USING RICE HUSK ASH AND CDW IN STANDARD CONCRETE

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Abstract

In major Indian cities there is a surge in construction and demolition waste (CDW) quantities causing an adverse effect on the environment. The use of such waste as recycled aggregate in concrete can be useful for both environmental and economic aspects in the construction industry. This study discusses the possibility to replace natural coarse aggregate (NA) with recycled concrete aggregate (RCA) in structural concrete. An investigation into the properties of RCA is made using crushing and grading of concrete rubble collected from different demolition sites and under construction roads locations around Neelbad Bhopal. Aggregates used in the study were: natural sand, dolomite and crushed concretes obtained from different sources. Groups were designed to study the effect of recycled coarse aggregates quality/content, cement dosage, use of superplasticizer. Tests were carried out for: compressive strength, flexural strength and workability. The results showed that the cement in concrete can be replaced by cow dung ash up to 10%. Concrete rubble could be transformed into useful recycled aggregate and used in concrete production with properties suitable for most structural concrete applications. A significant reduction in the properties of recycled aggregate concrete (RAC) made of higher percentage RCA was seen when compared to natural aggregate concrete (NAC), while the properties of RAC made of a blend of 60% NA and 40% RCA showed not much significant change in concrete properties.

Keywords Cement Concrete, flexural strength, Rice Husk Ash, Recycled Aggregate, Strength parameters, water absorption, Workability.

1 Introduction

Construction sector consumes maximum amount of natural resources and energy. Manufacturing of construction products requires raw materials and energy. Majority of the raw materials are mined from the earth. Natural resources are mined indiscriminately for construction purposes, causing environmental problems. Energy is expended for converting the raw materials into useful construction products. In addition, the construction materials and products are hauled over long distances spending fossil fuel energy. There are many instances where laws have been enforced to preserve precious natural resources and even ban mining of sand from the river beds. Raw material extraction, manufacture of materials, transportation and construction cause environmental damage and greenhouse gas (GHG) emissions. Estimates show that more than 40% of the total energy and 30% of the material resources are consumed by the habitat and related infrastructure some researchers (Ruuska and Hakkinen) estimate that better construction and use of buildings in the European Union

would influence 42% of energy consumption and more than 50% of all extracted materials. There is an urgent need for minimizing the mining of raw materials and reducing energy consumption.

To reduce the dependence on natural material as the main source of concrete agricultural waste and animal waste provide an alternative for construction industries. Cattle manure ash or cow dung ash are considered as a waste material which could have a promising future in construction industries as partial or full substitute of fine aggregate. The use of cow dung ash in concrete provides potential environment as well as economic benefits for all construction industries, particularly in those areas where a considerable amount of cow dung ash is produced. The chances of pollution due to cow dung ash will be reduced and it will be cost effective for construction. The use of waste material in new construction helps to save of energy. The use of cow dung ash in concrete mix can also solve the problem of disposing these waste materials.

C&D waste materials include the waste generated during new constructions, renovations, or demolition of RCC structures, roads, bridges etc. Segregation of RA [RCA and RFA] from other components of C&D waste like wood, asphalt shingles, metal, cardboard, bricks, plastics, soil, etc, is a major task which consumes time and finances. The use of C&D waste in building construction is yet to gain popularity in India. Creating awareness on use of RA in concrete constructions is one of the environment friendly solutions for sustainable construction, and is the need of the hour. The notification of Central Public Work Department (CPWD) in 2016 has made it mandatory for the CPWD and National Building Construction Company (NBCC) to recommend utilization of Recycled Concrete Aggregates (RCA) generated within a radius of 100km of construction in Lean Concrete, Plain Cement Concrete (PCC) and Reinforced Cement Concrete [RCC]. A clause recommends partial replacement of natural coarse aggregates with Recycled Concrete Aggregates; 25% for plain Cement Concrete, 20% only up to M25 grade RCC and 100% in Lean Concrete in less than M15 grade.

Infrastructure services include management of water supply, sanitation, solid waste, land and urban environment etc. Studies show that about 25% of Municipal Solid Waste is contributed by construction and demolition. India produces about 165-170 MT of construction debris annually. By the year 2047, municipal solid waste generation in India is expected to reach 300 MT and the land requirement for disposal of this waste would be 169.6km2 as against the 20.2km2 in 1997 for management of 635 48MT

2 Literature Review

To supplement automated search, a manual search was also done. The manual procedure involved searching the reference sections of the papers identified by the automated search and referring the text/reference books. Any relevant references within those papers/reference books were followed up

- **Manuel Contreras Llanes et.al. 2021** carried out research for production of eco-friendly concrete paver units using recycled aggregate as coarse aggregate. They prepared samples containing different percentages of aggregate replacements with recycled aggregates & conducted different tests on paver units. The results explained that up to 50% replacement can be a good solution. .The values of water absorption lesser than 6.0% and tensile strength upper than 3.6 MPa were obtained, which are similar to those of a reference sample and within the limit values established by the regulations.

