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Study of strength and durability parameters of concrete with partial replacement of natural aggregates and cement with Recycled aggregate and Rice husk ash- A Review

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Abstract : *Concrete is one of the most widely used construction material ; it is usually associated with large amount of construction and demolition waste is generated every year in India. Therefore, there is strong need to expand the industrial applications of construction and Demolition waste (CD&W). Similarly, as cement accounts for up to 10% of global CO2 emission, it is imperative to reduce the embodied CO2 of concrete. As recycle concrete aggregate (RCA) and rice husk ash (RHA) is also a waste generated hugely in India, so this can be used as partial replacement of natural aggregate with recycle concrete aggregate and cement with rice husk ash. This paper presents a literature review concerning particularly on the enhancement method for RCA from construction and demolition wastes. The use of pozzolanic materials either for surface coating of RA or intermixed within the concrete are effective and feasible to improve the overall Strength of concrete. The brief objective of research will be take a two pronged approach by investigating the effect of rice husk ash with fixed proportion of recycled aggregates for all the mixes to evaluate the strength and potential structural applications.*

Keywords -*Construction and Demolition Waste , Rice Husk Ash , Recycle Concrete Aggregate*

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I. INTRODUCTION

The construction industry generates large amounts of Recycled aggregate (RA) derived from construction and demolition waste is suitable for partial or entire replacement for natural aggregate when making new concrete. Therefore, there is strong need to expand the industrial applications of construction and Demolition waste (CD&W). one of the most often used applications is as coarse aggregate. The replacement ratio of aggregates has a significant effect on the strength properties of concrete and Replacement of natural aggregates with up to 25% RCA does not alter the strength properties of concrete remarkably. Beyond 25% aggregate replacement, the compressive strength and modulus of elasticity of RCA concrete are affected (Thomas, Thaickavil, & Wilson, 2018). However, the aggregate from the CD&W used in the low-quality application such as paving concrete urban roads or for the non-structural purpose. This is due to the question raised regarding the performance of the recycle aggregate and the main issue to find out environmental friendly methods for improving the quality of the recycle aggregate.

When recycle aggregate is added to the concrete mix, it makes the concrete lighter than natural aggregate concrete mix. In other words, recycle aggregate concrete mixes are not denser than natural coarse aggregate concrete mixes. recycle aggregate concrete mixes have decreased the thermal conductivity and thermal diffusivity of the concrete mixes. At the same time recycle aggregate is increased the specific heat capacity of the concrete mixes. If recycle aggregate and different types of cement materials are compared, recycle aggregate decreased the density and thermal conductivity more than different types of cement materials (SF, PFA & GGBS) concrete mixes (Damdelen, 2018).The water absorption rate of RA depends on their total absorption capacity and size; generally, as the size decreases and total water absorption capacity increases, the absorption rate decreases, which will influence the amount of additional water. RA may have considerable angularity and surface roughness, which may result in increased inter-particles friction and, consequently, in poorer workability. Under these circumstances, to avoid the addition of extra water that would increase the effective w/c ratio, the use of water-reducing admixtures is an effective approach to decrease the water requirement of such mixes and maintain constant slump levels (Silva, Brito, &Dhir, 2018).

Improvement of RA with a fly ash or slag coating not only can improve the pore structure of RA, but also can react with existing Ca(OH)2 to produce additional secondary CSH products to strengthen the ITZ layer. Modified RA with CO2 can also react with hydration products to produce CaCO3 for micro-pore structure

strengthening. (Guo, et al., 2018) Therefore, in order to produce a more durable RAC it is suggested to use pozzolanic materials and CO2 treatment prior to use in concrete. Sometimes construction and demolition wastes are probably gypsum contaminated, which may lead to internal surface attack in new concrete containing recycle aggregate. According to (Abida, Nahhabb, Al-aayedia, &Nuhaira, 2018) the higher percentage of contaminated recycle aggregate the lower the strength and higher the expansion. Pozzolanic materials are either natural or artificial such as fly ash and rice husk ash have gained acceptance as mineral admixture and or cementations replacement materials in many parts of the world. Pozzolan materials could be incorporated into the concrete mix, and it could modify its properties at different aspects. In instead, the incorporation of pozzolanic materials resulting in the reduction of bleeding it also improves workability, reduced heat of hydration, increased the resistance to aggressive chemical attack and minimizes the environment pollution (Adnan & Omar, 2016).

