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A Novel Approach for Comparative Study Based Performance Recycled Aggregate in Conventional Concrete

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Abstract: *The use of natural aggregate is growing increasingly prevalent as the construction industry develops to a higher level. Recycled aggregate can be used as a replacement material to lessen the demand for natural aggregate. In contrast, there is a lot of solid trash produced during building deconstruction that is challenging to deal with. These problems can be resolved positively by using approaches for resource recovery, reuse, and recycling. This paper presents an effective way to reclaim and reuse recycled aggregates. Research demonstrates that the qualities of concrete, such as compressive strength, split tensile strength, and flexural strength, are significantly impacted by the use of recycled aggregate as a replacement material. Recycled aggregates present significant reductions in properties like porosity, water absorption, and density which are also taken into consideration and suitable treatments have been discussed here. Using recycled aggregate also lessens dust and CO2 emissions, two environmental issues. The use of recycled aggregate with appropriate treatment methods proves an ideal aggregate used construction industry.*

Keywords: Construction, Aggregate, Recycled, Concrete, Civil.

I. INTRODUCTION

The construction industry is set to become the third-largest industry globally by 2025.Due to its beneficial characteristics, such as durability, adaptability, sufficient compressive strength, cost-effectiveness, etc., concrete is one of the most often used construction materials in the world. The whole industry relies on natural resources to fulfilling this demand resulting depletion of natural resources. On the other hand, a huge amount of construction demolished waste is generated and disposed it into nature as a waste material.40% of the overall construction demolition trash is made up of concrete, 30% of it is ceramic, 5% of it is plastic, 10% of it is wood, 5% of it is metal, and 10% of it is other combinations. Market Insider reports that the worldwide construction output will increase from US$ 10.6 trillion in 2017 to US$ 12.7 trillion in 2022. These numbers show that the construction industry has grown by over 25% during the past five years. Mining, blasting, and crushing processes are used to produce aggregates from raw rock materials. The effects of mining and blasting operations on the environment and the airborne dust and filth they create have negative health effects. Increasing mining activities result in a reduction in the availability of natural rock sources and other issues. In addition to reporting the fundamental characteristics of recycled coarse aggregate, this effort compares these characteristics to those of natural aggregates. All aggregate qualities undergo fundamental alterations, and their implications for concrete work are thoroughly examined.

In the present paper, Section II exclusively provides a literature survey, Section III provides details about the system overview which contains the architecture. Section IV explains the implementation of the system and Section V concludes the paper.

II. LITERATURE SURVEY

The literature used for this project work gives a detailed review of literature related to the reclamationmethods and improvement techniques for recycled aggregates. In this literature, detailed information about the recycled aggregate,

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its properties as well as the methodology, and materials used by the previous researchers are included. In paper [1-6] authors compare the properties of concrete made from recycled aggregate and briefs about the results. The production method used for reclaiming aggregate from construction waste is also discussed in this paper. He gives detailed information about the materials, proportions, and mixes that he has adopted for making concrete cubes. He has tested concrete cubes for compressive strength cast from different grades of concrete. He also tested RCA for tensile strength as well. Study indicates Aggregate should be reclaimed from concrete having a higher grade. In papers [4], [7] and [8] author has highlighted the comparative analysis of the experimental results of the properties of fresh and hardened concrete with different replacement ratios of natural with recycled coarse aggregates. He has adopted mainly three mixed proportions replacing 0%, 50%, and 100% of recycled concrete aggregates. Studies show almost the same compressive strength after 28 days of curing whereas strength after 2 days and 7 days has considerable variation. Authors in [9]-[11] have tested concrete made from recycled aggregate with varying percentages of chemical admixture. 1.5%, 1.8%, and 2.0% of the weight of the binder have been adopted for testing purposes. For increasing the bonding properties of concrete, a higher percentage of cement is suggested. Study shows that 1.5% and 2.0% admixtures cannot give satisfactory results hence 1.8% admixtures are finalized for improving recycled concrete aggregates.

