Literature Review on Self Compacting Concretes And Self Compacting Concrete Containing Iron Slag

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Abstract- *The cement and fine aggregate are the most commonly used materials for concreting, plastering and masonry work. Usually Concrete is compacted by vibrations in order to expel entrapped air, making it denser and homogeneous because compaction is necessary to produce durable concrete. Full compaction is difficult due to heavy reinforcement, as a result self-compacting concrete (SCC) was developed. Self-compacting concrete (SCC) can be defined as a concrete which can be placed with its own weight with or without vibration. Iron slag is a waste material which is produced in India at large quantity. The use of iron slag as a partial replacement material for fine aggregate is a good remedy against its disposal. In this paper an overview on the literature on mechanical and durability behaviour of self-compacting concrete and self compacting concrete with iron slag as a partial replacement of fine aggregate is carried out based on recent research studies*

Keywords- Self compacting Concrete, Compressive strength, Split tensile strength, Durability, Iron slag

I. INTRODUCTION

Concrete is compacted by providing vibrations in order to expel entrapped air, making it denser and homogeneous because compaction is necessary to produce durable concrete. Due to heavy reinforcement, compaction of concrete is very difficult and to provide proper compaction without segregation in such areas self-compacting concrete (SCC) is used. Self-compacting concrete (SCC) can be defined as a concrete which can be placed with its own weight with or without vibration. SCC facilitates proper filling and good structural performance of heavily reinforced congested members. Cement is the most commonly used material in concrete. Since concrete useage is increasing day by day due to increase in the construction works consumption of materials also get increased. The cement and fine aggregate are the most reliable materials used for concreting, plastering and masonry work. The main problems such as acute shortage, high price and enormous usage of M sand in the construction. Iron slag can be used as an alternative to M sand since iron slag is produced in large quantity all over the world.

II. REVIEW OF LITERATURE

2.1 Durability Study on Self compacting concrete

Gaywala(1) *et.al*(2011) conducted a study on self compacting concrete. In this study they evaluated the mechanical properties such as compressive strength, tensile strength pullout test and flexural strength. To determine the durability of self compacting against salt and sulphate the SCC cubes were soaked in Nacl solution of concentration 3.5% for 90 days and loss in mass and strength of Self Compacting Concrete were compared with unsoaked specimen. . Change in mass of SCC with 15% flyash as a replacing material for cement gives considerably less reduction in mass change after 100 days. SCC with 15% flyash as a replacing material for cement shows better mechanical properties when compared to 25%, 35%, 45% and 55% of flyash content.

Narayanee(2) et.al(2016) conducted a durability study on high strength self compacting concrete. Replacement of Flyash is about 20% by weight of cement. SCC of grades ranging from M30 to M50 were investigated. To evaluate the fresh properties of SCC various tests such as slump flow test, V funnel test, U tube test, L box test etc. were studied. Mechanical properties of SCC were such as compressive strength, flexural strength and split tensile strength were evaluated. Durability study on SCC were evaluated by conducting various tests such as acid resistance test, alkaline resistance test, sulphate resistance test and water absorption test. While comparing the compressive strength of SCC for sulphate resistance test and alkaline resistance test shows better durability property.

Nirmalkumar(3) *et.al*(2016) conducted a study on durability properties of SCC using silica fume and quarry dust. The cement was replaced with 20% Silica Fume and 20% of Quarry Dust. Fresh concrete properties such as slump flow test, L box test, V box test etc was evaluated. Hardened properties of SCC such as compressive strength, flexural strength, split tensile strength were evaluated. Durability properties such as water absorption test, acid resistance test, chloride resistance test, sulphate resistance test etc. were carried out. When partial replacing cement with 20% silica

fumes and 20% aggregate with quarry dust showed good durability property.

