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ESTABLISHMENT OF FRAME OF REFERENCE FOR MANAGEMENT AND REUSE OF DEMOLITION CONCRETE WASTE

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Abstract - *Demolition of old structures to make way for new and modern ones is common features in metropolitan areas due to rapid urbanization. The strict environmental laws and lack of dumping sites in urban areas are making the disposal of demolition waste problematic. To overcome this problem, the demolition concrete waste can be recycled and reused. The project presents a frame of reference for the management and reuse of demolition concrete waste. For this an experimental study is conducted to find out the properties of concrete with demolished concrete waste as coarse aggregate replacement. In these studies different percentage is used to replace natural coarse aggregate and the strength is evaluated. The results compared with the natural coarse aggregate concrete. And to obtain a workable ratio of recycled coarse aggregate in concrete. This study will help in identify the usage of demolished concrete waste in construction and helps to save the environment by effective waste management.*

Key Words: **Concrete waste, RAC,**

1 INTRODUCTION

1.1 General

Concrete is the world's second most consumed material after water, and its widespread use is the basis for urban development. It is estimated that 25 billion tonnes of concrete are manufactured each year in our country. Many countries have recycling schemes for C&DW to avoid dumping to landfill, as suitable landfill sites are becoming scarce particularly in heavily populated countries. Charges on landfill dumping often make recycling concrete aggregate a preferred option. Aggregate typically processed from demolition waste concrete is termed as Recycled Coarse Aggregate (RCA).. It can be crushed and reused as a partial replacement for natural aggregate in new concrete construction.

1.2 Need For The Reuse Of Demolished Concrete Waste

Recycling or recovering concrete materials has two main advantages. It conserves the use of natural aggregate and the associated environmental costs of exploitation and transportation, and it preserves the use of landfill for materials which cannot be recycled.

Regardless of the replacement ratio, recycled aggregate concrete (RAC) had a satisfactory performance, which did not differ significantly from the performance of control concrete in this experimental research.The production technics of recycled aggregate, the mixture proportion, the physical property, the durability, the basic mechanical behavior and the structural performance of recycled aggregate concrete are mainly investigated. The results indicate that it is feasible to reuse waste concrete and the recycled aggregate concrete which can be adopted in both self-bearing members and load-bearing members in civil engineering.

1.3 Scope

The scope of the study is a comparative analysis of the experimental results of the properties of fresh & hardened concrete with different replacement ratios of natural with recycled coarse aggregate. Recycled aggregate was made by crushing the waste concrete of laboratory test cubes & precast concrete columns.

1.4 Objectives of the Study

The management of demolished concrete through partial replacement of coarse aggregate with demolished concrete achieve waste management in construction sector by eliminating demolished concrete landfills

1. To find out the % use feasible for construction.
2. To reduce the impact of waste materials on environment.
3. To carry out different tests on partial recycled aggregates concrete & natural aggregates concrete.
4. Compare their results

2 METHODOLOGY

2.1 General

In this the composite material comprises of recycled concrete aggregate. The coarse aggregate used for the concrete works are partially replaced by the composite material comprising of recycled concrete aggregate. The concrete specimens are casted, cured and tested as per IS codes and standards for various strength aspects of cement concrete.

Phase-I: Preparation of RCA.

Phase-II: Determination of properties of NCA and RCA.

Phase-III: Partial replacement of NCA by RCA.

Phase–IV: Establishing the mix proportion of concrete

Phase V: Determination of properties of concrete

In this, the physical properties of cement, fine aggregate, NCA, RCA is carried out are specific gravity, water absorption, abrasion value and impact value. The properties of concrete such as slump test, compressive strength, the Split tensile test and the flexural strength is evaluated.

Primary coarse aggregates are replaced partial by recycled concrete aggregates in different percentage so as to make the concrete. The different mixes are then compared with referral mix and an optimum percentage of recycled concrete aggregate is determined on the basis of test results.

As per IS: 516-1959 and IS: 5816- 1999, the following harden concrete tests is evaluated.

