

Study on effect of strength and durability parameters and performance of Self Compacting Concrete replacement with GGBS at different dosages

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Abstract. To investigate experimentally, the behavior of exterior beam-column joint and strength characteristics of Self Compacting Concrete (SCC) containing Viscosity Modifying Admixture (VMA), and Ground Granulated Blast Furnace Slag (GGBFS). Since there is no standard method of mix design is available for SCC. Hence mix design was arrived as per the rules of European Federation of National Associations Representing for Concrete (EFNARC). Marsh cone test was used to find the saturation of various kind of cements by adding the dosage of super plasticizer accordingly. In this investigation SCC was made by usual ingredients such as cement, fine aggregate, coarse aggregate, water and ground granulated blast furnace slag at various replacement levels (10%, 20%, 30%, 40%, and 50%), with that the Super Plasticizer (Glenium B233) and viscosity modifying agent (Glenium Stream 2) was used in appropriate amount for achieving the better flow in the concrete. The experiments were carried out by maintaining a constant water-powder ratio of 0.45. At various replacement levels the performance of freshly prepared SCC is checked by conducting tests such as slump flow, T50 slump flow, U-tube, L-box and V-funnel tests. Mechanical characteristics like Compressive, Split-tensile and Flexural strength examined. Also, the durability study for SCC after 28, 56 and 90 days curing was done by conducting a number of the tests like saturated water absorption, porosity, carbonation depth and alkalinity measurement

1 Introduction

Concrete is that the high wide utilized material in innovation development so significant thought is attempted for upgrading the properties of cement regarding quality, strength boundaries. Various sorts of cement are set up to build up the differed properties of cement. Up until now, this improvement are frequently managed out into four stages. The quickest is the antiquated customary quality solid that is contained just four principal materials that are concrete, water, fine and coarse totals. With a quick increment and a much bigger interest for lodging and foundation, supplemented by ongoing improvements in innovation, as multi celebrated structures and long range spans, bigger compressive quality cement was basic. When these mineral admixtures top off a piece of the pc, the estimation of SCC will be decreased prominently if the mineral admixtures are squander or mechanical result. Also, the utilization of mineral admixtures inside the production

of SCC not exclusively conveys monetary points of interest anyway conjointly reduces warmth of hydration. The mix of mineral admixtures conjointly lessens the requirement for thickness increasing substance admixtures. The lower water substance of the solid expert to raised toughness, moreover to raised mechanical trustworthiness of the structure. Self-compacting concrete (SCC) is a creative concrete that doesn't include any vibration for putting and compaction. It will flow underneath its own weight, entire filling formwork and achieving full compaction, even within the presence of clogged reinforcement. Self-compacting concrete suggests an expedient rate of concrete arrangement, with quicker construction times and simple flow across clogged reinforcement.

2 Material properties and Investigations

To acquire explicit experimental data that improves to grasp the mechanical behaviour and optimum dose of

ground granulated blast furnace slag (GGBFS) OF 10%, 20%, 30%, 40%, and 50%, and as partial replacement of aggregate sand as fine combination, the experimental programme was obsessed.

Cement 53-grade OPC was utilized within the examination requiring a selected gravity of three .12, fineness of cement as 7.5 nothing and primary and final setting times of cement were twenty eight minimum and 570 minimum severally.

River sand as fine aggregate was used. The specific gravity and bulk density of sand were a pair of.68 and 1.8 g/cm³ severally. Coarse aggregate utilized is squashed rock precise aggregate passing through 20mm and held on 4.75mm sieve. The coarse aggregate utilized is complies to IS 383-1970 and is tested as per IS 2386-1963 for its physical properties. Its specific gravity 2.75, Bulk density (loose state) as 1488 kg/m³ and (compacted state) as 1559 kg/m³. Potable water was utilized in the investigations for each mixing and hardening of specimens. GGBFS based concrete is considerably more resistant to the ingress of chloride ions in concrete separately from reduced permeability. GGBS was procured in JSW Steel Ltd, Karnataka mainly having SiO₂ as 35.20%, Al₂O₃ as 19 % and CaO as 34.90 %.

