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Study of Strength Properties of Concrete with Construction Debris as Aggregates

[1] Sai Samanth.A, [2] Prakhar
[1][2]Manipal Institute of Technology
Manipal, Karnataka,India
[1]samanth.anuma@gmail.com, [2]30prakhar12b@gmail.com

Abstract: **--This paper deals with analysis of properties of concrete replaced by recycled construction and demolition debris as aggregates in concrete mix. Determining the replacement ratio of this debris as fine and coarse aggregate is presented in this paper with experimental results. This effective utilization of the debris as aggregates without altering the properties of conventional concrete contributes in solid waste management and also helps in finding partial replacement for sand and quarry**

Index terms: **Construction and demolition debris, Solid waste management, Recycled aggregate concrete.**

I. INTRODUCTION

According to 'waste management world' statistics, in India, 48 million tonnes of solid waste is produced per annum, construction and demolition waste contributes about 15 million tonnes. In the year 2014, Rs 70 crores was integrated for solid waste management facility to meet Delhi's garbage disposal needs for the next 20 years.

The total non-reusable waste from the construction industry in India is estimated to be between 12 million to 14.7 million tonnes per year, out of which 7 to 8 million tonnes are concrete and brick waste. Most of this waste is landfilled in rural areas.

In India 650million kg sand is used per year which is dug exponentially from rivers, if 20% to 25% of sand is replaced by concrete waste as fine aggregate around 150 million kg of sands can be saved.

This use of construction debris as coarse and fine aggregate is an alternative for the replenishing quarry and river sand.

Since the weak and less homogeneous parts of old concrete could be departed easily from the concrete in crushing process, the most part of recycled fine aggregates were made of the mortar which has a relatively high volume of porosity than coarse aggregates.[1]

II. OBJECTIVE

The main objective of this paper is to prove that the replacement of construction debris as aggregates in concrete without altering their conventional properties. This partial replacement of crushed construction debris as both fine and coarse aggregate helps in solid waste management. Mentioning the replacement ratio up to which the values are within the permissible limits and not effect the requisites of the concrete.

III. EXPERIMENTAL PROGRAMS.

The construction and demolition waste is collected, crushed and segregated into fine and coarse recycled aggregated. Locally available sand, quarry is used as natural aggregates and ordinary Portland cement is used for making M20 grade concrete using both natural and recycled aggregates.

1. TESTS FOR AGGREGATES

a. SIEVING.

The crushed waste is sieved to collect fine and coarse aggregate separately.

Fine aggregate: Material passing 4.75mm.

Coarse aggregate: Maximum size 20mm and retained on 4.75mm size.

b. SPECIFIC GRAVITY.

Aggregate is washed thoroughly and immersed in distilled water. By lifting and dropping the entrapped air is removed and it is weighed (W1). After allowing it to drain, transferred to dry cloth and jolting for 25 times weight (W2) is noted. Aggregates are allowed to surface dry until no further moisture can be remove by cloth and weight (W3) is noted.

Specific gravity=(W3)/(W3-(W1-W2)).

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2. TESTS FOR CONCRETE

a. COMPRESSION TEST.

Compression test is conducted on 150*150*150 mm cubes in UTM. The specimen are casted and are tested on 28th day. The strength is computed using Fc =p/a where p-maximum load and A- cross sectional area.

b. FLEXURAL TEST.

Flexural test is conducted on 100*100*500 mm specimen cured for 28 days. The flexural strength is tested on 3 specimen determined by two point loading. Computed by expression Fb=PL/BD^2. where p-maximum load, l-length, B-width, D-depth

c. SPLIT TENSILE TEST.

Split tensile test is conducted on cylinder of 300mm length and 150mm diameter in universal testing machine. Tested after 28 days and computed by Fs=2p/3.14ld.

IV. EXPERIMENTAL OBSERVATIONS.

MATERIALS USED
i. AGGREGATES

As per IS 383-1970 requirement
Fine aggregates:
The material is sieved through 4.75mm sieve and fine aggregates are obtained.

Specific gravity
Natural fine aggregate (NFA)-2.64
Recycled fine aggregate (RFA)-2.41

Coarse aggregate:
The material passing 20mm sieve and retained on 4.75mm sieve is collected as coarse aggregate.

