A STUDY ON SELF COMPACTING CONCRETE MADE WITH PARTIAL REPLACEMENT OF FINE AGGERGATE WITH ROBO SAND AND GGBS AS ADMIXTURE

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Abstract - *Self Compacting Concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in section with congested reinforcement. Use of SCC can also help in minimize hearing related damage on the work site that is induced by vibration of concrete. In this work experimental studies are carried out to understand the fresh and hardened properties of Self Compacting Concrete (SCC) in which cement is replaced by Ground Granulated Blast Furnace Slag (GGBS) and Fine aggregate by Robo sand in various proportions for M50 grade concrete. The proportions in which cement replaced are 10% of GGBS, , 20% of GGBS, 30% of GGBS,and 40%0f GGBS. The Proportion of fine aggregate replaced at 0%, 25%, 50%, 75% and 100%. The compressive strength behaviour, Flexural behaviour and Split tensile strength behaviour of SSC were studied along with wrokbailiy. The parameters are tested at different ages in accordance with Bureau of Indian Standards (BIS) for the various proportions in which cement is replaced and also the obtained parameters are compared with normal SSC (100% cement). Super plasticizer GLENIUM 8233 is used to maintain workability with constant Water-Binder ratio. The optimum strength was obtained at 30% replacement with GGBS and 100% replacement of robo sand.*

***Key Words*:: self-Compacting Concrete, GGBS, Robo Sand, Fresh and Hardened properties of concrete**

1. INTRODUCTION

The present study focus on the self compacting concrete made with GGBS and robo sand. In this study GGBS and robo sand are used at various proportions. As we know the extraction of sand from rivers causing an adverse effect on environment there is a need of replacing it with an alternate material.
When the construction industry in Japan experienced a decline in the availability of skilled labour in the 1980s, a need was felt for a concrete that could overcome the problems of defective workmanship. This led to the development of self-compacting concrete, primarily through the work by Okamura. A committee was formed to study the properties of self-compacting concrete, including a fundamental investigation on workability of concrete, which was carried out by Ozawa et al. at the University of Tokyo. The first usable version of self-compacting concrete was completed in 1988 and was named "High Performance Concrete", and later proposed as "Self Compacting High Performance Concrete".

1.1 Self-Compacting Concrete

Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. Use of SCC can also help minimize hearing-related damages on the worksite that are induced by vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced.

1.2 GGBS and Robo Sand

GGBS is used to make durable concrete structures in combination with ordinary portland cement and/or other pozzolanic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia (particularly in Japan and Singapore) for its superiority in concrete durability, extending the lifespan of buildings from fifty years to a hundred years. Use of GGBS significantly reduces the risk of damages caused by alkali–silica reaction (ASR), provides higher resistance to chloride ingress-reducing the risk of reinforcement corrosion and provides higher resistance to attacks by sulfate and other chemicals. Concrete containing GGBS cement has a higher ultimate strength than concrete made with Portland cement. It has a higher proportion of the strength-enhancing calcium silicate hydrates (CSH) than concrete made with Portland cement only, and a reduced content of free lime, which does not contribute to concrete strength. Concrete made with GGBS continues to gain strength over time, and has been shown to double its 28-day strength over periods of 10 to 12 years.
Environmental factors and shortage of good quality river sand has led to the invention of Manufactured Sand Also known as M Sand or Robo Sand. Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days good sand is not readily available; it is transported from a long distance. Those resources are also

exhausting very rapidly. The artificial sand produced by proper machines can be a better substitute to river sand. The sand must be of proper gradation (it should have particles from 150 microns to 4.75 mm in proper proportion).

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2. Experimental Investigations

Before designing the mix for self compacting concrete, preliminary investigations were carried out on raw material of concrete and the results are tabulated in Table No.1 and Table No.2.

Table 1.Properties of aggregate

Property	Fine Aggregates	Coarse Aggregates
Specific Gravity	2.61	2.76
Water Absorption	0.50%	0.5%
Moisture Content	Nil	Nil
Maximum size (mm)	4.25	20
Fineness modulus	2.51	7.56
Grading Zone	Zone II	-------

Table 2: Properties of Cement

Properties	Experimental Results	Standards
Specific Gravity	3.13	3.10 - 3.15
Initial setting time (min)	42 min	30 (min)
Final setting time (min)	450 min	600 (max)
Fineness (%)	0.5	0.1(min)

In this study we are using the materials GGBS and robo sand as alternate materials for concrete. So the properties of both the material were tested in order to get a accurate mix design for concrete. The results are tabulated in Table No.3 and Table No.4.

