ICSD/24

PARAMETRIC STUDY OF GREEN CONCRETE AND CONVENTIONAL CONCRETE ON STRENGTH AND DURABILITY PARAMETERS

Mr. Sidheshwar Murkute
P. G Student, Structural Engineering, B. R. Harne College of Engineering, Karav-Vangani, India.
*sidheshwarmurkute@gmail.com
Mr. Madan S. H.
Asst. Prof., Civil Engineering, B. R. Harne College of Engineering, Karav-Vangani, India.
Dr. V. A. Patil
Principal, B. R. Harne College of Engineering, Karav-Vangani, India.

Abstract

Green Concrete is a resource-saving structure that reduces environmental impact, carbon dioxide emissions, and waste water. Here comparative evaluation of strength and durability properties of conventional concrete and green concrete incorporating recycled coarse aggregates and fly ash. In the laboratory total of three series of concrete mixtures were prepared. Series I, II and III were prepared with the water to cement (W/C) ratio of 0.3, 0.4 and 0.5 respectively. Each Series, comprises of 3 concrete types named as conventional concrete mixture with 0% RCA and 0% flyash indicated by notation R0. Recycled concrete mixture with 50% RCA and 0% flyash indicated by notation R50. And green concrete mixture with 50% RCA and flyash was incorporated as 25% replacement to cement indicated by notation R50F25. As per IS 10262 1982 and IS 456 the mix design of concrete for all mix proportions is done. A marginal reduction in compressive strength and tensile strength has been noticed in the case of green concrete (10 to 12%). And this may be due to lesser angularity index of recycled aggregates. A large reduction in tensile strength of 25% was noticed in recycled aggregate concrete compared to conventional concrete. This may be attributed to less binding of aggregates in the case of recycled aggregate concrete. Results shows that water absorption, Chloride ion permeability and Sorptivity of concrete [R50] increased due to the intrinsic porosity of RCA compared to conventional concrete [R0]. And water absorption, chloride ion permeability and Sorptivity of Green concrete [R50F25] is almost same as conventional concrete [R0]. This is due to the pozzolanic action of flyash present in green concrete. Green concrete shows Moderate rate of chloride ion permeability for W/C of 0.3 and 0.4 slightly high rate of chloride ion permeability for W/C of 0.5.

Keywords: Green Concrete, Water to cement ratio, recycled coarse aggregates and Fly ash, Compressive strength, Tensile strength, Water absorption, Chloride ion permeability and Sorptivity of concrete.

.

1. Introduction

Green concrete is a concrete, partially or completely substituted for cement or fine aggregate or coarse aggregate. Alternative materials may be wastes of manufacturing processes. Another name for Green Concrete is a resource-saving structure that reduces environmental impact, carbon dioxide emissions, and waste water. "Green concrete" is a revolutionary topic in the history of concrete industry. This was first invented in 1998 by Dr.WG in Denmark. Slag, fly ash, power plant waste, recycled concrete, mining waste, waste glass, incinerated slag, red mud, burning soil, sawdust, burning ash and foundry sand can be properly used in green concrete.

2. Literature Review

Literature review on the works carried out by earlier researchers on strength and durability properties of green concrete is conducted. The summary and gap of literature are discussed below.

2.1 Summary of literature

Utilization of industrial waste like flyash can be made to improve the various properties of recycled aggregate concrete. The results from previous studies showed that mechanical properties like compressive strength, tensile strength and modulus of elasticity of concrete at all the ages reduced as the percentage of recycled aggregates and flyash increased. With the 40% use of recycled coarse aggregates in concrete, workable and good strength concrete can be obtained. Durability properties of recycled aggregate concrete can be improved by incorporation of flyash in concrete. The results from previous studies also showed that one of the helpful ways to use a high percentage of recycled aggregate in structural concrete is by incorporating 25–35% of fly ash as some of the disadvantages induced by the utilization of recycled aggregates in concrete could be reduced.

