

Green Concrete vs Conventional Concrete: A Comparative Study

¹MD Salman, ²Tusar Kumar, ³Rajan Patel, ⁴Mintu, ⁵Muzaffar Ahmad & ⁶Aaqib Wani

^{1,2,3,4,5}Accurate institute of Management and Technology, Greater Noida (India)

⁶NSJY Accurate Solutions Pvt. Ltd., Okhla Vihar, New Delhi (India)

ARTICLE DETAILS

Article History

Published Online: 07 September 2018

Keywords

Green concrete, Compressive strength, Density, Natural Coarse aggregate (NCA), Recycle coarse aggregate (RCA).

ABSTRACT

With the rapid urbanization, construction and demolition waste is generated in large scale. This waste comprises of hazardous material like insulation, nails, electric wiring, shingle, dredging materials, tree stumps and rubble. Construction waste also contains lead, asbestos and other hazardous materials. The major component of waste is made up of bricks, concrete, and wood. India generates 530 million tonnes of C&D waste annually estimated by the ministry of environment and forest. This waste is dumped in landfill sites or placed in roadsides or river sides which is the cause of reduction of natural resources and pollution like soil, air and water pollution. To reduce this threat for the future, we can recycle this waste to safeguard our environment. This study is based on replacement of natural coarse aggregate (NCA) by recycled coarse aggregate (RCA) thus creating a form of green concrete. The main purpose of this research was to investigate the effectiveness of using green concrete towards promotion of sustainable built environment and to examine the alternative techniques to reduce consumption of natural aggregates, sand and cement. Focus was also to Investigate the compressive strength properties of green concrete made out with RA and compare its performance to ordinary concrete and to Determine the benefits of using green concrete for which concrete was collected from different sites of Greater Noida and then was crushed to procure coarse aggregate of size 10 mm. Concrete of M20 grade was prepared and casted into 21 moulds of size 150mm×150mm×150 mm, different percentages of RCA were used to replace NCA viz. 0%, 50%, 100%. Seven cubes of each percentage were casted to get optimum results and were tested for compressive strength and density after 7, 14, and 28 days. The experimental analysis showed that compressive strength for 0%, 50% and 100% replacement of NCA by RCA where recorded as 30.66 N/mm², 28.88 N/mm², and 22.22 N/mm² respectively after 28 days.

1. Introduction

Green Concrete is a term given to a concrete that has had extra steps taken in the mix design and placement to insure a sustainable structure and a long life cycle with a low maintenance surface. E.g. Waste Reduction, Energy saving, CO₂ emissions, wastewater. Today the word green is not just limited to color; it represents the environment, which is surrounding us. Green concrete is a revolutionary topic in the history of concrete industry. Demand of construction materials is increasing because of urbanization and industrialization which possess a serious problem of C&D waste disposal. To protect our environment and conserve the rapidly vanishing natural resources should be the base of sustainable development [1]. C&D waste is generated enormously, this waste causes many ill effects on environment and health, presence of asbestos and lead in C&D waste causes diseases like asthma, malaria, dengue etc. this waste contaminates soil, surface water and also causes air pollution, if the process continues it will be a big threat to environment in future. There are different ways for disposing this waste e.g. landfill sites, incineration plants, etc these are costlier and occupy lands, sometimes these methods of disposing the C&D waste can be frantic therefore recycling is the best option. The concept of recycling of C&D waste came when buildings and roads were demolished during World War II, there was need to recycle the waste which United States in 1970's tapered off [2]. If high quality recycled coarse aggregate is used for construction there will be no effect on strength of concrete [3]. Among the

various reasons of using recycled coarse aggregate, one reason is to make construction green and eco friendly. Construction includes 50% of raw materials derived from nature more over it consumes 40% of total energy and produces 50% of total waste [4]. According to the previous survey, the most common reason for not using recycled construction waste is lack of awareness, lack of recycling techniques and possibilities of recycling [5]. Construction from recycled coarse aggregates has prone to be economical and technically feasible [6]. This research is an alternative for the problems caused by C&D waste by replacing natural coarse aggregate in construction material by recycled coarse aggregate which was collected and crushed to get aggregates of size 10 mm and concrete mix of grade M20 was prepared at the ratio of 1:1.5:3, further the procedures like mixing, vibrating was done to cast 21 cubes of size 150mm×150 mm×150 mm with different replacement proportions (0%, 50% and 100%) and curing was done up to 28 days. The testing program included sieve analysis of both natural and recycled coarse aggregate, water absorption, moisture content, specific gravity test of both coarse and recycled aggregate, density and compressive strength tests were done. The result of the whole process proved to be efficacious and can be easily adopted in our daily construction practices.