1. Slump test

2. Compressive strength test

3. Split tensile test

4. Flexural strength test

The proposed compositions for testing are as follows

- Conventional concrete with RCA 0%
- Sample-1 – with RCA -25%
- Sample-2 – with RCA - 30%
- Sample-3 – with RCA - 40%

2.2 MATERIAL TESTING AND PROPERTIES

2.2.1 Cement

Cement is a binder, a substance that sets and hardens and can bind other materials together. It is usually fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. The cement and water form a paste that binds the other materials together as the concrete hardens. In the present work 53 grade Dalmia cement is used for casting cubes and cylinder for concrete mixes and the following tests were carried out on cement

PROPERTIES OF CEMENT	VALUES
Specific Gravity	3.15
Normal StandardConsistency	28.5%
Initial SettingTime	175 mins
Final SettingTime	310 mins
Fineness of Cement	3.07%

2.2.2. FINE AGGREGATE

Fine aggregate or sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of grain or particle, but is distinct from clays which contain organic minerals. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains.

Fine aggregate are material passing through an IS sieve that is less than 4.75 mm. Usually natural sand is used as a fine aggregate. At places where natural sand is not available crushed stone is used as a fine aggregate. The sand used for the experimental work was locally procured and conformed to grading zone II. The sand was first sieved through 4.75 mm sieve to remove any particle greater than 4.75 mm sieve and then washed to remove dust.

PROPERTIES OF FINE AGGREGATE	VALUES
Specific Gravity	2.655
Fineness Modulus	2.7
Bulk Density	1.78
Water Absorption	0.54%

2.2.3 COARSE AGGREGATE

Those particles that are predominantly retained on the 4.75mm sieve are called coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in the present work. According to IS 383:1970 coarse aggregate maximum 20mm coarse aggregate is suitable for concrete work. But where there is no restriction 40mm or large size may be permitted. In case of close reinforcement, 10mm size can also be used. In the present investigation, the following tests were carried out: The results of the tests on Coarse aggregate are given in the Table 2.2.3

PROPERTIES OF COARSE AGGREGATE	VALUES
Specific Gravity	2.78
Water Absorption	0.44%
Fineness Modulus	5.28
Crushing value	24.52

2.2.4 RECYCLED CONCRETE AGGREGATE (RCA)

The hardened concrete returned to concrete plant can be crushed and reused as a partial replacement for natural aggregate in new concrete construction. The hardened concrete can be sourced either from the demolition of concrete structures at the end of their life. It is termed as Recycled Coarse Aggregate (RCA).The aggregates were properly graded and then mixed with the respective natural aggregate in appropriate percentages. The use of recycled materials has become accepted throughout the ready mixed concrete industry in response to increasing environmental focus and the increasing cost of disposing of waste material. The results of the tests on recycled Coarse aggregate are given in the Table 2.2.4

Fig No 2.2.3 Recycled Coarse Aggregate

PROPERTIES OF RECYCLED COARSE AGGREGATE	VALUES
Specific Gravity	2.7
Water Absorption	1.95%
Fineness Modulus	3.55
Crushing value	23.90%
Impact Value	16.51%

2.2.5 WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked in to very carefully.

2.3 CONCRETE MIX DESIGN M -20 GRADE PCC

As per IS: 10262 (Appendix C)

The actual quantity of ingredients per m3 of Concrete

Cement	=	300.00	Kgs / m3
20 mm	=	805	Kgs / m3
10 mm	=	534	Kgs / m3
Natural Sand	=	687	Kgs /m3
Water	=	148	Kgs / m3

2.4 TESTING

2.4.1 CASTING & CURING

The mixing duration was 2-5 minutes and then the water was added as per the mix proportion. The mixing was carried out for 3-5 minutes duration. Then the mix poured in to the cube moulds of size 150 x 150x 150 mm and then compacted manually using tamping rods as in fig -1. The cubes are demoulded after 1 day of casting and then kept in respective water for curing at room temperature with a relative humidity of 85% the cubes are taken out from curing after 3,7 & 28 days for testing.

The demolished concrete has been collected from the ongoing demolishing activities The coarse aggregate used for the concrete works are partially replaced by the composite material comprising of recycled concrete aggregate. The concrete specimens are casted, cured and tested as per IS codes and standards for various strength aspects of cement concrete.

