EFFECT OF ROBO SAND ON STRENGTH CHARACTERISTIC OF RECYCLED AGGREGATE CONCRETE

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Abstract

With increased depletion of natural construction materials, alternative means must be sought for substitution of the same. Excessive energy consumption in the production of construction materials, environmental setbacks and debris disposal are some of the other burning issues fuelling the need for reuse of the raw materials. With the need of natural sand, there is an urgent need for a product that matches the properties of natural sand in concrete. Construction- Demolition waste and ROBO Sand are some of the upcoming resources which enables effective replacement of the materials of mineral origin. In the present work, natural coarse aggregate was replaced with recycled coarse aggregate and river sand was replaced with ROBO Sand in different percentages in plain cement concrete. Different strength test were conducted with combination of ROBO Sand and recycled aggregate to study the effect of these two materials on strength Concrete with a characteristic compressive strength of 30 N/mm^2 (M30 grade), was used for our study. In total, 16 sets of 6 cubes each were cast and tested.

Keywords: *ROBO Sand, recycled aggregate*

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1. INTRODUCTION

Concrete is a major building material which is used in construction throughout the globe. It is extremely good and is used for all types of structures. Due to rapid growth in construction sector, the extreme usage of concrete is rapidly increasing every year. This results in huge extraction of natural aggregates, which occupy 65 to 80% of the total volume of concrete. Out of the total composition of concrete, fine aggregate consumes 20 to 30 % of volume. With a few local exceptions, it is expected ROBO Sand to be a global practice. Developing countries face lot of problems regarding exploitation of natural resources. Now a days the availability of natural sand is a constraint .due to the immense growth in new designs old structures are demolished and the waste management is a problem, to overcome these problems some innovative way of recycling of waste should be done.

Current levels of demolition waste at UK construction sites are in the region of 70 Mt per annum [1]. Of this only 10% finds use as aggregate, but mainly in road construction [2], where traditionally low grade aggregates are used. The remaining items are disposed as landfill. This low level of use clearly has economic and environmental implications and given the potential benefits associated with the material, dumping is no longer considered sustainable

1.1 Objectives

To study effect of ROBO Sand on compressive strength,tensile strength of recycled aggregate concrete and natural aggregate concrete. To study the cost aspects and arrive an optimum combination

1.2 Research Study

In our study, for each composition, four combinations each was tested. For 0% Recycled coarse aggregate (RCA), 0%, 30%,50% and 100% Robo sand (RS)was added. Likewise for 30%, 50% and 100% RCA, RS is mixed as 0%, 30%,50% and 100%. Totally 16 mix proportions were tested. Strength test in terms of compression and tensile stress. Concrete mix of M30 is used for our study.

2. MATERIAL PROPERTIES & MIX DESIGN

2.1 Cement

The cement used for the investigation was Ordinary Portland Cement with 53 grade. The specific gravity of cement was found out by density bottle method and the corresponding value is 3.15

2.2 Coarse Aggregate

Crushed aggregate available from local sources has been used. To obtain a reasonably good grading, aggregate passing through 20mm IS sieve and retained on 16mm IS sieve was used. The properties of coarse aggregate such as specific gravity and fineness modulus are found out as per Indian Standard guidelines. The specific gravity of coarse aggregate is 2.70.

2.3 Fine Aggregate

Locally available river sand of size less than 4.75 mm was used. The specific gravity of fine aggregate is 2.65, fineness modulus was found to be 2.7 as per IS 383:1970.

2.4 ROBO Sand and Recycled Coarse Aggregate

ROBO Sand are crusher dust which are collected from local

quary and aggregate from demolished building are used as recycled coarse aggregate.Table 1 shows the Specific gravity of RS and RCA.

