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An Experimental Study on Recycled Coarse Aggregates

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ABSTRACT: Recycled aggregates concrete utilizes materials from concrete and masonry constructions. Re use of demolition waste avoids the problem of waste disposal and is also helpful in reducing the gap between demand and supply of fresh aggregate. Many researchers state that the recycled aggregates that are obtained from concrete specimen make good quality concrete. For improving the quality of recycled coarse aggregate, various surface treatment methods such as washing the recycled aggregates with water and diluted acid were investigated. Strength properties of the treated and untreated coarse aggregate were compared. The results indicated that the compressive strength of recycle aggregate is found to be less than the natural aggregate. A lot of experiments have been made to investigate the strength behavior of recycled aggregate concrete using demolition waste. Tests results show that behavior of concrete like workability, variation of strength made with recycled aggregate is more or less similar to conventional concrete. Mix designs can be made using recycled aggregate for structural concrete elements instead of disposing off the recycled concrete to achieve economy.

Keywords: Construction material, demolition waste, recycled coarse aggregate, compressive strength, Acids.

I. INTRODUCTION

Concrete is the premier construction material across the world and the most widely used in all types of civil engineering works, including infrastructure, low and high-rise buildings, defense installations, environment protection and local/domestic developments. Concrete is a manufactured product, essentially consisting of cement, aggregates, water and admixture. Among these, aggregates, i.e. inert granular materials such as sand, crushed stone form the major part. Traditionally aggregates have been readily available at economic price. However, in recent years the wisdom of our continued wholesale extraction and use of aggregates from natural resources has been questioned at an international level. This is mainly because of the depletion of quality primary aggregates and greater awareness of environmental protection. In light of this, the availability of natural resources to future generations has also been realized. In fact many governments throughout the world have now introduced various measures aimed at reducing the use of primary aggregates and increasing reuse and recycling, where it is technically, economically, or environmentally acceptable.

A. Need to use RCA

Waste arising from Construction and Demolition constitutes one of the largest waste streams within the Asian and many other countries, the results of a recent study undertaken by the CSIR. has revealed that nearly a million tonne of C & D waste ends up. This is in addition to large quantities that are dumped illegally. Thus, construction demolition waste has become a global concern that requires sustainable solution. It is now widely accepted that there is a significant potential for reclaiming and recycling demolished debris for use in value added applications to maximize economic and environmental benefits. As a direct result of this, recycling industries in many part of the world, including South Africa, at present converts low value waste into secondary construction materials such as a variety of aggregate grades, road materials and aggregate fines. Often these materials are used in as road construction, backfill for retaining walls, low grade concrete production, drainage and brickwork and block work for low-cost housing. While Accepting the need to promote the use of RCA in wider applications, it must be remembered that the aggregate for concrete applications must meet the requirements set in relevant specifications for its particular use.

The gap between these interests has to be reduced in steps that are manageable and the use of RCA in structural concrete has to be promoted gradually. Similarly considerable attention is required to the control of waste processing and subsequent sorting, crushing, separating and grading the aggregate for use of the concrete construction industry. In some developed countries C & D waste is now regularly recycled and reused, albeit mainly as fill, drainage and sub base materials, and there is considerable scope for increasing this market and the use of these materials. In addition, there is an urgent need for legislative or regulatory measures to implement sustainable C & D waste management strategy and encourage recycling for use in value added applications.

II. LITERATURE REVIEW

Limbachiya and Leelawat (2000) found that recycled concrete aggregate had 7 to 9% lower relative density and 2 times higher water absorption than natural aggregate. According to their test results, it shown that there was no effect with the replacement of 30% coarse recycled concrete aggregate used on the ceiling strength of concrete. It also mentioned that recycled concrete aggregate could be used in high strength concrete mixes with the recycled concrete aggregate content in the concrete.

Sagoe, Brown and Taylor (2002) stated that the difference between the characteristic of fresh and hardened recycled aggregate concrete and natural aggregate concrete is relatively narrower than reported for laboratory crush recycled aggregate concrete mixes. There was no difference at the 5% significance level in concrete compressive and tensile strength of recycled concrete and control normal concrete made from natural aggregate

In the same year, Poon (2002) reported that there were not much effect of the compressive strength of brick specimens with the replacement of 25% and 50% of recycled aggregate. But when the percentage of recycled aggregate replacement increased, the compressive strength of the specimens was reducing.