2.2 Gap of literature

Previous studies also showed that drawbacks of recycled aggregate concrete can be improved by incorporating certain amount of flyash. It can be used as replacement for cement or as an additional cementitious material in concrete. In the present study use of flyash as partial cement replacement is presented. The effect of Recycled coarse aggregates and flyash on strength and durability properties are investigated.

3. Objectives and Scope

3.1 Objectives

The main objective of this research is comparative evaluation of strength and durability properties of conventional concrete and green concrete incorporating recycled coarse aggregates and fly ash.

3.2 Scope

Selection of materials and material characterization. Concrete mix design, Casting and curing of test specimens. Hardened concrete properties and durability properties improvement.

4. Experimental Study

4.1 Materials

Cement: Cement of 53 grade confirming to grade IS 8112-1989 is used of specific gravity 3.1.
Flyash: Flyash of Class F grade collected and used in this study. From test Specific gravity of the flyash was found to be 2.16.
Fine aggregates: In the present Work crushed stone aggregates were used of gradation zone II and specific gravity 2.7.
Natural Coarse aggregates: In the present work, crushed stone aggregates of size 20mm down were used of specific gravity 2.66 and water absorption 0.3%.
Recycled coarse aggregates: In the present work, crushed recycled concrete aggregates collected from demolished concrete building of size 20mm to 4.75mm were used of specific gravity 2.2 and water absorption 3.02%.

4.2 Concrete Mix

In the laboratory total of three series of concrete mixtures were prepared. Series I, II and III were prepared with the water to cement (W/C) ratio of 0.3, 0.4 and 0.5 respectively. Each Series, comprises of 3 concrete types named as conventional concrete mixture with 0% RCA and 0% flyash indicated by notation R0. Recycled concrete mixture with 50% RCA and 0% flyash indicated by notation R50. And green concrete mixture with 50% RCA and flyash was incorporated as 25% replacement to cement indicated by notation R50F25.

Table 4.1 Specimen details for conventional concrete for R0, R50 and R50F25 each

Type of test	Geometry of specimen	W/C ratio	No. of specimens	Curing time(days)
1.Compression test	Cube 150x150x150 mm^3	0.3	9	3,7,28
		0.4	9	3,7,28
		0.5	9	3,7,28
2.Split tensile strength test	Cylinder d=150mm h=300mm	0.3	3	28
		0.4	3	28
		0.5	3	28
3.Rapid chloride ion penetration test	Cylinder d=100mm h=50mm	0.3	3	28
		0.4	3	28
		0.5	3	28
4.Water absorption test	Cylinder d=100mm h=50mm	0.3	3	28
		0.4	3	28
		0.5	3	28
5.Sorptivity test	Cylinder d=100mm h=50mm	0.3	3	28
		0.4	3	28
		0.5	3	28

4.3 Tests

Compressive strength of the specimens was determined using a CTM machine with 2000kN capacity. The compression strength was measured at the ages of 3, 7, and 28 days.
The split tensile strength of the test specimens was estimated using a CTM machine with 2000kN capacity. At the age of 28 days split tensile strength of test specimens was measured.
Water absorption of the test specimens were oven dried for 24 hours at the temperature of 110˚C until the mass of the test specimen become constant and then soaked on water to measure % water absorption.
Rapid chloride ion penetration test cylinder specimens were subjected to 60V DC voltage for 6 hours using apparatus and cell arrangements. One reservoir was filled with 3.0% NaCl solution and other one with 0.3M NaoH solution and total charge passed was noted.
Sorptivity is the property of the material which indicates the capacity of the material to absorb and transmit water by capillary. The Sorptivity value of concrete can be estimated by the measurement of the rate capillary absorption.