2.2 Strength Properties on SCC

Ankaiah[4] et.al (2013) conducted a study on self compacting concrete. In this study they evaluated the mechanical properties such as compressive strength, split tensile strength. They had established a mix design equivalent to M50 grade self compacting concrete. The cement was replaced with fly ash at 40% by total weight of cement. Mechanical properties were evaluated at 3 days, 7 days, 14 days and 28 days. With the incorporation of fly ash in SCC, improves the mechanical properties of SCC. At 30% replacement of cement with fly ash gives better properties when compared to 10%, 20%, 40% and 50% replacement of cement with fly ash.

Ramanathan[5] et.al(2013) investigated the workability and durability characteristics of self compacting concrete with fly ash. In this study cement was replaced with fly ash at 10%, 20%, 30%, 40% and 50%. Fresh properties of concrete were evaluated by conducting various tests such as slump flow, V funnel, L box tests and U box tests. The durability of concrete was examined by conducting various tests such as acid resistance, sulphate attack and saturated water absorption at the age of 28, 56 and 90 days.

Narayanee[6] *et.al* (2016) presented an experimental investigation on the strength characteristics of Self-compacting concrete (SCC) with mineral admixture named Fly ash(FA). The several series of tests involving various binder combinations, water-binder ratio and high range water reducing admixtures and set retarding admixtures were used to optimize the mix proportions of SCC at different grades (M30, M35, M40, M45, M50). Various tests were carried out to study the characteristics of fresh concrete such as Slump flow, U-tube, V-funnel and L-box tests. For hardened concrete, various tests such as compressive strength, split tensile strength, and flexural strength at 7, 14 and 28 days were also investigated in this study. Test results showed that the workability characteristics of SCC are within the limiting constraints of SCC and have a better strength parameters were obtained.

Harini[7] *et.al* (2015) conducted an experimental study on self-compacting concrete. Slump test, compressive strength test and flexural strength test were conducted to study the mechanical behaviour of self compacting concrete. Self-compacting concrete where the cement is partially replaced with fly-ash and silica fume. Here Ordinary Portland Cement is replaced with 5%, 10%, 15%, 20% and 25% of fly-ash and 2.5%, 5%, 7.5%, 10% and 12.5% of silica fume. From the experimental investigations, it is observed that there is an increase in the fresh properties (workability) and increase in the hardened properties (split-tensile strength and compressive strength) for replacement of cement with silica fume. Similarly, there is an increase in the fresh properties (workability) and decrease in the hardened properties (split-tensile strength and compressive strength) for replacement of cement with fly ash.

Karthick[8] et.al (2016) conducted a study on Durability Properties of High Strength Self Compacting Concrete using Silica Fume and Quarry Dust. In this study cement was replaced with silica fumes at 20% and fine aggregate were replaced with quarry dust at 20% in M60 grade equivalent SCC. Fresh properties of concrete such as slump flow test, Lbox test, V funnel test and mechanical properties such as compressive strength, split tensile strength and flexural strength were evaluated. Durability tests such as alkalinity test, water absorption test, acid attack test, chloride attack test etc were also evaluated. From this study it can be seen that when partially replacing cement with 20% of silica fume and 20% fine aggregate with quarry dust shows very good resistance to alkaline attack, acid attack, sulphate attack and chloride attack than conventional concrete.

Table 1. Test results of self compacting concrete (strength test results)

Sl .No	Author	% replacement		Test results		
		cement	Fine aggregate	Compressive strength (Mpa)	Split tensile strength (Mpa)	Flexural strength (Mpa)
1	Ankaiah et.al	20% fly ash	-	60	3.201	-
2	Ramanathan et.al	0	-	30	1.74	3.00
		10		32.19	1.88	4.20
		20		37.89	2.01	5.01
		30		41.42	2.06	5.80
		40		37.18	1.96	5.20
		50		35.90	1.84	4.70
3	Narayanee et.al	20	-	45.4	4.33	
4	Harini et.al	20	20	67.33	5.96	6.84
5	Karthick et.al	0	-	50.405	4.10	
		5	-	48.11	3.95	
		10	-	46.45	3.67	
		15	-	45.36	3.42	
		20	-	44.50	3.01	
		25	-	43.54	2.80	

