

PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH DEMOLITION WASTE

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Abstract - A lot of concrete structures are destroyed in India and other countries. The quantity of demolition waste recycled is however low. This will lead to severe environmental destruction and the need to have a lot of space to dispose of wastes. Our concept therefore tries to recycle a concrete in demolished buildings. The demolition waste that we studied was obtained in the Shastri park, MCD Construction and Demolition Waste Recycling Process Plant of Indo Enviro Integrated Solution Limited. Any concrete construction should be constructed using a substantial amount of natural coarse aggregate. Thus, it can reduce the price of the purchase of natural coarse aggregate using the demolition material. In our research, the coarse aggregate will be substituted with demolition material in various mix proportion of 10 percent, 20 percent, 30 percent, 40 percent, 50 percent and 100 percent. The cubes and cylinder were cast under different proportions of various mixes and left to cure after 7 days and 28 days. Upon curing, Split tensile strength of the concrete cylinders and compressive strengths of concrete cubes were examined.

Key Words: Demolished material, Compressive strength, Split tensile strength, Natural coarse aggregate.

1. INTRODUCTION

In developing countries like India, where infrastructure development is rapidly increasing, there is a significant demand for construction materials. At the same time, these countries produce large quantities of construction and demolition waste. Proper disposal of this waste is essential due to environmental pollution and land requirements. Conservation of natural resources such as sand and aggregates is also necessary to maintain ecological balance. Several studies have reported that a large portion of demolition waste consists of concrete debris that can potentially be reused in construction [1]-[4]. After suitable processing and separation, these materials can replace natural aggregates in concrete or be used as base material in pavement structures [5].

Previous research has shown that recycled aggregates can successfully replace a portion of natural aggregates without significantly affecting concrete performance [6]. It has been reported that replacing up to 20% of natural aggregate results in only minor changes in mechanical properties [7].

Further studies indicate that the addition of recycled fine aggregate up to 20% or recycled coarse aggregate up to 30% does not significantly reduce the strength of concrete [8]. However, strength gradually decreases as the replacement level increases beyond these limits [9].

The quality of recycled aggregate significantly influences the mechanical properties of concrete, especially at lower water-cement ratios [10], [11]. Some researchers observed that higher water-cement ratios reduce the negative effects of recycled aggregates on compressive strength [12]- [14].

Khatib reported that concrete containing recycled aggregates may show faster strength development after 28 days due to the presence of old cement paste [15]. Similarly, Khalaf and De Venny demonstrated that recycled aggregate concrete can still be used in many structural applications despite having slightly lower strength than conventional concrete [16].

Recent studies also highlight those recycled aggregates derived from construction and demolition waste can improve sustainability in the construction industry while reducing environmental impacts [17]- [20]

2. Materials and Methods

2.1 Materials

1) Cement

The specimens for the cement materials test were cast using OPC cement of grade 43.

Table -1: Cement properties

Property	Value
Specific Gravity	3.15
Standard Consistency	34%
Final Setting Time	410 min
Initial Setting Time	130 min

2) Fine Aggregate

River sand that is readily available in the area is processed through a 4.7mm screen to produce fine aggregate.

Table -2: Aggregate Properties

Property	Value
Fineness Modulus	2.6
Moisture Content	0.5%
Water Absorption	1.90%
Specific Gravity	2.65

Table -4: Recycle Coarse Aggregate Properties

Property	Value
Specific Gravity	2.46
Impact Value	26%
Water Absorption	5.4%
Fineness Modulus	6.4
Moisture Content	0.98%

3) Coarse Aggregates

Natural Coarse Aggregate (NCA)

Table -3: Coarse Aggregate properties

Property	Value
Specific Gravity	2.74
Impact Value	18%
Water Absorption	1.2%
Fineness Modulus	5.8
Moisture Content	0.35%

Recycled Coarse Aggregate (RCA)

Aggregate waste is a product of the dismantling of concrete structures. The recycled aggregate used in this research is obtained in one of the plants of Indo Enviro Integrated Solution Limited in Shastri Park, which is known as the MCD Construction and Demolition Waste Recycling Process Plant. After strictly passing through 20mm and keeping 10mm IS sieve, this material is used.