2.4.2 SLUMP CONE TEST

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site work. For the present work, slump tests will be conducted

Sl.No.	SAMPLES	Slump(mm)
1	CONVENTIONAL CONCRETE(RCA0%)	80
2	SAMPLE 1 (RCA 25%)	80
3	SAMPLE 2 (RCA 30%)	75
4	SAMPLE 3 (RCA 40%	75

2.4.3COMPRESSIVE STRENGTH TEST

The compressive strength of concrete is determined at the age of 7 days and 28 days using cubes. The test was carried out on 150mm x 150mm x 150mm size cube as per IS: 516-1959. A 3000kN capacity standard compression testing machine was used to conduct the test. For the studies on compressive strength, cubes are tested with a replacement of coarse aggregate by RCA in various proportions as 3 samples.

Compressive strength =Crushing load/ Area of cross section

=W/A (N/mm2)

Size Of mould =150mmx150mmx150mm

Area of cube =150mmx150mm

= 22500mm2

Compressive Strength Results

SL.No	SAMPLES	COMPRESSIVE STRENGTH N/mm2			
		7 days		28 days	
1.	CONVENTIONAL CONCRETE (RCA 0%)	23.56	23.34 (Avg.)	33.36	33.72 (Avg.)
		23.00		34.47	
		23.46		33.32	
2.	SAMPLE 1 RCA 25%)	24.89	24.77 (Avg.)	36.67	35.84 (Avg.)
		25.96		33.78	
		23.47		37.07	
3.	SAMPLE 2 (RCA 30%)	23.11	23.88 (Avg.)	32.44	32.06 (Avg.)
		24.89		30.62	
		23.64		33.11	
4.	SAMPLE 3 (RCA 40%)	20.40	22.44 (Avg.)	28.98	29.54 (Avg.)
		23.64		29.51	
		23.29		30.13	

2.4.4 SPLIT TENSILE STRENGTH TEST

The splitting tests are well known indirect tests used for determining the tensile strength of concrete cylinders also referred as split tensile strength of concrete. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontally.. The magnitude of this tensile stress fsp is given by the formula (IS: 5816-1999

Fsp = 2P/πdl N/mm2 where,

Fsp =Split tensile strength (N/mm2)

P =Load at Failure (N)

d =Diameter of the specimen (mm)

l =Length of the specimen (mm)

SL.No	SAMPLES	SPLIT TENSILE STRENGTH N/mm2			
		7 days		28 days	
1.	CONVENTIONAL CONCRETE (RCA 0%)	2.26	2.25 (Avg.)	3.02	3.13 (Avg.)
		2.24		3.14	
		2.27		3.22	
2.	SAMPLE 1 RCA 25%)	2.46	2.39 (Avg.)	3.53	3.45 (Avg.)
		2.43		3.41	
		2.48		3.42	
3.	SAMPLE 2 (RCA 30%)	2.27	2.25 (Avg.)	3.12	3.10 (Avg.)
		2.23		3.03	
		2.25		3.14	
4.	SAMPLE 3 (RCA 40%)	2.56	2.53 (Avg.)	3.03	3.07 (Avg.)
		2.51		3.17	
		2.53		3.00	

2.4.5 FLEXURAL STRENGTH TEST

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have been designed which assure uniform distribution of pull applied to the concrete.. The value of the modulus of rupture (extreme fiber stress in bending) depends on the dimension of the beam and manner of loading.

Flexural strength,

F = Pl/bd2 where,

P = maximum load in Newton

L = length of the specimen

B = width of the specimen

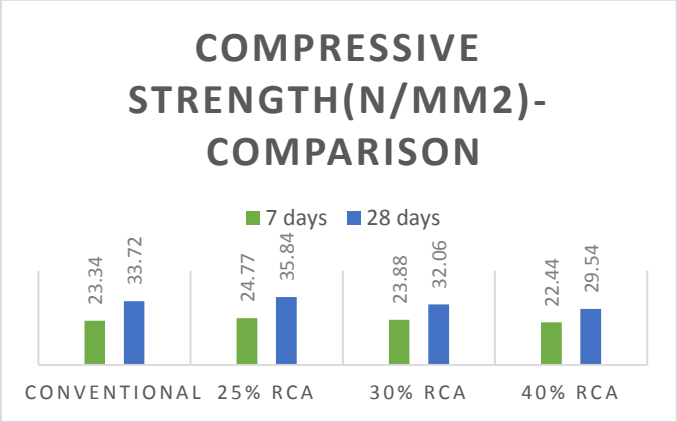
d = depth of the specimen.

