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Effect of Acid Treated Recycled Aggregate On Properties of Concrete

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ABSTRACT- The main factors effecting the usage of recycled course aggregate (RCA) in concrete mix was its lack of quality. The surface of the recycled aggregate may contain some cement mortar which affects the quality of recycled aggregate. This paper is about to study on recycled aggregate in various test performances by the acid soaking treatment methods using sulphuric acid, nitric acid, hydrochloric acid. FIVE series of concrete mixtures are prepared those are natural aggregate, recycled aggregate, recycled aggregate with HCL, recycled aggregate with H2SO4, recycled aggregate with HNO3. The effectiveness of using these treated recycled aggregate in concrete and strength, durability characteristics of concrete were examined and their properties of aggregates were calculated. In the test results the behaviour of recycled aggregate has improved after soaking in acid treatment. Out of this three acids first recycled aggregates treated with sulphuric acid has given best results, after that nitric acid somehow better but hydrochloric acid has given very poor performance. From the overall study the strength and durability characteristics of concrete by recycled aggregate can be improved in a good way by using the treated recycled aggregate in concrete.

KEYWORDS- Natural coarse aggregate, Untreated recycled aggregate, Treated recycled aggregate, sulphuric acid, nitric acid, hydrochloric acid.

I. INTRODUCTION

Concrete is a most versatile and largely used as construction material in the world, present over 6 billion tonnes produced each year in the world. It is the most widely used material around the globe after water. Concrete is a strong mouldable construction material. We can transform into any shape before initial setting starts. The basic ingredients of concrete are aggregate, cement; water and presently we use some admixtures as our requirement. Cement is the fixture that binds the ingredients and aggregates like fine and coarse aggregate will occupy about 60-75% of the total portion of concrete which gives bulk to the concrete mix, but the aggregates are not involved in the chemical processes. The ease with which structural elements of concrete can be formed into different shapes and sizes is due to the freshly mix concrete is of a plastic consistency which gives the material to flow into fabricated formwork. Concrete is generally the least expensive and most promptly accessible material.

A. Objectives

The object of this research is to improve the quality of recycled aggregate. Research on the effectiveness of pre-soaking treatment for recycled aggregate by using different acids.

- Investigating the current practices of recycled aggregate in construction.
- Try to locate the problems that weaken the quality of concrete by using recycled aggregate. • To reduce the quantity of mortar, which is attached to recycled aggregate by acid solutions namely HCL, H2SO4, HNO3
- Experimenting with these four solutions and assessing the benefits possibly gained
- We hope that this research will be a small contribution for further generation in the advance of the utilization of recycled aggregate as construction material. Because it is the necessary a new source of aggregates.

II. MATERIALS USED

- Ordinary Portland cement ASTM Type 1 Ordinary Portland cement with a specific gravity of 3.15 and specific surface area of 3540 cm2 /g was used for this experimental study. The chemical composition of the cement was found through XRF analysis and it was given in Table 1

Table 1: Physical and chemical composition of ordinary Portland cement (OPC)

Description	Composition
Physical Properties	
Color	Grey
Specific gravity	3.15
Specific surface area(cm2/g)	3540
Chemical Composition	
CaO (%)	62.8

SiO2 (%)	20.3
Al2O3 (%)	5.4
Fe2O3 (%)	3.9
MgO (%)	2.7
Na2O (%)	0.14
K2O (%)	62.8

- Fine aggregates

Uncrushed locally available natural river sand with a fineness modulus of 3.35 was used as fine aggregate.

- Coarse Aggregate

Availability of crushed granite from nearby local quarry with size of 16 to 20 mm was used as natural coarse aggregate.