II. PROBLEM STATEMENT

Annually a huge amount of construction and demolition (C & D) waste is generated which is really harmful and posing an adverse effect to the environment. Utilization of such waste as recycled aggregates and rice husk ash in concrete could be helpful both for environmental and economic aspects in the construction industry. Due to the waste disposal of landfills, increasing waste generation with the population have demanded the need for "recycling the C & D waste". Similarly, as cement accounts for up to 10% of global CO2 emissions (commercial aviation industry accounts for 3%), it is imperative to reduce the embodied CO2 of concrete. Thus, the sustainability of concrete is a major issue which needs to be addressed. Ways of achieving this is to recycle concrete waste back into concrete to reduce waste and use cement replacements with rice husk ash to reduce CO2 emissions.

III. LITERATURE REVIEW

Durability of recycled aggregate concrete - A review (Guo, et al., 2018) Explain the effects of use of RA on durability of concrete. The durability of RAC is usually weaker than NAC due to the adhered mortar on the RA. For this reason, the performance of RAC can be improved by enhancing the properties of RA or adding mineral admixtures. In this paper, the durability of RAC including the impermeability, chloride penetration resistance, carbonation resistance, frost resistance and alkali aggregate reaction is critically reviewed and Understanding the durability of concrete with RA. From these they conclude that the higher the amount of adhered mortar of RA, the higher the porosity and water absorption, leading to poor durability performance of RAC.

Expansion and strength properties of concrete containing contaminated recycled concrete aggregate(Abida, Nahhabb, Al-aayedia, & Nuhaira, 2018) Investigated the strength and durability characteristics of concrete made with gypsum contaminated fine and coarse RCA with different replacement dosages ranging from 0 to 100%. The source of the contaminated recycled aggregate was crushed gypsum-plastered concrete cubes. The investigated properties were expansion, compressive strength, splitting tensile strength, and modulus of rupture. From the results of the experimental The compressive strength was lower with increasing the replacement level of virgin aggregate by contaminated RCA and The splitting tensile strength and flexural strength generally exhibited trend similar to compressive strength.

Strength and durability of concrete containing recycled concrete aggregates(Thomas, Thaickavil, & Wilson, 2018) This research intends to analyse Strength and durability properties of concrete made with recycled concrete aggregates (RCA) they studied by an experimental investigation. The variables considered in the study are water-cement ratio, cement content and percentage of replacement of coarse aggregate (CA). Compressive strength, splitting tensile strength, modulus of elasticity and flexural strength are evaluated to study the influence of replacement of stone aggregates with recycled concrete aggregates in concrete. The durability properties such as water absorption, acid attack resistance and chloride permeability they also determined. In result it is found that the replacement ratio of aggregates has a significant effect on the strength properties of concrete.

Effect of cement and admixture on the utilization of recycled aggregates in concrete(Tahar, Ngo, El Hadj Kadri, Debieb, & Aggoun, 2017) Investigated the effect of type of cement and admixture on fresh and hardened properties of concrete with coarse and fine recycled aggregates (RA) and the fresh (slump, air content and density) and hardened (compressive strength and elastic modulus) properties of recycled aggregates concrete (RAC) are analyzed and compared with those of natural aggregates concrete (NAC). In results of this experimental investigation they conclude that the slump of RAC decreases when the percentage of RA Increases and the slump of RAC with RS is almost constant when the percentage of RA is lower than 30%. However, there is significant slump loss beyond 30% of substitution and the density of RAC decreases with the increase in percentage of RA for different combination of cement and admixture.