2.3 Self compacting concrete with iron slag as partial replacement for fine aggregate

Pofale[9] et al.(2012) conducted an experimental investigation of using iron slag as an alternative to normal aggregates (coarse and fine) in concrete. In this study, concrete of m20, m30 and m40 grades were considered for a w/c ratio of 0.55, 0.45 and 0.40 respectively for the replacements of 0, 30, 50, 70 and 100% of aggregates (coarse and fine) by iron slag. The whole study was done in two phases, i.e. Replacement of normal crushed coarse aggregate with crystallized slag and replacement of natural fine aggregate with granular slag. The investigation shows an improvement in compressive strength, split tensile and flexural strength over control mixes by 4 to 8 %. The replacement of 100 % slag aggregate (coarse) increased concrete density by about 5 to 7 % compared to control mix. The observations showed that the iron slag could be effectively utilized as coarse and fine aggregates in all the concrete applications since it improves the strength properties of concrete.

Mehta[10] et al.(2017) investigated the properties of self compacting concrete by adding iron slag as partial replacement of fine aggregate. In this paper, mechanical properties of self-compacting concrete (scc) made with iron slag (is) are investigated. The possibility of using iron slag as partial replacement of fine aggregates in concrete mix is studied and evaluated based upon the percentage of the partial replacement of fine aggregate with iron slag. In this study, iron slag obtained from industry is replaced with fine aggregate accordingly in the range of 0, 0.1, 0.2, & 0.3 by weight of m25 grade of concrete. Various tests were done for evaluating fresh properties, compressive strength and split tensile strength. The experimental results showed that the iron slag replacement with fine aggregate content gives better strength than control mixture of self compacting concrete and can be suitably used in self compacting concrete.

Singh[11] et al. Conducted a study on the effect of iron slag as partial replacement of fine aggregates on the durability characteristics of self-compacting concrete. Durability characteristics of self-compacting concrete (scc) made with iron slag (is) are studied in this paper. For this purpose, initially, a control scc was designed, and then fine aggregates were partly (0, 10, 25 and 40%) replaced with iron slag. Various tests were done for fresh SCC properties, compressive strength and durability properties such as rapid chloride permeability, water absorption, resistance to sulphate attack and ultra-sonic pulse velocity up to the age of 365 days. SEM and XRD analysis were also carried out. The test results showed that SCC incorporating iron slag gives better strength and durability than control mixture of SCC and can be suitably used in SCC.

Table 2. Test results on SCC with iron slag as partial replacement material for fine aggregate

Sl No.	Author	% replacement of Iron slag	Compressive strength (Mpa)	Split tensile strength (Mpa)
1	Pofale et al	10	45	3.70
		20	49	3.89
		30	47	3.90
		40	44	3.92
		50	42	4
2	Mehta et al	0	32.56	3.30
		10	33.56	3.52
		20	35.85	3.75
		30	24.21	2.23
3	Singh et.al	0	35	2.5
		10	34	2.6
		25	40	3.1
		40	42	3.3

III. CONCLUSION

In this paper a review on self compacting concrete and self compacting concrete containing iron slag as a partial replacement material for fine aggregate is presented. From this detailed review it is revealed that

- Self compacting concrete can be easily applied at areas where compaction is very difficult due to heavy reinforcement.
- Mechanical properties such as compressive strength, split tensile strength etc were improved by the incorporation of iron slag as a partial replacement material for fine aggregate.
- Compressive strength of SCC was found to be more for the addition of 20% iron slag by the volume of concrete.
- Durability studies on SCC containing iron slag as a partial replacement material for fine aggregate showed that incorporation of iron slag improves the impermeability of concrete.

The effect of sulphate on self compacting concrete were not examined and a study has to be conducted on SCC with iron slag as a partial replacement material for fine aggregate to analyze its sulphate resistance behavior, acid behavior.

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