2. Materials and Methodology

2.1 Materials: Table 1 shows the materials and their total quantity used.

Table 1 Materials used

Material	Quantity
Cement opc 43 grade	34 kgs
Fine aggregate	66.814 kgs
Natural coarse aggregate	40.663 kgs
Recycled coarse aggregate	59.420 kgs
Water	17.993 ltrs

2.2 Methodology

2.2.1 Crushing of rubble: The rubble was collected and crushed into 10-12 mm aggregates.

2.2.2 Batching: Precise and accurate quantities of materials were weighed for different mix proportions. Table 2 shows the proper measured quantity of materials per cube.

Table 2 Batching of materials used

Replacement Proportion in percent	Cement in Kg's per cube	Fine aggregate in Kg's per cube	Natural Coarse Aggregate in Kg's per cube(NCA)	Recycled coarse aggregate in Kg's per cube(RCA)	Water in liter per cube
0	1.523	2.543	4.956	0	.761
50	1.523	2.543	2.478	1.890	.761
100	1.523	2.543	0	3.782	.761

2.2.3. Mixing: To bring uniform consistency in mix a concrete mixer was used for mixing and mixing time was 2-3 minutes, speed of mixer drum was 18-20 rpm

2.2.4. Workability: Slump test was performed with w/c ratio for 0% and 50% replacement was taken as 0.50 and for 100% replacement was taken as 0.60 to maintain the 75mm slump.

2.2.5. Compaction: A table vibrator was used for compaction which is driven on electric motor.

2.2.6. Curing: Curing tank was used to cure the cubes for 28 days to attain maximum strength.

3.2 Specific gravity Test

Table 4 Specific gravity

Material	Specific Gravity
Fine aggregate	2.66
Natural coarse aggregate	2.69
Recycled coarse aggregate	2.49
Cement	3.15

3.3 Moisture content Test

Table 5 Moisture content

Material	Moisture content in percent
Fine aggregate	0.5
Natural Coarse aggregate	Nil
Recycled coarse aggregate	Nil

3. Tests and Results

Following tests were performed during the whole process; the sequential analysis is described below

3.1 Fineness modulus Test

Table 3 Fineness modulus test results

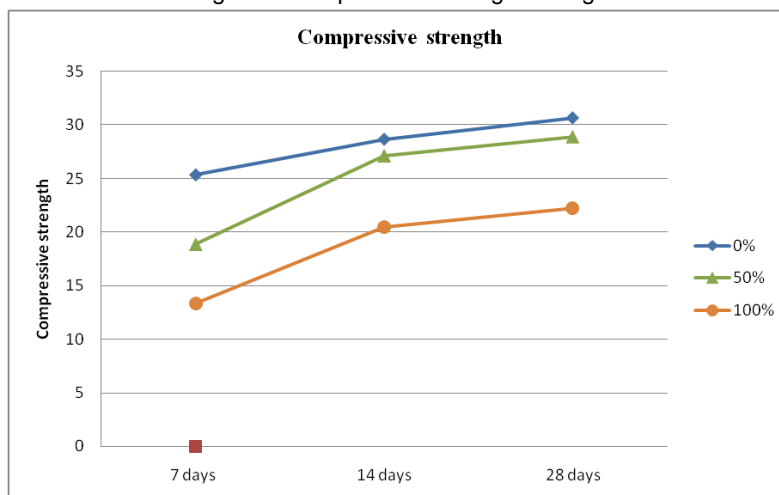
Material	Fineness modulus
Fine aggregate	2.36
Natural Coarse aggregate	7.02
Recycled coarse aggregate	6.13

3.4 Compressive Strength Test

Table 6 Compressive strength

Curing period	Percentage Replacement		
	0% RCA	50%RCA	100%RCA
7 days	25.33	18.88	13.33
14 days	28.66	27.11	20.44
28 days	30.66	28.88	22.22

