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# Comparison of Compressive Strength of concrete by Partial replacement of Recycled Coarse Aggregates

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**ABSTRACT:** The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often; concrete is being the most important and widely used material. Concrete has contributed to the advancement of civilizations throughout history. The main constituent of the concrete is cement, sand, coarse aggregate and water, replacing some of these materials makes significant changes in cost as well as performance. The amount of construction waste has been dramatically increased in the last decade, and social and environmental concerns on the recycling of the waste have consequently been increased. Waste concrete is particularly crucial among the construction wastes. In terms of making a construction, most of people use new materials as concrete mixture because people do not think yet about the use of recycled materials from building utilized materials as green building material. This study aims to partially replace coarse aggregates by recycled coarse aggregates and test its compressive strength; due to coarse aggregates also contribute financial as well as environmental effect in overall world. Recycling construction material plays an important role to preserve the natural resources. In this research concrete waste is from demolished structure (Bridge across Kalwa River, Junagadh, Gujarat-India) has been collected and coarse aggregate of 0 %, 15%, 25% and 50% are used for preparing fresh concrete of M-25 grade with 0.50 w/c ratio and compressive strength test performed on 15 X 15 X 15 cm cubes after 7, 14 and 28 days of curing.

**KEYWORDS:** Recycle Coarse aggregates (RCA), Compressive strength, Concrete.

### I. INTRODUCTION

Concrete is very familiar in civil engineering field since almost all the part of structure need to be concrete. This is because the properties of the concrete which have strong chemical bonding, high compressive strength and their durability can last for long life term very suitable to become part of structure. Concrete is a manufactured product, essentially consisting of cement, aggregates, water and admixture(s). Among these; aggregates, i.e. inert granular materials such as sand, crushed stone or gravel form the major part. Traditionally aggregates have been readily available at economic price. Crushed concrete is available nowadays in large quantities, which results from the demolition of old structures and waste concrete from new structures. A report presented in 1999 to the European Commission estimated the amount of no recycled construction waste to be 130 million ton/year. A decrease in the compressive strength was generally observed in all concretes in which the natural coarse aggregate was replaced with recycled aggregate prepared by the crushing of old concrete. The mechanical properties of the concrete decreased with the increase in the proportion of aggregate replaced. In fact many governments throughout the world have now introduced various measures aimed at reducing the use of primary aggregates and increasing reuse and recycling, where it is technically, economically, or environmentally acceptable. For example, the UK government has introduced a number of policies to encourage wider use of secondary and recycled coarse aggregate (RCA- defined as minimum of 95% crushed concrete) as an alternative to naturally occurring primary aggregates. Waste arising from Construction and Demolition constitutes one of the largest waste streams within the EU, Asian and many other countries. For

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example, it is estimated that core waste (described as those types of materials which are obtained from demolished building or civil engineering infrastructure) amounts to around 180 million tonnes per year. It is now widely accepted that there is a significant potential for reclaiming and recycling demolished debris for use in value added applications to maximize economic and environmental benefits. As a direct result of this; recycling industries in many part of the world, including South Africa, at present converts low-value waste into secondary construction materials such as a variety of aggregate grades, road materials and aggregate fines. Often these materials are used in as road construction, backfill for retaining walls, low-grade concrete production, drainage and brickwork and block work for low-cost housing.

## 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, demolished concrete waste-Recycled Coarse aggregates in the form of coarse aggregate.

**Cement:** In our experiments we use 53 grades Ordinary Portland cement which is specified as per IS 12269-2013.

**Fine aggregates:** Natural sand of Bhadar River near to Junagadh region – Gujarat, INDIA is used in concrete.

**Coarse aggregates:** Natural coarse aggregates of size having 20 to 25mm are used to make M25 grade of concrete.

**Recycled Coarse aggregates:** RCA are collected from demolished structure, a Bridge across Kalwa River, Junagadh, Gujarat-India. The concrete obtained using demolished waste aggregate satisfies the minimum requirements of New bought aggregates. 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 demolished waste concrete is high when compared with conventional concrete. Moisture retaining and water absorbing capacity of demolished waste are more compared to conventional concrete. The range of sieve sizes for coarse aggregate was from 40mm to 4.75mm.