Investigation of 30% recycled coarse aggregate content in sustainable concrete mixes, (Damdelen, 2018).There are 2 concrete groups to investigate and compare the effects of 30% RCA and the main aim helps to

use 30% RCA content in buildings for controlling CO2 emissions . This research carries out a thorough investigation of fresh & hardened RCA concrete, the thermal performance (thermal properties & thermal dynamic properties) with 30% recycled coarse aggregate content. In Experimental result found that When RCA is added to the concrete mix, it makes the concrete lighter than natural aggregate concrete mix and It decreased the thermal conductivity and thermal diffusivity but this mixture useful than the ordinary concrete.

Experimental investigation on rice husk ash as cement replacement on concrete production (Alex, Dhanalakshmi, & Ambedkar, 2016) In this paper RHA has been used as cement additive in concrete making. The objective of this work is to optimize the grinding conditions (15 and 60 min) and the amount of RHA replacement (10, 15 and 20 %) required for various types of RHA used as a supplementary cementitious material. Results of characterization of RHA, strength development and pozzolanicbehavior of RHA are also determined. Thus, it could be concluded that addition of RHA as SCM proves to be the better option for sustainable development, thereby solving the negative impacts during cement manufacturing process like CO2 emission, resource depletion, high cost and also the solid waste disposal problem associated with agricultural waste activity to a certain limit and The average particle size decreased with increasing grinding time whereas, the specific surface area increased with increasing grinding time for all types of RHA samples.

Rice husk ash as a partial replacement of cement in high strength concrete containing micro silica: Evaluating durability and mechanical properties (Zareeia, Amerib, Dorostkarc, & Ahmadic, 2017) Tried to evaluate the effects of RHA addition in cement according to some experimental background of what influence theses admixtures may have on concrete composition. they presented different levels of RHA addition from 0 to 20% followed by some tests to examine the influence of additions on basic properties of concrete and Mainly this paper presents benefits resulted from various ratios of rice husk ash(RHA) on concrete indicators through 5 mixture plans with proportions of 5, 10, 15, 20 and 25% RHA by weight of cement in addition to 10% micro-silica (MS) to be compared with a reference mixture with 100% Portland cement. The performance of rice husk ash in concrete is of factors influencing the amount of silica added. This is because rice husk ash contains 85% to 95% weight percent of amorphous silica. Rice husk ash as a pozzolanic reactive material can be used to improve surface area of transition zone between the microscopic structure of cement paste and aggregate in the high-performance concrete.

Improvement of the compressive strength and water absorption of recycled aggregate concrete by using uncontrolled burnt rice husk ash (Adnan & Omar, 2016) studied the performance of Recycled Aggregate Concrete (RAC) containing Uncontrolled Burning Rice Husk Ash (UBRHA). In the term of compressive strength, water absorption and ultrasonic pulse velocity has been investigated. In this study the recycled aggregate has been used in various percentages such as 0%, 50% and 100%, and UBRHA proportions from 0%, 5%, 10%, 15% and 20%. From this study, it was found that the compressive strength of RAC is decreases when RA percentage increases. However, the utilization of URBHA as cement replacement material could enhance the performance of recycled aggregate concrete. In this study, it was found that the optimum replacement for UBRHA is 5% and he result of compressive strength is higher compared to concrete containing RA without UBRHA.

IV. OBJECTIVES

- To study the effect of different volume of recycle aggregate and rice husk ash on strength parameters of Concrete mixes with Natural aggregates and cement respectively.
- To compare the mechanical properties of Recycled concrete aggregates and Rice husk ash, with conventional concrete.
- To Check durability Parameters of Concrete with partial replacement of NA and Cement with RA and Rice Husk Ash.

V. EXPERIMENTAL MATERIAL

A. Cement

When it comes to different grades of cement, the 43 Grade OPC Cement provides consistently higher strength. As per the Bureau of Indian Standards (BIS), the grade number of a cement highlights the minimum compressive strength that the cement is expected to attain within 28 days. For 43 Grade OPC Cement, the minimum compressive strength achieved by the cement at the end of the 28th day shouldn't be less than 43MPa or 430 kg/sqcm and Cement is the major raw material used in construction Industry. Therefore, quality of cement must be checked before using it as a building material. Following tests can be performed on cement in laboratory to check its quality.