Mandal, Chakarborty and Gupta (2002) also found that there will no effects on the concrete strength with the replacement of 30% of recycled aggregate. But the compressive strength was gradually decreasing when the amount replacement of recycled increased. They concluded that the properties and the strength characteristic of recycled aggregate concrete were deficiency when compared to the specimens that made by the natural aggregate.

III. EXPERIMENTAL WORK

The main aim of this research project is to utilize recycled concrete as coarse aggregate for the production of concrete. It is essential to know whether the replacement of RCA in concrete is inappropriate or acceptable. The recycled aggregates were crushed and soaked in water for 24 hours for water treatment then kept for drying. Similarly the recycled aggregate soaked with diluted sulphuric, hydrochloric and nitric acids separately and then those aggregates were used for casting of concrete cubes.

A. Material testing and Mix design

Cement. Ordinary Portland Cement 43 grade hydraulic cement was used in the present investigation. It was tested as per IS: 4031-1968 and IS: 8112-1989 recommendations for the hydraulic cement.

Sl No.	Test Parameters	Results	As per IS 8112-1989 (Specifications of 43 Grade OPC Cement)
1	Initial setting time and Final setting time	72 minutes and 240 minutes	Not less than 30 min. and not more than 600 minutes.
2	Specific Gravity	3.09	-
3	Soundness	1mm	Not less than 10mm
4	Normal Consistency	31%	-
5	Compressive Strength	-	-
	3 days	26.57N/mm^2	Not less than 23 N/mm^2
	7 days	35.32N/mm^2	Not less than 33N/mm^2
	28 days	45.52N/mm^2	Not less than 43N/mm^2

Coarse Aggregate. 20mm down size coarse aggregate was used in the present work which met the grading requirements as per IS 383-1970.

Fine Aggregates. Locally available sand was used in the present work. The sand belongs to zone – II as per IS 383-1970.

Recycled Coarse Aggregates. Crushed concrete aggregate waste passing through 20mm and retained on 4.75mm I.S sieve were used as recycled coarse aggregate and they met the grading requirements.

Water. Potable tap water available in the college laboratory was used in the present experimental work.

Acid Properties. The recycled aggregates were crushed and soaked in water for 24 hours for water treatment then kept for drying. Similarly the recycled aggregate soaked with diluted sulphuric hydrochloric and nitric acids separately and then those aggregates were used for casting of concrete cubes, prisms and cylinders. The acid which was bought was highly concentrated so 0.1ml of concentrated acid was mixed with 150 ml of water.

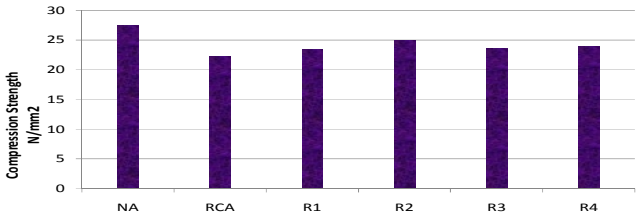
Specimen details.

Aggregate type	No. of cubes
NCA	3
RCA	3
RCA with water treatment	3
RCA with HNO_3	3
RCA with H_2SO_4	3
RCA with HCL	3

IV. RESULTS AND DISCUSSIONS

Results

Notations	**Compressive Strength (N/mm^2)**
NA (Natural Aggregate)	27.45
RA (Recycled Aggregate)	22.3
R1 (Recycled Aggregate with Water Treatment)	23.4
R2 (Recycled Aggregate Treated with Nitric Acid)	24.95
R3 (Recycled Aggregate Treated with Sulphuric Acid)	23.50
R4 (Recycled Aggregate Treated with Hydrochloric Acid)	23.90



It is observed from the Fig above, compared to natural aggregate concrete; the compressive strength of recycled aggregate was decreased by 18.76%. The recycled aggregate treated with water has increased 4.93%, nitric acid by11.88%, sulphuric acid increased by 5.38% and hydrochloric acid increased by 7.17% than the recycled aggregate.

V. CONCLUSION

Based on the results obtained from the experiment the following conclusions are drawn:

1. The test results showed that the compressive of the recycled aggregate concrete is found to be lower than the natural aggregate.
2. The strength of recycled aggregate concrete can be improved by the water and acid treatments.
3. Recycled aggregate treated with nitric acid displayed the decent result compared to the hydrochloric and sulphuric acid and from economical point of view; water and acid treated recycled aggregates can be used in place of natural aggregates for temporary structures.

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