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Research paper

Performance of Recycled Concrete Aggregate in Self Compacting Concrete

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Abstract

This article presents the influence of the Recycled Concrete Aggregate (RCA) on the mechanical properties of self-compacting fly ash concrete (M30 Grade). The RCA from local construction demolition site were employed as a replacement for natural coarse aggregate (0% - 30%) in self-compacting concrete (SCC). The Viscosity modifying material used in this study was Class F fly ash. The results indicate that recycled concrete aggregate can be replaced by an optimal 25% replacement percentage in the manufacture of SCC without significantly affecting strength and durability.

Keywords: *Recycled aggregates, Self compacting concrete, Strength parameters.*

1. Introduction

Self-compacting or consolidating concrete is one of the remarkable and innovative developments in the construction field recently. The main benefit of using SCC is that the hat will run at its own weight without the need for vibration required for placement and compaction with overburdened reinforcement and complexity of the formwork. In view of these potential benefits, this method has been applicable in many countries in building construction and construction.

RCA uses concrete demolition materials and calcined clay masonry aggregates. Reuse of demolition waste disposal and is also helpful in reducing the gap between the demand and supply of crushed granite fresh aggregate. RCA from construction demolition site may be replaced in whole or in part by natural aggregates in the manufacture of SCC. The use of concrete waste as a coarse aggregate (CA)reduces the emission of CO_2(15-20%)by reducing the utilization of lime stone by 60% [1].While the amount of demolition waste materials generated in India has not yet been quantified properly, it is thought that presently the yearly rate of demolition of buildings and other structures in the major cities has reached one to 2%.Therefore, Though the research on RCA in concrete is going on for past 70 years, the use of recycled aggregate (RA) is of great importance to save resources, to protect the environment and to achieve sustainable development in the construction sector [2].

2. Literature reviewed

Ravindrajah (1987) describes the main problems in the demolition of concrete structures. The demolition of old buildings is on the rise, either because they are outdated, dangerous, need to be repaired and rehabilitated, or to allow the construction of new larger and larger structures. As a result, a large amount of concrete demolition is generated as waste and disposed of by landfill or landfill. Transport costs and the lack of landfills, however, make disposal a major problem.

Dhir (1999) investigates the ability of recycled aggregates (ACR) to be used in BS 5328 mixtures. Results on aggregate properties have shown that smooth concrete and reinforced concrete residues can be milled with existing equipment. to provide RCA with physical properties that meet the current requirements of BS882.

Prakash (2006) discusses many practices in the concrete industry that pose a potential threat to our environment and give rise to grave concern. Alongside the increase in consumption, the volume of waste from companies using concrete is increasing.

N R Gayawala (2011) obtained maximum compressive strength by adding amount of fly ash by 15% and for tensile strength they also got maximum tensile strength by adding 15% amount of fly ash in self-compacting concrete they also found that SCC had good durability properties than normal concrete. For flexural strength and pull out strength addition of 15% of fly ash in mix is enough for maximum strength

The use of recycled aggregates in the production of new concrete has gradually increased from an environmental and economic point of

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view. However, information on the quality of recycled concrete is still rare. This study attempts to study the influence of recycling aggregates on the strength parameters of self-compacting concrete.

3. Materials used

a. *Cement –The physical and chemical properties of OPC 53 were cited in Table 1 and Table 3 respectively.*

Table 1: Physical Properties of OPC 53

Parameter	Specific Gravity	Fineness (m^2/kg)	Setting time (Minutes)		Consistency (%)
			Initial	Final	
Obtained Results	3.13	310	43	340	29
Requirements of IS 12269	3.1 – 3.15	≥ 225	≥ 30	< 600	30 – 35

b. *Viscosity modifier (VMA) Class F fly ash.*

Table 2: Physical Properties of Fly ash

Parameter	Color	Specific Gravity	Fineness (m^2/kg)	Bulk density (kg/m^3)	Fineness
Obtained Results	Dark grey	2.10	425	1157	18.2
Requirements of IS 3812	-	-	≥ 320	-	-