SL.No	SAMPLES	FLEXURAL STRENGTH N/mm2			
		7 days		28 days	
1.	CONVENTIONAL CONCRETE (RCA 0%)	3.89 3.34 3.42	3.55 (Avg.)	4.84 4.79 4.73	4.78 (Avg)
2.	SAMPLE 1 RCA 25%)	3.91 4.62 4.27	4.27 (Avg.)	4.98 5.16 4.62	4.92 (Avg)
3.	SAMPLE 2 (RCA 30%)	3.91 4.09 3.73	3.91 (Avg.)	4.62 4.80 4.62	4.68 (Avg)
4.	SAMPLE 3 (RCA 40%)	3.56 3.73 4.27	3.85 (Avg.)	4.27 4.27 4.62	4.39 (Avg)

PROPERTIES OF COARSE AGGREGATE	VALUES
Specific Gravity	2.78
Water Absorption	0.44%
Fineness Modulus	5.28
Crushing value	24.52

2.5 RESULTS AND DISCUSSIONS

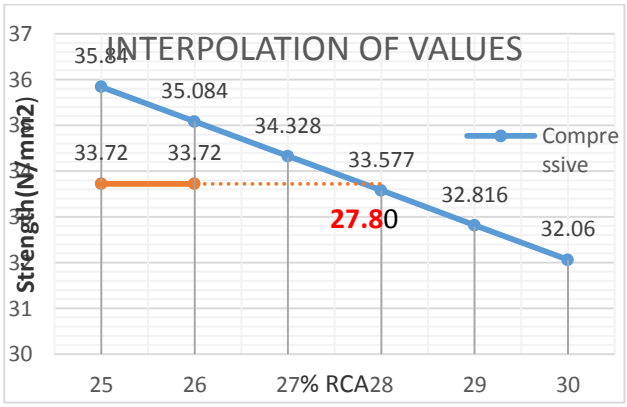
The various results obtained from the slump test, compressive strength tests, tensile strength tests and flexural strength tests were discussed and tabulated. The barcharts representing the test results were also provided.



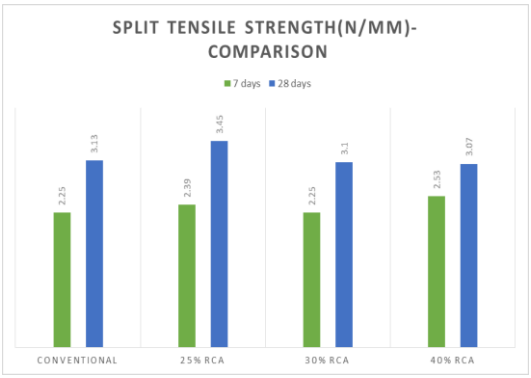
Comparison of Compression Strength Test Results

From the result it is seen that compressive strength of conventional concrete after 28 days is 33.72 N/mm2. By interpolating the test results of concrete using RCA, the 28 days strength of conventional concrete can be obtained by replacement of 27.8% of coarse aggregate with RCA

Interpolated Values of Compression Strength



Interpolated Values of Compression Strength



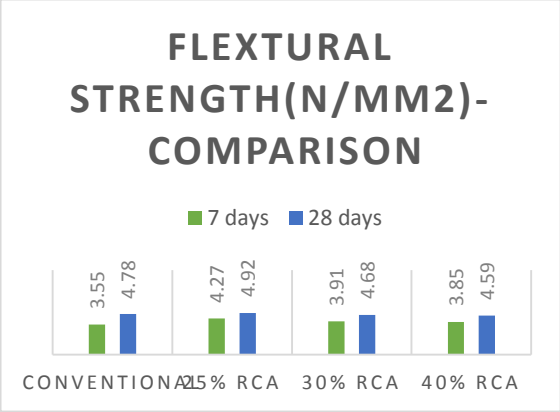
Comparison of Split Tensile Strength Test Result

From the result it is seen that split tensile strength of conventional concrete after 28days is 3.13N/mm2. By interpolating the test results of concrete using RCA, the 28

days strength of conventional concrete can be obtained by replacement of 29.5% of coarse aggregate with RCA.