Physical Properties Properties of Cement
Method of Test / References: IS: 4031(Part 4; Part 11; Part 5; Part 3;Part 1; Part 6;) 1988, RA 2009

Sr No.	Name of Test	Unit	Test Result	Specified Limits (IS 269-2015)
				43 Grade
1	Standard Consistency	(%)	31.0	----
2	Density of cement	(g/cc)	3.15	----
3	Initial Setting Time	(min)	185	30 Min
4	Final Setting Time	(min)	295	600 Max
5	Soundness by Le- Chateliers Method	(mm)	0.67	10 mm Max
6	Fineness by Dry Sieving	(%)	3.4	10% Max
7	3 Days Compressive Strength	(N/mm^2)	25.5	23 Min
	7 Days Compressive Strength		35.0	33 Min
	28 Days Compressive Strength		47.0	43 Min

B. **Rice Husk Ash**

The use of durability enhancing mineral admixtures or supplementary cementing materials has gained considerable importance the last decade or so as a key to long service life of concrete structures. There are many mineral admixtures that are used in way through out the world but rice husk ash stands out as an eco-friendly, sustainable and durable option for concrete.

Physical Properties of Rice Husk Ash: Method of Test / References: IS:1727: 1967, RA - 2013

Sr No.	Name of Test	Unit	Test Result
1	Standard Consistency	(%)	29
2	Density of Rice Husk Ash	(g/cc)	2.26
3	Initial Setting Time	(min)	175
4	Final Setting Time	(min)	305
5	Fineness by Wet Sieving	(%)	30
6	7Days Compressive Strength	(N/mm^2)	26
	28 Days Compressive Strength		42

C. **Coarse Aggregate and Recycle Concrete Aggregate:**

Coarse Aggregate

Aggregate plays an important role in construction. Aggregates influence, to a great extent, the load transfer capability of structure. Hence it is essential that they should be thoroughly tested before using for construction. Not only that aggregates should be strong and durable, they should also possess proper shape and size to make the structure act monolithically. Aggregates are tested for strength, toughness, hardness, shape, and water absorption.

Recycle Concrete Aggregate

When structures made of concrete are demolished or renovated, concrete recycling is an increasingly common method of utilizing the rubble. Concrete was once routinely trucked to landfills for disposal, but recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws, and the desire to keep construction costs down.

1)Sieve analysis for Coarse Aggregate and Recycle Concrete Aggregate
Fineness Modulus:

Details	Result (10 mm)	Result (20 mm)	Result RCA (10mm)	Result RCA (20 mm)
Fineness Modulus	6.93	7.17	6.73	7.10

3) Specific Gravity & Water Absorption of 10mm & 20mm Coarse Aggregate and Recycle Concrete Aggregate IS: 2386 (Part 3)

Sr no	Details	CA (10mm)	CA(20mm)	RCA (10mm)	RCA (20mm)
1	Specific Gravity (Bulk)	2.886	2.903	2.996	2.983
2	Apparent Specific Gravity	3.031	3.010	3.031	3.010
3	Water Absorption	1.655	1.216	1.701	1.30

4) Aggregate Impact Value and Crushing Value – IS: 2386 (Part-4) and

Sr no	Details	Result (10mm)	Result (20mm)	ResultRCA (20mm)
1	Aggregate Impact Value %	13.60	12.63	13.60
2	Aggregate CrushingValue%	13.67	12.92	14.03

5) Flakiness and Elongation Test (IS) 2386 Part 1 (For 10mm & 20mm Aggregate)

Sr no	Details	Result (10mm)	Result (20mm)	ResultRCA (20mm)
1	Flakiness Index%	11.98	10.05	9.00
2	Elongation% Index	10.94	10.59	9.09
3	Combined (EI+FI) %	22.91	20.65	18.09

