

# Comparative Study of Mechanical Properties of Recycled Coarse Aggregates Subjected to Different Treatments

M.Tech. Scholar Ombir, Asst. Prof. Sonu Mor

Dept. of Civil Engg.,  
PM College of Engineering,  
DCRUST, Sonapat, Haryana, India 131001

**Abstract-**The majority of the solid waste produced worldwide is composed of construction and demolition (C&D) waste, which is disposed of in landfills. The concept of properly extracting, treating and reusing this treated material as a replacement of virgin coarse aggregates in fresh concrete, especially for lower level applications and it is very evident from past research by carried out by various researchers around the globe. The utilization of recycled aggregates (RA) made from C&D waste in concrete building is discussed in this paper. The study provides a description of the impact of recycled aggregates on the characteristics of both fresh and hardened concrete in addition to a brief explanation of the engineering features of recycled aggregates. However, this study demonstrates that high-quality concrete may be produced using recycled aggregates that are collected from site-tested concrete specimens. This paper examines how different treatment to the recycled aggregates affects the properties of concrete in fresh and hardens state. For this study replacement ration of 50% is considered i.e half of the requirement of coarse aggregates is used from recycled aggregates. The specimens are tested for slump values in fresh state and split tensile strength as well as compressive strength tests are carried out at the 28 days age. From tests it is evident that untreated recycled aggregates should not be used as such as a replacement of coarse aggregates because it imparts a lower compressive strength as well as tensile strength in harden state. Also due to porous nature of untreated recycled aggregates it absorbs a lot of water and hence workability of concrete i.e slump values are found to be lower then what is required at a given w/c ratio.

**Keywords-**Coarse Aggregates, RCA, Slum Test.

## I. INTRODUCTION

Aggregates for the construction of new concrete can now be found in concrete demolition waste. Construction and demolition (C&D) trash is reportedly produced in Europe at a rate of 180 million tonnes annually, or 480 kg/person/year. Rapid building has produced significant construction and demolition debris. Natural aggregates are rapidly running out in the meantime. An other approach to resolving this issue using concrete scrap as aggregates.

Recycled aggregates may come from abandoned structures, such as concrete roadbeds, airport runways, and bridge supports. Recycled aggregate concrete is a term used to describe concrete that has been built or manufactured utilising these types of resources. The recycled aggregate concrete will have an impact on the original concrete due to a number of important aspects and strong qualities. Concrete's strength, size distribution, and capacity to absorb water, for instance, will all be impacted.

Recycling concrete scrap from demolished structures aids in the preservation of natural resources and the reduction

of pollution. Before using the aggregate to make concrete, a few tests will be performed to establish its qualities. The main focus of this study is on finding the best treatment to the raw recycled aggregates which will effectively enhance the properties of recycled aggregates and give desired strength to the concrete. This study is focused on the effectiveness of employing treated or recycled aggregates as a replacement for ordinary aggregates to construct a concrete structure.

## II. RECYCLED AGGREGATES

Global issues brought on by rapid industrial expansion include the depletion of natural aggregates and the huge amount of waste produced by construction and demolition activities. Utilizing recycled concrete aggregates for making concrete is one technique to lessen this issue. Old concrete is primarily made of recycled aggregates, and recycling efforts thus have the added benefit of lowering landfill discharge.

In order to employ RCA for the creation of concrete, old concrete must be broken, removed, and crushed into a

material with specific size and quality requirements. By saving natural resources and minimising the disposal of demolition waste from old concrete, recycling concrete contributes to sustainable development. Typically, recycled aggregates have a lower specific gravity and higher water absorption. When recycled aggregates are employed, they have a lower density than regular aggregates. In comparison to natural aggregates, recycled aggregates have a significantly higher porosity.

It can be utilised as aggregates in concrete mixing after going through a few mechanical operations. The broken-down concrete buildings are crushed and sieved to the desired size. The physical characteristics of recycled aggregate are shown in Table 1, and Fig. 1.

### III. MATERIAL PREPARATION

#### 1. General:

Construction trash is used to produce recycled aggregates. Concrete roadbeds, pavements, fractured concrete, and airport runways are all potential sources for recycled aggregates. The machine crushed the concrete scraps, and the products were sieved to determine aggregate size.