Table 3: Properties of GGBS

Test Conducted	Results
Specific Gravity	2.88
Fineness-Specific surface in m2/kg by Blaine's permeability method	369
Residue on 45 micron sieve ,%	2.0

GGBS is known as a good pozzolonic material and it is used as a replacement of cement at various percentages.
Based on the sieve analysis conducted for robo sand its been observed that robo sand is confining to zone II in IS383:1970.

Table 4-.Sieve analysis of Robo Sand

IS Sieve (µm)	Weight retained (g)	Percentage weight retained (kg)	Percentage cumulative weight retained	Percentage finer
4750	5	0.5	0.5	0.5
2360	95	9.5	9.5	10
1180	250	25	25	35
600	116	11.6	11.6	46.6
300	270	27	27	73.6
150	135	13.5	13.5	87.1
75	129	12.9	12.9	100
Pan	5	0.5	--	0

2.1. Mix Proportion of concrete:

Initially the concrete mix is designed for M50 grade using IS10262:2009. As self compacting concrete requires high amount of fine content the fine aggregate content is increased and coarse aggregate content is reduced. Super plasticizer is used to reduced the water content, so that there won't be any adverse effect on strength of concrete.
Mix proportions for M50 Grade are listed below.

Cement = 429 kg/m^3
Water = 150 kg/m^3
Fine Aggregate = 929.16 kg/m^3
Coarse Aggregate = 982.56 kg/m^3
Chemical Admixture = 4.29 kg/m^3
Water Cement Ratio = 0.35

Table 5- Replacement of materials in Mixes

Mix	Alternate Substitution
Mix 1	0% Replacement for any materials
Mix 2	GGBS replaced at 10% for cement
Mix 3	GGBS replaced at 20% for cement
Mix 4	GGBS replaced at 30% for cement
Mix 5	GGBS replaced at 40% for cement
Mix 6	GGBS replaced at 30% for cement+ Robo sand replaced at 25%

Mix 7	GGBS replaced at 30% for cement+ Robo sand replaced at 50%
Mix 8	GGBS replaced at 30% for cement+ Robo sand replaced at 75%
Mix 9	GGBS replaced at 30% for cement+ Robo sand replaced at 100%

The mix obtained target mean strength of 58.25Mpa. So the replacement of materials has been adopted for the above mix at various proportions. The replacement of materials has been done as shown in Table No.5.

2.2. Tests on Fresh Concrete:

To assess the self-compact ability of concrete fresh concrete has been subjected for slump flow test, L-box test, U-box test and V- funnel test. The results are compared with standard values. Results for all the four tests are tabulated in Table No.6.

Table 6: Tests on Fresh Concrete

Mix	Slump flow test test	L-box test	V funnel test	U-box test
Mix1	720mm	0.87	13.12 s	32mm
Mix2	722mm	0.89	12.23 s	29mm
Mix3	731mm	0.93	11.46 s	28mm
Mix4	737mm	0.94	10.2 s	27mm
Mix5	748mm	0.99	9.85 s	25mm
Mix 6	739mm	0.96	9.37 s	26mm
Mix 7	712mm	0.93	9.07 s	29mm
Mix 8	689mm	0.89	8.62 s	31mm
Mix 9	617mm	0.82	8.1 s	34mm
Desired value	**650mm**	**0.80 to 1.0**	**8 to 12 sec**	**<30mm**

2.3. Tests on Hardened Concrete

As strength is the main parameter of concrete, it is tested for compressive strength, tensile strength and flexural strength after 7 and 28 days curing. Initially 5 mixes were catsed to decide the optimum content of GGBS based on 28 days strength obtained and the results are tabulated in Table No. 7.

Table 7: Strength properties of concrete mixes

Mix	Compressive Strength (Mpa)		Split Tensile Strength (Mpa)		Flexural Strength (Mpa)	
	7days	28days	7days	28days	7days	28days
Mix 1	41.26	59.46	3.39	5.21	4.49	6.13
Mix 2	42.65	60.79	3.56	5.65	4.79	6.82
Mix 3	42.78	62.27	3.99	5.96	4.8	6.97
Mix 4	44.06	64.96	3.96	6.03	5.12	7.13
Mix 5	42.59	61.47	3.82	5.6	5.06	6.87
Mix 6	45.92	67.56	4.12	6.47	5.42	7.42
Mix 7	48.23	69.62	4.26	6.55	5.56	7.86
Mix 8	49.73	72.29	4.57	6.89	5.78	8.16
Mix 9	51.46	75.87	4.63	7.04	5.98	8.22

Based on the results obtained its been decided that mix 4 got maximum strength among five mixes and optimum content of GGBS is concluded as 30%. After that mix 6. Mix 7, mix 8 and mix 9 were casted and optimum content of robosand is decided.

