ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Studies on Strength and Acid Resistance of Conventional Concrete and Self Compacting Concrete

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ABSTRACT:

Self compacting concrete is a fluid mixture, which is suitable for placing in difficult condition and is structures with congested reinforcement without any vibrators. The resulting concrete has an excellent surface finish. Self compacting concrete (SSC) has evolved from being a novel concrete to a material Technology that can be used commonly and benefited from its applications where conventional / vibrated concrete is inadequate. SSC is one of the High Performance Concretes with excellent strength and durability properties.

The ongoing research works concentrate on developing SSC mixes and exploring its application in major construction projects. SSC can be made using sufficient powder along with a super plasticizer in order to make it flow while keeping coarse aggregate in a viscous suspension. The relative proportion of filler in total powder is likely to influence the properties of SSC both in fresh and hardened states. An attempt has been made in this project work to develop mix design of SSC for M50, using the industrial by-products Fly ash, Rice Husk Ash (RHA) and investigate its flow and strength properties in comparison with conventional concrete.

The flow properties such as passing ability, filling ability, and segregation resistance and compaction factor are checked by conducting various tests. The compressive strength of concrete at the age of 3,7 & 28 days and also the split tensile strength and flexural strength for 28 days are reported and also the parameters like percentage weight loss, Acid durability factor and Acid attack factors in 2% and 5% concentration solutions of H2So4and HCL.

Keywords:

Self-Compacting Concrete, micro silica, workability, compressive strength.

(I).INTRODUCTION:

These days, apart from steel, concrete is the most common and widely used as structural material in construction field. Concrete defined as a composite material made up of composed granular material (the aggregate or filler) embedded in a hard matrix of material (cement or binder) and water. They are many types of concrete with different material used in mix design. The Self Compacting Concrete is a concrete which flows and settles due to its own weight without segregation and bleeding. SCC has several advantages over normal conventional concrete. It can flow easily in congested reinforced areas such as in beam column joints. The terms "High performance concrete" and "High strength concrete" are often taken to mean the same thing. However, as indicated, "High performance" strictly relates to a concrete that has been designed to have good specific characteristics, such as high resistance to chloride ingress or high abrasion resistance, as a result it may also have a high strength. High-strength concrete is specified where reduced weight is important or where architectural considerations call for small support elements. By carrying loads more efficiently than normal-strength concrete, high-strength concrete also reduces the total amount of material placed and lower the overall cost of the structure. The most common use of high strength concrete is for construction of high-rise buildings.

A. SELF COMPACTING CONCRETE:

Development of Self-Compacting Concrete (SCC) is a desirable achievement in the construction industry in order to overcome problems associated with cast-in-situ concrete. SCC is not affected by skills of labours, the shape and amount of reinforcement or the arrangement of a structure and due to its high fluidity and resistance to segregation it can be pumped longer distances. The concept of SCC was proposed in 1986 by Professor Hajime Okaruma, but the prototype was first developed in 1988 in Japan, by Professor Ozawa (1989) at the University of Tokyo.

SCC was developed at the time to improve the durability of concrete structures. Since then, various investigations have been carried out and SCC has been used in practical structures in Japan, mainly by large construction companies.Investigations for establishing a rationalmix design method and Self-Compacting testing methods have been carried out from the viewpoint of making it a standard concrete. Self-Compacting Concrete is cast so that no additional inner or outer vibration is necessary for the compaction. It flows like "honey" and has a very smooth surface level after placing. With regard to its composition, Self-Compacting Concrete consists of the same components as conventionally vibrated concrete, which are cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. Usually, the chemical admixtures used are High-Range Water Reducers (super plasticizers) and Viscosity Modifying Agents, which change the rheological properties of concrete. Mineral admixtures are uses as an extra fine material, besides cement, and in some cases, they partially replace cement. In this study, the cement content was partially replaced with mineral admixtures, micro silica that improves the flowing and strengthening characteristics of the concrete. The main reasons for the employment of SCC can be summarized as follows:

•To shorten the construction period.
• To assure compaction in the structure- especially in confined zones where compaction is difficult.
•To eliminate noise due to vibration.

B. HIGH STRENGTH CONCRETE:

High-strength concrete has a compressive strength greater than 40 Mpa. High-strength concrete is made by lowering the water-cement (W/C) ratio less than 0.35. Often micro silica is added to prevent the formation of free calcium hydroxide crystals in the cement matrix, which might reduce the strength at the cement-aggregate bond. Low W/C ratios and the use of micro silica make concrete mixes significantly less workable, which is particularly likely to be a problem in high-strength concrete applications where dense rebar cages are likely to be used. To compensate for the reduced workability, super plasticizers are commonly added to high-strength mixtures. Aggregate must be selected carefully for high-strength mixes, as weaker aggregates may not be strong enough to resist the loads imposed on the concrete and cause failure to start in the aggregate rather than in the matrix or at a void, as normally occurs in regular concrete.