#### 2. Preparation of Recycled Aggregates:

Since concrete has a porous structure, crushed aggregates are typically unable to be employed directly to create a new structure. This is because these aggregates absorb a lot more water than typical aggregates do. Treatment of recycled aggregates is must before using them as a replacement of coarse aggregates in order to decrease the amount of water absorption inside the aggregate, recycled aggregates must be treated. In present study the recycled aggregates are give different types of treatments namely Cement Treatment (CTRA), Thermal Treatment (TTRA), Fly Ash Treatment (FTRA), Acid Treatment (ATRA) For comparative analysis Conventional Coarse aggregates (CC) and Untreated Recycled Aggregate (UTRA) are also used for this present study.

A number of combinations can be formed using varying percentage of Recycled aggregate replacement but in present study aims to identify which treatment to RA result the best and maximum strength of concrete so 50% replacement is is selected for present study. Means out of total coarse aggregate requirement half will be the recycled aggregates and half portion will be of conventional coarse aggregates. For better comparison and understanding one set of samples are made with coarse aggregates only without any replacement with Recycled aggregates.

**2.1 Thermal treatment:** A thermal mechanical method is used to remove the adhering mortar from the RA. The recycled aggregate was placed in a muffle furnace for 24 hours at a temperature of 300°C. The aggregates were then abraded with the Los Angeles abrasion

machine to reduce the weight, and then sieved to produce aggregates with a maximum size of 20mm. Sieved aggregates are then swapped for traditional aggregate in concrete at various percentages.

**2.2 Acid treatment:** Sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) is diluted to 0.1 M using distilled water. Aggregates to be treated will now be presoaked for 24 hours in diluted H<sub>2</sub>SO<sub>4</sub> and then dried in the sun for 24 hours before being used in concrete. The amount of mortar on the surface and porous holes in the aggregate are minimised by removing it. This reduces water absorption rates and improves the aggregate's binding properties with other materials. The strength and durability of the material will be improved by lowering the water absorption rate and improving the binding property.

**2.3 Cement treatment:** RA was coated with thin cement slurry in this treatment method. The cement-to-RA ratio was chosen depending on the mix design. The cementitious material required by design is replaced with 50% cement for coating the recycled aggregate in this procedure. Then, in order to make cement slurry, water was added. The coated aggregate was then sun-dried for 24 hours. As a result, the surface dried aggregate is utilised in concrete casting, and its properties in concrete have been studied.

**2.4 Fly ash treatment:** RA was coated with thin fly ash slurry in this treatment method. The mix design determined the ratio of fly ash slurry to RA. Appendix 1 contains the mix design used in the investigation. The fly ash material required by design is replaced with 50% fly ash for coating the recycled aggregate in this process. The coated aggregate is then dried in the sun for 24 hours after being combined with water to make fly ash slurry. As a result, the surface dried aggregate is employed in concrete casting, and its properties in concrete are investigated.

### IV. RESULT AND DISCUSSION

M30 Grade of concrete cubes are casted for each six categories i.e Conventional Aggregates (CA), Cement Treatment (CTRA), Thermal Treatment (TTRA), Fly Ash Treatment (FTRA), Acid Treatment (ATRA) and Untreated Recycled Aggregate (UTRA). 7 days and 28 days compressive strength is measured and and split tensile test is carried out on the specimen at the age of 28 days. For fresh concrete slump test is conducted to have an idea of workability of each.

Following results were obtained during our study,

#### 1. Slump Test:

The flow of concrete mixing was determined for fresh concrete using the slump test, as shown in Fig 5. The slump test readings lie between 40 and 75 mm. The lowest slump value was 40mm for UTRA mm and 75mm, and the maximum value was CTRA. The slump test results are shown in the following graph. The lowest slump of untreated recycled aggregates because water absorption

for the untreated RA is maximum with hence lower down the workability.

Compression test was conducted on the specimens at the age of 28 days.