- Recycled Aggregate

If a structure is constructed with concrete and is demolished, the demolished concrete may be utilized for landfills for disposal, but recycling concrete has a many benefits that have made it more attractive option in the presence environmental condition. When an aggregate in concrete collected from demolishing places or sites is dump on a crushing machine, metals such as rebar or removed with magnets a grow through hcrushers and finally filtered out through methods like hand picking and water floatation but this process is only used for large quantity of concrete aggregate recycling. In this project I am taken a small quantity of recycled aggregates so it is use to collect recycled aggregate by manually with the help of hammer. Concrete was once used that should be used again for landfills for disposal through trucks but the process of recycling of concrete should have a number of benefits that have made it a more advantage and it may keep construction costs down. Recycling of concrete is now a day's an important because it protects natural resources and mostly eliminates the need for disposal by using the readily available concrete as a source of aggregate for few constructions or any other application before the construction and demotion.

- Acid

Acids like HCL, H2SO4, HNO3 solutions were prepared with 0.1M and RCA were soaked in this acid solutions up to 24 hours and then the aggregate were taken out from solution and washed with portable tap water thoroughly and then sundried between 3 to 4 hours. Aggregate obtained from treated solutions were named as RCAHCL,

A. Rcah2so4, Rcahno3 Treatment Methods for Recycled Aggregate

The various treatment methods for recycled aggregate is the key factor in preparation of concrete by recycled aggregate are

- Impregnation of silica fumes solution.
- Addition of fly ash or silica fume.
- Polymer treatment method.
- Ultrasonic treatment method.
- Acid treatment method.

Here in this paper we study by using acid treatment method for treating Recycled aggregate.

III. MIX DESIGN PROPORTION OF MIX

Cement =400kg/m3 Water =160kg/m3 Fine aggregate = 651.582 kg/m3 Coarse aggregate = 1202.08 kg/m3 Chemical admixture = 8.5kg/m3 W/c ratio = 0.4

MIX RATIO

Cement: F.A: C.A: water

For 1m3 of concrete mix 400: 651.585: 1202.08: 160 For unit quantity of concrete mix 1: 1.628: 3.0052: 0.4

In this study, cylinders are tested for tension having specimen size 150mm in diameter and 300mm height. At least 3 specimens are required to cast for testing at least an age of 7 and 28 days as per the requirements of IS 516-1959 the tests are conducted. The mean values are reported as strength of the specimen. Split tensile test is conducted on cylinders in Compressive Testing Machine (CTM) with a capacity 200 tones.

B. Flexural Strength Test

In this study, prisms are tested for flexure having specimen size of width and depth 100mm and length is 500mm.Atleast 3 specimen are casted to test at an age of 7 and 28 days. As per the requirements of IS 516-1959 tests should be conducted. The average values are reported as strength of the specimen. Flexure strength is conducted in compressive testing machine with a capacity of 200 tones.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

A. Compressive Strength

The experimental results reveal that incorporating acid-treated recycled aggregates in concrete moderately enhances compressive strength, workability, and durability compared to regular recycled aggregates. Acid treatment reduces the attached mortar content, mitigating the negative impact of adhered old cement paste. This technique shows potential for sustainable construction without compromising concrete performance.

Table 2: Mix proportion of cement, couarse & fine aggregate

RCA treated type	Cement	Fine Aggregate	Coarse Aggregate
RCA	1	1.62	3.12
HCL	1	1.61	3.15
H2SO4	1	1.65	3.27
HNO3	1	1.66	3.162

B. Experimental Procedure

Compressive and Split tensile strength and Flexural strength were evaluated through the cube specimens of size 100x 100 mm and the cylinders of size 100 mm diameter and 200 mm height respectively at the ages of 7, and 28 days. The tests were conducted in accordance to the requirements of IS516 26. In each test three specimens were tested and the mean values were reported as strength of the specimens.

C. Tests Conducted On Concrete

- Compressive Strength Test

In this study, cubes are tested for compression having specimen size 150mm cubes. At least three specimens are required to cast for testing at ages of 7 and 28 days. As per the Requirements IS 516-1959 the tests are conducted. The average values were reported as strength of the specimen. Compressive strength is conducted on cubes in compressive testing machine with a capacity of 200 tones.