In some applications of high-strength concrete the design criterion is the elastic modulus rather than the ultimate compressive strength.

(II)LITERATURE REVIEW:

Research by IRENE LA BARCA, RYAN FOLEV (2002) was done. Main objective is to monitor the variability of GGBFS sources. Since it is a by-product its properties are not concerned. Their properties are studied. They also studied strength again and air void development of different mixes.

Dr. JOHN KINUTHIA (1998) had done a work by replacing line with ground granulated blast-furnace slag (GGBS). Portland Cement (PC) replacement, were tested successfully by JOHN MOWLEM 7 CO PLE (in 1998). This became the first lime – GGBS road construction in the UK (4, 14, and 15). The technique was used recently on the A 130 near London.

BAI, J. CHAIPANICH, A. KINUTHIA, J.LEWIS, M. H., O'F ARRELL, M.SABIR B. And WILDS. (2003) compressive strength and hydration of waste paper sludge ash (WSA) - ground granulated blast furnace slag (WAS - GGBS) blended pastes Cement and Concrete Research, 33, 2003, 1189 - 1202.

O'FARRELL M, SABIR B. B, and WILDS (2001). A preliminary study of the cementations properties of waste paper sludge ash (WSA) - ground granulated blast furnace slag (GGBS) blends. Paper presented at an International symposium on Recovery and recycling of paper in March 2001 at the University of Dundee.

(III)PROPERTIES OF SCC:

SCC differs from conventional concrete in that its fresh properties are vital in deforming whether or not it can be placed satisfactorily. The various aspects of workability which control its filling ability, its passing ability and segregation resistance all need to be carefully controlled to ensure that its ability to be placed remains acceptable.

Workability:

The level of fluidity of the SCC is governed chiefly by the dosing of the super plasticizer.

ISSN No: 2348-4845
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However overdosing may lead to the risk of segregation and blockage. Consequently the characteristics of the fresh SCC need to be carefully controlled using preferably to of the different types of test.Segregation Resistance Due to high fluidity of SCC, the risk of segregation and blocking is very high, preventing segregation is therefore an important feature of the control regime. The tendency to segregation can be reduced by the use of sufficient amount of fines (<0.125) or using a viscosity modifying admixture (VMA).

(B) PROPERTIES OF HARDENED CONCRETE:

Compressive strength In all the SCC mixes compressive strength of standard cube specimens were compared to those traditional vibrated concrete with similar water cement ratio; if anything strengths were higher. There is little difficulty in producing Self compacting concrete with characteristics cube strength up to 30 Mpa.Tensile strength Tensile strength is assessed indirectly by the splitting test on cylinders. For SCC, the tensile strengths, they and the relationships between tensile and compressive strengths were of a similar order to those of traditional vibrated concrete.Bond strength The strength of the bond between concrete and reinforcement was assessed by pull-out tests, using deformed reinforcing steel of two different diameters, embedded in concrete prisms. For both civil engineering and housing categories, the SCC bond strengths, related to the standard compressive strengths, were higher than those of the reference concrete were.Modulus of Elasticity Result available indicates that the relationship between static between static modulus of elasticity and compressive strengths, were similar for SCC and the reference mixes. A relationship in the form of E/ (fc) 0.5 has been widely reported, and all the values of this ratio were close to the one recommended by ACI for structural calculations or normal weight traditional vibrated concrete.

(VI) GENERAL MIX PROPORTIONING:

To produce SCC the major work involves designing as appropriate mix proportion and evaluating the properties of the concrete thus obtained. In practice, SCC in its fresh state shows high fluidity, Self compacting ability and segregation resistance, all of which contribute to reducing the risk of honey combing of concrete with these good properties, the SCC produced can greatly improve the reliability and durability of the reinforced concrete structures. In addition SCC shows good performances in compressive strength test and can fulfill other considerations that requirements in the structural design. The ingredients for SCC are similar to other plasticized concrete cement, coarse aggregate, fine aggregate, and water, mineral and chemical admixture. No standard or all encapsulating method for determining mixture proportions currently exists for SCC. However, many different proportion limits have been listed in various publications. Multiple guidelines and "rules of thumb" about mixture proportion for SCC were found. The table summarized this information.