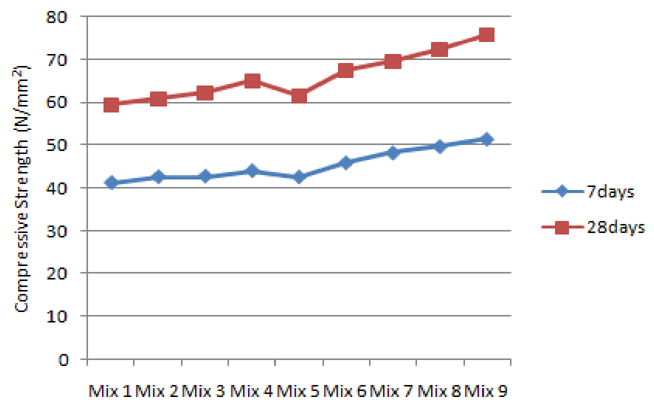

Chart -1: Compressive strength of SCC

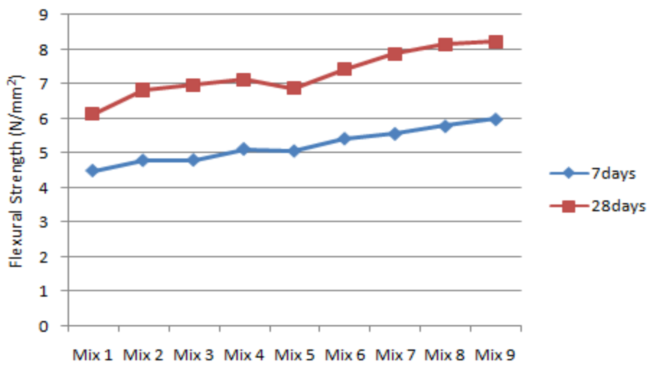

Chart -2: Flexural strength of SCC

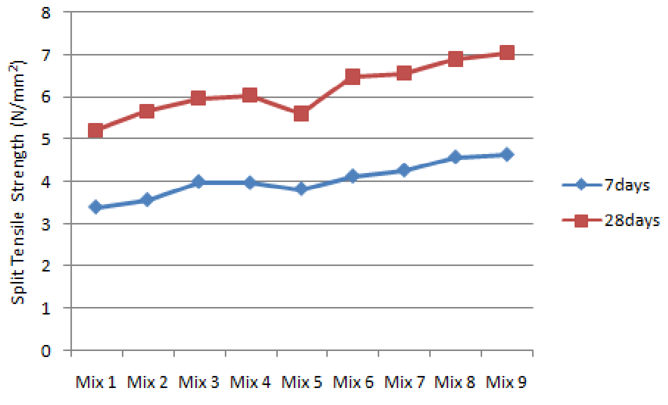

Chart -3: Split tensile strength of SCC

3. CONCLUSIONS

Based on the results obtained from the experiments conducted the following conclusions are drawn.

- Robo sand is a suitable replacement for fine aggregate in concrete
- The optimum strength is obtained for 30% GGBS and 100% Robo sand Compaction. But this combination failed in workability point of view.
- With Respective both strength and workability, optimum mix is concluded as 30% GGBS and 50% Robo sand Replacement
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4. REFERENCES

[1]. Ouchi, M.and Okamura, Hajme (1997)."Self- Compacting High Performance Concrete", Concrete International.50-54.
[2].Bui, V.K.; Montgomery, D.; Hinczak, I. and Turne., K, (2002),"Rapid testing method for segregation resistance of "self- compacting concrete",Cement and Concrete Research. 32: 1489-1496.
[3]. Kumar, P.(2006),"Methods of testing and design", IE (I) Journal- CV, Volume 86: 145-150.
[4]. Khatib, J.M. (2008), "Performance of self- compacting concrete containing fly ash",Construction and Building Materials. 22: 1963-1971.
[5]. Ferrara, Liberato; Park, Yong- Dong and Shah, Surendra P. (2006),"A method for mix design of fibre reinforced self-compacting concrete", Cement and Concrete Research. 37: 957-971.
[6]. Heba, A. Mohamed (2011),"Effect of fly ash and silica fume on compressive strength of self- compacting concrete under different curing conditions", Ain Shams Engineering Journal. 2: 79-86.
[7]. Lachemi, M and Hossain, K.M.A. (2004), "Self-consolidating concrete incorporating new viscosity modifying admixtures", Cement and Concrete Research. 34: 917-926.
[8]. Cengiz, Duran Aity (2005), "Strength properties of high-volume fly ash roller compacted and workable concrete and influence of curing condition", Cement and Concrete Research. 35: 1112-1121.
[9]. Sahmaran, Mustafa and Yaman, Ismail Ozgur (2007), "Transport and mechanical properties of self- consolidating concrete with high volume fly ash", Cement and Concrete Composites. 31: 99-106.