- Split Tensile Test

Compressive strength of natural aggregate concrete, recycled aggregate concrete, recycled aggregate concrete treated with acid solutions like hydrochloric acid, sulphuric acid, nitric acid is tested in compressive testing machine (CTM) which is shown in table 5.1. Compressive strength results are tested are in the age of 7 and 28 days are shown in chart 5.1. The test results in compressive strength that sulphuric acid treated recycled aggregates improved 27.182% compared to RCA and nitric acid is 13.57% and last hydrochloric acid is 9.73% improved after 28 days curing. And more over untreated recycled aggregate give poor performance.

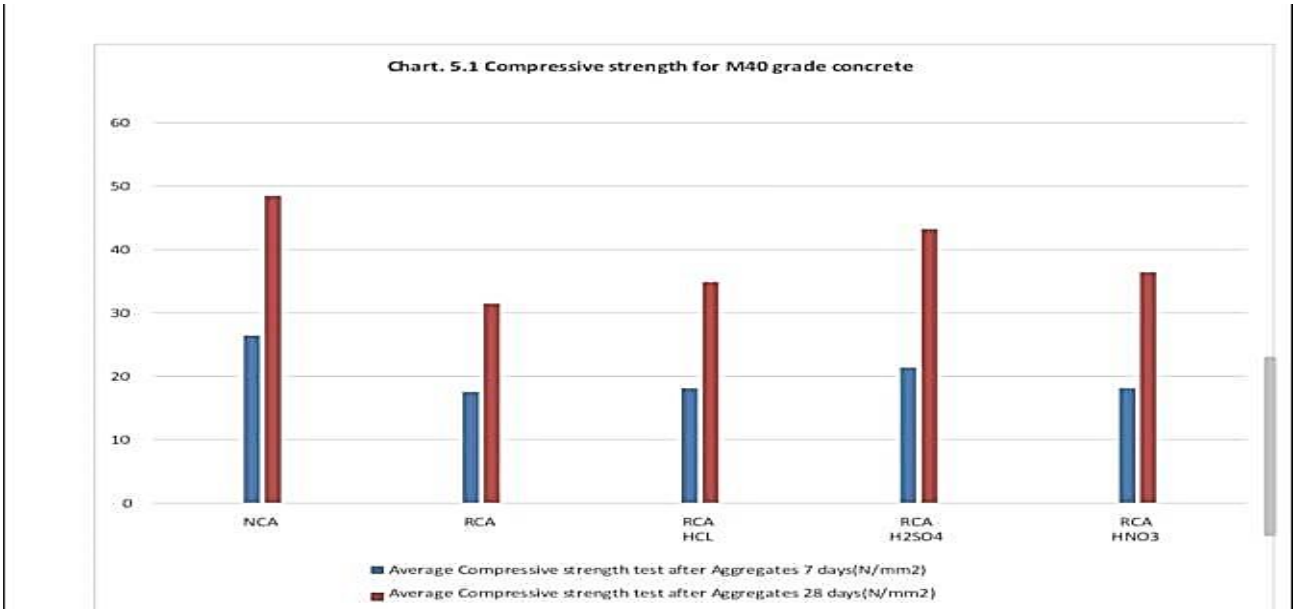

Figure 1: Compressive Strength

D. Split Tensile Strength

Natural aggregate concrete recycled aggregate concrete and treated recycled aggregate concrete mixes are tested in compressive testing machine for split tensile strength at the age of 7 and 28 days and are shown in table 5.2. and chart 5.2. in Split tensile test in Split tensile test the performance of sulphuric acid treated recycled aggregates improved 18.62% compared to RCA and nitric acid is 17.19% and last hydrochloric acid is 7.08% improved after 28 days curing. The attached mortar and loose mortar particles are removed after treatment to a greater extent from recycled aggregates which improve the bonding strength between aggregate and mortar. It leads to strength improvement of recycled aggregate concrete. Similar process was observed in the earlier report