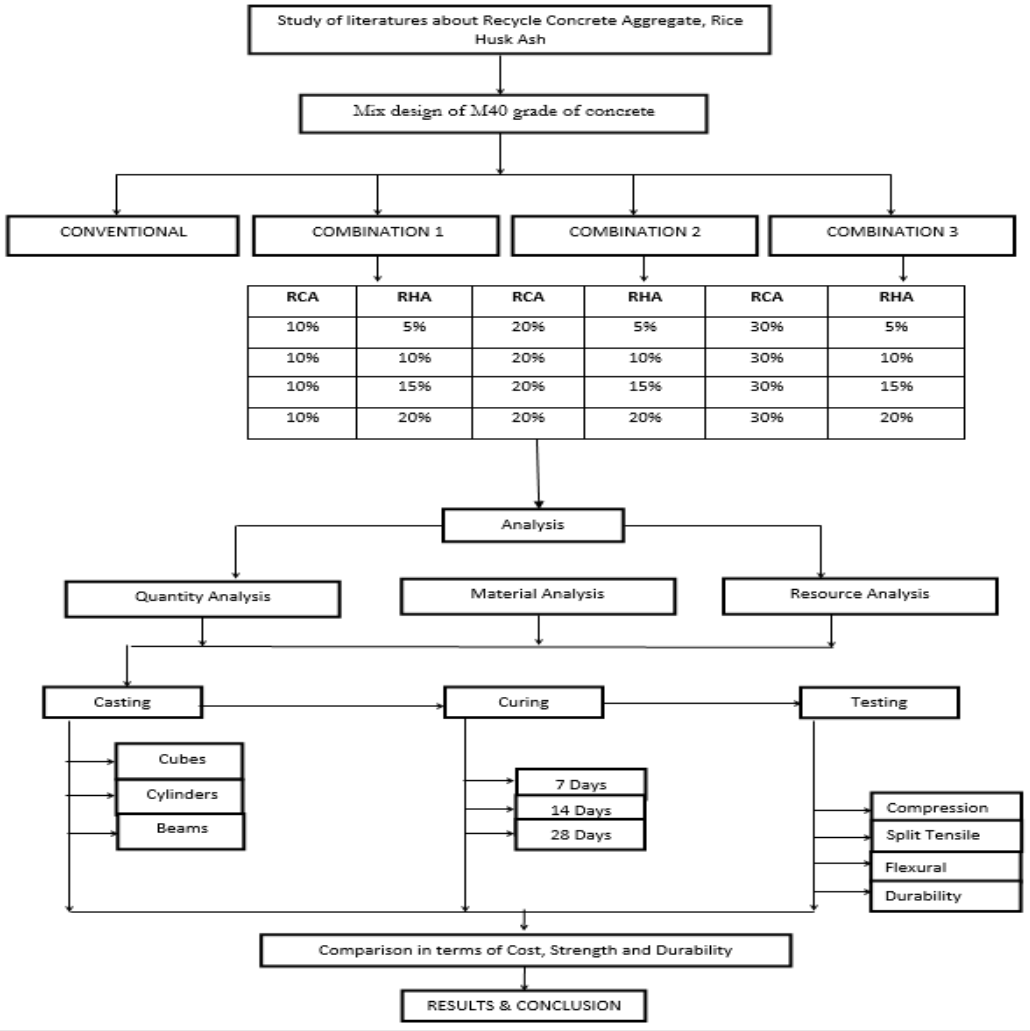
D. **Fine Aggregate:**

There are different methods for testing of sand quality at construction site for concrete construction. Quality of sand is as much of importance as other materials for concrete. Aggregate most of which pass through 4.75 mm IS sieve is known as fine aggregate. Fine aggregate shall consists of natural sand, crushed stone sand, crushed gravel sand stone dust or arable dust, fly ash and broken brick (burnt clay).

Physical Test on Fine Aggregate (Sand) 1) Sieve Analysis of Fine Aggregate (River Sand & Crushed Sand) Fineness Modulus:

Details	River Sand	Crushed Sand
Fineness Modulus	3.04	3.06

VI. METHODOLOGY



VII. Expected Outcomes

- Strength & Durability parameters will be increased.
- Cost optimization will be using RA and RHA.
- Contributing towards Sustainable development & also will be useful for the society **service.**

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