- **Natt Makul et.al. 2021** The proposed strategy could be to sequentially separate demolition waste such as roof finishes, waterproof materials, interior and exterior materials, etc. Closing life cycles is the main approach used for efficient structures for the recycling and reuse of construction and demolition waste in the production and recovery of materials, especially when recycling and reusing materials. In the life cycle, the recycling of recovered materials allows them to be used for new construction purposes, avoiding the use of natural concrete aggregates. Government, design institutes, construction departments and project managers

should be involved in the creation and use of RCA.

- **Athanasia Soultana et.al. 2021** produced the cement mortars using the upgraded recycled concrete aggregates (sand granulometry) for the total replacement of natural aggregates and recycled concrete fines activated through a thermal treatment method as a partial cement substitution material. Cement mortar specimens were tested for their compressive and flexural strength, density and water absorption performance. The results showed that the combined usage of upgraded recycled concrete sand for total replacement of primary crushed sand and recycled concrete fines as partial cement replacement material is a promising option to produce cement mortars.

- **Abbas O. Dawood*, Hayder AL-Khazraji, Raad S. Falih 2021** the impact of utilizing polyethylene terephthalate (PET) squanders as an incomplete substitution of normal sand is explored to concentrate on the mechanical and actual properties of cement. Fine total (sand) is somewhat supplanted by comparable weight rates of PET waste particles while keeping up with any remaining extents. Mechanical tests for pressure, parting, flexure, modulus of flexibility, energy ingestion, and hub strain just as actual tests for thickness, shrinkage, and assimilation, are performed. Furthermore, the ultrasonic heartbeat speed is introduced. All examples are noticed for 7, 14, and 28 days. The tests results introduced that the presence of PET particles changed the physical and mechanical properties of delivered cements. Actual properties (thickness and ultra sound speed) step by step diminished as PET proportions expanded, while an expansion in retention rate was noticed. The discoveries additionally uncovered an expansion in energy assimilation and pivotal strain of the specimenswith5%–20%replacementpercentages, while the modulus of flexibility diminished as the PET substance expanded.

- **Mônica Batista Leite & Marcela Crusoé Figueiredo 2020** evaluated the influence of the Portland cement replacement by 0, 5%, 10%, 15% and 20% of Construction and Demolition Waste (CDW) filler. It was found that all SCC mixtures, at 28 days, had the average compressive strength above 50 MPa, without showing significant loss with up to 20% of CDW filler. For splitting tensile strength, SCC recycled mixtures reached up to 92.5% of the SCC used as reference. Absorption rate and air voids index of SCC recycled mixtures had a maximum increase of 1.60%Compared to the reference one. So, it is possible to conclude that the use of the

	Using rice husk ash as Cement Replacement by volume, is feasible for SCC production.		
S.No.	Sample ID	Cement %	Cow dung Ash %
1	CONC 0	100	0
2	CR 5	95	5
3	CR 10	90	10
4	CR 15	85	15
5	CR 20	80	20
	Using Recycled aggregate as Coarse Aggregate Replacement		
S.No.	Sample ID	Coarse Aggregate %	Recycled aggregate %
1	CONC 0	100	0
2	AR 10	90	10
3	AR 20	80	20
4	AR 30	70	30
5	AR 40	60	40
6	AR 50	50	50
7	AR 60	40	60

CDW filler up to 20% in substitution of cement,

3 Methodology Adopted

In this work, the mix design and testing method is used to perform Utilisation of rice husk ash & Recycled Aggregate in Concrete as per IS-standards. In order to study the effect of cow dung ash as a partial replacement of cement & Recycled aggregate as replacement of coarse aggregates.

Table 1: Cases considered for study

4 Results

The results got from tests directed on solid clearing blocks have been talked about in this part.