2.2 Mix Proportion

Concrete of grade M25 was prepared with RCA replacing NCA at: 0%, 10%, 20%, 30%, 40%, 50%, and 100%.

2.3 Specimen Preparation

Concrete specimens were prepared for both compressive and tensile strength evaluation. Cubes of dimensions 150 mm x 150 mm x 150 mm were cast for compressive strength testing, while cylindrical specimens of 150 mm diameter and 300 mm height were prepared for split tensile strength testing. After casting, all specimens were demolded and cured in potable water for durations of 7 and 28 days. The curing temperature was maintained between 27° C and 30° C to ensure uniform hydration and proper strength development.

3.0 Results and Discussion

The results of numerous tests performed on concrete specimens, including tensile strength tests, and compressive strength, are presented.



3.1 Slump test

The results of measuring the slump of the concrete with recycled coarse materials are shown below

Table -4: Workability Comparison between Different Percentage replacement of RCA

S.No	Type of Concrete	% Replacement of RCA	Slump Value (mm)
1	Normal Concrete	0%	100
2	RCA Concrete	10%	95
3	RCA Concrete	20%	93
4	RCA Concrete	30%	88
5	RCA Concrete	40%	85
6	RCA Concrete	50%	80
7	RCA Concrete	100%	70

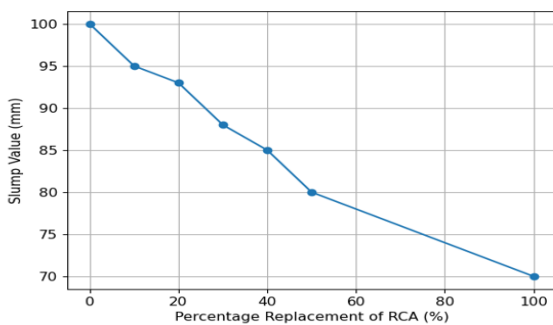


Fig -1: Workability of different % replacement of RCA

The slump value is decrease as the percentage of replacement of RCA increase.

3.2 COMPRESSIVE STRENGTH TEST

Cube compression tests were conducted to find out the influence of the substitute of coarse aggregate with demolition waste. Replacement ratios were considered as 0%, 10, 20, 30, 40, 50 and 100. The examinations were done on both the 7 and the 28 days.



Fig -2: Different Types of Rupture

S.NO	TYPES OF CONCRETE	%REPLACEMENT OF RCA	7 DAYS STRENGTH (MPa)	28 DAYS STRENGTH (MPa)
1	NORMAL CONCRETE	0	22.62	34.36
2	RCA CONCRETE	10	24.63	34.52
3	RCA CONCRETE	20	24.65	34.74
4	RCA CONCRETE	30	24.18	34.41
5	RCA CONCRETE	40	21.03	27.36
6	RCA CONCRETE	50	20.84	27.04
7	RCA CONCRETE	100	11.19	24.43

Table -5: Compressive Strength Value of Cube

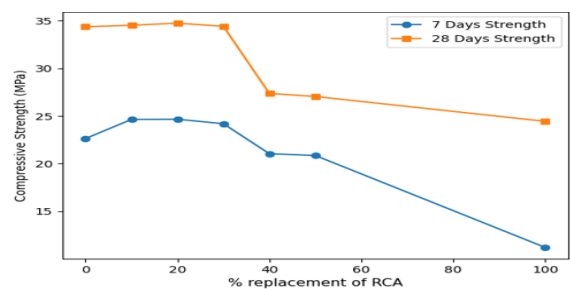


Fig -3: Strength Variation for Various % Replacement of RCA in Cube

3.3 SPLIT TENSILE STRENGTH TEST

On cylinders, the split tensile strength was assessed by partially replacing coarse aggregate with demolition waste at different ratios: 0%, 10%, 20%, 30%, 40%, 50%, and 100% on the 7th and 28th days.



