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PRODUCTION OF RECYCLED AGGREGATE FOR STRUCTURALCONCRETE

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Abstract - Recycling demolished concrete is crucial for efficient resource utilization and environmental preservation. The study investigates the use of recycled aggregate in structural concrete production. This study focuses on the mix design of recycled aggregate concrete using the IS mix design procedure with a targeted design strength. Five different concrete proportions were investigated, ranging from 0% ,25% ,50% ,75% and 100% replacement of natural aggregates by recycled aggregates. Results were discussed, with a focus on comparing cube compressive strength to cylindrical compression strength and cylindrical compression strength to split tensile strength. The findings were compared with existingstandards and provisions, and regression models were formulated to enhance understanding and prediction of concrete properties. This paper contributes valuable insights into the mix design of recycled aggregate concrete, facilitating sustainable construction practices in line with industry standards and regulations.

Key Words: Natural Aggregate Concrete, Recycled Aggregate Concrete, Compressive Strength test, Split Tensile Strength test.

1.INTRODUCTION

Recycled aggregate concrete (RAC) is a material produced from crushed construction and demolition waste, primarily consisting of concrete and aggregate materials like sand, gravel, slag, and crushed stones. It is cost-effective to purchase and involves recycling waste materials, which would otherwise take up valuable space in landfill sites. Produces crush and compress existing waste concrete to create concrete aggregate of specific size and quality, reducing landfill waste.

Recycled aggregate have relatively higher fineness modulus and lower bulk density, with no appreciable change in grading curve from that of natural aggregate [1]. Growing environmental concerns have produced demands for greater use of waste materials in construction [2]. The water permeability of brick aggregate concrete is marginally lower than that of artificial aggregate concrete [3]. The compressive strengths including the prism and the cube compressive strengths of RAC generally decrease with increasing RAC contents. But the ratio of prism compressive strength and cube compressive strength is higher than that of normal aggregate concrete [4]. Use of recycled aggregates in concrete provides a promising solution to the problem of Construction and Demolished waste management [5]. It was observed that the presence of recycled aggregates seemed to produce lower performance levels in terms of sustained load [6]. The type of recycled aggregate and the percentage of replacement are the factors that clearly influenced the most properties, especially the absorption of water [7]. The presence of mortar reduces the recycled aggregate particle density and effects of the aggregates, enhancing their water absorption capacity [8]. Reliable waste generation is a basic requirement for formulating successful waste management strategies [9]. The tensile strength is expected to decrease with increasing recycled aggregate content. Nevertheless, it is possible to control this effect by carefully selecting the recycled whenproducing concrete [10].

2.PROPERTIES OF THE RECYCLED AGGREGATE

Crushed concrete and other building waste are used to make recycled aggregate concrete, which has a number of material qualities. Its first characteristic is its uneven particle size distribution, which impacts compaction and structural stability. It changes workable concrete mixes because it absorbs more water than naturalaggregate. While its density varies depending on constituent materials and compaction levels, it is generally different from virgin aggregate concrete. The strength of recycled aggregate concrete may be less than that of its natural counterpart due to variables such as the quality of the original material and processing methods. Another factor to take into account is durability, which is affected over time by carbonation and pollutants. Its permeability and resilience to freeze-thaw cycles are impacted by its porosity, which is frequently higher than that of concrete with natural aggregate. Quality control procedures are essential to guarantee performance and consistency because of the variations in it.

In contrast with the accordingly NAC, the RAC has higher water absorption, lower apparent density and bulk density [11]. Challenges in CDW management in China were analyzed based on key concepts in circular economy theory [12]. A pragmatic, recycling – based closed – loop waste management approach is highly recommended to achieve these enormous benefits [13]. Construction and demolition wastes can be transformed into useful recycled aggregate utilized in concrete production with properties suitable for construction applications in India [14]. In terms of RAC reinforcement, the TSMA method seems to be a fairly worthwhile method due to cost – effectiveness and operability [15].

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2.1 PROPERTIES OF MATERIALS

This outlines the collection of materials including cement, fine aggregate, coarse aggregate, and water tested in accordance with the procedures specified in IS Codes to ensure their suitability for concrete production. The findings reveal that all materials meet the pertinent provisions outlined in the IS Code of practice. Theresults from a variety of tests on raw materials cement, fine aggregate and coarse aggregate are discussed in this section.

2.1.1 Properties of the cement

The physical properties of cement are specific gravity, normal consistency, initial setting time and fineness of cement tests had been executed and the results are being presented in Table 1.

Table 1: Physical properties of cement.

S.No	Properties	Results
1	Specific gravity	3.15
2	Initial setting time	30 mins
3	Normal consistency	32%
4	Fineness of cement	7%

2.1.1 PROPERTIES OF FINE AGGREGATE

The physical properties of fine aggregate are specific gravity, fineness modulus and zone grading tests had been executed and the results are being presented in Table 2.

Table 2: Physical properties of fine aggregate.

S.No	Properties	Result
1	Specific gravity	2.67
2	Fineness Modulus	2.71
3	Grading	Zone II

2.1.3 PROPERTIES OF COARSE AGGREGATE

The physical properties of coarse aggregate are specific gravity, bulk density and water absorption tests had been executed and the results are presented in Table 3.

