

Experimental Study Of Concrete By Partial Replacement Of Coarse And Fine Aggregate By Demolished Concrete Waste

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ABSTRACT: The cost of construction materials are increasing to high rates for a conventional building is a major factor that affects the housing delivery worldwide. This has necessitated research for alternative cost effective materials in construction. Therefore properties of concrete with **Demolished concrete (D&C) waste** as aggregate replacement is studied in the project using **M25 Grade Concrete**. In these studies 3 different combinations of natural material D&C Waste content in the proportion 50% Recycled Coarse Aggregate(RCA), 50% RCA & 10% Recycled Fine Aggregate(RFA), 50% RCA & 20% RFA had replaced. The cube, beam and cylinder are casted as samples and tested then physical and mechanical properties are determined. The samples are tested for density, compressive strength, flexural strength & splitting tensile for 7 & 28 days and compared with conventional concrete.

KEYWORDS: Demolished concrete waste aggregate, Compressive strength, split tensile strength, flexural strength

I.INTRODUCTION

Concrete is the premier civil engineering construction material. Concrete is considered as brittle material, primarily because of its low tensile capacity and poor fracture toughness. Concrete manufacturing involve consumption of ingredients like cement, aggregates, water and admixtures(s). Among all the ingredients, aggregates form the major part. Inert granular materials such as sand, crushed stone or gravel form the major part of the aggregates. Traditionally aggregates have been readily available at economic prices and of qualities to suit all purposes. But, the continued extraction of aggregates from nature has caused its depletion at an alarming rate. Many of the non-decaying waste materials will remaining the environment for hundreds, perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. Use of this materials in such a rate leads to preservation of natural aggregates sources. In light of this in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete a sustainable and environmentally friendly construction material. Different alternative waste material and industrial by-products such as fly-ash, bottom-ash, recycled aggregates, foundry sand, china clay sand, crumb rubber, glass were replaced with natural aggregate and investigated properties of the concretes. Apart from above mentioned waste materials and industrial by-products, few studies identified that **C&D Waste**, the recycled by product, can also be used as aggregate in concrete. India produces about 20% of the C&D Waste produced in the world. Within India, Kerala produces 45% of it. Disposal of Demolished waste poses environmental issues as it is not easily degradable. Aggregate made by crushing demolished waste and acquiring the coarse aggregate from it for replacing the new set of new bought aggregate i.e, cost efficient. Disposal of C&D waste poses environmental issues as all of it won't stand as replacing for all circumstances since it is already been used.

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II.MATERIAL PROPERTIES

2.1 Materials

In the design of conventional concrete the selection of proper ingredients evaluating their properties and understanding the interaction between different materials plays a major role in performance of the concrete. The ingredients used are cement, natural sand, coarse aggregate, super plasticizer demolished concrete waste in the form of fine aggregate and coarse aggregate.

2.2 Demolished concrete waste

The concrete obtained using Demolished waste aggregate satisfies the minimum requirements of New bought aggregates. Concrete using demolished waste aggregates resulted in acceptable strength required for structural concrete. Demolished waste may offer itself as a coarse aggregate as well as potential construction material in the field of construction industries and this would solve the environmental problem of reducing the generation of solid waste simultaneously. The Demolished waste-cement composite is compatible and no pre-treatment is required. Demolished waste concrete has better workability because of the smooth surface on the coarse aggregates. The impact resistance of C&D waste concrete is high when compared with conventional concrete. Moisture retaining and water absorbing capacity of C&D waste are more compared to conventional concrete. The demolished waste are obtained from a construction site. They are dried for few days before being crushed manually. The crushed materials are later transported to the laboratory where they were washed and allowed to dry under ambient temperature for several hours. Coarse aggregate show a wide diversity in size, weight, shape, and colour, depending on the crushing.

2.2.1 Recycled coarse aggregate

Table 2.1: Properties of recycled coarse aggregate

S.No	Physical properties	Result
1.	Specific gravity	2.4
2.	Physical form	coarse
3.	Size	20mm



Figure 2.1 Demolished concrete (RCA)

2.2.2 Recycled Fine Aggregate

Table 2.2: Properties of fly ash

S.No	Physical properties	Result
1.	Specific gravity	2.7
2.	Physical form	Gravel
3.	Size	0.75mic-4.75mm

2.4 Super plasticizers

Super plasticizer named Conplast SP430 is used. They can reduce mixing water requirements by up to 30%, thereby increasing the concrete compressive strength. The Sulphonated Naphthalene Formaldehyde based super plasticizer (Conplast Super Plasticizer – SP 430) u. The properties super plasticizer are shown The in Table 2.3.