Table (A) Limits on SCC Material Proportions:

	High fines	VMA	combination
Cementations, lb/yd3 (kg/m^3)	750-1000 (450-600)	650-750 (385-450)	650-750 (385-450)
Water /cementations material	0.28-0.45	0.28-0.45	0.28-0.45
Fine aggregate/mortar %	35-40	40	40
Fine aggregate/total aggregate %	50-58	-	-
Coarse aggregate/total mix %	28-48	45-48	28-48

Table (B) Comparison of strength properties of Hardened Concrete of M50 Grade:

Property	Strength at 3 days			Strength at 7 days			Strength at 28 days		
	CC	SCC	% Increase/ decrease	CC	SCC	% Increase/ decrease	CC	SCC	% Increase/ decrease
Comp. Strength (N/mm^2)	30.82	29.00	-5.67	37.57	36.34	-3.3	54.82	56.76	+3.53
Split Tensile Strength (N/mm^2)	-	-	-	-	-	-	5.48	5.64	+2.8
Flexural Strength (N/mm^2)	-	-	-	-	-	-	5.72	5.91	+3.2

(A) SLUMP FLOW TEST AND T50CM TEST:

The slump low is used to assess the horizontal free flow of SSC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete. The test method is based on the test method for determining the slumps. The diameter of the concrete circle is a measure for the filling ability of the concrete.

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(B) V-FUNNEL TEST AND VFUNNEL TEST AT MINUTES:

The described v-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20mm. The funnel is filled with about 12lt. of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow will increase significantly.

(C) L-BOX TEST METHOD:

Peterson has described the test, based on a Japanese design for underwater concrete. The test assesses the flow of the concrete and also the extent to which it is subject to blocking by reinforcement. The sections of bar can be of different diameters and speed at different intervals. In accordance with normal reinforcement considerations, 3x the maximum aggregate size might be appropriate. The bars can principally be set at any spacing to improve a more or less server test of the passing ability of the concrete.

(V)EXPERIMENTAL RESULTS:

Table 8.7.1 Weight Loss and Compressive Strength Loss for M50 –CC

Acid %	% Wt and % CS loss	DAYS					
		15	30	45	60	75	90
2% H_2SO_4	% Wt loss	2.26	5.20	6.48	8.28	10.28	19.20
	%CS loss	0.85	1.12	2.53	3.12	4.72	6.78
5% H_2SO_4	% Wt loss	3.45	6.79	9.28	11.28	13.20	15.75
	%CS loss	0.96	1.54	3.12	4.85	5.91	7.72
2% HCL	% Wt loss	1.39	3.21	5.49	7.78	10.79	14.72
	%CS loss	0.36	1.34	2.79	5.24	6.4	7.59
5% HCL	% Wt loss	1.38	3.45	5.56	7.76	11.79	13.72
	%CS loss	0.89	1.49	3.23	4.32	5.25	7.72

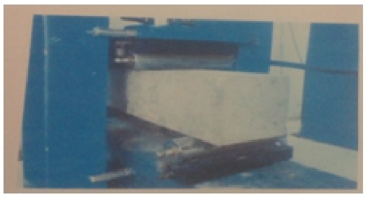
Table 8.7.2 Weight Loss and Compressive Strength Loss for M50 –SCC:

Acid %	% Wt and % CS loss	DAYS					
		15	30	45	60	75	90
2% H_2SO_4	% Wt loss	0.56	1.28	1.76	2.38	4.84	7.68
	%CS loss	0.74	1.00	2.36	2.79	3.56	4.67
5% H_2SO_4	% Wt loss	0.64	1.36	3.49	5.72	6.01	7.73
	%CS loss	0.81	1.23	2.83	3.73	4.89	6.75
2% HCL	% Wt loss	0.28	0.96	1.97	2.98	4.77	6.72
	%CS loss	0.3	1.12	2.12	4.36	5.92	6.42
5% HCL	% Wt loss	0.3	1.20	1.98	4.28	5.46	7.36
	%CS loss	0.66	1.32	2.56	3.42	4.39	6.39