Table 1. Proportions of GGBFS properties

Description	Percentage of content
Loss of ignition	1.2
Insoluble Residue	0.80
Magnesium oxide	11
Sulphate	1
Chloride	0.02
Manganese oxide	0.40
Glass content	90
Moisture	0.5

Glenium B233 is an admixture of a new generation supported made-to-order polycarboxylic ether having relative density of 1.09 & solid contents not 30 minutes by weight. Optimum indefinite quantity of Glenium B233 should be finished up with preliminary mixes. As a guide, some range of 500 ml to 1500ml per 100kg of cementitious material is for the most part suggested.

Glenium Stream 2 might be a head prepared to-utilize, fluid, natural, viscosity-modifying admixture (VMA) exclusively made for producing concrete with expanded viscosity and controlled rheological properties. During this investigation, the proportion of body modifying agent is taken as 0.082% for 1 kg/m³.

The mix proportioning was done by the approach of EFNARC guidelines for mix design for blending concrete M40 with replacement of GGBS in various dosages is tabulated with Table 2.

Table 2. Mix proportioning for M40 Grade

Cement kg/m ³	FA kg/m ³	C.A kg/m ³	GGBFS kg/m ³	Water kg/m ³	S.P % (bwp)
380	724	921	155	190	0.82
1	1.90	2.42	0.40	0.45	-

Various dosages of GGBS has 10%, 20%, 30%, 40%, and 50%, of several mix proportions are determined, in which the optimum dosage of GGBFS will attained for M40 grade of concrete with super plasticizer Glenium B233 and Glenium Stream 2 as viscosity modifying agent is added to the concrete while constructing the mix of the weight of the cement content. Though the specimens samples of M40 grade concrete specimens made with optimum amount of GGBFS replacement were casted.

Here is no detail system on behalf of SCC mix design and various scholarly foundations, admixtures, ready-mixed precast plants, and creating ventures have planned their particular mix proportioning ways. Further information on combine mix and on techniques of evaluating the properties of SCC is discovered within the EFNARC guidelines for SCC.

The estimation of slump is to be 550 millimeter least and of 800 millimeter most for a new SCC. The slump values and T50 values for different mixes are appeared in Table 4. And furthermore the deviation of the slump with the mixes are shown inside the Fig 1. T50 test is that the time take for a particular mix to achieve 500mm slump. This facilitates to grasp the filling ability of SCC mix difference of T50 with the combination is shown in the Fig 1.

Table 3. Dosage of Superplasticizer vs Flow time

Glenium B233	
Super plasticizer dosage (%)	Flow time in Second
0.1	50.65
0.2	45.97
0.4	31.08
0.8	22.74
0.87	20.33
0.9	21.45
1	22.17

Table 4. Properties of SCC mixes with % GGBS

MIX	Slump (mm)	T ₅₀ (seconds)	V funnel (seconds)	U-Box (mm)	L-Box mm
Control Mix	540	5.0	12.2	28	0.83
GGBFS-10%	625	4.0	11.0	26	0.85
GGBFS-20%	640	3.7	9.25	23	0.93
GGBFS-30%	650	3.6	8.4	21	0.91
GGBFS-40%	657	3.55	8.2	20	0.94
GGBFS-50%	645	3.8	8.0	24	0.91

T50 test is that the time take for a specific mix to achieve 500 millimeter slump. V-funnel test is cast-off for

flowing ability of the SCC for several mixes showing that the time taken for a sophisticated replacement is extremely less because of its fineness that happens in the mix in V-funnel is vi secs and the most time that may be taken to drop completely is 12 sec. Utilizing L-box test the passing ability having elevated powder content and littler coarse aggregate goes plainly through the fortifying bars. the base cost of H2/H1 is of 0.8 and the majority of 1.0. U-box test is

employed to seek out the passing capacity of SCC through the fortifying bars, like L-box test as stipulated by EFNARC having variation in height h2-h1 to be contained by the limit of 0-30 millimeter. U-Box difference in values declined for the mix comprising lesser coarse aggregates and a lot of powder materials. The values of L-box subsequent to the particular mixes are shown in Table 4.