Table 2.3 Properties of super plasticizer

S.NO	Physical Property	Value
I.	Solid content	42%
II.	Specific gravity	1.22

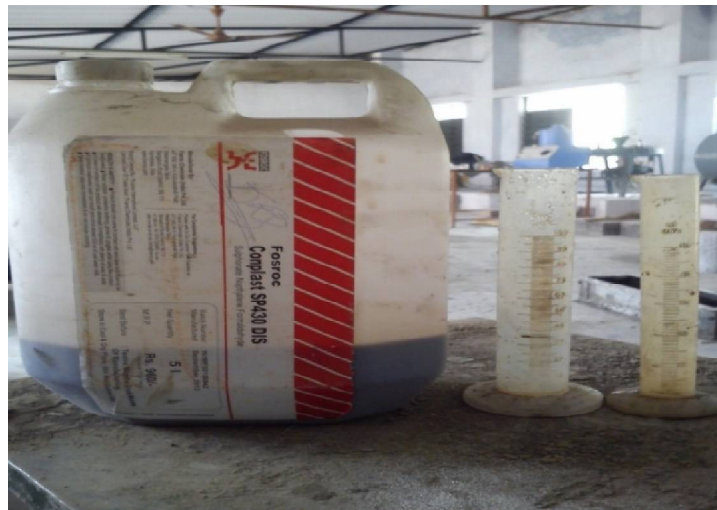


Fig. 2.2 Super plasticizer

III. MIX DESIGN

3.1 GENERAL

The process of selection suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability therefore becomes of vital importance.

3.2 MIX PROPORTIONS

Cement	= 383.2 kg/m ³
Water	= 191.6 kg/m ³
Fine aggregate	= 700 kg/m ³
Coarse aggregate	= 1130.04 kg/m ³

The table 3.1 shows the mix proportion of concrete.

Mix proportions	Cement kg/m ³	Fine Aggregate kg/m ³	Coarse Aggregate kg/m ³	Water kg/m ³	Chemical Admixture kg/m ³	RFA kg/m ³	RCA kg/m ³
Mix 1	383.2	700	1130.04	191.6	-	-	-
Mix 2(50% RCA)	383.2	700	565.02	191.6	-	-	513.66
Mix 3(10% RFA % 50% RFA)	383.2	630 .36	565.02	191.6	-	69.2	513.66
Mix 4(20% RFA & 50% RCA)	383.2	560	565 .02	191.6	-	138.52	513.66
Mix 5(20% RFA & 50% RCA)	307	602.56	614.5	153.2	6.14	152.366	558.64

Table 3.1 Mix proportion.

IV. EXPERIMENTAL PROGRAM

4.1 MECHANICAL PROPERTIES

4.1.1 Compression Test (Ref: IS: 516-1959)

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength. Compressive strengths were attained as a result of the compressive tests conducted on the cube specimens of size 150mm x 150mm x 150mm . Cube was placed on the platform of the compression testing machine. The load was applied gradually till the concrete cubes get failed. The specimens are subjected to compressive loads in compression testing machine as per IS: 516-1969 and the crushing load is noted which gives the compressive strength of that cube. The compressive strength is the ratio of crushing load to the surface area of the specimens expressed in N/mm². Similarly the compression strength values of all the cubes are found.



Fig 4.1 Test Set up for Compressive Strength Test

4.1.2 Flexure Test (Ref: IS: 516-1959)

The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol f_{cr} . The flexural strengths of the respective specimens have been obtained from the flexural tests performed on the prism specimens of size 100mm x 100mm x 500mm. The flexural strength are tested using a two point loading frame machine as per standard as shown in figure 5.2.



Fig 4.2 Test Set Up for Flexural Strength

The modulus of rupture can be determined by using the formula given below

$$f_{cr} = (P_{max} \times l) / bh^2$$

where,

- f_{cr} = Flexural strength
- P_{max} = maximum load in (N) kg.
- b = width of the prism in mm
- h = depth of the prism in mm
- l = span of the prism in mm

The loading must be applied centrally and without subjecting the specimen to any tensional stresses and restraints. The axis of the specimen shall be carefully aligned with the axis of the loading device. The load shall be applied without any shock and increasing continuously at specified rate.

4.1.3 Split tensile strength Test (Ref: IS: 5816-1999)

Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 150mm x 300 mm were casting using M₂₅ grade concrete. Specimens with Conventional Concrete and SCC of two different percentages were casted. During casting the conventional concrete cubes were manually compacted using tamping rods. After 24hours, the specimens were removed from the mould and subjected to water curing for 7, 14, 28 days. After curing, the specimens were tested for compressive strength as per IS: 5816-1999 using a calibrated compression testing machine of 2000KN capacity.