Table No 8.7.4 ACID DURABILITY FACTORS AND ACID ATTACK FACTORS

AGE	FACTORS	M50 – CC		M50-SCC	
		2% HCL	5% HCL	2% HCL	5% HCL
15	Sr	99.64	99.11	99.70	99.34
	ADF	14.23	14.15	14.24	14.19
	AAF	0.42	0.50	0.29	0.25
30	Sr	98.66	98.51	98.83	98.68
	ADF	28.18	28.14	28.25	28.19
	AAF	0.81	0.74	0.42	0.38
45	Sr	97.21	96.79	97.88	97.44
	ADF	41.66	41.48	41.95	41.76
	AAF	1.14	1.12	0.89	0.79
60	Sr	94.76	95.68	95.64	96.58
	ADF	54.14	54.67	54.65	55.18
	AAF	2.06	1.98	1.89	0.98
75	Sr	93.59	94.75	94.08	95.61
	ADF	66.85	66.67	67.20	68.29
	AAF	2.43	2.76	1.39	1.38
90	Sr	92.41	92.28	93.58	93.61
	ADF	79.20	79.09	80.21	80.23
	AAF	3.12	3.09	2.89	2.42

HORIZONTAL SLUMP



FLEXURAL STRENGTH TEST

Fig 4.5 Universal testing machine

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
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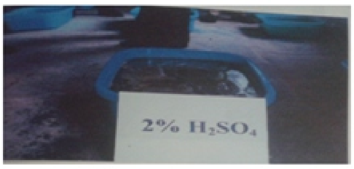
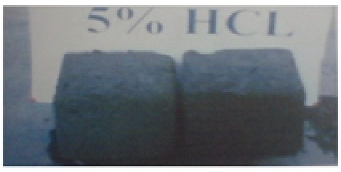
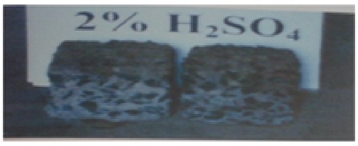
CUBES OF 2 AND 5% OF HCL CUBES



CUBES IN ACID



After Immersion of Cubes in Acid of 2% and 5% of HCL



After Immersion of Cubes in Acid of 2% and 5% of H_2SO_4

CONCLUSION:

The flow properties developed in SSC is satisfying recommended values. The segregation resistance of SCC is also good The optimum dosage of super plasticizer was found 1.75% by weight of powder. The quantity of cement required for SCC is less than that of conventional concrete. In conventional concrete of M50 grade addition of 5% RHA shows better results hence mix was optimized. Durability studies carried out in the investigation through acid attack test. SCC is more durable in terms of acid durability factor compared to the conventional concrete of same grade. Acid consumption in SCC is also less as compared to the conventional concrete. Percentage weight loss and percentage strength loss is less in SCC as compared to conventional concrete. This shows that SCC mix compared CC has resistance against Acid solution.

The percentage weight loss and strength loss of CC and SCC mixes after immersing in 2% and 5% H2SO4 and HCl solution increases corresponding to time. The investigation indicated that the ternary blended concrete (i.e. SCC) performed better acid resistance than the binary blended concrete (CC) The specimen of SCC and CC were severely deteriorated after immersion of 5% H2SO4 and 5% HCl. The mass losses of the SCC after 15 weeks were 40% less than the CC mix. Mass loss of nearly 10% was obtained in sulphuric solution with the SCC at 15 weeks and with the CC mix at 8 weeks. In hydrochloric solution the same loss was obtained at 15 weeks with SCC.

BIBLIOGRAPHY:

1.Kumar, Praveen & Kaushik, S.K (2003), can marginal material be used to produce Self Compacting Concrete. Proc. Of Third Quinquennial International Symposium on Innovative World of Concrete. Pune, Sept 2003 pg.116-119.

2.Malathy. R, Govindaswamy .T (2006) “Development of Mix Design Chart for various grades of SCC” ICI OCT-DEC 2006 pp No.19 to 27.

3.Sharma. V. M.(2006) Self Compacting Concrete- Role Admixtures”. 2006 Civil Engineering & Construction Review, Oct. 2006 pp.54-64.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

4.Specification and guidelines for SCC, EFNARC. Uk(2002).

5.Subramanian, S & Chattopadhyay, D,(2002),"Experim\ents for mix proportioning of Self Compacting Concrete", Indian concrete Journal, Jan.2002, Vol.76.No.1,pp.13-20.

6.Vengala, J. Sudarshan, M.S. & ranganath, R.V (2003), "Experimental study for obtaining Self Compacting Concrete", Indian Concrete Journal, Aug.2003, vol.77,No.8,pp.1261-1266.

7.Ozava, H. Santa, N. and Okamuro H., Evaluation of Self compatibility Of fresh concrete using the funnel test, concrete library of JSCE, No.25 pp.59-75,1995.

8.Okamura, H. and Ozawa, k., Mix Design for SCC, concrete library of JSCE, No 25,pp.107-120,1995.

9.Okamura H. Self compacting High performance concrete-concrete international journal, vol.19, No.7, July1997.