Table 2.1 PHYSICAL PROPERTY OF FINE & COARSE AGGREGATES

Sr. No.	Types of Aggregate	Fineness Modulus	Density (kg/m <sup>3</sup> )	Specific Gravity
1	Fine Aggregates	2.71	1714	2.62
2	Coarse Aggregates	7.07	1801.55	2.82
3	Recycled coarse aggregates	7.37	1636.46	2.70

## III. MIX DESIGN

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. Concrete mix for our experiment is prepared as per IS: 10262- 2009 using concrete mix design ratio as shown in table 3.1

Table 3.1 MIX PROPORTIONS (FOR 1 M<sup>3</sup> CONCRETE)

Water	Cement	Fine Aggregates	Coarse Aggregates
191.6 litres	380 kg	710.51 kg	1120.09
0.5	1	1.86	2.94

In our research we replace coarse aggregates with Recycle Coarse aggregates by 0 %, 15%, 25% and 50% weight of mixed designed achieved weight. Table 3.2 shows mix proportion of concrete with Recycled Coarse Aggregates (RCA).

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Table 3.2 MIX PROPORTIONS OF CONCRETE WITH RCA (FOR 1 M<sup>3</sup> CONCRETE)

Mix Proportions	Water (litres)	Cement (kg)	Fine Aggregates (kg)	Coarse Aggregates (kg)	Recycled Coarse Aggregates (kg)
Mix 1 (0% RCA)	191.6	380	710.51	1120.09	0
Mix 2 (15% RCA)	191.6	380	710.51	952.07	168.02
Mix 3 (25% RCA)	191.6	380	710.51	840.06	280.03
Mix 4 (50% RCA)	191.6	380	710.51	560.046	560.046

## IV. TEST METHODOLOGY

### 4.1. COMPRESSION TEST (IS: 516-1959)

Compression test is most common to find compressive strength of concrete, cube of size 150x150x150 mm were casted in the batch of three cubes; these cubes after casting placed for curing and after 7<sup>th</sup>, 14<sup>th</sup> and 28<sup>th</sup> days of curing these cubes were tested by applying load on it with the help of Compression Testing Machine which works on following principle:

$$\sigma = P/A \text{ N/mm}^2$$

Where, P is Compression load at failure of cube in N;  
A is Cross-sectional area of Specimen in mm<sup>2</sup>

In our experiment we cast cubes of 0% RCA, 15% RCA, 25% RCA and 50% RCA in batch of 3 cubes per 7<sup>th</sup>, 14<sup>th</sup> and 28<sup>th</sup> days of curing.

## V. EXPERIMENTAL RESULTS AND DISCUSSION

Results after 7, 14 and 28 days curing concrete cubes are as following:

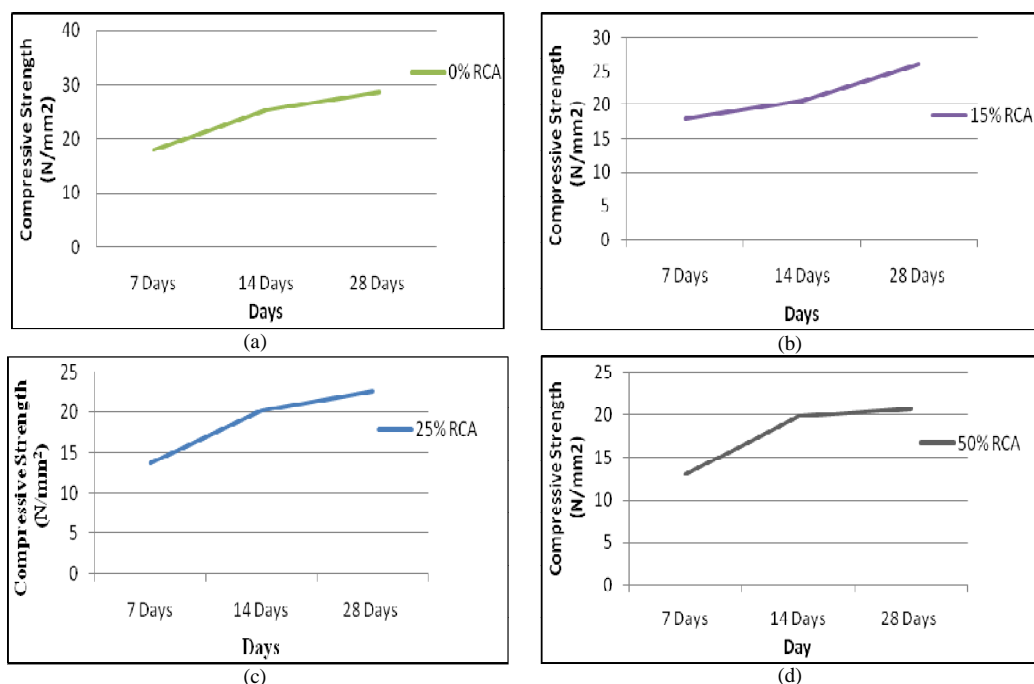


Fig. 5.1. Compressive Strength of Recycled Coarse Aggregates Concrete

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Table 5.1 COMPRESSIVE STRENGTH RESULT COMPERISONS

Percentage of RCA	0% RCA	15% RCA	25% RCA	50% RCA
Days	Compressive Strength (Mpa)			
7	18.07	18	13.7	13.03
14	25.33	20.62	20.11	19.81
28	28.7	26.07	22.6	20.69

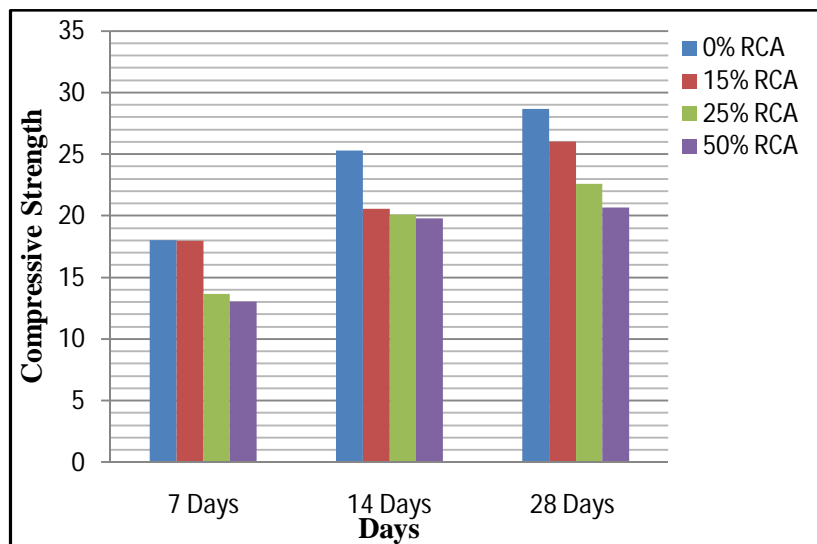


Fig. 5.2. Compressive Strength Comparisons of Recycled Coarse Aggregates Concrete

## VI. CONCLUSION

The experiment results shows that the compressive strength of concrete achieved at 28 days for 0% RCA, 15% RCA, 25% RCA and 50% RCA are 28.7 Mpa, 26.07 Mpa, 22.6 Mpa and 20.69 Mpa respectively. It means that reduction in strength of 15%, 25% and 50% replacements of RCA are about 9.16%, 21.25% and 27.90% respectively, which shows decrease in the compressive strength. Hence, Concrete with partial replacement of Natural Aggregate with RCA can be used only for low-strength concrete considering its advantages like, minimize the waste disposal problem and reduction in the cost of concrete. More parameters like Mix Design with trial and error method for partial replacement of Natural Aggregate with RCA to achieve target strength, moisture condition of recycled aggregate, etc can be considered to optimize the use of RCA.

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