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Study on the Strength Properties of Concrete with Demolished Waste as Coarse Aggregate

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Abstract: *In recent years, the increased rate of urbanization has led to be the generation and release of large amounts of construction and demolition (C and D) waste. From the viewpoint of environmental preservation and effective utilization of resources, it is beneficial and necessary to reuse C and D waste. Recycled concrete aggregate, which is obtained from C and D waste, is currently being considered as an alternative aggregate for structural concrete. Recycled aggregate concrete (RAC), an ecofriendly concrete produced by partial or full substitution of natural aggregates with recycled concrete aggregates in a concrete mix, has drawn much attention recently. Over the last decade, a significant volume of studies has been reported in the literature on the behaviour of RACs. In this study recycled coarse aggregates obtained by demolished concrete were used for the concrete production. Five different recycled aggregate concrete have been produced with 0 %, 10 %, 20 %, 30 %, 40 % of recycled coarse aggregates. In which that zero percentage of recycled coarse aggregate is a conventional concrete. The influence of the order of materials used in the concrete production with respect to improving its compressive strength have been analysed. The lower modulus of elasticity of the recycled coarse aggregate concretes with respect to conventional concretes was measure verifying the numbers models proposed by different scientist.*

Keywords: *Recycled concrete aggregate, conventional concrete, recycled aggregate concrete, water absorption, Compressive strength, Bulk density, Rebound hammer.*

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I. INTRODUCTION

Concrete is the mixture of cement, fine aggregate, coarse aggregate with addition of water. In which the coarse aggregate plays the main role as occupying nearly up to 75 % of concrete. But the resources of coarse aggregate get reducing day by day. So, we have to find alternate ways. In order to reduce the usage of natural aggregate can be used as the replacement materials. Recycled aggregates are comprised of crushed, graded inorganic practice processed from material that have been in the demolished debris. According to CSIRO, construction and demolition waste (C and D waste) makes up of 40 % of the total waste each year (estimate around 14 million tons) going to landfills. C and D contains mainly crushed concrete and other materials such as metals, brick, plastics, etc., The waste can be processed to produce high quality Re Cycled Aggregate (RCA) through a proper processing plant. The main reason for increase of volume of demolition waste are as follows:

1. Many of building, concrete pavements, bridges and other structures have overcome their age and limit of use due to structural deterioration beyond its repair and need to be demolished.
2. New construction for better economic growth.
3. Structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc.,

Recycling is the process that takes waste items and turns them into raw materials that can be made into new products. The recycling process begins with the collection of recyclable items, which are sent to a plant where they can be sorted and prepared for reuse. Sustainable building, also known as green construction, is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation and deconstruction. Sustainable construction is thus an aspect of sustainable development, defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Thus, sustainable construction should make efficient use of resources while minimizing any adverse impacts on the environment. Recycling and reuse of construction and demolition C and D debris is one

component of sustainable or green building construction. The EPA defines C and D debris as the waste material that is produced in the process of construction, renovation, or demolition of structures. Structures include buildings of all types (both residential and non-residential) as well as roads and bridges.

Components of C and D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. In the past when structures made of concrete are demolished or renovated, the concrete debris was routinely trucked to landfills for disposal. In the present era of greater environmental consciousness, more environmental legislations, and the desire to reduce construction cost, recycling has become a more attractive option of dealing with the rubble. Concrete recycling has been identified throughout the world as part of the strategy on responsible management of C and D materials. This is because the concrete recycling offers a number of benefits including keeping concrete debris out of landfills thereby conserving landfill space, reducing the amount of concrete aggregate required to be mined thereby conserving energy and resources, reduction of overall project cost by saving on the cost of concrete rubble disposal, and mitigating the pollution involved in trucking material over long distances. In many countries of the world such as the United states, Japan, the Netherlands, United Kingdom, Germany, Denmark, the codes, standards, and testing methods for recycled aggregate concrete already exist, or are at the proposal stage.

II. EXPERIMENTAL WORK

A. Materials

Cement: Ordinary Portland cement was used in casting the specimens. It is used as basic ingredients of concrete and mortar. The test results of specific gravity, fineness, initial setting time and consistency of the cement were conducted in the concrete laboratory and their test results are furnished in Table 1 and the chemical composition of cement is given in Table 2.

Sand: The fine aggregate serves the purpose of filling all the open spaces in between the coarse particles. Thus, it reduces the porosity of the final mass and considerably increases its strength. The material which passes through 4.75 mm sieve is termed as fine aggregate which has been taken for the testing purposes.

Recycled coarse aggregate: The material which is retained on 4.75 mm sieve is termed as coarse aggregate. Crushed stones of size 16 mm are used as coarse aggregate. The recycled aggregates and natural aggregates are used in proportion of 0 %, 10 %, 20 %, 30 %, and 40 % in concrete particles.

Natural coarse aggregate: The natural aggregate has a specific gravity of 2.75, it has a water absorption of 3 percent and it has particle size distribution as 16 mm.

Table No.1

S. No	Description	Results
1	Specific gravity	3.15
2	Fineness by sieve analysis	10 %
3	Initial Setting Time	110 minutes
4	Consistency	7 mm

Test results of cement

B. Concrete Preparation

Concrete has been prepared by hand mixing in the grade of M_{20} according to IS 10262:2009. Table 3 shows the concrete composition in parts by weight and the water cement ratio is 0.45. Concrete cube mould of dimension of 150 mm x 150 mm x 150 mm. The moulds are well greased and the concrete was placed in two layers with each layer damping was given for 20 times with steel rod. After 48 hours, the samples were de-moulded and it is taken for curing. Gunny bag curing is provided for the concrete cubes.