Table 1 Properties of Aggregates

Aggregate	Specific gravity
Recycled coarse aggregate (RCA)	2.65
Robo sand (RS)	2.29

2.5 Mix Design

Property	Value	
Required Characteristic compressive strength	30 MPa	
Maximum size of aggregate	20 mm	
Water Cement ratio	0.4	
Degree of workability	0.90	
Degree of quality control	Good	
Type of exposure	Moderate	
Mix Ratio	**Weight**	**Ratio**
Water	191 lit	0.40
Cement	478 kg	1.00
Fine Aggregate	519 kg	1.01
Coarse Aggregate	1179 kg	2.48

3. TESTING OF SPECIMEN

3.1 Cube Compressive Strength

Cubes of size 150 mm x 150 mm were cast and the strength development was monitored for the ages of 7 and 28 days for compression using digital compression testing machine of 3000 kN capacity. This paper presents the results of experimental investigations on concrete made with different percentages of recycled coarse aggregate and ROBO Sand. Specimens were designated. In all the four sets, natural sand and coarse aggregate was replaced in increasing percentages of 0, 30, 50&100.The first set had no replacement of aggregate while the last set had 100%replacement of natural aggregate with recycled coarse aggregate. The second and third sets had 30 and 50% aggregate replacements respectively. Totally 96 cubes were tested, for 7^{th} and 28^{th} day test with 3cube per combination.

3.2 Split Tensile Strength Test

For split tensile strength of concrete, 150mmx300mm cylinders were cast and cured for 7 and 28 days in water.

Chart 1- Compressive test

The test consists of applying compressive line loads along the opposite generators of a concrete cylinder placed with its axis horizontal between the platens. Due to the applied line loading a fairly uniform tensile stress is induced over nearly two – third of the loaded diameter as obtained from an elastic analysis. The magnitude of this tensile stress is given by $2P/\pi DL = 0.637P/DL$.

4. RESULTS AND DISCUSSION

4.1 Cube Compressive Strength

Table 2– Compressive strength in N/mm^2

MIX	RCA-ROBO SAND%	7^{th} Day	28^{th} DAY
Controlled	0-0	25.11	36.19
1	0-30	23.24	33.54
2	0-50	23.18	33
3	0-100	23.30	33.21
4	30-0	22.52	32.96
5	30-30	22.15	33.78
6	30-50	24.90	36.23
7	30-100	24.67	36.25
8	50-0	19.88	33.4
9	50-30	19.81	33.51
10	50-50	19.78	33.4
11	50-100	18.66	33.28
12	100-0	18.10	33.1
13	100-30	18.89	29.96
14	100-50	17.66	29.44
15	100-100	17.05	29.1

The results on compressive strength of control concrete (0-0 combination) and concrete with different percentages of ROBO Sand are shown in table 2. Graphs plotted between the mix and compression strength, to identify the maximum compression strength value in 7th and 28th day. It can be seen from the results that, control concrete strength is 36.19 N/mm2 and RCA And ROBO Sand combination for 30-100 was found to be good when compared to other combinations at the age of 28 days.