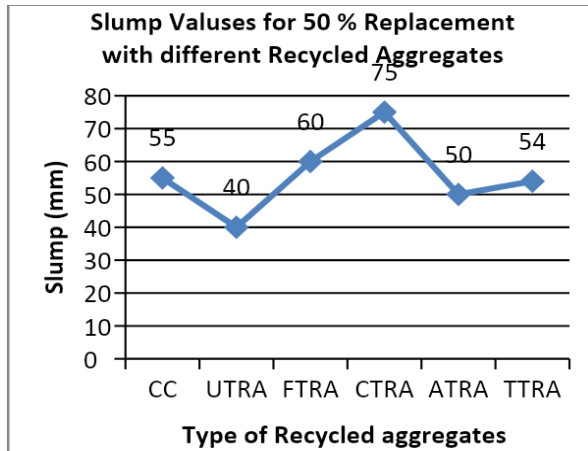


Fig 1. Slump Values for different Recycled Aggregates.

### 2. Split Tensile Strength:

Split tensile strength is calculated by preparing cylindrical specimens and testing them at different ages. 28 days tensile strength test results are shown in below table for 50% replacement with recycled aggregates.

Table 1. Split Tensile Strength.

Sr. No	Type of Recycled Aggregated (50% Replacement)	Split tensile strength
		N/mm <sup>2</sup> 28 Days
1	CC	4.23
2	UTRA	3.03
3	TTRA	3.72
4	ATRA	3.78
5	CTRA	4.27
6	FTRA	4.43

From above data it is clear that tensile strength of fly ash treated RA is found maximum (4.43) followed by CTRA, CC, ATRA, TTRA and least was found of UTRA.

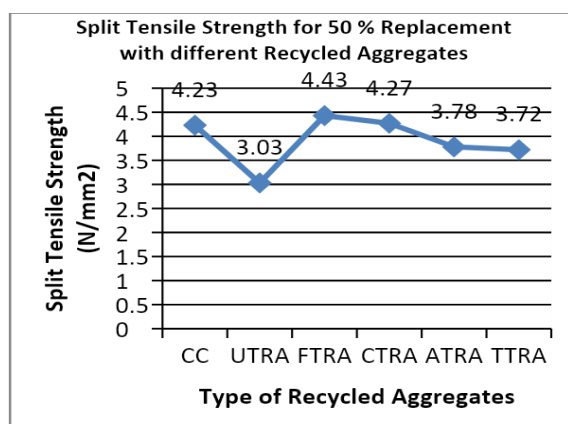


Fig 2. Split Tensile Strength.

### 3. Compressive Strength:

Table 2. Compressive Strength.

Sr. No	Type of Recycled Aggregated (50% Replacement)	Compressive strength
		N/mm <sup>2</sup> 28 Days
1	CC	36.5
2	UTRA	21.2
3	TTRA	29.2
4	ATRA	28.5
5	CTRA	34.5
6	FTRA	35.8

From above results it is clear that Cement Treated Recycled Aggregates and Flyash Treated Recycled Aggregates provide nearly same compressive strength as that of conventional coarse aggregates. Also it is clear that untreated recycled aggregates have minimum tensile strength which is less than the characteristic strength. So it is strongly recommended not to use untreated recycled aggregates as a replacement of coarse aggregates in concrete.

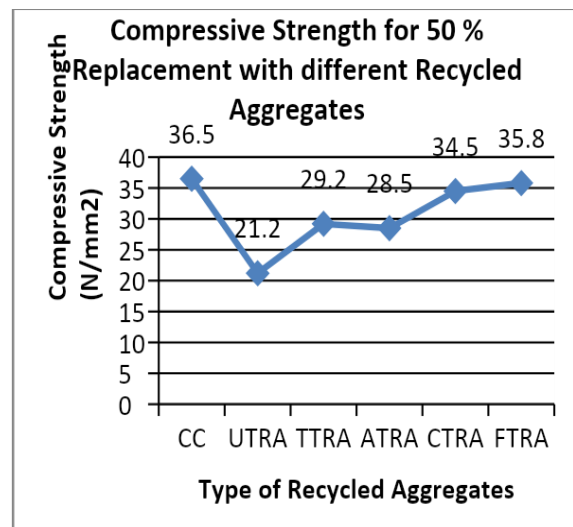


Fig 3. Compressive Strength.

## V. CONCLUSION

From results it is clearly evident that the recycled aggregates should be treated with a suitable method before substituting them. If untreated materials are directly used then this may result in lower strength of concrete. Also as mentioned earlier, this only one replacement ratio of 50% is adopted for this study; however, further study may be carried out to find the optimum percentage for replacement of coarse aggregates. Long-term study of recycled concrete aggregates should also be carried out to find the effect on concrete properties.

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