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Performance of Self Compacting Concrete (SCC) M_{70} Grade by Using M Sand and Limestone

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Abstract:

SCC is a type of High Performance Concrete (HPC) with excellent deformability and segregation resistance. It can flow freely and fill the reinforcement gap and corners of moulds without any vibration and compaction during the placing process. The gliding principle of self compaction is that "the sedimentation velocity of a particle is inversely proportional to the viscosity of the floating medium in which the particle exists". The another significance of mix proportion of SCC include low water to cement ratio, high volume of powder, high paste to aggregate ratio and less quantity of coarse aggregate. One of the popularly employed techniques to produce Self Compacting Concrete(SCC) is to use fine materials like M Sand, Limestone, Poly Carboxylate ester (PC) as Super plasticizer etc.

Keywords **: High Performance Concrete(HPC), Self Compacting Concrete(SCC), deformability, segregation resistance, M Sand, Limestone, Super plasticizer, Poly Carboxylate ester.**

I. INTRODUCTION

Self Compacting Concrete was originally developed at the University of Tokyo in Japan during 1980's used for highly congested reinforced structures like machine bases and columns or walls and in seismic regions along with durability. SCC also used where it is difficult or impossible to use mechanical compaction of concrete, such as underwater concreting, cast in-situ pile foundations,. SCC has characteristics such as high fluidity, good segregation resistance and distinctive self-compacting ability with out any need of external or internal vibration. And it reduces the risk of honey combing. It can be pumped over longer distances and they have Less noise from vibrators and reduced danger from Hand Arm Vibration Syndrome (HAVS), safe working environment, increased production efficiency. Ease to place, requiring fewer workers. Reduced wear and tear on forms from vibrator, less wear on mixers due to reduced shearing action, less energy consumption from vibration equipment. Fewer bug holes, patching, and increased bond strength. Self-compacting concrete (SCC) is a High Performance concrete (HPC), which flows and compacts only under gravity, and which has an excellent deformability and segregation resistance. By name it can be defined as a concrete, which can flow through itself and fill the gaps and corners of reinforcement without any need of external vibration. As per IS: 456-2000, Code of Practice for Plain and Reinforced Concrete, the design of Normal or high strength concrete is done. Standard concretes have a strength ranging 25MPa to 55MPa while those above 55 MPa are called as high strength concrete and Concretes having strength of 120MPa to 150MPa are called ultra high strength concrete. High strength concrete applied in tall buildings, bridges with long span and buildings in aggressive environments. Usually SCC have compressive strengths in the range of 60 to 100 N/mm2.

II. INVESTIGATION OF MATERIALS

SI. No.	Material	Description	Tests Carried Out	Result
1	Coarse Aggregate	Well graded with maximum size 20mm, ranges approximately between 10mm and 20mm Tested as per IS: 383-1970.	Impact Value	5.17
			Specific Gravity	2.7
			Flackiness Index	58.6%
			Elongation Index	34.13 %
2	Fine Aggregate	Fines less than 0.125mm, M-Sand with code IS: 383-1970.	Finess Test	2.66%
			Specific Gravity	2.63
3	Cement	Portland Pozzolana Cement(PPC) of 53 grade with codal provision IS: 1489-1991(Part I).	Setting Time of Cement a) Initial Setting Time = 31min b) Final Setting Time = 10hr	
			Consistency	35%
			Specific Gravity	3.14
4	Water	Portable water with pH value not be less than 6, with code as per IS: 3025-1964 Part 22 & Part 23.		

A. Mineral Admixtures

Mineral admixtures are added to concrete as a part of the cementitious material or as replacement of cement. Here we are using Lime stone as mineral Admixture. Its Optimum amount improve concrete properties such as workability and strength. It increases the hydration process in addition to the filling effect of micro aggregate and reduces the porosity of concrete. It adjusts the grading of the components to achieve an optimum compact and adjust the cohesiveness and reduce the heat of hydration and reaction rate. It improve the durability and resistance to chemical attack and reduce microcracks in the transition zones.

