	N
3 Days	23.42	24.90	23.56	22.60	22.83
7 Days	28.365	29.90	28.10	27.12	26.33
28 Days	32.55	35.44	34.32	32.55	31.97

C. Flexural Behaviour:

Flexure strength tests were carried out on beams of size 1500x150x230 mm on loading frame of capacity 50Tonne. All the beams were tested under Centre Single point load Condition. The beams are tested as simply supported beam. The beam designed as a under Reinforced beam having 10mm diameter main bars used as a tension as well as compression reinforcement and 6mm stirrups used as a shear reinforcement spacing of 6 inches. The deflectometer was set the bottom of the beam. Load cell as placed the beam. While the load was applied from hydraulic jack the deflectometer in the proving ring indicates the load applied on the beam.

Table: 8 Flexural Strength Test Results for M30 Grade of Concrete with Fly Ash and Quartz Powder as Admixture:

LOAD (KN)	DEFLECTION IN mm	
	FLY ASH	QUARTZ POWDER
5	0	0
10	0.1	0.1
15	0.23	0.2
20	0.36	0.3
25	0.5	0.4
30	0.6	0.5
35	0.7	0.6
40	0.8	0.7
45	1	0.9

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50	1.13	1
55	1.4	1.2
60	1.53	1.3
65	1.76	1.5
70	1.96	1.7

V.CONCLUSION

This project was overall interesting and from the results, Replacement of Fly Ash as admixture will be more workable than quartz powder satisfying all the tests such as Slump flow test, V – Funnel, U – Box method and L – Box method. For 20% replacement of cement by Quartz Powder, after 28 days of curing, self-compacting satisfying the target mean strength. Also, Split tensile strength concrete cylinder will have similar pattern of variation as compression strength. Similarly, for 20% replacement of cement by Fly ash, after 28 days of curing, self-compacting satisfying the target mean strength. Also, Split tensile strength concrete cylinder will have similar pattern of variation as compression strength. When it comes to Beams, the flexural behaviour of beam with Fly Ash performed well when compared to the specimen replaced with Quartz Powder. The ultimate load for specimen replaced with Fly Ash was increased when compared to specimen replaced with Quartz Powder.

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