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Analysis of different characteristics of concrete made with recycled aggregate

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ABSTRACT

The recycled concrete aggregate has limited application as fill and subgrade material below the foundation of structures, pavement, etc. these applications are non- structural applications. However, research has been ongoing all over the world especially in Japan, China, European countries and some parts of India also, from the last 50 years in order to find the potential implement of recycled aggregates as a structural grade concrete. The research work on mechanical and durability characteristics of concrete made with recycled aggregate concrete is presented here and is one such attempt to establish the RAC as a structural grade concrete. This research work focuses on mainly four structural properties of concrete i.e. Compressive Strength, Split Tensile Strength, Acid resistance test and alkalinity resistance test. In this present study the experimental concrete making without fiber and with fiber. The natural coarse aggregates are replaced with Recycled coarse aggregates at different replacement ratios. Four replacement ratios are considered in this present study 0%, 20%, 40% and 80%. Based on the results obtained it is found that on the addition of steel fibers there is an increase in almost all the structural properties of normal concrete and concrete made with recycled aggregates.

Keywords— *Recycled aggregate, Natural aggregate, Compressive Strength Test, Tensile Strength, Acid Resistance, Alkalinity Resistance Test*

1. INTRODUCTION

Nowadays the concrete industry is consuming a lot of natural resources. This causes lot of damage to environment and mother earth. So, the less cement and natural aggregates that are used in concrete production, the lower the impact on environment. The increase in cost of landfills, scarcity of natural resources for aggregate, encourages the use of construction waste as a source of aggregate. A manageable development has turned into an awesome worry over-development hone to the detriment without bounds of our planet. This is because of the way that the development business is an enormous purchaser of common assets and a tremendous waste maker too. High estimation of crude material utilization in the development business ends up one of the principal factors that reason ecological harm and contamination to our mom earth and the exhaustion of regular and mineral assets. Consistently, in excess of 165 million tones of common totals are utilized as a part of various common and modern developments. In the interim, roughly 109 million tones of development and pulverization buildups are created in the UK; around 60 million tones of this are gotten from concrete. The assets, for example, coarse totals, sands, and bonds will be at a distraught position, as these assets are not ready to adapt to the appeal in the development business.

2. MATERIALS USED

2.1 Cement

Cement is a fine grey powder material that can be made into paste usually by the addition of water. It is mixed with water, sand, gravel and crushed stone in order to make concrete. Ordinary Portland cement of grade- 43 (Shree Ultra tech cement) conforming to Indian standards IS: 8112-1989 has been used in the present study.

2.2 Fine Aggregate

IS: 383-1963 defines the fine aggregate as the aggregate most of which will pass 4.75 mm IS sieve. The fine aggregate is usually termed as Sand. The sand is generally considered to have a lower size limit of 0.007 mm. usually, natural sand is used as a fine aggregate. The sand used for the experimental work is locally available and conformed to grading zone III.

2.3 Coarse Aggregate

The coarse aggregate is defined as an aggregate most of which is retained on 4.75 mm IS sieve. The broken stone is generally used as a coarse aggregate. Locally available coarse aggregate having the maximum size of 12.5 mm was used in the present work

2.4 Recycled Coarse Aggregate

A large amount of tested concrete specimens e.g. cubes, cylinders, beams, etc. were lying in the concrete testing laboratory as shown in Fig 3.2(a). These specimens were used as a source of Recycled concrete aggregate. To obtain RCA, these specimens were broken down into small pieces manually using hammer as shown in Fig. 3.2(b). The broken pieces of concrete specimens were sieved, the larger fraction passing through 20 mm IS sieve but retained on 10 mm IS sieve. The fraction passing through 4.75 IS sieve was discarded.

2.5 Steel Fiber

Steel fibers provide a significant bridging effect on the cracking behavior of concrete and can control crack width and enhance shear capacity of RC members. Dramix Glued Hooked end type steel fibers Fig. 3.7, with diameter 0.5mm were used in the present investigation. The fibers were added in proportion of 1% by volume of concrete. The aspect ratio of the fiber adopted was 65.

3. EXPERIMENTAL PROGRAM

The objectives of this study were to examine the strength and durability of recycled aggregate concrete mix at different percentages of RCA. Properties which were examined are:

a) Compressive strength test
b) Tensile strength test
c) Acid resistance t-test
d) Alkalinity resistance test

