Permeability Behavior of Self Compacting Concrete

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Abstract-- Self compacting concrete (SCC) is the new category of high performance concrete characterized by its ability to spread and self-consolidate in the formwork exhibiting any significant separation of constituents. Elimination of vibration for compacting concrete during placing through the use of Self Compacting Concrete leads to substantial advantages related to better homogeneity, enhancement of working environment and improvement in the productivity by increasing the speed of construction. Understanding of this concrete flow property is of interest to many researchers. Flow properties of concrete at green stage are significantly governed by paste content, aggregate volume and admixture dosage. The flow properties of concrete is characterized in the fresh state by methods used for Self compacting concrete, such as slump-flow, V-funnel and L- box tests respectively. The number of trail mixtures are used and tests such as Slump Flow, V-Funnel, L-box etc. are conducted for their permissible limits, then the final proportions of ingredients and admixtures have been finalized for M30 , M 40 , M 50 and M 60 grade Concretes . In the present experimental investigation the main concentration is focused on permeability properties of self-compacting concrete mixes.

Key words: Permeability, Self-Compacting Concrete

I.INTRODUCTION

Concrete is an important versatile construction material, used in wide variety of situations. So it is very important to consider its durability as it has indirect effect on economy, serviceability and maintenance. So it is important to discuss the permeability characteristics of self-compacting concrete, as it has much bearing on durability. Aggressive chemicals attack concrete only in solution form. The penetration of this aggressive liquid will depend upon the degree of permeability of concrete. The extent of frost action and the resting of steel reinforcement also depend upon the permeability of concrete. So tests are also performed for determining the permeability of self-compacting concrete.

II. LITERATURE REVIEW

Ganesan et al. [1] studied the effect of steel fibers on the durability parameters of self-compacting concrete (SCC) such as permeability, water absorption, abrasion resistance, resistance to marine as well as sulphate attack.It was observed that the coefficient of permeability and wear of SFRSCCwere lower than the corresponding moderate strength concrete.

Under the marine and sulphate attack, the losses in mass of concrete and compressive strength of cubes were found to be negligible. It was observed that SFRSCC resists these attacks within tolerable limits and the optimum dosage of fibres for better performance was found to be 0.5 percent. Based on the experimental investigation, it was concluded that addition of steel fibres improved the durability aspects of self-compacting concrete. The loss in mass and compressive strength of cubes was found to be negligible under marine and sulphate attacks. It was observed that SFRSCC resists all these attacks within tolerable limits and the optimum dosage of fibers for better performance was found to be 0.5 percent.

JagadishVengala et al. [2] discussed the results of an experimental study of the fresh concrete properties and the development of strength of high performance self-compacting concrete at ages of 180 and 270 days. Based on fresh and hardened properties of SCC mixes they concluded that inclusion of fly ash as part replacement of coarse aggregate, as done in this study, has increased the paste content and hence enhances the self-compacting properties.

Naveen Kumar C et.al [3] have presented the results of experimental studies where in fly ash, metakaolin and their blends were used as fillers in SCC. The results showed that SCC can be produced with cement content, as low as 200Kg/m3 of concrete together with rest of the powder coming from fly ash. High strength SCC can be obtained through incorporation of metakaolin. Mixes with different fillers likesilica fume and metakaolin help in attaining a high earlyStrength of around 50-70 MPa which is very useful in pre-cast applications. They also can provide high durability when used along with fly ash.

Srinivasa Rao et al. [4] presented the design mixes of M 30 and M35 grade of Glass fiber self-compacting concretes using alkaline glass fibers and studied the various properties of the mixes.

Srinivasa Rao et al. [5 presented the design mixes of M 30 to M 65 grade of self-compacting concretes using EFNARC guidelines the studied the behaviors of compressive strength, split tensile strength and flexural strength behavior of the mixes M 30 to M 65 Grades of self-compacting concrete mixes.

III.RESEARCH SIGNIFICANCE

For a newly developing material like SCC, studies on durability is of paramount importance for instilling confidence among the engineers and builders. The literature indicates that while some studies are available on the durability of plain SCC and fiber reinforced SCC, a comprehensive study which involves durability parameter like permeability are not available for SCC. Hence, considering the gap in the existing literature, an attempt has been made to study on the durability parameters of SCC like permeability.

Experimental programme:

To study the permeability behavior of Self Compacting Concrete specimens of M 30, M40, M 50 and M 60 mixes. Materials

Cement: Ordinary Portland cement of 53 grades available in local market is used in the investigation. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of are 12269-1987.The specific gravity was 2.96 and fineness was 3200cm2/gm.

Coarse Aggregate: Crushed angular granite metal of 10 mm size from a local source was used as coarse aggregate. The specific gravity of 2.65 and fineness modulus 6.05 was used. Fine Aggregate: River sand was used as fine aggregate. The specific gravity of 2.55 and fineness modulus 2.77 was used in the investigation.