Fig -4 Formation of Various Crack on the Cylinder

Table -6: Split Tensile Strength Value of Cylinder

S.no	Types of Concrete	% Replacem ent of RCA	7 days strength (MPa)	28 days strength (MPa)
1	Normal concrete	0	1.97	2.72
2	RCA Concrete	10	2.14	3.18
3	RCA Concrete	20	2.10	2.96
4	RCA Concrete	30	2.02	2.87
5	RCA Concrete	40	1.87	2.70
6	RCA Concrete	50	1.78	2.58
7	RCA Concrete	100	1.51	1.91



Fig -6: Rebound hammer

Table -7: Rebound Hammer Strength result

S.no	Types of Concrete	% Replacement of RCA	7 days strength (MPa)	28 days strength (MPa)
1	Normal Concrete	0	23.20	34.50
2	RCA Concrete	10	24.60	34.70
3	RCA Concrete	20	23.10	34.20
4	RCA Concrete	30	22.16	33.50
5	RCA Concrete	40	21.83	30.20
6	RCA Concrete	50	17.33	29.30
7	RCA Concrete	100	16.22	20.80

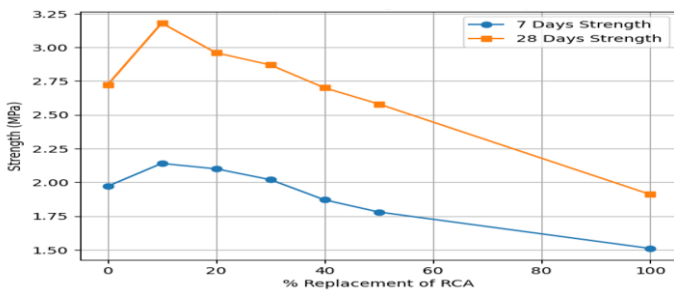


Fig -5: Strength variation for various replacement of RCA in split tensile test

3.4 REBOUND HAMMER TEST

When conducting the rebound hammer test, the instrument is positioned perpendicular to the surface of the material under examination. The plunger is then applied to the surface with a predetermined force, often achieved by fully compressing the spring-loaded mechanism. It is important to note that the plunger should be pressed at five different locations, and the average of these five readings should be taken into account for accurate results. This approach helps ensure a comprehensive assessment of the material's compressive strength.

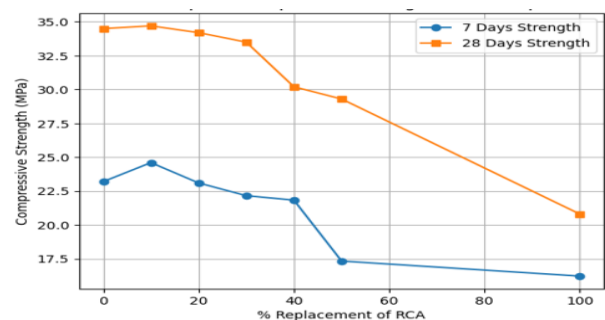


Fig -7: Strength variation for various replacement of RCA in rebound hammer test.

4.0 Conclusion

By using concrete crushed to partially substitute coarse aggregates, we have another way to recycle material and create something useful.

Because the density of the demolished concrete has a lower density than that of normal concrete, it is less expensive and more readily available.

Demolition waste aggregate exhibits substantially greater water absorption, moisture content, impact criteria, fineness modulus and lower unit weight, specific gravity as compare to natural aggregate.

The minimum value of compressive strength of 7 days strength after replacing 100% normal aggregate with demolition waste is 11.19.

The maximum value of compressive strength of 28 days strength after replacement of 20 % natural aggregate with demolition waste is 34.74.

The ideal replacement rate for natural aggregate with demolition debris is 30%.

Split tensile strength and compressive strength of concrete are sufficient up to 30% replacement, however after that point demolition aggregate reduces the strength's value.

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