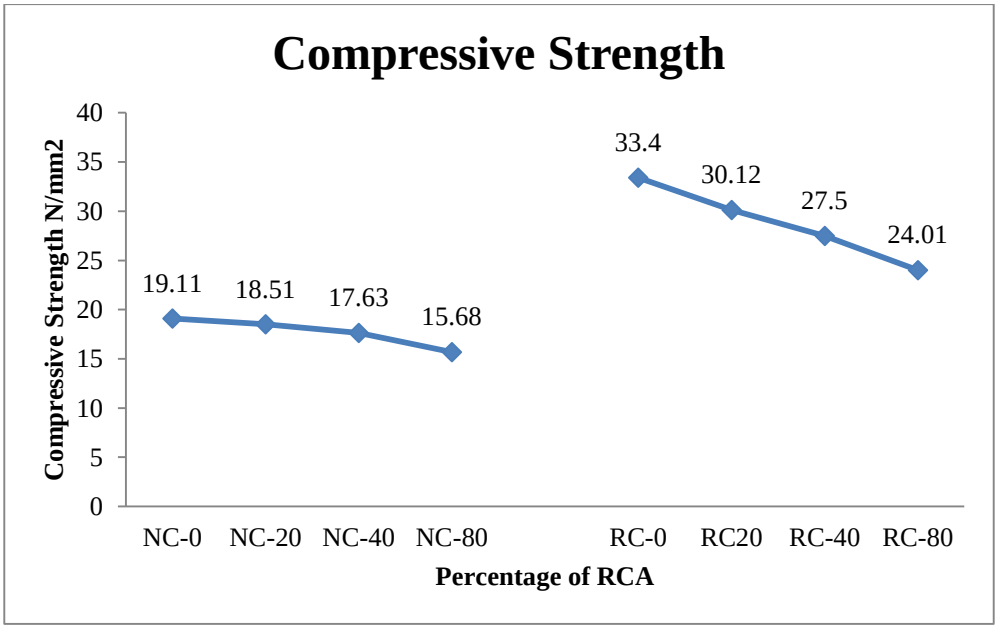
4. RESULT AND DISCUSSION

In this chapter, the result obtained from the testing of various concrete specimens of SERIES-A and SERIES-B, are interpreted. This chapter describes the effect of replacement ratio of recycled coarse aggregates with natural coarse aggregate, and the effect of steel fibers on structural performance of concrete. In order to predict the structural performance of concrete made with RCA, compressive strength, split tensile strength and durability performance of RAC are evaluated.

4.1 Compressive strength results

Table 1: Cube Compressive Strength at 28 days

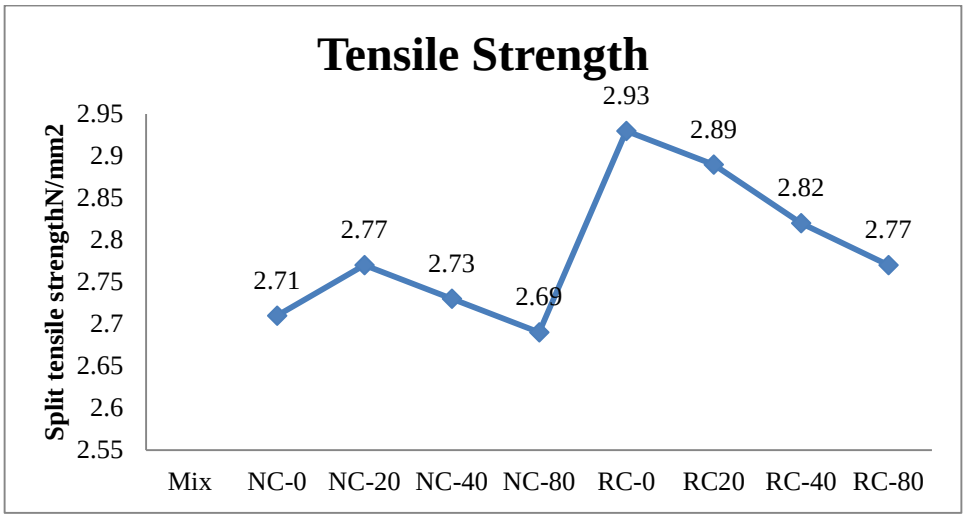
Mix.	Description	Percentage %	Compressive strength N/mm2
Without Fibers)	NC-0	0	19.11
	NC-20	20	18.51
	NC-40	40	17.63
	NC-80	80	15.68
(With fiber)	RC-0	0	33.40
	RC-20	20	30.12
	RC-40	40	27.50
	RC-80	80	24.01