Specific gravity
Natural coarse aggregate (NCA) -2.82
Recycled coarse aggregate (RCA) –2.67

ii. Ordinary Portland cement (43 grade)

Requirement as per IS:8112-1989
Observed values
Fineness test - 90 µ sieve 1.04%
Initial setting time 30 min 97 min
Final setting time 600 min 398 min
28 d compressive strength 43 N/mm2 46.82N/mm^2
Soundness test Up to 10 mm 2.6 mm
• M20 grade (1:1.5:3) and w/c ratio 0.60 prepared

RECYCLED FINE AGGREGATE CONCRETE

	Cement	NFA	NCA	RFA	Water
Conventional concrete.	250	375	750	0	150
10% RFA concrete	250	337.5	750	37.5	150
20% RFA concrete	250	300	750	75	150
30% RFA concrete	250	262.5	750	112.5	150
40% RFA concrete	250	227	750	150	150
50% RFA concrete	250	187.5	750	187.5	150

Table - I

Compressive strength	28 days
Conventional concrete	27.9
10% RFA concrete	27.12
20% RFA concrete	26.74
30% RFA concrete	26.34
40% RFA concrete	25.86
50% RFA concrete	25.45

Table - II

Flexural strength	28 days
Conventional concrete	4.87
10% RFA concrete	4.72
20% RFA concrete	4.35
30% RFA concrete	3.89
40% RFA concrete	3.73
50% RFA concrete	3.44

Table - III

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Split tensile strength	28 days
Conventional concrete	3.36
10% RFA concrete	3.05
20% RFA concrete	2.78
30% RFA concrete	2.52
40% RFA concrete	2.38
50% RFA concrete	2.29

Table- IV

RECYCLED COARSE AGGREGATE CONCRETE.

	Cement	NFA	NCA	RCA	Water
Conventional concrete.	250	375	750	0	150
10% RCA concrete	250	375	675	75	150
20% RCA concrete	250	375	600	150	150
30% RCA concrete	250	375	525	225	150
40% RCA concrete	250	375	450	300	150
50% RCA concrete	250	375	375	375	150

Table - V

Compressive strength	28 days
Conventional concrete	27.9
10% RCA concrete	27.65
20% RCA concrete	27.38
30% RCA concrete	26.93
40% RCA concrete	26.45
50% RCA concrete	26.25

Table – VI

Flexural strength	28 days
Conventional concrete	4.87
10% RCA concrete	4.91
20% RCA concrete	4.77
30% RCA concrete	3.65
40% RCA concrete	3.02
50% RCA concrete	2.83

Table - VII

Split tensile strength	28 days
Conventional concrete	3.36
10% RCA concrete	3.18
20% RCA concrete	3.08
30% RCA concrete	2.96
40% RCA concrete	2.89
50% RCA concrete	2.78

Table – VIII

V. RESULTS AND DISCUSSIONS

The variation in the strength parameters can be observed for changing the replacement ratio of the natural aggregates with recycled aggregates.

The values in table 1 and 5 give use the proportions and quantity of material used to make conventional and recycled concrete.

The tables have been tabulated for the strength parameters of conventional concrete and the recycled concrete of replacement ratio 10%, 20%, 30%, 40% & 50%. Compressive strengths of recycled fine and coarse concrete are tabulated in tables 2 and 6.

Flexural strengths of recycled fine and coarse concrete are tabulated in tables 3 and 7.
Split tensile strengths of recycled fine and coarse concrete are tabulated in tables 4 and 8.

Compressive, Flexural and Split tensile strengths of concrete of the recycled fine and coarse is compared to conventional concrete. The reduction (in terms of percentage) are tabulated for 10% and 50% RFA/RCA concrete.

STRENGTH REDUCTION OF CONCRETE MADE WITH RFA.

RFA	Compressive	Flexural	Split tensile
10%	2.79%	3.08%	9.22%
50%	8.78%	29.36%	13.09%

STRENGTH REDUCTION OF CONCRETE MADE WITH RCA

RCA	Compressive	Flexural	Split tensile
10%	0.89%	-0.82%	5.35%
50%	5.91%	41.88%	17.26%

These values of the strength parameters show that the percentage increase in recycled aggregates reduces the strength but are within the permissible limits and the recycled concrete has attained its minimum required strength(20N/mm^2).

Use of recycled debris as coarse aggregate has less reduction of compressive strength when compare to fine with that of conventional concrete.

Use of RCA in concrete has increased the Flexural strength when replaced with 10% coarse

VI. CONCLUSION

Thus the use of construction and demolition debris as both coarse and fine aggregate in concrete by partial replacement without effecting much of the strength properties helps in solid waste management. Use of construction debris as fine aggregate acts as alternative source for sand and as coarse aggregate helps in reduction of rock blasting for quarry stones which are used exponentially.

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