4.1 Rice husk ash as cement Replacement

Table 2: 28-days compressive strength result MPA

Mix	Rice husk ash (%)	Compressive strength MPa
CONC 0	0	35.59
CR 5	5	36.35
CR 10	10	35.56
CR 15	15	29.02
CR 20	20	26.53

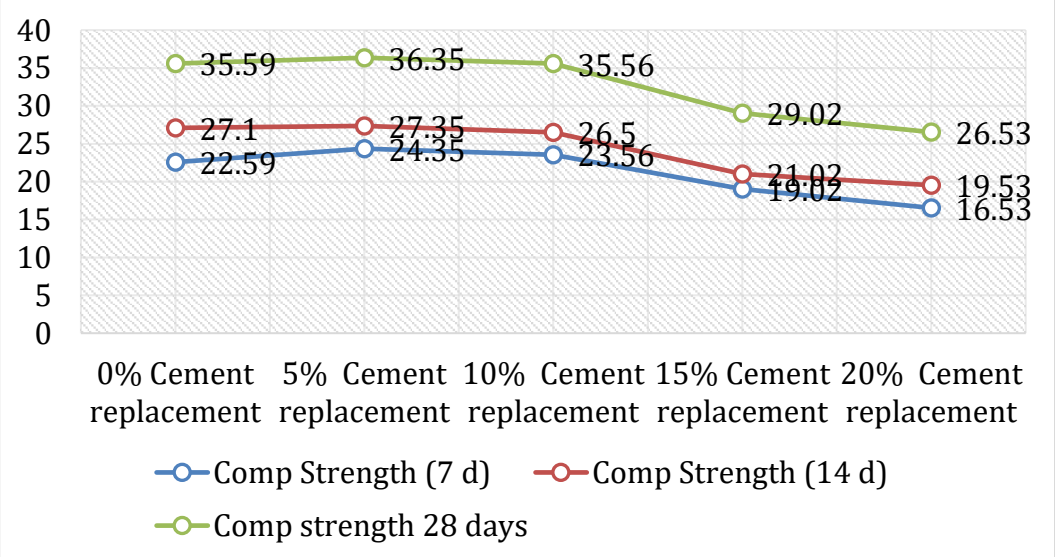

Figure 1: Comparative values of compressive strength at different age

Table 3: 28-days flexural strength result MPA

Mix	Rice husk ash (%)	Flexural strength MPa
CONC 0	0	4.61
CR 5	5	4.79
CR 10	10	4.73
CR 15	15	4.65
CR 20	20	4.60

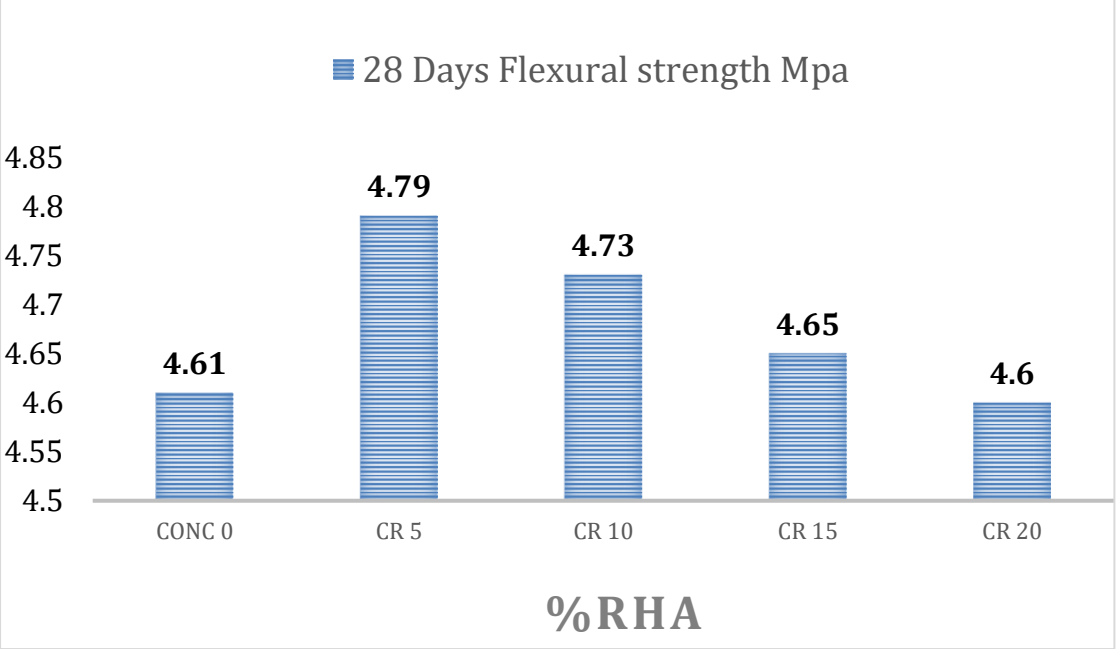

Figure 2: 28-days *Flexural* strength result MPa

Table 4: Cement replacement vs. Slump

Mix	Rice husk ash (%)	Slump mm
CONC 0	0	95
CR 5	5	98
CR 10	10	92
CR 15	15	90
CR 20	20	85

