

- Strength Analysis of Recycled Demolished Concrete as Coarse & Fine Aggregate For Rigid Pavement

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Abstract Utilization of waste materials and byproducts is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. To reduce this impact and achieve a more sustainable product, waste materials can be incorporated into concrete in the form of RA (Recycled aggregate). The most extensively researched material used in the production of RA is waste and demolished concrete, that is, fine and coarse debris from demolition sites. Concrete with RA as a component in the mixing process is referred to as recycled aggregate concrete (RAC). here we utilized recycled coarse and fine aggregate (RCA & RFA) by replacing natural coarse aggregate by 0%, 20%, 40%, 60% & 80% and fine aggregate by 0%, 10%, 20%, 30% & 40% to analyzed strength properties of concrete.

Key Words: recycled aggregate; recycled aggregate concrete; mechanical properties; load test; structural concrete

1.1 INTRODUCTION

The recycled aggregate used are taken from the demolished concrete members. Most of the concrete wastes are taken from waste concrete members. These concrete wastes are crushed and Recycled coarse aggregates (RCA) were produced. The use of recycled aggregates in concrete proves to be valuable building materials in technical, environment and economical respect. Use of recycled aggregates in concrete can be useful for Environmental protection and economical aspects. Recycled aggregates are the materials for the future. 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.

1.2 RCA AN OVERVIEW

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 tone 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.

1.3 OBJECTIVES

- ▶ To investigate the effect of recycled coarse aggregate on the strength of concrete.
- ▶ To reduce the impact of waste materials on environment.
- ▶ To carry out different tests on recycled aggregates & natural aggregates & compare their results.

1.4 RESEARCH METHODOLOGY

The following tasks are to be carried out in order to achieve the research objectives:

1. Collecting the required information and documents demolished concrete waste.
2. Undertaking a comprehensive literature review on relevant subjects focused on the usage demolished concrete waste.
3. Developing an adequate experimental program to study the use demolished concrete waste in the form of coarse & fine aggregate.
4. Analyzing the experimental output test results to draw conclusions.

1.5 EXPERIMENTAL DETAIL

The RCA contents are calculated as weight percent of coarse aggregate in the control mix. The fineness modulus of coarse aggregate with various RCA content is between 5.34 to 5.75 and RFA is between 2 to 4. The RCA can be considered as partial coarse aggregate substitute and RFA as a fine aggregate substitute retaining the mix ratio as the same. The divided particle size is assumed to be 20mm for coarse aggregate. It is considered as replacement to coarse aggregate and fine aggregate in natural coarse and fine aggregate in various percentages.

Table-1: Physical properties of RCA, RFA and natural coarse & fine aggregate

Properties	RCA	Natural Coarse aggregate	RFA	Natural Fine aggregate
Specific gravity	2.79	2.89	2.60	2.65
Absorption (%)	2%	0.5%	1.2%	0.5%
Color	Pale white	Dark	Pale white	Dark
Shape	angular	Angular	Rounded	Rounded

Concrete Mix

Control mix concrete and modified with various RCA and RFA contents as listed in Table-2 are prepared. By considering the use RCA and RFA in the mixes as much as possible and achieve suitable workability was attempted and strength criteria of Grade M20 concrete mix is analyzed.

Table -2: Mix Specifications

Mix	Proportion of RCA	Proportion of RFA
Control Mix A	0%	0%
A1		10%
A2		20%
A3		30%
A4		40%
A5	20%	0%

A6		10%
A7		20%
A8		30%
A9		40%
A10	40%	0%
A11		10%
A12		20%
A13		30%
A14		40%
A15	60%	0%
A16		10%
A17		20%
A18		30%
A19	40%	
A20	80%	0%
A21		10%
A22		20%
A23		30%
A24		40%

Tests on concrete

Compressive strength test-For the testing program, a series of standard compressive tests are conduct with variable controlling factors: water-cement ratio, RCA & RFA content. All the tests will done for 28-days compressive strength accompanied by a slump flow test for each case sample.

1.6 LABORATORY TESTING RESULTS AND DATA ANALYSIS

This main aim of this is to obtain the fresh concrete workability and the hardened concrete compressive strength as the essentials for the analyses following the methodology targeting to highlight the usefulness of considering RCA & RFA as a main component within the concrete mix. Proper treatment of uncertainties within the data analysis process required understanding the sources of errors for determining the final output results.

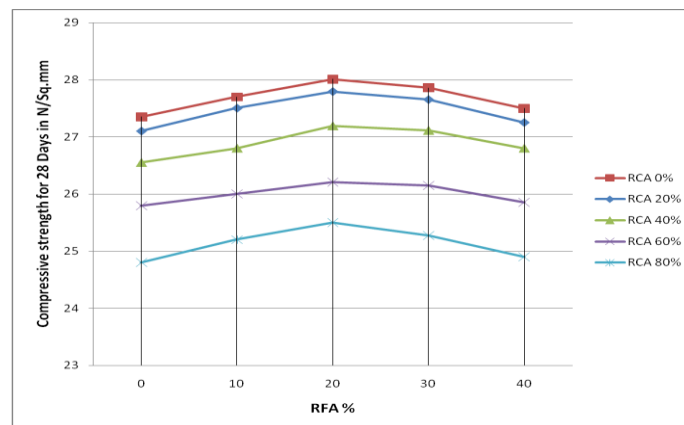
It is worthy to mention that for the sake of simplicity, some of the variables that may actually influence the hardened concrete compressive strength such as various combinations of RCA & RFA mix. Content and the mixing water cement ratio. As it can be seen, the fresh concrete workability is inversely affected by the increase of water-cement ratio.

We test the specimen for compressive strength test for 28 days following results are obtained

Table - 3: Compressive strength test

Mix	RFA	RCA	Compressive Strength 28 days in N /sq.mm
A	0	0	27.35
A1	10		27.7
A2	20		28.01
A3	30		27.86
A4	40		27.5
A5	0	20	27.1
A6	10		27.5
A7	20		27.79
A8	30		27.65

A9	40		27.25
A10	0	40	26.55
A11	10		26.8
A12	20		27.19
A13	30		27.11
A14	40		26.8
A15	0	60	25.79
A16	10		26
A17	20		26.21
A18	30		26.15
A19	40		25.85
A20	0	80	24.8
A21	10		25.2
A22	20		25.5
A23	30		25.27
A24	40		24.9



Graph 1- compressive strength test results for 28 days in N/ sq. mm

1.7 CONCLUSIONS

This study intended to find the effective ways to reutilize the RCA particles as concrete aggregate. Analysis of the strength characteristics of concrete containing e-waste gave the following results.

1. It is identified that RCA & RFA can be disposed by using them as construction materials..
2. The compressive strength of concrete containing RCA aggregate is retained more or less in comparison with controlled concrete specimens. However strength noticeably decreased when the RCA content was more than 80%.

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