B. Chemical Admixtures

Chemical admixtures are used in SCC as an ingredient, which can be mixed to the concrete immediately before or during mixing. Here for this project, Polycarboxylate Ether (PCE) chemical admixture is used. They help in the efficient use of large amount of cementitious material in high strength and SCC so as to obtain the lowest water to cementing materials ratio.

- ***Super Plasticizers***

The water content is to be increased to improve workability. Corresponding amount of cement is added to get the water cement ratio constant, so the strength will remain the same. To avoid the usage of more quantity of water and cement, Superplasticizer is used to improve the fluidity of the mix and increase the workability of concrete. For this project, Poly Carboxylate Ether (PCE) Admixture used.

III. EXPERIMENTAL PROGRAMME

The tests recommended by the authority EFNARC [European Federation of Producers and Applicators of Specialist Products for Structures, May 2005] for determining the properties of fresh SCC, M70 grade of concrete are Slump flow test, L-box test, V-funnel test, U-box test, Orimet test & GTM Screen Nan Su method of mix design [2001] was adopted for suitable mix proportions. A total of 24 cubes of standard size 150mm x 150mm x 150mm were cast with different ratios of superplasticizer Polycarboxylate ester for determining the compressive strength. The present investigations are mostly directed towards developing a mix with good SCC, with different sizes of coarse aggregate and for M_{70} grade of concrete. The properties and details of fresh properties and hardened properties of SCC with different sizes of coarse aggregate and different.

Mix Design and Proportioning

- ***Target mean strength***

$F_t = F_{ck} + 1.65\ S$; where S = 6 and $F_{ck} = 70$

$F_t = 70 + (1.65 \times 6)$

$F_t = 79.9\ N/mm^2$

- ***Calculation of water content***

W/C ratio = 0.42

Max. water content for 20mm CA is 208L, 3% increase for every 25mm slump over and above 50mm slump. Estimate water content for 100mm slump is $= \frac{208 \times 6}{100} + 208$

= 221 liter

- ***Calculation of weight of materials***

Weight of cement = $\frac{wt.of\ water}{water\ cement\ ratio}$

= $\frac{221}{0.42}$

= 526 kg/m^3

Weight of Admixture = 1.2% weight of cement

= 1.2 x ($\frac{422}{100}$)

= 5kg

Weight of fine aggregate

= volume of F.A x specific gravity of F.A. x1000

= 0.2259x2.70x1000

= 609.93 kg/m^3

Weight of Coarse Aggregate

= volume of C.A x specific gravity of C.A.x1000

= 0.4587x2.80x1000

= 1284.36 kg/m^3

Water : cement : F.A. : C.A = 0.42 : 1 : 1.45 : 3.04

IV. TESTS ON CONCRETE

A. Tests on Fresh Concrete

- ***Slump Flow Test and T_{50} cm Test***

The slump flow is used to measure the filling ability. A slump cone was firmly placed centrally on base plate. About 6L concrete was filled and raised vertically upwards allowing the concrete to flow freely. The time taken for concrete to reach the 500mm diameter spread circle was recorded called as T_{50} time. After flow finish, the final diameter of concrete in two perpendicular directions are taken, and average is called as slump flow.

- ***L – Box Test***

The apparatus consists of a 'L' shape having a vertical section which is filled with 14L concrete and let it flow to the horizontal section by lifting the movable gate. When the flow stopped, the height of the concrete at the end of the horizontal section is expressed as a proportion of that the vertical section called as H_2/H_1 ratio or blocking ratio. This is an indication of passing ability. At 200mm and 400mm from the gate of the horizontal section of the box can be marked and the time taken to reach these points are called as T_{20} and T_{40}.

- ***V-Funnel Test and V-Funnel Test at T_5 Minutes***

The equipment have a V-shaped funnel, which filled with 12L of concrete with trap door closed and a bucket placed underneath. The trap door opened and concrete was allowed to flow under gravity. The time taken for the complete discharge of concrete to the bucket is measured to determine the filling ability. Then funnel was refilled with concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time increases; it is done to determine T_5 Minutes Test.