Table 5. Mix proportioning of SCC with GGBFS percentage and their inference

CEMENT kg/m ³	GGBS kg/m ³	C.A kg/m ³	WATER kg/m ³	SP ml	VMA ml	W/P ratio	MIX RATIO	CONCLUSION
3.25	4.94	4.55	1.46	28.30	2.66	0.45	1:1.52:1.4	Segregation
3.42	4.86	4.10	1.54	29.75	2.80	0.45	1:1.42:1.30	Bleeding
3.62	5.14	3.98	1.63	31.49	2.97	0.45	1:1.42:1.10	Bleeding
3.50	5.08	4.42	1.58	30.45	2.87	0.45	1:1.45:1.26	Good Flow ability
3.58	5.23	3.94	1.61	31.15	2.95	0.45	1:1.46:1.10	Excess flow

Table 6. Strengthened Properties of SCC mixes with % GGBS

w/p	Mix no	Compressive Strength (in days)			Split Tensile Strength (in days)			Flexural Strength (in days)		
		7	28	56	7	28	56	7	28	56
0.45	Control	24.24	44.55	47.64	0.64	1.73	2.11	1.12	3.14	3.84
	GGBFS-10%	25.12	46.2	49.84	0.77	1.84	2.24	1.24	3.3	3.94
	GGBFS-20	26.99	47.4	51.03	0.84	1.95	2.48	1.35	3.45	4.19
	GGBFS-30	26.01	45.2	53.14	0.76	1.72	2.69	1.28	3.35	4.55
	GGBFS-40	23.77	42.3	50.14	0.71	1.48	2.54	1.1	3.19	4.36
	GGBFS-50	22.12	40.41	49.68	0.58	1.31	2.35	1.04	3.04	4.16

