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Fresh and Hardened Properties of SCC with Different Types of Fine Aggregates

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Abstract- *Concrete is the most extensively used material in civil engineering construction so that considerable attention is taken for improving the properties of concrete with respect to strength and durability. In spite of different types of concrete available, Self compacting Concrete has its own advantages and applications in the field of Civil Engineering. This study is dealing with the behaviour of SCC incorporated with different types of filler materials which replaces fine aggregate partially in M_{30} mix. Foundry sand, quarry dust, saw dust and recycled waste glass are the materials for replacement of aggregate. Fly ash is used as mineral admixture and Super plasticizer is added to the mix to get flowability. Fresh properties will checked using slump cone, U-box , V-funnel and L box tests. Hardened properties such as compressive strength and split tensile strength are to be done to analyse strength parameters.*

Key Words: Self-Compacting Concrete, Fresh properties, Hardened properties.

1. INTRODUCTION

Concrete is the most extensively used material in civil engineering construction so that considerable attention is taken for improving the properties of concrete with respect to strength and durability. The invention of Self Compacting Concrete (SCC) can be considered as a major evolution in the construction industry. Self-consolidating concrete (SCC) is a highly workable concrete that can easily flow through congested reinforced concrete members and adequately fill voids and complex formwork with minimal compaction and without apparent segregation or bleeding. The development of SCC represents one of the most significant recent advances in concrete technology to achieve a workable SCC mixture, one can simply increase the water-to-cementitious materials ratio (W/CM). However, such practice may cause segregation and bleeding, negatively affect the mechanical properties of concrete, and most importantly inflict destructive effects on concrete durability.To alleviate such effects, the development of SCC usually requires the use of Super plasticizers along with viscosity-modifying admixtures (VMA).

This report dealswith fresh and hardened properties of SCC with different types of fine aggregates. The sand material will replace with Foundry sand, quarry dust, saw dust and recycled waste glass. Fly ash is used as mineral admixture and Super plasticizer is added to the mixes to get flowability and passing ability. Fresh properties are checked using slump cone, U-box, V-funnel and L box tests. Hardened properties such as compressive strength and split tensile strength test are conducted for strength parameter studies.

2.MATERIALS AND METHODS

2.1 Materials

Ordinary Portland cement of 53 grade with specific gravity 3.03 was used for all mixes.Class F fly ash was also blend with cement. Manufactured sand was used as fine aggregate conforming to zone II of IS 383:1970 having a specific gravity 2.69. The coarse aggregate (CA) had a maximum size of 12mm.The specific gravity of coarse aggregate was 2.67. The Msand was partially replaced by Foundry Sand (FS), Quarry Dust (QD), Saw Dust (SD), Recycled Waste Glass (WG) from 0 to 80% in steps of 20%.The super plasticizer used in this study wasMaster Glenium ACE 30Tproduced from BASF.It is an admixture of a new generation based on second-generation polycarboxylic ether polymer. Clean potable water available in the laboratory was used to mixing the concrete. The properties of all materials are shown in Tables 1 and Table 2.

Table-1: Properties of cement and fly ash

Physical property	Material	
	Cement	Fly ash
Normal consistency	32%	31%
Initial setting time (min)	90	190
Final setting time(min)	330	335
Specific gravity	3.03	2.10

Table- 2: Properties of fine aggregates

Property	Msand	FS	QD	SD	WG
Sieve analysis	Zone II	Zone IV	Zone II	Zone II	Zone I
Specific gravity	2.69	2.89	2.76	3.2	2.45
Water absorption	2.68	5.44	6.03	4.39	2.44

2.2 Mix Proportion

Mix proportion of SCC for this study was based on the EFNARC.Dosage of super plasticizer was fixed as 0.8, total powder content (cement+ fly ash) as 500, Coarse aggregate is added 730 kg/m^3,which are not included below. Mix proportion details are given in table 3.

Table- 3: Details of mix proportions (kg/m^3)

Mix design ation	Cem ent	Fly ash	Fine aggregate					Wat er pow der ratio
			M-sand	FS	QD	SD	WG	
MS100	350	150	100	0	0	0	0	0.42
FS 20	350	150	800	200	0	0	0	0.41
FS 40	350	150	600	400	0	0	0	0.40
FS 60	350	150	400	600	0	0	0	0.39
FS 80	350	150	200	800	0	0	0	0.32
QD 20	350	150	800	0	200	0	0	0.41
QD 40	350	150	600	0	400	0	0	0.45
QD 60	350	150	400	0	600	0	0	0.46
QD 80	350	150	200	0	800	0	0	0.49
SD 20	350	150	800	0	0	200	0	0.49
SD 40	350	150	600	0	0	400	0	0.50
SD 60	350	150	400	0	0	600	0	0.51
SD 80	350	150	200	0	0	800	0	0.52
WG 20	350	150	800	0	0	0	200	0.41
WG 40	350	150	600	0	0	0	400	0.36
WG 60	350	150	400	0	0	0	600	0.35
WG 80	350	150	200	0	0	0	800	0.34

2.3 Specimen Preparations

The specimens of 150mmX 150mmX150mm are used for testing cube compressive strength for 7, 28 days. For determining the split tensile strength, cylindrical specimens of size 100mm diameter and 300mm height is used.