- ***J– Ring Test***

The apparatus having a rectangular section with a open steel ring.. The base plate is a square marked with its center. The J – Ring can be used in combination with the Slump flow test and they describe about flowing ability and the passing ability, the slump cone was placed centrally inside J-Ring, and filled 6 liters of concrete. The slump cone is vertically raised upwards and allowed flow out freely through the rings. The difference in height between the concrete inside and outside is measured and the average is measured.

- ***U-Box Test***

U-Box test measures the filling ability of SCC. The equipment consists of a vessel that is divided by a middle wall into two compartments and an opening with a sliding gate in between them. 20 liters of concrete was completely filled in the left hand section. The concrete flows upwards while gate was lifted and the height measured.

B. Tests on Hardened Concrete

- ***Compressive Strength Test***

Compressive strength is the capacity of concrete to resist compressive stress up to when it fails. The cube specimen of size 150mm x 150mm x 150mm with different percentage of superplasticizer are tested. After the curing of 7th, 14th, 28th days the cube specimens transferred to the swiveling head of the machine such that a uniform loading 140Kg/cm^2/min was applied centrally and vertically.

The specimen breaks and the pointer starts moving back at the maximum load to failure was noted.

V. RESULTS OF SCC

A. Test Results In Fresh SCC

SI. NO	METHOD	UNIT	RESULT
1	Slump flow test	mm	706
2	T_{50} cm Slump flow	sec	4
3	J – Ring	mm	5.1
4	V – Funnel	sec	8
5	V – Funnel at T_5 minutes	sec	9
6	L – Box	h_2/h_1	0.8
7	U – Box	(h_2-h_1) mm	28.6

Table 1 : Test Results in Fresh SCC

B. Test Results In Hardened SCC

SI. No.	Mix In % of Superplasticizer	7th DAY	14th DAY	28th DAY
1	M1 (0%)	32.6	44.1	66.4
2	M2 (0.3%)	37.2	47.2	68.0
3	M3 (0.6%)	43.9	53.9	73.0
4	M4 (0.9%)	39.2	50.5	70.0

Table 2: Test Results in Hardened SCC

C. Compressiver Strength Vs SCC Mix Relationship

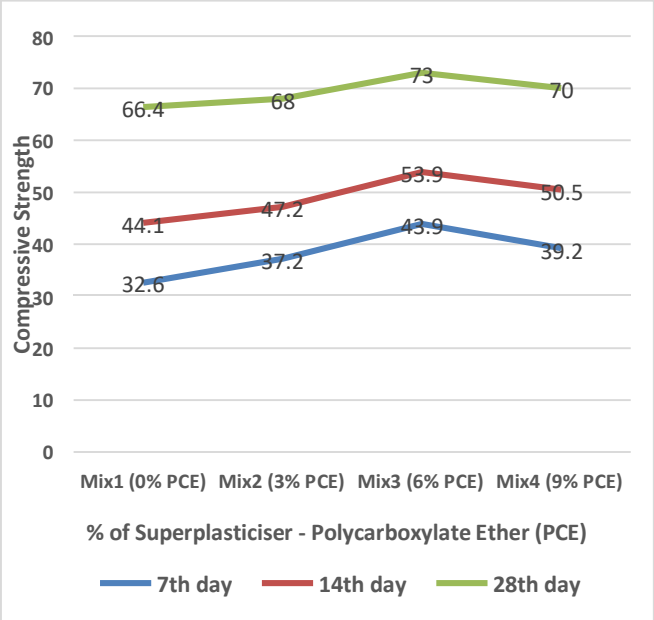

Fig.5.1 Compressive Strength Vs SCC Mix Graph

VI. CONCLUSION

This project helps to conclude the high performance of M70 Self Compacting Concrete achieved by using M Sand, and chemical admixture like super plasticizer Poly Carboxylate Ester (PC) and Mineral admixture limestone by increasing an optimum amount. We can use this technology to future construction works and it will helps to improve the work quality and it will ensure the easiness of works. From this work, the strength of concrete increases when Polycarboxylate Ester added. And reaches a maximum at 6% and started to reduce its strength after 6%.

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