In this paper [5] author has quoted the feasible amount of superplasticizer named "Conplast SP 430" manufactured by Fosroc. The superplasticizer used is a Sulphonated naphthalene-based polymer liquid admixture. Cementitious materials used are silica fume, Blast furnace slag. Tests have been conducted with varying percentages of cementitious materials. Compressive strength and tensile strength tests are carried over this specimen to find an equivalent amount of cementitious material and the amount of superplasticizer to be used. The study defines the percentage of superplasticizer as 0.7% of the weight of the binder. Results are showing that SFRCA (silica fume recycled aggregate concrete) and BFSRCA (blast furnace slag recycled aggregate concrete) contribute to the preservation of the environment and can achieve the same final performance with probably less cost than ordinary concretes [12]-[14]. In the paper authors [15]-[17] have analyzed the rheological properties of concrete made from recycled aggregates. The effects of recycled aggregates on workability (Fluidity) and viscosity have been taken into consideration and solutions are discussed in this paper. To counteract these effects on rheological properties some respective measures are suggested. The use of admixtures, superplasticizers, and proportions are discussed to achieve workable concrete. The authors have compared the results based on the type of superplasticizer used in different mix proportions of RCA with natural sand. The best suitable superplasticizer is then tested on samples made from totally recycled aggregates. Study shows that Polycarboxylate copolymers or modified polycarboxylate polymers were the most efficient to improve rheological properties.

III. SYSTEM OVERVIEW

Figure 1 shows the system methodology in detail. Which initial phase contains a brief study of the literature survey. The literature survey contains a study of material and recycled process. It also includes a case study about site visits and data collection.

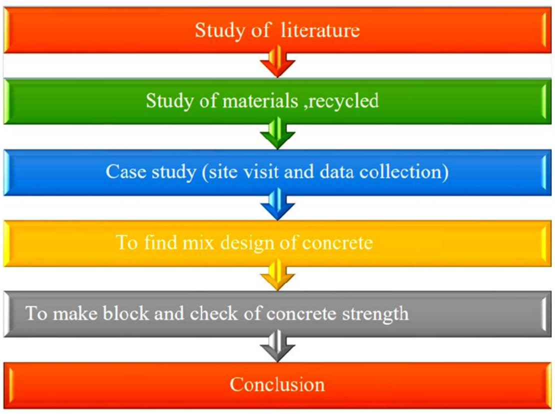

Fig. 1. System Methodology

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IV. IMPLEMENTATION OF DETECTION METHOD FOR DDOS ATTACKS

4.1 Materials and Methods

Materials:

1. Cement:

In this experiment, all concrete mixes used 53-grade ordinary Portland cement (OPC) under the trade name "Birla super cement 53 grade." The cement that was used was lump-free and brand-new. Cement was tested in accordance with IS 12269:1987. Cement was discovered to have a specific gravity of 3.15. Table 1 lists the physical characteristics of the used cement.

Table 1: Physical Properties of Cement

Particulars	Experimental results	As per standards
1. Fineness	268 m^2 /kg	225 m^2 /kg
2. Soundness	7 mm	10 mm
3. Setting time (minutes)		
a) initial set	38	30
b) final set	270	600
4. Compressive strength		
A) 3 days	34	27
B) 7 days	44	37
C) 28 days	58	53
Temperature during testing	28°C	27° C ± 2%

2. Fine Aggregate:

The artificial sand utilized for the experimental programme was purchased locally and was confirmed to be zone-II sand.

Table 2: Properties of Artificial Sand

Description of properties	Values of fine aggregate
Specific gravity	2.62
Fineness modulus	2.525
Bulk density	1.6325
Zone	II

3. Natural Coarse Aggregate:

In the experiment, coarse aggregate with a basalt origin was used. C.A. from nearby stone quarries, size 20mm and below, was used.