2.4 Methods

2.4.1 Fresh properties

A concrete mixture may be called as SCC only if the mix have shown three properties ie, filling ability, passing ability and segregation resistance. To check these requirements slump flow, L-box, U-box and V-funnel tests were performed according to EFNARC guidelines. The test results are shown in Table 4.

2.4.2 Mechanical properties

Compressive strength (150X150X150mm cubes)and split tensile strength (cylinder100X300mm) was determined at the age of 7 and 28 days in triplicates.

3. RESULTS AND DISCUSSIONS

3.1 Fresh Properties of SCC

The observed results of fresh properties of SCC mixes are shown in Table 4. The table shows the properties such as slump flow, U-box, L-box and V-funnel. In the case of slump flow, all mixes exhibits satisfactory value within the range of 650-800 which is an indication of good deformability. All other fresh properties of these mixes kept a fine agreement with the limits prescribed by EFNARC guideline. The workability of SCC mixes decreased with the addition of FS. But through the addition of QD and SD the workability got increased up to 40% and 80% respectively. Up to the addition of 60% WG got increasing tendency of workability.

Table- 4: Fresh properties of SCC

Mix design ation	Slump flow mm		U box, mm		L box		V funnel, sec	
	Min	Max	Min	Max	Min	Max	Min	Max
	650	800	0	30	0.8	1	6	12
MS 100	696		6		0.85		8.8	
FS 20	725		2		0.95		7.32	
FS 40	720		1		0.86		7.94	

FS 60	700	2	0.84	6.08
FS 80	680	4	0.88	6.00
QD 20	710	11	0.91	10.84
QD 40	740	9	0.8	8.8
QD 60	717.5	13	0.93	8.6
QD 80	712.5	12	0.9	8.08
SD 20	680	3	0.83	6.07
SD 40	687	2	0.81	7.4
SD 60	690	2	0.84	6.9
SD 80	695	4	0.80	6.7
WG20	682.5	12	0.97	11
WG40	685	8	0.89	9
WG60	700	6	0.81	8.2
WG80	690	7.9	0.90	9

3.2 Compressive Strength

From the results obtained, it was observed that the compressive strength of concrete incorporating FS is less than the concrete with M- sand for all replacement. But, the strength obtained is satisfactory for the mix with Foundry sand. For Quarry dust, maximum strength is obtained with 20% replacement of M-sand. Further addition of Quarry dust reduces the strength. But, up to 60% replacement of M-sand gives satisfactory result. The addition of Saw dust did not give a satisfactory strength to SCC. Addition of recycled waste glass is give good result up to 60% replacement. The results of compressive strength are shown in Table 5 and Chart-1(a) and Chart-1 (b).

Table-5: Compressive strength of SCC mixes

Mix	Compressive strength (MPa)	
	7 Day	28Day
MS100	34	48.8
FS 20	31.86	46.97
FS 40	30.24	43.15
FS 60	27.1	41.77
FS 80	21.2	30.77
QD 20	25.2	40.5
QD 40	27.9	39
QD 60	25.25	36.57
QD 80	23.7	27.1
SD 20	22.6	24.9
SD 40	21	26.8
SD 60	18.4	24
SD 80	16.2	22.8
WG 20	30.05	44.6
WG 40	41.1	43
WG 60	26.15	39.4
WG 80	25.9	28.54

3.3 Split Tensile Strength of SCC mixes

From the result, it has been observed that the split tensile strength showed a decreasing trend with the increasing percentage replacement of M-sand. The split tensile strength is maximum at 20% replacement for Foundry sand and Saw Dust and further addition of these materials which replaces M-sand decreases the split tensile strength of SCC. Maximum split tensile strength is obtained for sand replacement at 60% with Quarry Dust and 40% for recycled waste glass.The test results given in Table-5 and Chart-2(a) and Chart-2(b).