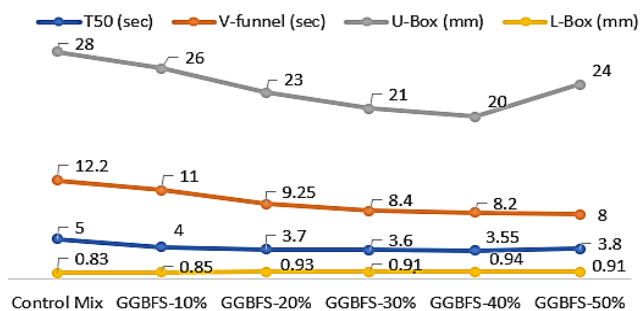


Fig.1. Fresh properties of SCC mix with % GGBFS

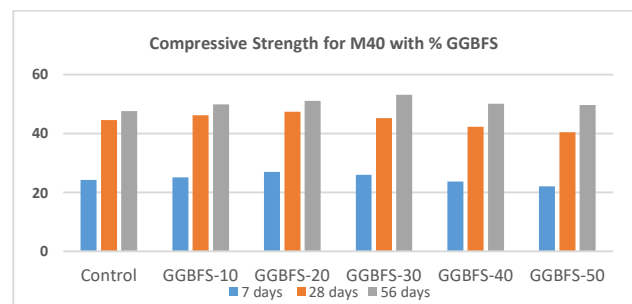


Fig.2. Compressive Strength of SCC with % GGBFS

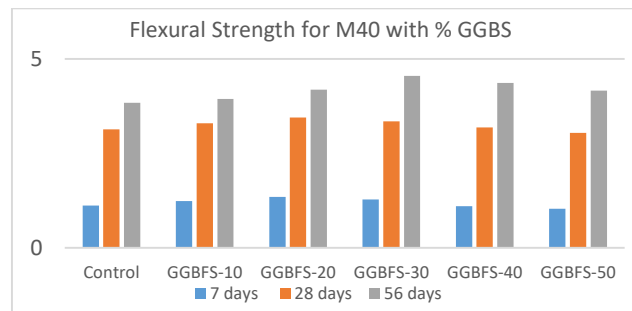


Fig.3. Flexural Strength of SCC with % GGBFS

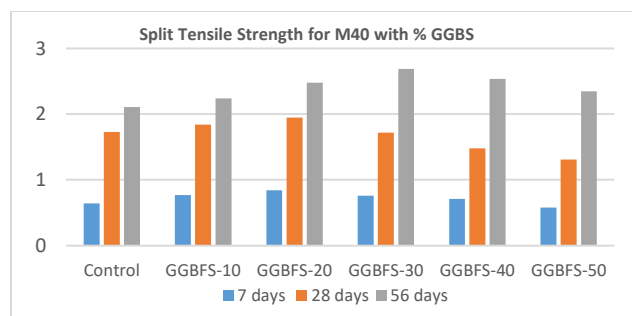


Fig.4. Split Tensile Strength of SCC with % GGBFS

Table 6. Water Absorption % SCC mixes with % GGBS

Replacement of cement with GGBFS (%)	Water absorption (%)		
	7 days	28 days	56 days
0%	3.89	3.63	3.45
10%	3.64	3.57	3.25
20%	3.48	3.24	3.12
30%	3.01	2.92	2.70
40%	2.78	2.45	2.41
50%	2.11	1.94	1.86

Table 7. Effective porosity for SCC mixes with % GGBS

Mix Proportions with GGBFS (%)	Effective porosity (%)		
	7days	28days	56days
0%	6.95	6.70	6.43
10%	6.90	6.66	6.31
20%	6.68	6.26	6.00
30%	6.39	6.00	5.81
40%	6.18	5.20	5.00
50%	5.86	4.30	4.00

Table 8. Alkalinity for SCC mixes with % GGBS

Replacement of cement with GGBFS (%)	pH		
	7days	28days	56days
0%	11.97	11.8	11.61
10%	11.01	11.0	10.57
20%	10.85	10.8	10.13
30%	10.46	10.4	9.94
40%	10.03	9.93	9.60
50%	9.94	9.79	9.25

Table 9. Sulphate Attack for SCC mixes with % GGBS

Mix Proportions with GGBFS (%)	Avg. reduction in weight (%)		
	7days	28days	56days
0%	1.48	2.14	2.80
10%	1.27	1.97	2.56
20%	1.16	1.90	2.47
30%	1.09	1.82	2.31
40%	1.05	1.72	2.29
50%	1.01	1.65	2.22

Table 10. Carbonation Depth for SCC mixes with % GGBS

Cement Replacement with GGBFS (%)	Depth of penetration (mm)		
	7days	28days	56days
0%	63	58	51
10%	52	47	40
20%	45	42	34
30%	42	40	32
40%	39	37	30
50%	36	35	29

3 Conclusions

In light of the trial examinations and test outcomes the accompanying ends are recorded as underneath -

1. For 30 % GGBFS substitution levels , the new properties explicit were magnificent as related with 10% percent, 20%, 40% and 50% GGBFS replacement therefore if increasing the GGBFS replacement it can be a stronger effective concrete in self-compacting concrete.
2. The Glenium Stream two having 0.082 with no need a % of 30 minutes GGBFS having higher fluidity and viscosity of the glue is managed and composed by cautious choice and proportioning of the concrete and augmentations, by restricting the water/powder proportion and afterward by expansion of super plasticiser and (as a discretionary) a thickness changing admixture overseeing these instruments of SCC, their similarity and cooperation is significant to accomplishing great filling capacity, passing capacity and protection from segregation..
3. In the vicinity accessible VMA contains a fundamental effect on the ongoing properties of self-compacting concrete. Addition of GGBFS brings about achieving extra viscous mix. For 30% GGBFS substitution, the compressive strength watched higher when compared with 10%, 20%, 40% and 50% GGBFS replacement having higher strengths for 7, 28 and 56 days compared with the conventional cement.
4. Increasing the substitution rates of mineral admixtures have diminished compressive strength and increment both split strength and Flexural strength. In the durability properties, the water absorption percentage is increased in SCC with GGBFS from 0% and further decreased in 50%. The optimum values for porosity varies from 20 % to 30 % to the SCC mixes with GGBFS. The alkalinity values in terms of pH increased in 0% and lowered down in 50 %.
5. The average reduction in weight for sulphate attack test is having 2.18 and 2.80 for 28, 56 days to 0% and having a optimum values for 30 % and decreased for 50 %. The depth of penetration in carbonation test is very low in 50 % for 7, 28, 56 days.

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