4. Recycled Concrete Aggregate:

Crushing sound, clean demolition trash that contains at least 95% by weight of concrete and has a total contamination level that is typically less than 1% of the bulk mass results in coarse recycled concrete aggregate (RCA). Here, old concrete is first removed from the concrete laboratory waste, and the removed concrete samples are subsequently crushed to the necessary aggregate size (20 mm or less). The hammer is used manually to complete this process. The remaining particles are then sieved out and used to grade the aggregates. Crushers are an option if this reclamation is carried out on a wide scale.

Fig.2: Construction Demolition Waste

To take back Recycled concrete aggregate is made from scrap concrete that has been broken down into the necessary aggregate sizes before undergoing certain simple tests, including the impact test, L.A. abrasion test, and crushing test. Brickbats and other alien objects were taken out of the scrap concrete. Recycled aggregates are gathered from the demolished site and broken into the necessary sizes using a breaker and a hammer. Environmental attributes are being used more and more to evaluate building materials. By employing easily accessible concrete as a source of aggregate for new concrete or other purposes, recycling of concrete preserves natural resources and removes the need for disposal. Concrete recycling is a rather straightforward process. It entails dismantling, removing, and crushing pre-existing concrete to create a product of a certain size and caliber. The quality of the recycled material utilized has a big impact on how well concrete made with RCA turns out.

Fig.3: Reclaimed Recycled Aggregates

Roofing materials, asphalt, dirt and clay balls, chlorides, glass, gypsum board, sealants, paper, plaster, and other potentially hazardous elements must all be avoided. Any embedded items, including reinforcing steel, must also be removed. The same standards required for conventional aggregates should be passed by recycled concrete aggregates manufactured from all but the lowest quality original concrete. In addition to the original materials, recycled concrete aggregates also include hydrated cement paste. In comparison to identical virgin aggregates, this paste lowers the specific gravity and enhances the porosity. A higher RCA porosity results in more water absorption. Recycled aggregate is more porous and absorbent than many natural aggregates because it contains mortar from the original concrete. According to test results, recycled coarse aggregate absorbed between 5% and 6% of water. Absorption in natural aggregate is typically between 1% and 2%. Recycling aggregate and natural aggregate that is mixed directly into new concrete were tested for their effects on the workability of the material.

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Table 3: Physical Properties of Natural and Recycled Concrete Aggregate.

Description of properties	Values for natural aggregate	Values for recycled aggregate
Specific gravity	2.91	2.5
Bulk density	1.764 kg/lit	1.742 kg/lit
Los Angeles abrasion value	13.56%	19.65%
Crushing value	11.92%	19.96%
Impact Value	5.20%	11.92%

5. Fly Ash

Fly ash is a waste product from thermal power plants that have several cementing qualities, including high density and fineness. It can also be utilized as a binding agent in concrete. Fly ash contains very minute particles, which increase concrete's density and decreases its permeability.

6. Silica Fume

A by-product of making silicon metal or ferrosilicon alloys is silica fume. Concrete is one of silica fume's best applications. It is an extremely reactive pozzolana due to its chemical and physical characteristics. Concrete made with silica fume can be extremely strong and long-lasting.

4.2 Tests on Aggregates

Aggregate Impact Value

AIV stands for aggregate impact value and measures how strong the aggregate is under impact. The aggregate's resistance to dynamic load is indicated by AIV. The aggregate is weaker the higher the AIV. Previous research has shown that the AIV of RCA (10-20%) is higher than that of NCA (5-10%). (Table 2). Because of the bonded mortar and cement paste, RCA is less sturdy and has a higher AIV.

Table 4: Impact Value Test

Impact value test		
Sr. No	Aggregate type	Value
1	NCA	5.20%
2	RCA	14.29%

Aggregate Abrasion Value

The wear resistance of aggregate is gauged by the aggregate abrasion value (AAV). When the material loss due to wear increases, a higher AAV is obtained. Typically, RCA has a higher AAV than NCA. The usual Los Angeles abrasion values of RCA are higher than those of NCA and range from 20% to 45%. Notwithstanding of origin, the AAV of RCA is typically below the permitted maximum limit (50% by weight) for structural applications.