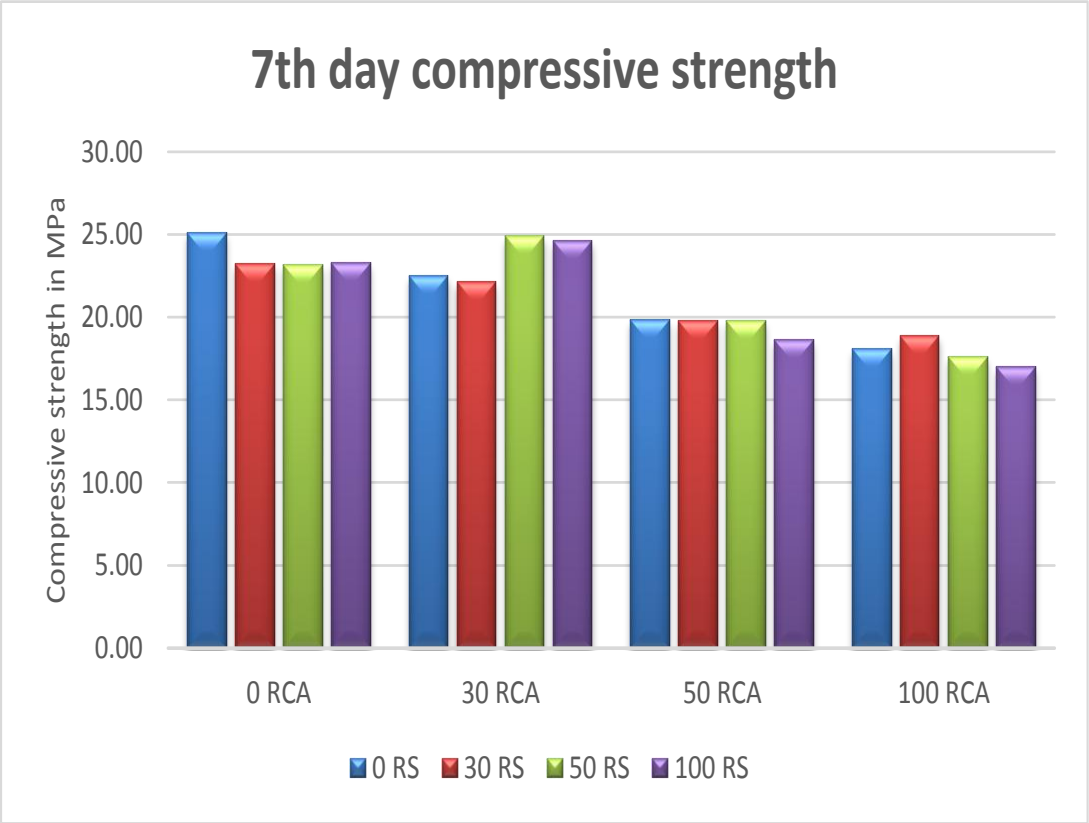

Chart 1 - 7th day compressive strength of the mixes

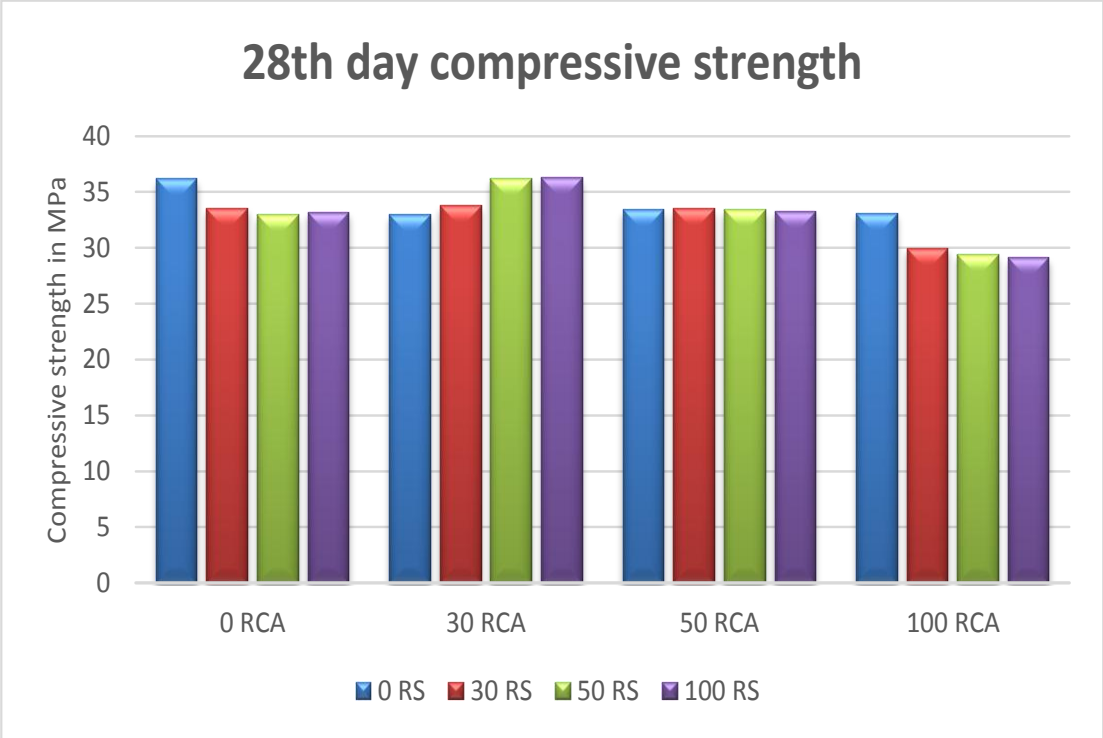

Chart 2 - 28th day compressive strength of the mixes

All the different combinations shows better strength . In 7days and 28days curing 30% RCA and both 50% and 100% ROBO (Mix 5 & 6) Sand gives more strength when compared to other combinations. When RCA percentage increased, the results are seen decrease in strength. Therefore it can be said that, when 30%RCA and 100% RS is used, the strength of the concrete was similar to control concrete. Percentage increase of strength of mix 5and 6 is 0.11% and 0.16% respectively. It will pave the way to minimize the use of natural sand and natural aggregate and encourage the use of waste materials like ROBO SAND and RCA there by reducing disposal problem. It is also to be noted that, in the above case there will be considerable reduction in cost of construction, which in turn encourages the use of RCA in solving environmental problem The intermediate results depicting the various combinations of ROBO SAND+RCA can be used according to the design strength required considering the economical aspects.

4.2 Split Tensile Strength Test

Split tensile strength for all the mixes are tabulated in table 3. 7th day and 28th day tests were made for the mixes. Tensile stress variation for various mixes with respect to controlled concrete is noted in chart 3.

Table 3– Tensile strength in N/mm^2

MIX	RCA-ROBO SAND%	7th Day	28th DAY
Controlled	0-0	3.28	4.22
1	0-30	3.18	4.15
2	0-50	3.18	4.12
3	0-100	3.19	4.13
4	30-0	3.20	4.13
5	30-30	3.06	4.09
6	30-50	3.48	4.22
7	30-100	3.36	4.23
8	50-0	3.32	3.82
9	50-30	3.30	3.79
10	50-50	3.30	3.78
11	50-100	3.29	3.92
12	100-0	3.25	3.91
13	100-30	3.24	3.84
14	100-50	3.17	3.91
15	100-100	3.08	3.79