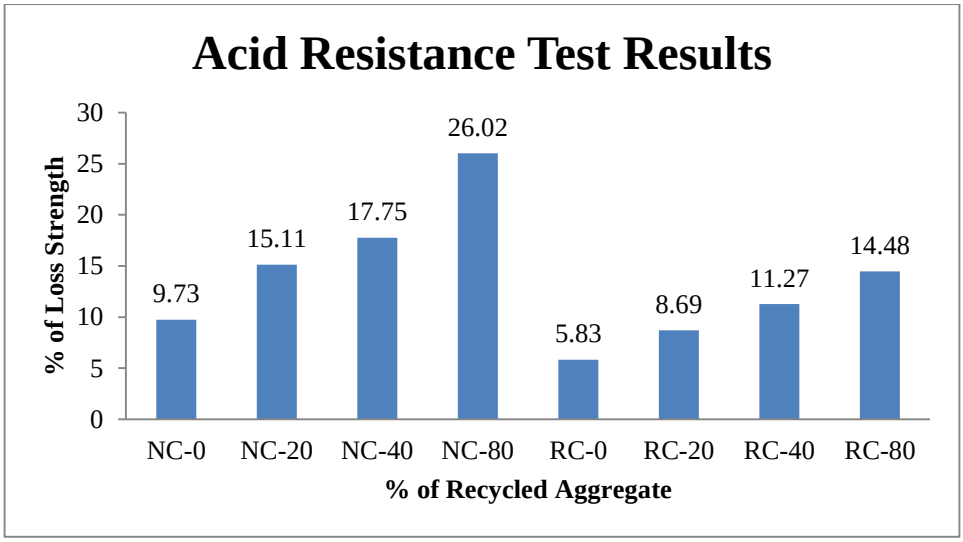


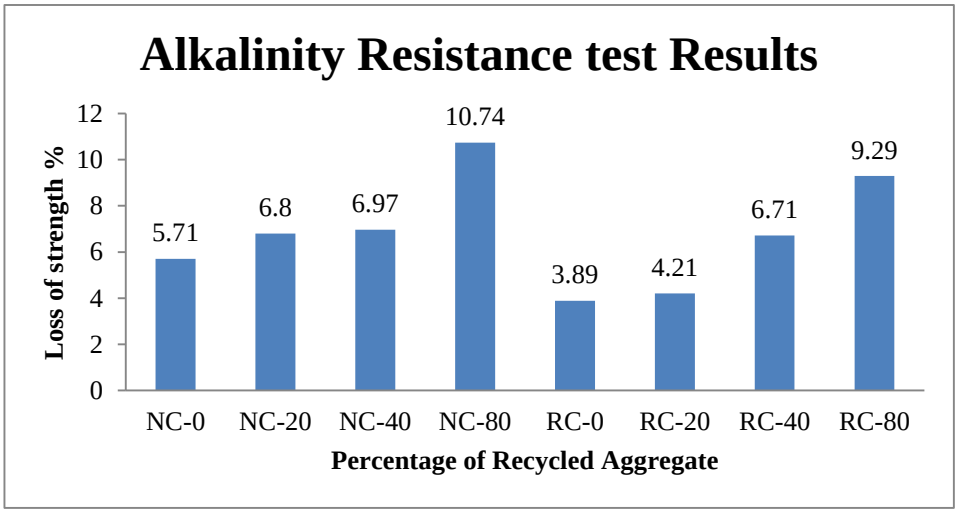
4.2 Tensile strength result

Table 2: Split Tensile Strength at 28 days

Series	Specification- Id	Replacement ratio	Splitting Tensile Strength at 28 days
SERIES-A (Without Fibers)	NC-0	0	2.71
	NC-20	20	2.77
	NC-40	40	2.73
	NC-80	80	2.69
SERIES-B (With Fibers)	RC-0	0	2.93
	RC-20	20	2.89
	RC-40	40	2.82
	RC-80	80	2.77







5. CONCLUSIONS

- Experimental works on the use of recycled aggregates have proven that good quality of concrete could be produced with recycled aggregates. Based on the experimental investigation reported in the present work, the following conclusions are drawn:
- The 28 days compressive strength of concrete made with recycled concrete aggregate decreases with the increase in replacement ratio for the same w/c ratio. However for replacement ratio up to 20%, the compressive strength of RAC is comparable to that of NAC.
- The reduction in compressive strength of concrete made with recycled concrete aggregate is in the range of 5% to 10% for a 25% replacement ratio. And this reduction for 80% replacement ratio is in the range of 20- 25%.
- The addition of steel fiber (1% by volume) in the concrete mix shows an improvement in compressive strength for all replacement ratios. This improvement is in the range of 20-22% than without fibers.
- The results show that the tensile strength of the RAC is comparable to the natural concrete. This result is due to the increased absorption of the attached mortar and effective interfacial transition zone which indicates a good bond between aggregate and mortar matrix.
- On the addition of steel fibers to RAC, the increase of tensile strength of RAC with 80% replacement ratio is 19% for 28 days. The increase of tensile strength for 40% and 20% replacement is 24% and 27% respectively for 28 days.
- Compressive strength, Tensile strength results of RAC show decrease in strength with increase in percentage replacement of conventional aggregates by recycled aggregates, However, RAC with fibers showed improvement in mechanical properties when compared to RAC.
- In view of the other advantages such as conservation of natural resources, free recycled material from landfills and elimination of disposal problems, the Recycled Aggregates, and Recycled Aggregate Concrete can be considered as a potential and suitable alternative material with a bright future.
- It has seen that the increase in recycled aggregate percentage with increasing loss of strength due to acid solution. Addition of steel fiber in concrete than less strength loss compares to without steel fiber concrete.
- It was observed that concrete less effect due to alkalinity solution attack compares with acid attack and increasing percentage of Recycled aggregate with increasing loss of strength.

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