5. Results

5.1 Compressive strength

Table 5.1 Results of compressive strength

W/C ratio	Concrete type	No. of Specimens	Compressive Strength(MPa)		
			3 days	7 days	28 days
0.3	[R0]	9	15.38	18.43	22.2
	[R50]	9	12.5	16.76	20.98
	[R50F25]	9	13.7	17.2	21.4
0.4	[R0]	9	14.4	17.83	21
	[R50]	9	13.26	16.43	19.35
	[R50F25]	9	14.2	16.7	20.3
0.5	[R0]	9	14	16.5	20.5
	[R50]	9	12.38	15.66	18.97
	[R50F25]	9	13.1	16.2	19.5

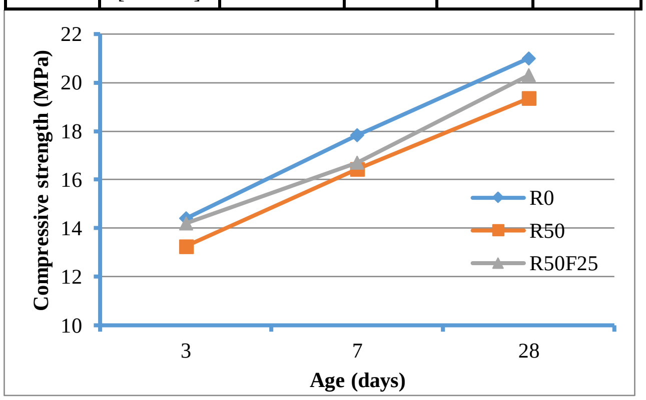

Figure 5.1 Compressive strength with age for W/C ratio of 0.3

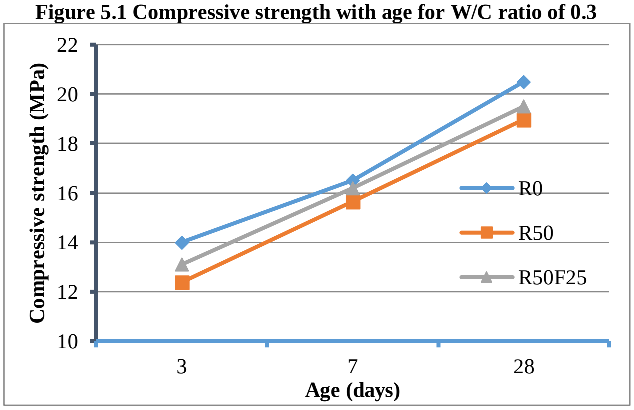

Figure 5.2 Compressive strength with age for W/C ratio of 0.4

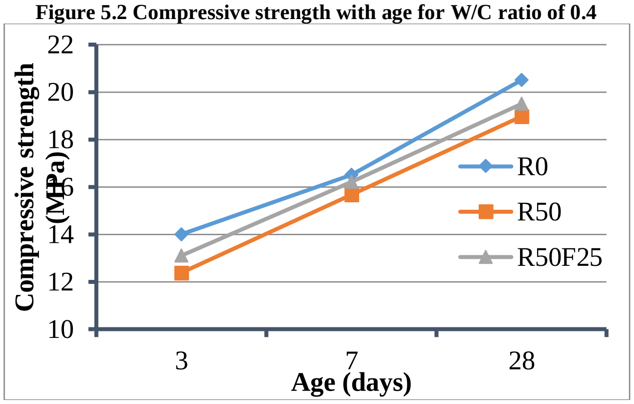

Figure 5.3 Compressive strength with age for W/C ratio of 0.5

5.2 Split tensile strength

Table 5.2 Results of split tensile strength

Concrete type	No. of Specimens	Split tensile strength (MPa)		
		W/C ratio 0.3	W/C ratio 0.4	W/C ratio 0.5
[R0]	3	4.91	3.75	3.25
[R50]	3	3.39	2.85	2.56
[R50F25]	3	3.85	3.1	2.72