Table No. 2

S. No	Chemical composition	Percentage of cement
1	Lime	61.80
2	Silica	21.20
3	Alumina	5.30
4	Iron oxide (Fe_2O_3)	3.40
5	Loss of ignition	2.80
6	Magnesium oxide (MgO)	0.60
7	Chloride	0.10

Chemical Composition of Binder

III. RESULTS AND DISCUSSION

A. Density

The density is determined by the ratio of the weight of the concrete to the volume of the concrete cube. Density expresses the dead load of the structure. Generally, the specific gravity of recycled aggregate, silica fume and fly ash are high compared with natural aggregate. Hence the recycled aggregate concrete exhibits high density than conventional concrete. The densities of concrete cubes made with different replacement such as 0%, 10%, 20%, 30% and 40%. The density values of concrete cube are given in table 4.

Table No. 3

S. No	Proportions	Natural aggregate, NA	Recycled concrete aggregates RCA
1	0 %	100 %	0 %
2	10 %	90 %	10 %
3	20 %	80 %	20 %
4	30 %	70 %	30 %
5	40 %	60 %	40 %

Concrete composition

Table No. 4

Type of concrete	Proportions (%)	14 Days (kg/mm^3)		28 Days (kg/mm^3)	
		Before Curing	After Curing	Before Curing	After Curing
CC	0	2429.63	2488.88	2474.07	2595.56
RC	10	2488.88	2613.30	2488.89	2607.41
RC	20	2488.88	2631.10	2491.85	2637.04
RC	30	2518.52	2637.04	2503.70	2654.81
RC	40	2518.52	2642.96	2506.66	2660.74

Concrete Densities

CC = convensional concrete
RC = recycled concrete

B. Compressive strength

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. The compressive strength of the different proportions is arrived and the results are compared with conventional concrete. The compressive strength of various proportions is listed in Table 5. Figure 1 shows the compressive strength of cube concrete at 14 days and 28 days.

Table No. 5

Type of concrete	Proportions (%)	14 Days (N/mm^2)	28 Days (N/mm^2)
CC	0	29.33	30.22
RC	10	30.78	30.89
RC	20	33.78	31.11
RC	30	29.56	35.33
RC	40	27.73	40.53

Compressive strength of cube

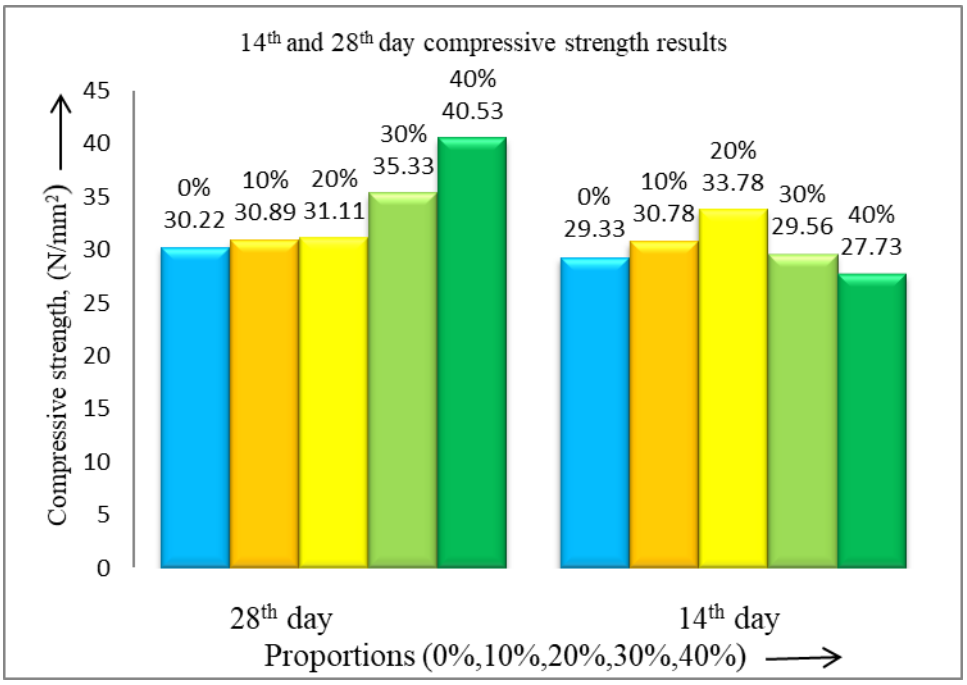

Fig .1 compressive strength of cube at 14 days and 28 days

C. Water absorption test

The water absorption test has been taken at the time period of 14 and 28 days of the concrete. The test results values are presented in the Table 6.

Table No. 6

Type of concrete	Proportions (%)	14 Days (N/mm^2)	28 Days (N/mm^2)
CC	0	2.44	4.91
RC	10	4	5.71
RC	20	4.5	5.85
RC	30	4.71	6.04
RC	40	4.94	6.15

Water absorption of cubes

IV. CONCLUSIONS

- In this research study, ordinary Portland cement grade of 53 have been used and to attain the targeted compressive strength values for concrete.
- Use of demolished waste as coarse aggregate (CA) conserves natural aggregates, reduces the impact on landfill and cost savings in the transportation of aggregate, waste products and in waste disposal.
- It reduces the impact on dwelling landfill space, reduces disposal costs, and may reduce overall projects costs.
- According to journals when the percentage of recycled coarse aggregate (RCA) replacement was increased, compressive strength gets reduced. But in this research studies, we used demolished waste as CA it's increases the strength up to 40 % proportions afterwards the strength got reduced.
- The result of strength values where increased than target compressive strength (26.6 Mpa) by using low water cement ratio as 0.45, partial replacement with natural aggregates, proper compaction and adding with concrete hydrated particles as mortar.
- The water absorption and bulk density of RCA replaced mixes are higher than normal mix but within permissible limits.

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