Table 3: Chemical Properties of OPC 53 and Fly ash

Component	SiO_2	Fe_2O_3	SO_3	Na_2O	K_2O	MgO	Al_2O_3	CaO
OPC 53	24.51	3.49	1.41	0.44	0.62	2.15	6.86	63.11
Fly ash	54.01	7.36	0.22	0.42	0.74	1.73	26.80	3.23

c. *Fine aggregate*

Table 4: Properties of fine aggregate

Parameter	Grade	Specific Gravity	Fineness (m^2/kg)	Bulk density (kg/m^3)	Water absorption
Obtained Results	II	2.55	2.56	1885	1.40
Requirements of IS 3812	I - IV	≥ 2.60	2.30 – 3.10	-	-

d. *Coarse aggregate – Locally available granite crushed stones passing through 20mm sieve and retained on 12.5mm was used in this study.*

Table 5: Properties of Coarse aggregate

Parameter	Specific Gravity	Fineness modulus	Bulk density (kg/m^3)	Water absorption
Obtained Results	2.75	6.95	1485	0.80
Requirements of IS 3812	≥ 2.60	6.50 – 8.00	-	≤ 3.00

e. *Super plasticizers – For the better workability and to control the water content in SCC, Conplast 420 of 3.5% was used.*

f. *Recycled Concrete Aggregate –Recycled concrete aggregate was acquired from the demolished construction waste and concrete cubes which are more angular and higher absorption capacity.*

Table 6: Properties of RCA

Parameter	Specific Gravity	Fineness modulus	Bulk density (kg/m^3)	Water absorption
Obtained Results	2.44	6.55	1246	3.45
Requirements of IS 3812	≥ 2.60	6.50 – 8.00	-	≤ 3.00

g. *Mix Proportions – Mix design was made to produce M30 grade SCC.*

Table 7: Concrete Mix Proportions (kg/m^3)

Description	RCA replacement %	Cement	Fine Aggregate	Coarse Aggregate	Recycled concrete aggregate	VMA (Fly ash)	Water
SCC	0	310	910	890	0	138	185
RCASCC05	5	310	910	845	45	138	185
RCASCC10	10	310	910	801	89	138	185
RCASCC15	15	310	910	756	134	138	185
RCASCC20	20	310	910	712	178	138	185
RCASCC25	25	310	910	667	223	138	185
RCASCC30	30	310	910	623	267	138	185

4. Experimental investigation

4.1. Fresh properties of SCC

M30 self-compacting concrete was produced by partially replacing natural aggregates with recycled concrete aggregates. The concrete has been freshly examined and hardened. SCC is characterized by its flow, passing and resistance to separation. The concrete mix has recently been tested in accordance with EFNARC recommendations.

Table 8: Fresh properties of SCC

Description	Slump flow (mm)	T50cm Slump (Sec)	V-Funnel (Sec)	L-Box (H1/H2)	J-Ring (H1-H2)
EFNARC	650 – 800	2 – 5	6 – 12	0.8 – 1.0	0 – 10
SCC	770	2.4	6.9	0.9	4
RCASCC05	752	2.49	7.15	0.91	4.5
RCASCC10	731	2.64	7.3	0.93	6
RCASCC15	708	2.67	7.4	0.92	6.5
RCASCC20	694	2.73	7.65	0.93	7
RCASCC25	678	2.8	7.88	0.94	8
RCASCC30	660	2.93	8.1	0.94	8.5

4.2. Hardened properties of SCC

The strength properties of the SCC made with RCA are shown in Table 9 to 11.

Table 9: Compressive strength

Description	Compressive strength in N/mm^2			
	3 days	7 days	14 days	28 days
SCC	12.87	26.51	32.4	36.83
RCASCC05	12.71	26.35	32.27	36.6
RCASCC10	12.54	26.22	32.03	36.55
RCASCC15	12.38	26.1	31.92	36.37
RCASCC20	12.21	25.99	31.75	36.11
RCASCC25	12.19	25.9	31.68	35.99
RCASCC30	11.30	25.43	30.79	35.22

Table 10: Tensile strength

Description	Tensile strength in N/mm^2			
	3 days	7 days	14 days	28 days
SCC	1.49	2.96	3.59	3.99
RCASCC05	1.42	2.85	3.52	3.91
RCASCC10	1.39	2.83	3.46	3.89