4.2 Recycled Aggregate as Coarse Aggregate Replacement

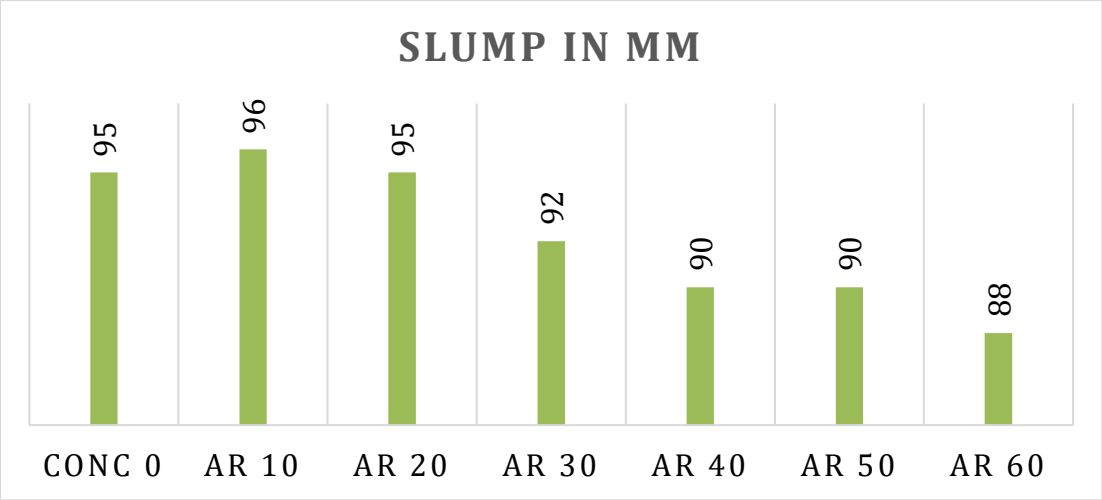

Figure 3: *Aggregate replacement* Vs. Workability

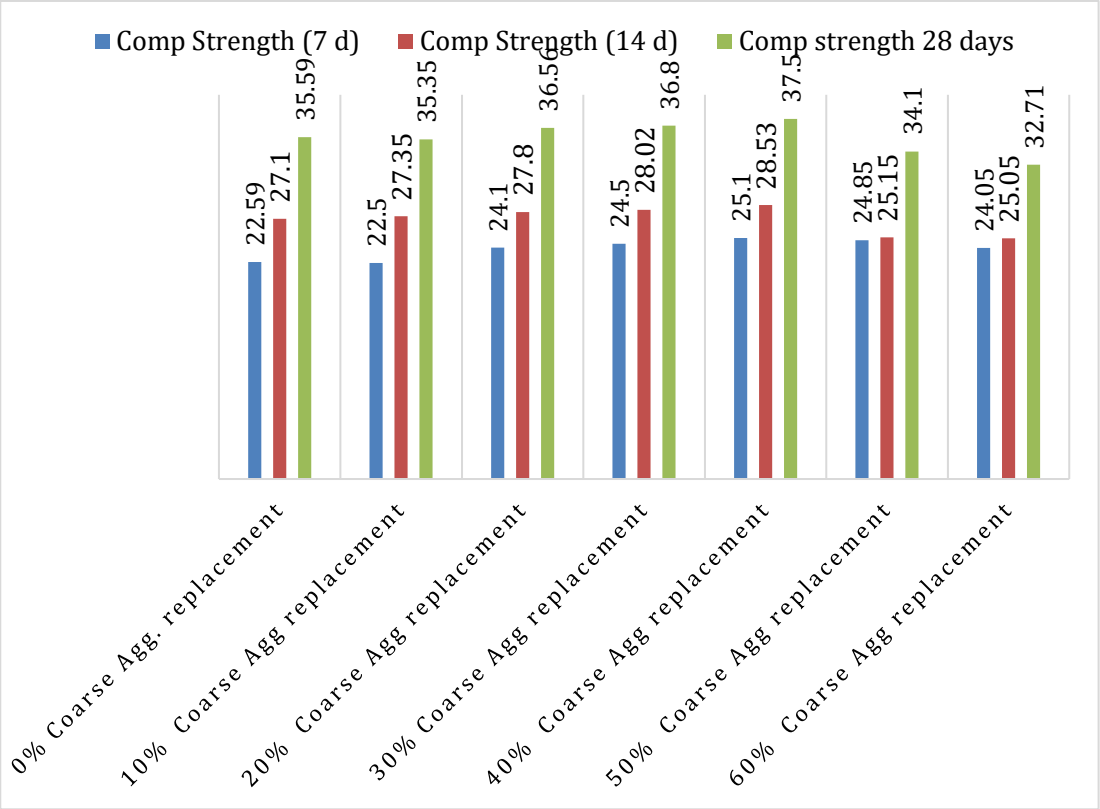

Figure 4: Compressive Strength of M30 Grade Contain of CDW

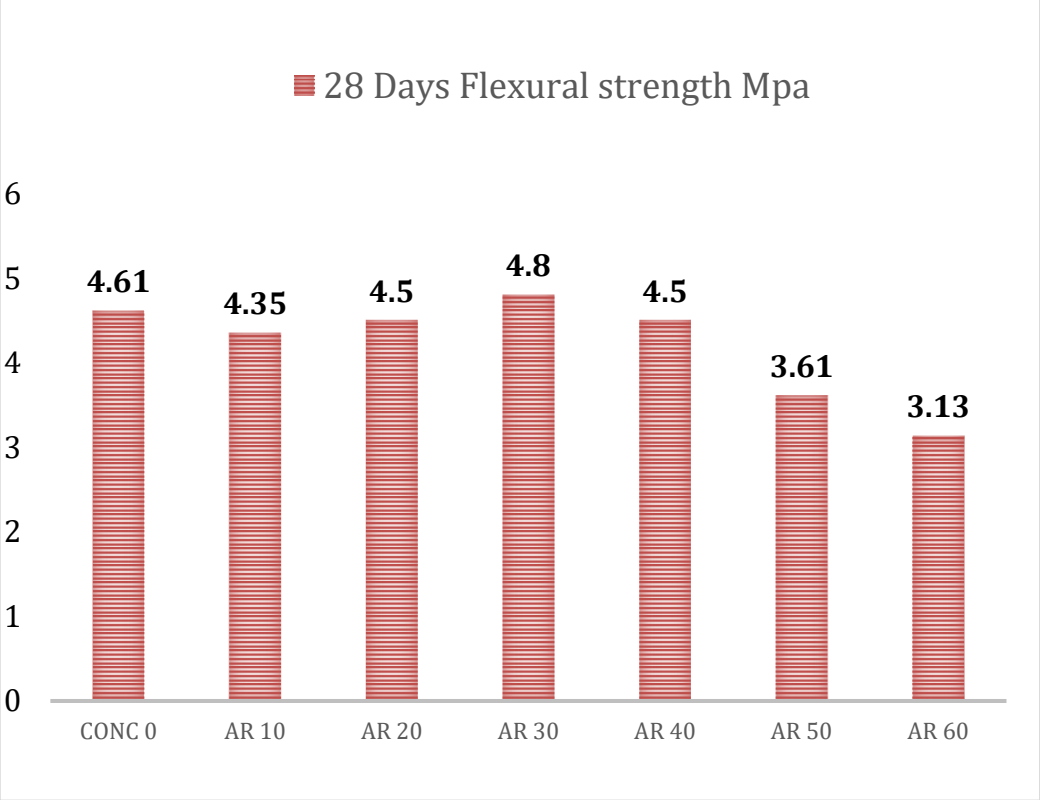

Figure 5: Flexural Strength of M30 Grade Contain of CDW

5.5 Test results for sample with optimum replacement

From the previous sections the optimum amount of replacements are as following.

- Optimum % replacement of cement with rice husk ash - 10 %
- Optimum % replacement of coarse aggregate with recycled aggregate – 40%

One sample of M30 grade concrete was prepared with replacement of cement with rice husk ash & % replacement of coarse aggregate with recycled aggregate respectively.

Table 4: Cement replacement vs. Slump

28 days Compressive strength (MPa)	28 days Flexural strength (MPa)	Slump Value (mm)
31.25	3.90	98

5 Conclusion

Both compressive strength and flexural strength of concrete increases initially with the inclusion of RHA and then decreases. Maximum compressive strength and flexural strength of concrete at 28 days is found when cement is replaced up to 5% and 10% by RHA in concrete mix. The optimum level for the replacement (by weight) of RHA for moderate exposure condition i.e. M30 grade, is found to be 5% to 10%. The test result clearly shows that AR40 mix which was obtained by using 40 % of recycled aggregates yields a better compressive and tensile strength. Even there is slight reduction in the strength compared to Conventional Concrete it does not have an adverse effect. RHA & Recycled aggregate based concrete is an economic environmental friendly solution to developing nations like India. The price of 1 ton of RHA is only a small fraction of one ton production of natural Aggregate & Recycled aggregate are also cheap.

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