Viscosity Modifying Agent: A Viscosity modified admixture for Rheodynamic Concrete which is colorless free flowing liquid and having Specific of gravity 1.01+0.01 @ 250C and pH value as 8+1 and Chloride Content nil was used as Viscosity Modifying Agent.

Admixture: The Modified Polycarboxylated Ether based Super Plasticizer which is Brown Color and free flowing liquid and having Relative density 1.08+0.01 and pH value as7+ 1 and Chloride Content nil was used was Superplasticizer.

Fly Ash: Type-II fly ash from Vijayawada Thermal PowerStation, Andhra Pradesh was used as cement replacement material. The properties fly ash are confirming to I.S. 3812 –1981of Indian Standard Specification for Fly Ash for use asPozzolana and Admixture.

Test Specimens: Test specimens consist of cylinder dia.150mm and Height 150mm were casted. These were casted using different Concrete mixes as given in Table 1. These specimens were tested as per IS 516 and 1199.

IV. TEST PROCEEDURE

The SCC specimens (cylinder dia. 150mm and height150mm) are cured for 180 days and loaded in the cells, these specimens are sealed with jute, rosin and wax on all the round of the cells such that water allowed above the specimens should percolate though the top surface of the specimens and collected in the bottles kept below the cell with funnel arrangements. A constant air pressure of 15 kg/cm^2 is maintained along with water pressure of 2 kg/cm by usingair compressor throughout the experiment for a specified period of time. Then the coefficient of permeability is calculated using the following formula

$K= Q / (\sum (H/L)*A*T)$
Where K= Coefficient of permeability
Q = Quantity of water collected in cc
T = Time in seconds = (4) (60) (60) sec = 14400 sec
A = Cross sectional area of the specimen in cm^2 = 176.71 cm^2
H/L = ratio of pressure head to thickness of the specimen = (2 X 100) /15 = 13.333

V.DISCUSSION

Workability: Table 2 provides a summary of the properties of the Self Compacted Concrete mixes in the fresh state. As it is evident, the basic requirements of high flow ability and segregation resistance as specified by guidelines on Self Compacted Concrete by EFNARC are satisfied. The workability values are maintained by adding suitable quantities of superplasticizers.

Water to Cementitious Ratio: The Water to cementitious material by weight was kept at about 0.40 for M30 grade, 0.34 for M 40 grade and 0.30 for M50 grade of concrete and for M60 Grade of Concrete the Water Content was reduced till the water to cementitious ratio by weight was 0.26 in the Mix.

Table 3 gives the co-efficient permeability of various grades of self-compacting mixes of M 30, M 40, M 50, and M 60. These values are observed to be varied from 10.02 x10-8 to7.23 x10-8 m/sec.

VI. CONCLUSION

The higher grade of the self-compacting concrete mixes the resistance to the permeability is more in comparison with lower grade of the self-compacting concrete mixes. This is because of the transformation of large pores to fine pores as a consequence of the pozzolanic reaction between cement paste and fly ash substantially reduce the permeability in the cementitious matrix.

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Table 1-- Quantities per 1 cum of Self Compacting Concretes

Grade of Concrete	Cement (kg/m^3)	Fly ash (kg/m^3)	Coarse Aggregate (kg/m^3)	Fine aggregate (kg/m^3)	Water (kg/m^3)	SP (kg/m^3)	V.M.A (kg/m^3)
M 30	225	225	865	898	179	4.50	0.315
M 40	258	258	835	836	176	5.16	0.413
M 50	360	240	797	796	180	6.00	0.480
M 60	400	250	785	785	172	9.75	0.460

Table 2 -- Rheological Properties Of Self CompactingConcrete Mixes

		M 30	M 40	M 50	M 60	Permissible limits [6] Efnarc	
						Min	Max
V Funnel		10 sec	5 sec	10 sec	8 sec	6 sec	12 sec
Abrams slump Flow		660 mm	700 mm	660 mm	720 mm	650 mm	800 mm
T_{50cm} slump Flow		5 sec	2 sec	5 sec	3sec	2 sec	5 sec
L-Box	H_2/H_1	0.85	0.90	0.8	0.88	0 .82	1.0
	T_{20}	1sec	2 sec	2sec	2 sec	1sec	2 sec
	T_{40}	2 sec	3 sec	3 sec	3 sec	2sec	3sec
V-Funnel		12 sec	11 sec	12 sec	14 sec	11 sec	15 sec

Table 3 -- Co-Efficient Of Permeability of Self CompactingMixes

Grade of Concrete	Time of Collection of Water (Hrs)	Pressure head (H) (m)	Quantity of water collected cc	Coefficient of permeability x 10^{-8} m/sec
M 30	4	2	340	10.02
M 40	4	2	300	8.84
M 50	4	2	270	7.95
M 60	4	2	245	7.23