Table 3: Physical properties of coarse aggregate.

S.No	Properties	Result
1	Specific gravity	2.66
2	Bulk Density(Kgs/M^3)	1320
3	Water absorption(%)	0.52

2.1.4 CASTING OF SPECIMENS

The cube and cylinder specimens were prepared for the mixes

a)150 x 150 x 150 mm standard cubes for Compressive strength.

b)150mm diameter and 300 mm height standard cylinders for cylindrical compressive strength and split tensilestrength.

2.1.5 RESULTS OF TESTING OF SPECIMENS

The maximum compressive stress that is experienced by the material before its breakdown. Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.

2.1.6 COMPRESSIVE STRENGTH OF CUBES

Based on the results obtained from the experimentation, the results are presented below.

Nomenclature	Replacementof NAC withRAC (%)	7 days	28 days	56 days	90 days
RAC	0	26.96	34.73	39.4	43.33
RAC	25	25.9	33.84	38.44	42.57
RAC	50	25.44	33.18	37.62	40.95
RAC	75	24.07	32.29	35.89	37.55
RAC	100	23.69	30.44	34.51	34.88

From the above table shows that the compression strength of cubes RAC-0, RAC -25, RAC -50, RAC -75, and RCA-100 are listed respectively. Compressive strength are in decreasing order, when the recycled aggregate proportion increases the compressive strengths are decreasing and the decrease of compressive strength with respect to RCA with respect to RCA-25 to RCA-100.

2.1.7 COMPRESSIVE STRENGTH OF CYLINDERS

A compressive axial load is applied to molded cylinders or cores until failure occurs. The compressive strength of the specimen is calculated by dividing the maximum load achieved during the test by the cross-sectional area of the specimen. It refers to the strength of hardened concrete when measured by a compression test, which entails crushing cylindrical concrete in a compression testing machine. It tests the capacity of concrete to withstand a load before experiencing failure.

Based on the results obtained from the experimentation, the results are presented below.

Table 5: Results of compressive strength of cylinders

Nomenclature	Replacementof NCA withRCA (%)	7 days	28 days	56 days	90 days
RAC	0	21.62	27.62	31.43	34.66
RAC	25	20.85	27.12	30.66	34.04
RAC	50	20.09	26.51	30.09	32.77
RAC	75	19.19	25.85	28.7	29.99
RAC	100	18.78	24.38	27.58	27.85

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From the above table shows that the compression strength of cylinders RAC-0, RAC-25, RAC-50, RAC-75, and RAC-100 are listed respectively. Compressive strength are in decreasing order, when the recycled aggregate proportion increases the compressive strengths are decreasing and the decrease of compressive strength with respect to RAC-25 to RAC-100.

2.1.8 SPLIT TENSILE STRENGTH OF CYLINDERS

The split tensile test is an indirect way of evaluating the tensile test of concrete. In this test, a standard cylindrical specimen is laid horizontally, and the force is applied on the cylinder radially on the surface which causes the formation of a vertical crack in the specimen along its diameter.

Based on the results obtained from the experimentation, the results are presented below.

Nomenclature	Replacementof NCA withRCA (%)	7 days	28 days	56 days	90 days
RCA	0	2.16	2.75	3.13	3.47
RCA	25	2.08	2.7	3.07	3.39
RCA	50	2	2.64	3	3.28
RCA	75	1.91	2.58	2.87	2.99
RCA	100	1.87	2.43	2.75	2.79

From the above table shows that the split tensile strength of cylinders RAC-0, RAC-25, RAC-50, RAC-75, and RAC-100 are listed respectively. Compressive strength are in decreasing order, when the recycled aggregate proportion increases the compressive strengths are decreasing and the decrease of compressive strength with respect to RAC with respect to RAC-25 to RAC-100.

3.CONCLUSION

Based on the results of experimentation and the analysis of results, the following conclusions seem to be valid.

1. The literature review carried out of led to the identification of the need for conducting the feasibility studyfor producing recycled coarse aggregate concrete cubes and cylinders.
2. The cube and cylinder compressive strength decreases as the recycled coarse aggregate percentage increases in this study. Similarly, the split tensile strength also reduces.
3. The cube compressive strength of recycled aggregate concrete (replacing of natural aggregate with recycled aggregate from 25%, 50%, 75% and 100%) is in the range of 42.57 to 34.88 N/mm^2, whereas natural coarse aggregate concrete is having a cube compressive strength of 43.33 N/mm^2.
4. The cylinder compressive strength of recycled coarse aggregate concrete (replacing of natural coarse aggregate with recycled coarse aggregate from 25%, 50%, 75% and 100%) is in the range of 34.04 to 27.85 N/mm^2, whereas natural coarse aggregate concrete is having a cylinder compressive strength of 34.66 N/mm^2.
5. The split tensile strength of recycled coarse aggregate concrete (replacing of natural coarse aggregate with recycled coarse aggregate from 25%, 50%, 75% and 100%) is in the range of 3.39 to 2.73 N/mm^2, whereas natural coarse aggregate concrete is having a tensile strength of 3.47 N/mm^2.

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