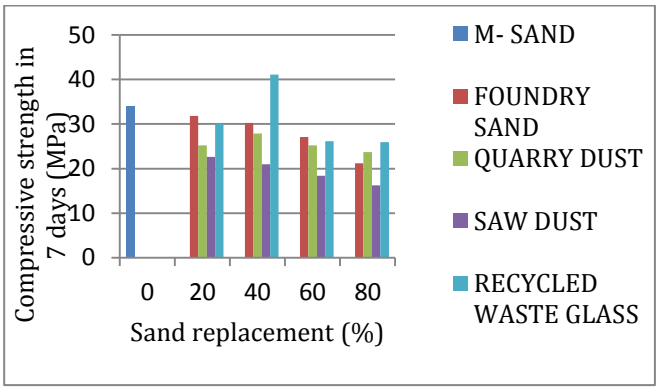

Chart-1(a): Variation of compressive strength for different %replacement of M- sand at 7 days

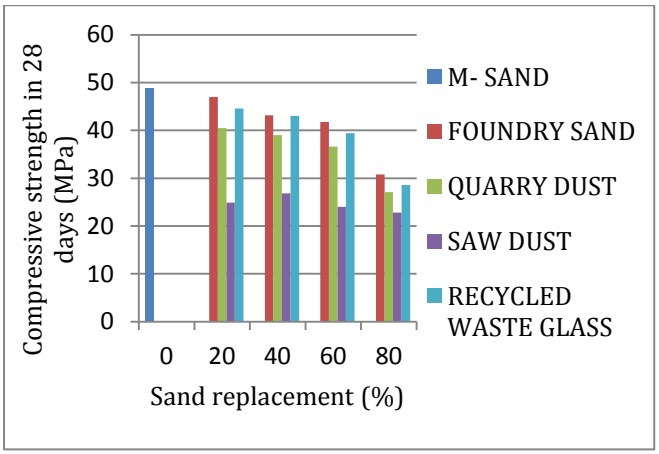

Chart-1(b): Variation of compressive strength for different %replacement of M- sand at 28 days

Table-6: Split tensile strength of SCC mixes

Mix	Split tensile strength (MPa)	
	7 Day	28 Day
MS100	2.77	4.583
FS 20	2.388	9.14
FS 40	2.101	4.617
FS 60	2.356	4.458
FS 80	2.738	3.121
QD 20	2.165	2.547
QD 40	2.993	3.566
QD 60	2.611	4.076
QD 80	2.101	2.484
SD 20	1.8	2.1
SD 40	1.6	2
SD 60	0.87	1.6
SD 80	0.8	1.2
WG 20	2.99	3.75
WG 40	3.184	4.26
WG 60	3.082	3.566
WG 80	2.484	2.675

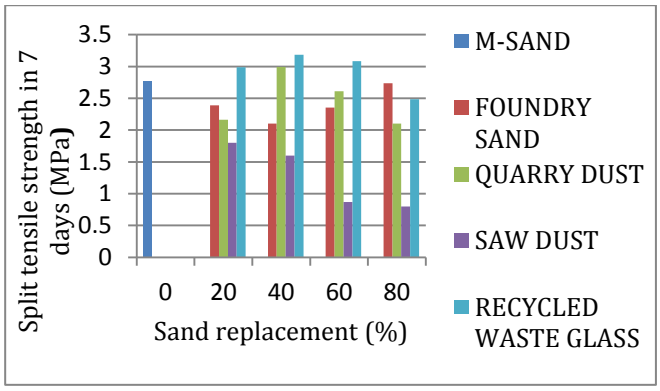

Chart-2 (a): Split tensile strength for different % replacement of sand at 7 days

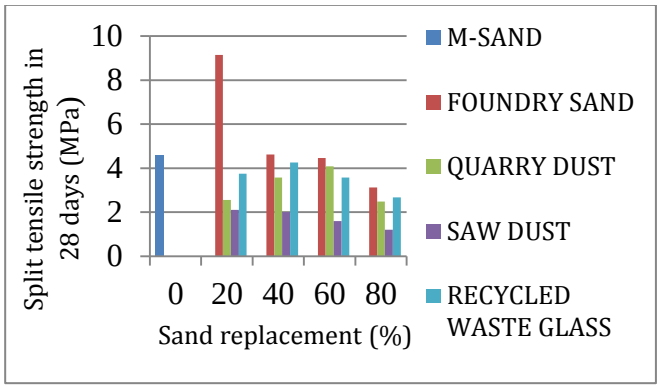

Chart-2 (b): Split tensile strength for different % replacement of sand at 28 days

4. CONCLUSIONS

The slump flow test, the V-funnel test, the L-box test and the U box test results were found to be satisfactory, i.e. passing ability, filling ability and segregation resistance were well within the limits as per available guidelines. From this experimental study it can be inferred that Foundry sand and Quarry dust and recycled waste glass are blend well to improve the overall workability, which is the prime characteristics of SCC. The use of fly ash in SCC mixes reduces the possibility of bleeding and segregation.The compressive strength of SCC has been found to be satisfactory by the addition Foundry sand, Quarry dust and Recycled Waste Glass to the SCC by replacing M-sand at different %. But the use of Saw Dust is not satisfactory.Better mechanical and fresh properties of concrete can be obtained with the replacement of sand with Foundry sand up to 80% and with Quarry dust and recycled waste glass are up to 60%.

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