RCASCC15	1.35	2.82	3.45	3.87
RCASCC20	1.32	2.81	3.43	3.88
RCASCC25	1.32	2.8	3.42	3.86
RCASCC30	1.25	2.72	3.29	3.63

Table 11: Flexural strength

Description	Flexural strength in N/mm^2			
	3 days	**7 days**	**14 days**	**28 days**
SCC	1.93	3.97	4.86	5.52
RCASCC05	1.91	3.95	4.84	5.5
RCASCC10	1.88	3.9	4.82	5.48
RCASCC15	1.85	3.89	4.79	5.46
RCASCC20	1.85	3.85	4.76	5.42
RCASCC25	1.83	3.83	4.75	5.38
RCASCC30	1.71	3.72	4.66	5.39

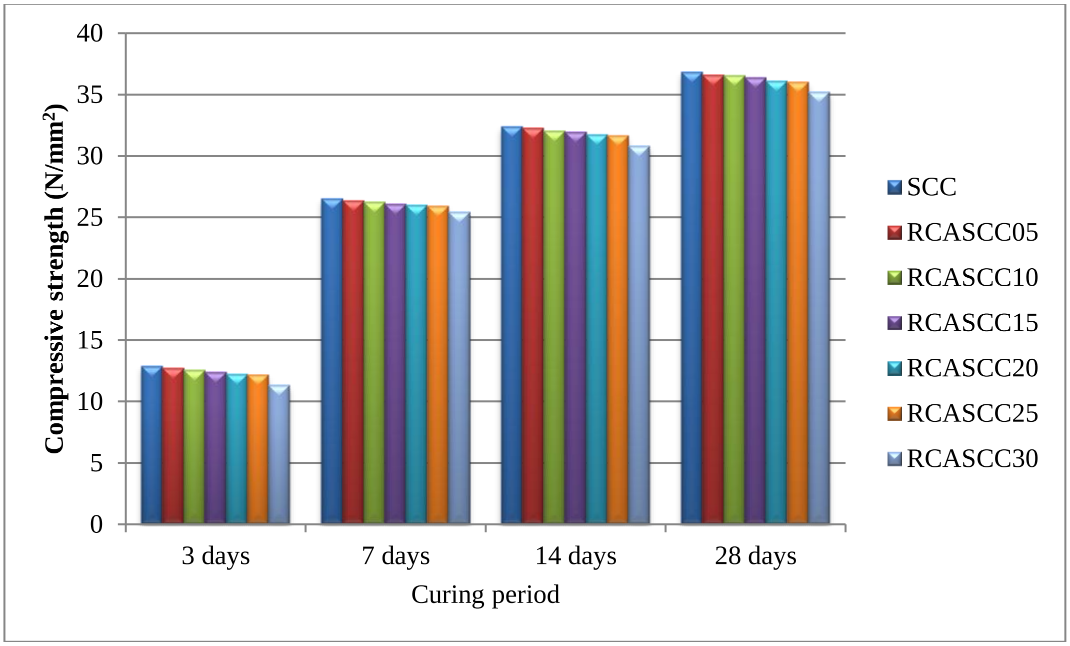

Figure 1: Compressive strength

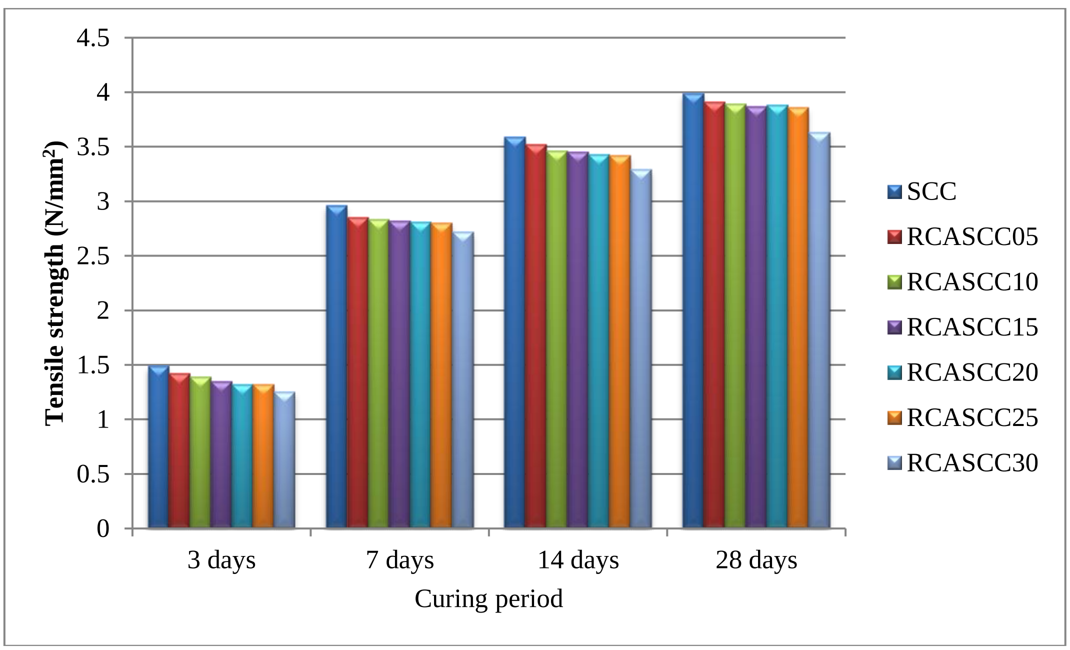

Figure 2: Tensile strength

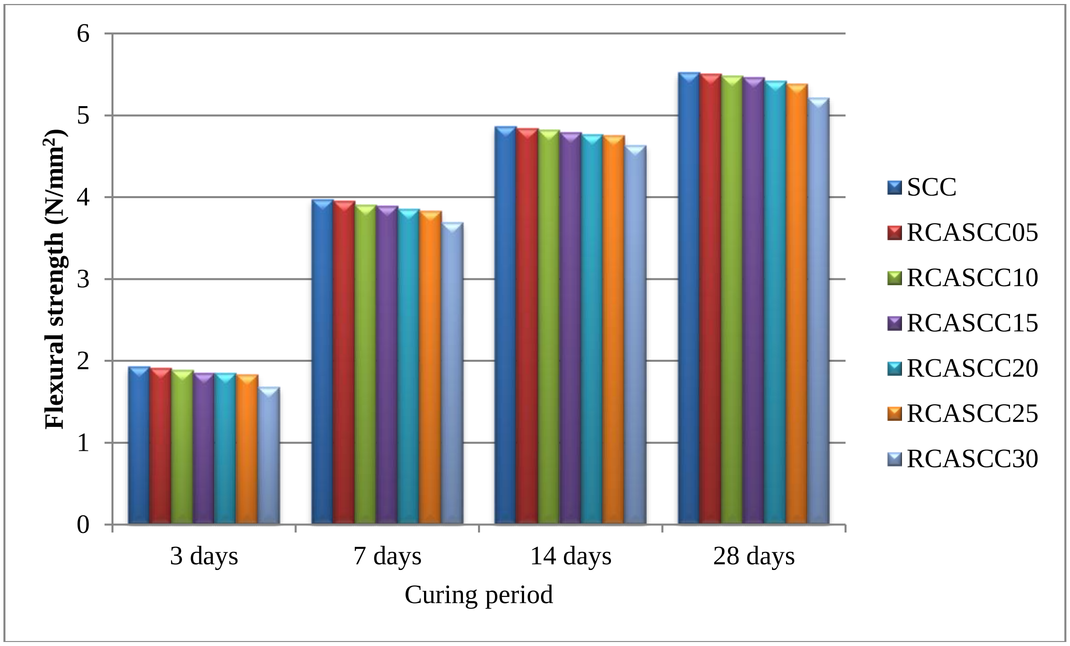

Figure 3: Flexural strength

5. Results and discussions

The results show that the when RCA partly replaced for coarse aggregate, a sustainable concrete could be manufactured.

There was a reduction in the strength properties by increasing the amount of RCA replacement in SCC at all ages of curing thought the optimum results were identified at 20-25%.

Self-compacting concrete manufactured with RCA has reached the target strength in all mixtures and meets the guidelines given in the EFNARC specifications.

The addition of the RCA content linearly reduces the strength properties, but a 30% replacement shows a slight, insignificant decline in the strength properties.

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