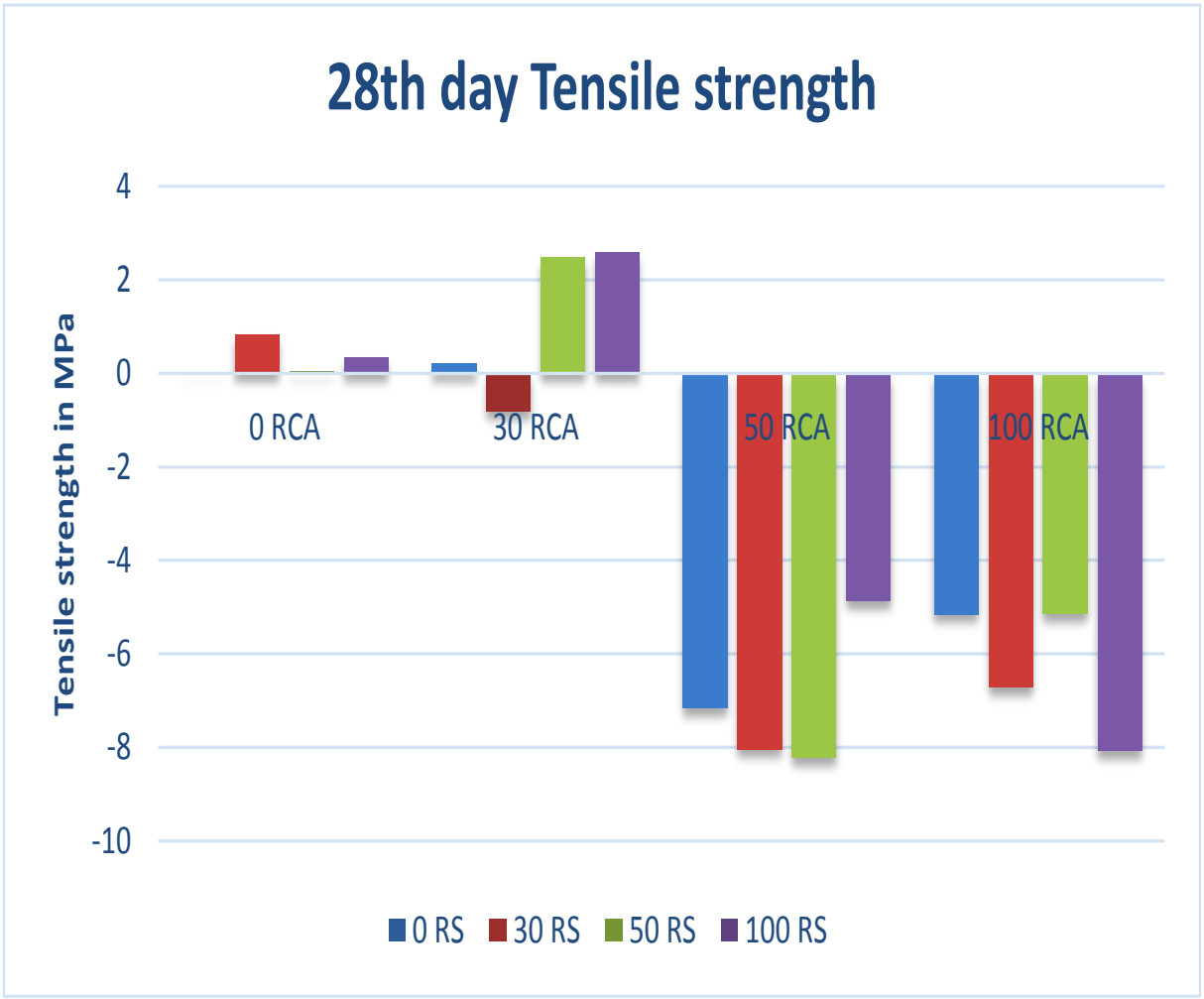

Chart 3- Percentage Variation in tensile strength

It is seen from the chart 3, that there is percentage increase in tensile strength when the RCA is added upto 30%. Above which, gives less strength than the controlled concrete. Maximum of 8% strength decrement is seen in mixes with RCA added more than 30%. While seeing the increment in tensile stress, the mix 5 (50% RS and 30%RCA) and mix 6 (100% RS and 30% RCA) shows 2.48% and 2.56% respectively. Though tensile strength is not an important factor in concrete, it is essential to know the performance of concrete with this new materials. Therefore these tests were made and results are discussed.

5. CONCLUSION

From the detailed experimental investigations carried out for different combinations of RCA with different percentages of ROBO SAND, following conclusions are arrived:

1. Strength aspect of RCA and ROBO Sand based concrete for 30-100% has shown good results both for 7days and 28 days curing..
2. Cost aspect- to achieve reasonable strength with reduced cost comes with the same combination of 30% RCA and 50% or 100% ROBO SAND.
3. Replacement of Natural aggregate with RCA above 30% is possible to achieve a strength reduction of about 20% of target mean strength (without any mineral admixture).

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BIOGRAPHIES

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