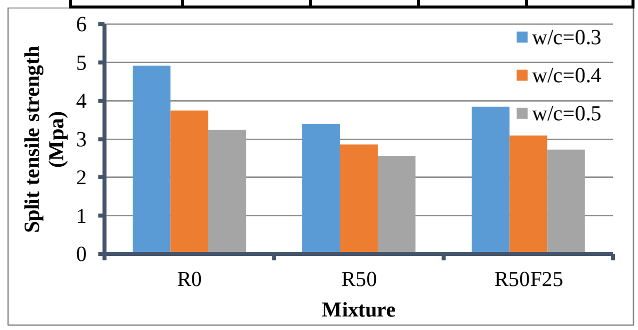

Figure 5.4 Twenty eight days split tensile strength

5.3 Water absorption test

Table 5.3 Results of water absorption test

Concrete type	Avg % Water absorption		
	W/C ratio 0.3	W/C ratio 0.4	W/C ratio 0.5
[R0]	2.209	2.791	2.887
[R50]	2.865	3.458	4.132
[R50F25]	2.401	2.871	3.256

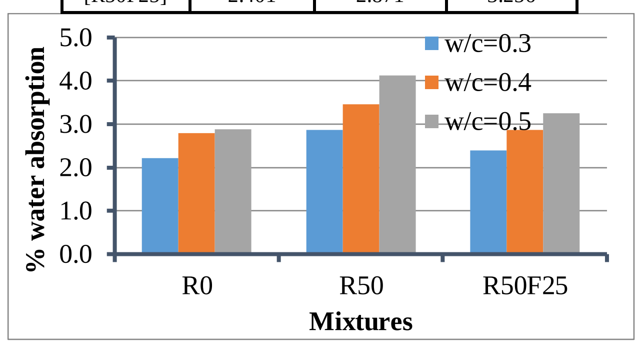

Figure 5.5 Comparison of twenty eight days water absorption

5.4 Rating of chloride ion permeability test

Table 5.4 Rating of chloride ion permeability

Mixure	W/C ratio	Charge passing in Coulombs	Chloride penetration rate
R0	0.3	1560	Low
	0.4	2381	Moderate
	0.5	3649	Moderate
R50	0.3	2804	Moderate
	0.4	3782	Moderate
	0.5	4841	High
R50F25	0.3	2134	Moderate
	0.4	2947	Moderate
	0.5	4024	Slightly High

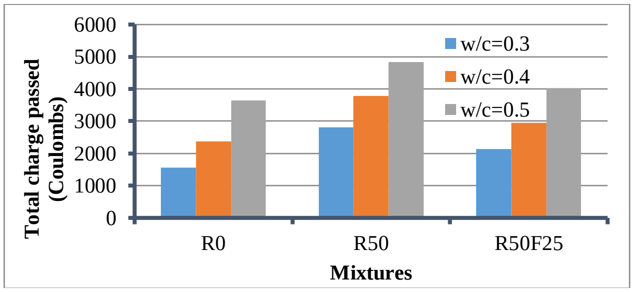

Figure 5.6 Comparison of RCPT results

5.5 Sorptivity test

Table 5.5 Sorptivity test results at 28 days

Concrete type	Avg Sorptivity value (mm/min$^{0.5}$)		
	W/C ratio 0.3	W/C ratio 0.4	W/C ratio 0.5
[R0]	1.9369	2.3243	4.2612
[R50]	4.6486	5.4234	6.1981
[R50F25]	2.3243	3.0991	4.6486

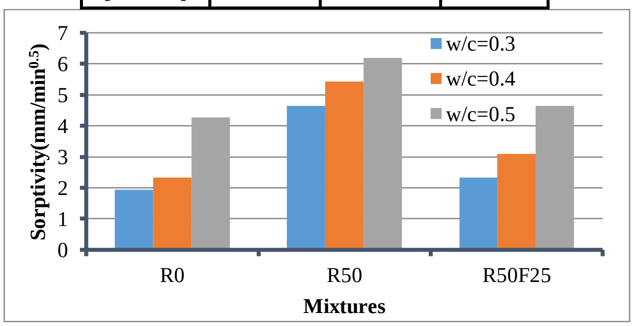

Fig 5.7 Comparison of Sorptivity test results

6. Conclusions

The experimental study conducted on green concrete has revealed that:

1. For a given W/C ratio the green concrete has shown lower workability than the conventional concrete and this may be due to moisture absorption of recycled aggregates.
2. A marginal reduction in compressive strength and tensile strength has been noticed in the case of green concrete (10 to 12%) which may be due to lesser angularity index of recycled aggregates.
3. A large reduction in tensile strength of 25% was noticed in green concrete compared to conventional concrete. This may be attributed to less binding of aggregates in the case of recycled aggregate concrete.
4. Results shows that water absorption, Chloride ion permeability and Sorptivity of concrete [R50] increased due to the intrinsic porosity of RCA compared to conventional concrete [R0]. And water absorption, chloride ion permeability and sorptivity of Green concrete [R50F25] is almost same as conventional concrete [R0]. This is due to the pozzolanic action of flyash present in green concrete.
5. Green concrete shows Moderate rate of chloride ion permeability for W/C ratio of 0.3 and 0.4 slightly high rate of chloride ion permeability for W/C ratio of 0.5
6. Green concrete results in better performance and durability which ensures long lifetime concrete and can be used for conventional use for the structures with important factor 1 and 1.2 as per IS 1893-2016.

7. References

[1] Nobuaki Otsuki, M.ASCE, Shin-ichi Miyazato, and Wanchai Yodsudjai "*Influence of recycled aggregate on interfacial transition zone, strength, chloride penetration and carbonation of concrete*" journal of materials in civil engineering, pp 443-451,2003.

[2] Shi Cong Kou, Chi Sun Poon, Dixon Chan "*Influence of fly ash as a cement addition on the hardened properties of recycled aggregate concrete*" Journal of material and structures, pp 1191-1201, 2007.

[3] Shi Cong Kou, Chi Sun Poon, Dixon Chan "*Influence of fly ash as a cement replacement on the hardened properties of recycled aggregate concrete*" Journal of materials in civil engineering, pp 709-717, 2007.

[4] M.L. Berndt "*Properties of sustainable concrete containing fly ash, slag and recycled concrete aggregate*" Journal of Construction and Building Materials, pp 2606-2613, 2009.

[5] Mark Reiner, Stephan A. Durham and Kevin L. Rens "*Development and analysis of high-performance green concrete in the urban infrastructure*" International Journal of Sustainable Engineering pp 198-210, 2009.

[6] Weerachart Tangchirapat, Rak Buranasing, and Chai Jaturapitakkul "*Use of high fineness of fly ash to improve properties of recycled aggregate concrete*" journal of materials in civil engineering, pp 565-571, 2012.

[7] S.C. Kou, C.S. Poon "*Enhancing the durability properties of concrete prepared with coarse recycled aggregate*" Journal of Construction and Building Materials, pp 69–76, 2012.

[8] C. Thomas , J. Setién , J.A. Polanco, P. Alaejos , M. Sánchez de Juan "*Durability of recycled aggregate concrete*" Journal of Construction and Building Materials, pp 1054-1065, 2012.

[9] Rattapon Somna, Chai Jaturapitakkul, Amde M. Made "*Effect of ground fly ash and ground bagasse ash on the durability of recycled aggregate concrete*" Journal of cement and concrete composites, pp 848-854, 2012.

[10] Suvash Chandra Paul and Gideon P.A.G. van Zijl "*Mechanical and durability properties of recycled concrete aggregate for normal strength structural concrete*" International journal of sustainable construction engineering and technology, vol 4 No.1, 2013.

[11] S. F. U. Ahmed "*Properties of Concrete Containing Construction and Demolition Wastes and Fly Ash*" Journal of materials in civil engineering, pp 1864-1870, 2013.