Table 5: Abrasion Value Test

Abrasion value test		
Sr. No	Aggregate type	Value
1	NCA	13.56%
2	RCA	19.56%

Aggregate Crushing Value

The resistance of an aggregate to crushing under gradually applied compressive load is measured by the aggregate crushing value (ACV). The aggregate is stronger the lower the value. According to the information that is currently accessible, the RCA's ACV (20–30%) is significantly greater than the NCA's (14–22%) (Table 2). This is expected given the RCA particles' relatively weak cement paste and mortar attachments.

Table 6: Crushing Value Test

Crushing value test		
Sr. No	Aggregate type	Value
1	NCA	11.92%
2	RCA	19.96%

Fig.4 Crushing Test Machine

V. RESULT

Table 12: Compressive Strength

Compressive strength			
Aggregate type	Days		
	3	7	28
NCA	23.11	40.44	45.78
RCA	16.24	24.28	39.18

Tests specimen are made from 20%, 30%, and 40% replacements with RCA, and results showing 30% replacement gives better results over 20% and 40%. To achieve an additional increase in strength and reduce the effects of porosity and weaker portions sticking over the surface addition of silica fume and fly ash is preferable. In this paper effects of replacements of cement by silica fume and fly ash have been determined. Various amounts and percentages of FA and SF are used to cast specimens. Replacement of Cement with fly ash gives better results up to a limit and then reduces with an increase in the percentage of fly ash. Simultaneously use of silica fume gives notable results with an increase in percentage. Compressive strength increases with an increase in SF but it is not feasible to use a higher percentage of SF due to economic constraints.

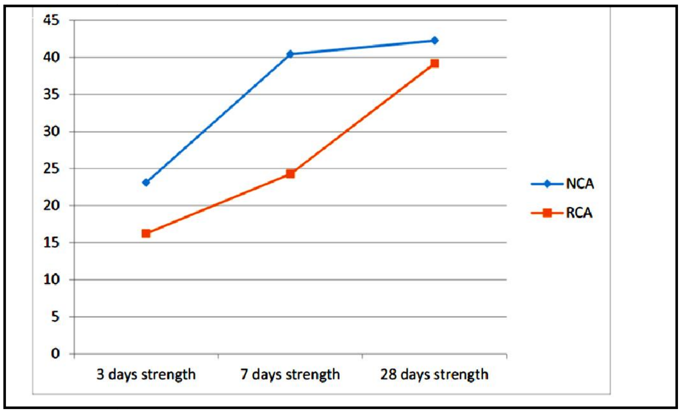

Fig.4: Behavioural Comparison between RCA & NCA

VI. CONCLUSION

Recycled concrete aggregate made from construction and demolition waste will have porous nature than NCA. In cement stones, dust particles on the surface will make them smooth, resulting in reduced bond strength. High water absorption capacity will require more water and increase the w/c ratio. The higher water-cement ratio decreases the compressive strength of concrete. The workability of concrete also reduces due to RCA. From compressive strength test results, it is observed that the compressive strength of concrete made from 100% RCA is considerably less than concrete made from natural/conventional coarse aggregates. And hence partial replacement is advisable. This study found that there is not much variation in strength between ordinary concrete and concrete made from 30% replaced RCA. Hence replacement up to 30% is feasible. Cement stone/paste present on the surface of the concrete may lead to chemical reactions like alkali-aggregate reactions. The use of fly ash may reduce alkali-aggregate reactions. The strength of concrete increases linearly with the increase in the percentage of fly ash up to the limit, further addition of fly ash reduces strength. Hence 30% fly ash is feasible for the replacement of cement. The cost of processing recycled concrete aggregate and transporting it to the site will prove economical over the production and transportation of natural aggregate. Natural aggregate requires mining, blasting, transporting, and breaking this material into required sizes and transportation facilities. The rough surface of RCA will contribute to additional strength gain and hence care should be taken to achieve the rough surface of RCA as discussed in the paper

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