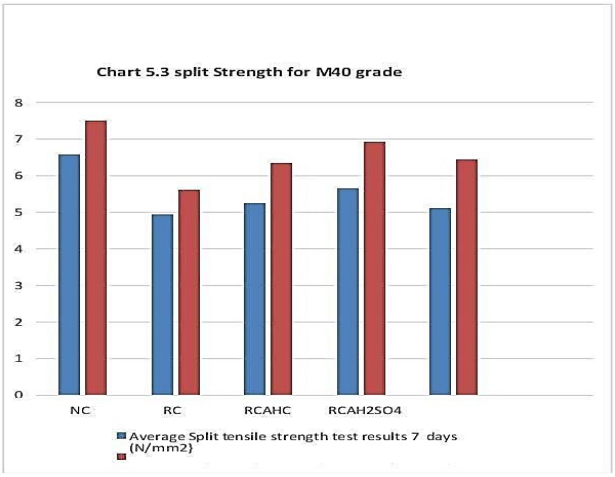

Figure 2: Split Tensile Strength

E. Flexural Strength

For flexural strength all the concrete mixes like natural aggregate concrete, recycled aggregate concrete, and treated recycled aggregate concrete are tested and the flexural strength results are at the age of 7 days and 28 days can be shown in table
and chart 5.3. In Flexural strength test performance of sulphuric acid treated recycled aggregates improved

16.64% compared to RCA, nitric acid is 10.41% and last hydrochloric acid is 8.8% improved after 28 days curing Here the tested results show that the compressive strength, split tensile strength and flexural strength of the recycled aggregate is found to be lower than the natural aggregate. However, the recycled aggregate concrete strength can be improved by acid treatments

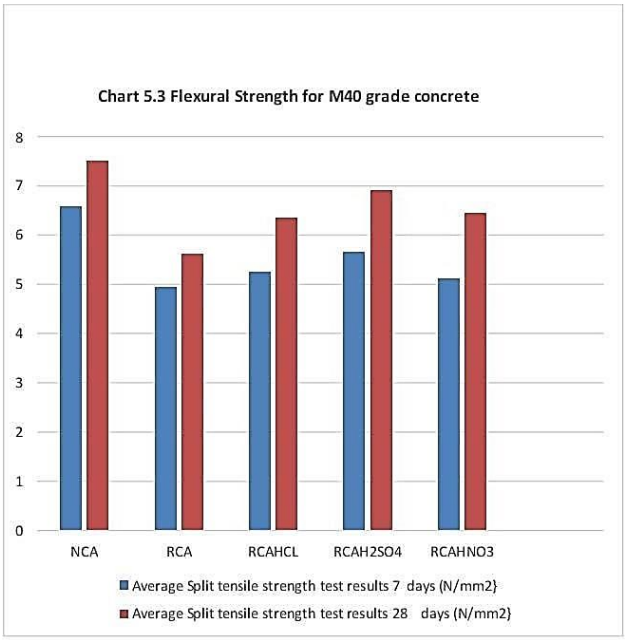

Figure 3: Flexural Strength

V. CONCLUSION

Based on the results observed in the experimental study the following conclusions are discussed below

- The mortar content was removed from recycled aggregate after acid treatment and there by its physical and mechanical properties of recycled aggregate are improved. The experimental study from compressive strength, tensile strength and flexural strength of recycled aggregate concrete was lower than that of natural aggregate concrete in all ages due to the attached mortar presents in recycled aggregates.
- The test results indicated in compressive strength that sulphuric acid treated recycled aggregates improved 27.182% compared to RCA and nitric acid is 13.57% and last hydrochloric acid is 9.73% improved after 28 days curing.
- In Split tensile test the performance of sulphuric acid treated recycled aggregates improved 18.62% compared to RCA and nitric acid is 17.19% and last hydrochloric acid is 7.08% improved after 28 days curing.
- In Flexural strength test performance of sulphuric acid treated recycled aggregates improved 16.64% compared to RCA and nitric acid is 10.41% and last hydrochloric acid is 8.8% improved after 28 days curing.
- out of this three acids first recycled aggregates treated with sulphuric acid has given best results and second nitric acid somehow better but hydrochloric acid has given very poor performance
- From overall study by using acid treatment The strength and durability characteristics of concrete by recycled aggregate can be improved in good way Hence this method can be considered and employed in the application on large scale RAC project

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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