Interpolated Values of Split Tensile Strength

% of RCA	INTERPOLATED VALUES
25	3.45
26	3.38
27	3.31
28	3.24
29	3.17
30	3.10

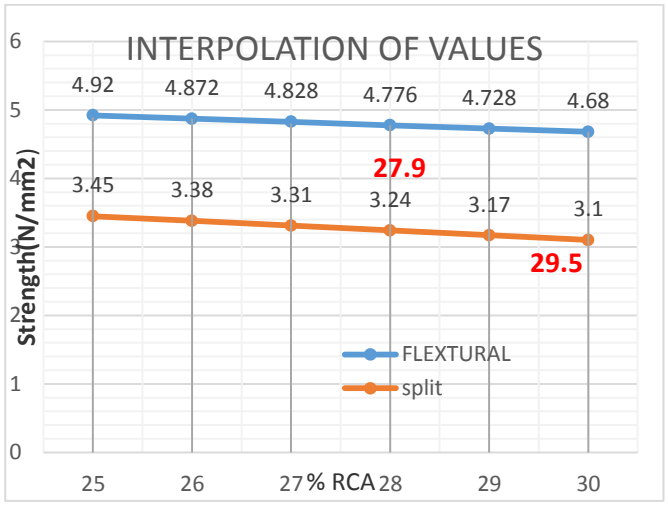


Comparison of Flexural Strength Test Results

From the result it is seen that Flexural Strength of conventional concrete after 28 days is 4.78N/mm2. By interpolating the test results of concrete using RCA, the 28 days strength of conventional concrete can be obtained by replacement of 27.9% of coarse aggregate with RCA.

Interpolated Values of Flexural Strength

% OF RCA	INTERPOLATED VALUES
25	4.92
26	4.872
27	4.828
28	4.776
29	4.728
30	4.68



Interpolated Values of flexural strength and split tensile strength

Based on the results obtained, it is found that

 The workability was found to be maximum for RCA concrete with 25% replacement and it is in a decreasing order when the percentage replacement increases. It may be due to the increased absorption of water by the recycled aggregate.

 The compressive strength of concrete was maximum when the coarse aggregate was replaced with 25% RCA. It is seen that compressive strength decreases when the percentage of RCA increases. Anyhow when considering the interpolated values of percentage RCA the compressive strength of conventional concrete can be attained when percentage of RCA is 27.8

 The split tensile strength of concrete was maximum when the coarse aggregate was replaced with 25% RCA and it decreases when the percentage of RCA increases.From the interpolated values of percentage RCA it can be seen that split tensile strength of conventional concrete can be attained when the percentage RCA is 29.5.

 The flexural strength of concrete was maximum when the coarse aggregate was replaced with 25% RCA and flexural strength decreases when the percentage of RCA increases. From the interpolated values of percentage RCA it can be seen that flexural strength of conventional concrete can be attained when the percentage RCA is 27.9.

CONCLUSIONS

Due to the critical shortage of natural aggregate, the usage of demolished concrete as recycled coarse aggregate (RCA) is increasing. Using the recycled coarse aggregate, conserves natural aggregate, reduces the impact on landfills, decreases energy consumption and can provide

cost savings. The application of recycled aggregate has been started in many countries for construction projects.

In this project, the basic properties of recycled coarse aggregate concrete is evaluated and compared these properties with natural aggregates concrete. It is revealed from this study that compressive strength ,split tensile strength and flexural strength of conventional cement concrete can be attained by cement concrete using recycled coarse aggregate, when the percentage replacement of RCA is 27.8,29.5and 27.9 respectively.

Hence it is concluded that cement concrete using recycled coarse aggregate with a percentage replacement of 27% (twenty seven percentage) can be safely and effectively used for construction purposes.

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