Two packing strips of plywood 3mm thick were provided between the specimen one at top and another at bottom. The specimen was placed on the plywood strip and aligned so that, the central horizontal axis of the specimen is exactly perpendicular to the load applying axis. The second plywood strip was placed length wise on the cylinder and the top platen was brought down till it touched the plywood. The load was applied without shock and increased continuously until the resistances of the specimen to the increasing load broke down and no greater load can be sustained.

$$\text{Tensile strength of concrete } f_t = \frac{2p}{\pi dl}$$

Where ,

P = Maximum load in N applied to the specimen

L = Measured length in cm of the specimen

D = Measured diameter in cm of the specimen

V.RESULTS AND DISCUSSION

5.1 GENERAL

This chapter deals with the results obtained from the various experiments conducted to access mechanical properties. The aim of the study is to determine the compressive strength, flexural strength and split tensile strength. so the results of test specimens are presented. The discussion on the results also presented in this chapter.

5.2 MECHANICAL PROPERTIES

The mechanical properties of concrete such as compressive strength, flexural strength and split tensile strength are determined from the standard experiments. They are as follows.

5.2.1 Compressive Strength

The compressive strength of replacement of demolished concrete waste aggregate is arrived. The compressive strength value for replacement of demolished concrete waste Table 5.1 Shows compression test results.

Table 5.1: Compressive Strength of Cubes with Partial Replacement of demolished concrete

Curing days	COMPRESSIVE STRENGTH N/mm ²				
	Mix 1(0%)	Mix 2(50% RCA)	Mix 3(10% RFA & 50% RCA)	Mix 4(20%RFA & 50% RCA)	Mix 5(20%RFA& 50%RCA admixture)
7 days	21.3	21.6	16.8	15.3	21.5
28 days	29.5	27.3	25.7	24.5	27.9

5.2.2 FLEXURAL STRENGTH

The flexural strength of replacement of demolished concrete waste aggregate is arrived.. Table 5.2 shows flexural strength test results

Table 5.2: Flexural Strength of beams with Partial Replacement of demolished concrete waste aggregate

Curing days	FLEXURAL STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(50%)	Mix 3(10%RFA & 50%RCA)	Mix 4(20%RFA & 50%RCA)
28 days	4.9	4.6	4.3	4.2

5.2.3 SPLIT TENSILE STRENGTH

The variation of split tensile strength at the age of 28 days with different percentage of demolished concrete waste as a coarse and fine aggregate, from the test results, it was observed that the maximum split tensile strength was obtained for mix of 50% replacement of coarse aggregate by RCA. Table 5.3 flexural strength test results

Table 5.3: split tensile strength of Cylinder with Partial Replacement of demolished concrete waste aggregate

Curing days	SPLIT TENSILE STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(50%)	Mix 3(10%RFA & 50% RCA)	Mix 4(20%RFA & 50% RCA)
28 days	3.2	3.3	2.4	2.1

aggregate

VI. CONCLUSION

M25 grade of concrete is used in study and the tests are conducted for various properties of demolished concrete waste can be replaced with 50% RCA, 50% RCA & 10% RFA and 50% RCA & 20% RFA in concrete. Based on the experimental investigation following conclusions are drawn.

1. Optimum level of replacement of demolished concrete waste of RCA found to be 50% and the results are nearer to the conventional concrete.
2. Also replacement of fine aggregate by RCA 10% is additional to 50% RCA results are nearer to the conventional concrete.
3. But in additional of replacement of 20% RFA the compressive strength is gradually decreased. This problem can be overcome by adding mineral admixtures.
4. The Flexural strength of all three sets of replaced concrete is also nearer to the value of Flexural strength of Conventional concrete
5. The splitting tensile test value of 50% RCA replaced concrete is nearer to the value of Conventional concrete

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6. But the another two sets of 50% RCA & 10% RFA and 50% RCA & 20% RFA splitting tensile test values are decreased gradually.
7. Replacement of demolished concrete waste in new concrete it will decrease the coast of making concrete and reduce the waste generated from the old demolished concrete.

REFERENCES

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3. **N.SIVAKUMAR (2010)** Studied the percentage of RCA replacement and found that when RCA replacement increases, its compressive strength gets reduced. However when water/cement ratio mix was decreased, the compressive strength increases.
4. **Prof. DHARMESH K.BHAGAT (2013)** from his study this can be concluded that, RCA exhibits comparatively less specific gravity than NA. As the water absorption of RCA was found to be greater than NA, because of adhering mortar and cement paste
5. **VAISHALI.G.HORPADE (2014)** Found that consideration of both shear strength and workability, its recommended to limit the replacement of natural coarse aggregate with recycled coarse aggregate up to 20% limit .