Figure 1 Compressive Strength Vs Age



3.5 Density

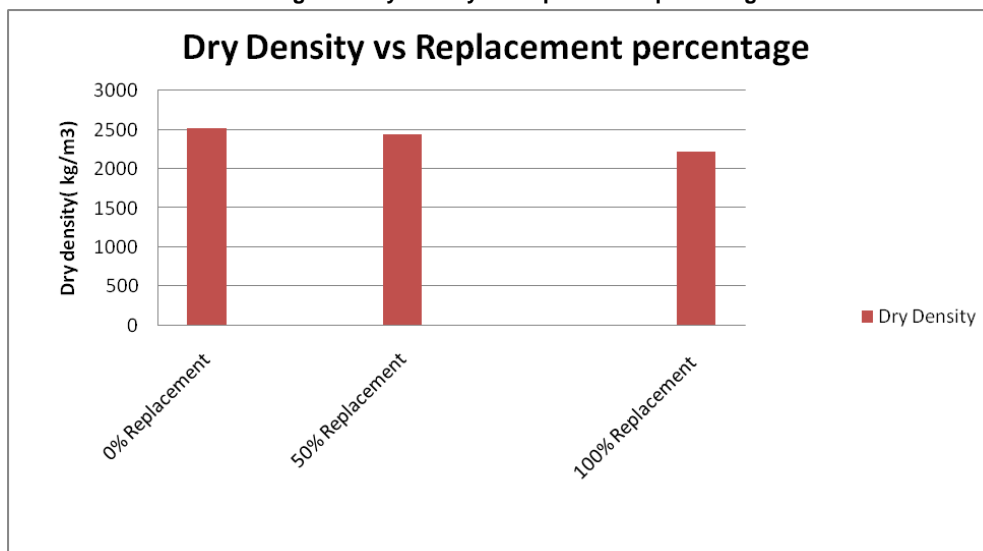
Density of concrete depends on ratio of Natural Coarse aggregate and recycled aggregate ratio. Density of concrete decreases as the percentage of recycled aggregate is

increased i.e. density is inversely proportional to percentage of recycled aggregate. The results thus obtained are given in following table.

Table 7 Density

S. No	Proportion				Dry density(kg/m ³)
	Cement	Fine aggregate	Natural coarse aggregate	Recycled coarse aggregate	
1	1	1.5	3	0	2520
2	1	1.5	1.50	1.50	2440
3	1	1.5	0	3	2340

Figure 2 Dry density Vs Replacement percentages



4. Discussions

On the basis of above study the following observations are made regarding the properties and behavior of concrete. On the partial replacement of NCA by RCA:

- 1) Maximum compressive strength is attained at 50% replacement, strength of concrete decreases on increase in replacement of aggregates.
- 2) The workability of concrete decreases on increase of percentage of green concrete because water absorption is higher in green concrete than in natural aggregate.
- 3) The cement mortar adhered on green concrete decreases the workability and compressive strength of concrete

- 4) The dry density of concrete decreases as percentage is increased after 28 days of curing.

5. Conclusions

Using green concrete saves energy protects environment and cost of transportation and excavation of natural resources. Use of rubble waste reduces the production of waste through construction industries therefore it is an eco friendly construction material. Construction by such green concrete is suitable for construction purposes like lightly reinforced beams, slabs, walls, columns, floors, lining of canal, strip footing, mass concreting etc with minimal difference in strength parameters.

References

1. Topcu Bekir Ilker, Guncan Fuat Nedim(1995), Cement Concrete Research, Using waste concrete as aggregate. pp: 85–90.
2. Buck, A. D. (1977). ACI Journal, Recycled concrete as a source of aggregate. pp 212–219.
3. Mirjana Malešev 1, Vlastimir Radonjanin 1 and Snežana Marinković (2010), Sustainability, Recycled Concrete as Aggregate for Structural Concrete Production pp 1204-1225;
4. Oikonomou, N. (2005). Cement and Concrete Composites, Recycled concrete aggregates. Pp 315–318.
5. M. Chakradhara Rao, S. K. Bhattacharyya ,S. V. Barai(2011), Materials and Structures, Influence of field recycled coarse aggregate on properties of concrete, pp 205–220.
6. Brett Tempest, Tara Cavalline, Janos Gergely, David Weggel(2010), Concrete Sustainability Conference, Construction and Demolition Waste used as Recycled Aggregates in Concrete, Solutions for Increasing the Marketability of Recycled Aggregate Concrete pp 1-13