Comparative Study and Performance of Recycled Aggregate in Conventional Concrete

BHUSHAN INGOLE1, DINESH PATIL2, SHUBHAM INGLE3, YOGESH PIMPARKAR4, ASHISH P. WAGHMARE[5]

[1, 2, 3, 4] *U. G. Student, Department of Civil Engineering, D. Y. Patil S. O. E. T, Lohegaon, Pune, Maharashtra, India*

[5] *Associate Professor, Department of Civil Engineering, D. Y. Patil S. O. E. T, Lohegaon, Pune, Maharashtra, India*

Abstract- ***With the advance development in construction industry, the usage of natural aggregate is getting and more severe. In order to reduce this demand of natural aggregate, recycled aggregate can be used as a replacement material. On other hand demolition of structures are taking place and producing lots of solid waste which is difficult to dispose. These issues can be handled positively which includes recovery, reuse and recycling techniques. This paper presents an effective way to reclamation and reuse of recycling aggregates. Study shows that the use of recycled aggregate as a replacement material has a significant effect on the properties of concrete like compressive strength, split tensile strength, and flexural strength. 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. Use of recycled aggregate also reduces the environmental problems like CO2 emission and dust. Use of recycled aggregate with appropriate treatment method proves as ideal aggregate used in construction industry***

Indexed Terms- ***Construction demolition waste, recycled concrete aggregate, Conventional aggregate, curing period, partial replacements, laboratory tests.***

I. INTRODUCTION

Construction industry is set to become third largest industry globally by 2025. Concrete is one of the most widely used construction material in the world mainly due to its favourable features like Durability, versatility, satisfactory compressive strength, cost effectiveness etc. Whole industry is relying on natural resources for fulfilling this demand resulting depletion of natural resources. On other hand huge amount of construction demolished waste is generated and disposed it into the nature as a waste material. Out of the total construction demolition waste, 40% is of concrete, 30% ceramic's, 5% plastics, 10% wood, 5%metal, & 10% other mixtures. As reported by market insider global construction output is forecast to rise US$ 12.7 trillion in 2022, up from US$ 10.6 trillion in 2017. These figures indicate a tremendous growth in the construction sector, almost 25% in 5 Years. Mining, blasting and crushing operations are carry out to obtain aggregates from raw rock materials. Mining & blasting works affects the natural resources & releases dust and dirt into the air which causes health problems. Increased mining operations decreases natural sources of rock and causes various problems. This project reports the basic properties of and recycled coarse aggregate and also compares these properties with natural aggregates. Basic changes in all aggregate properties are determined and their effects on concreting work are discussed at length.

II. OBJECTIVES

- Replacement of natural coarse aggregate with recycled coarse aggregates.
- Enhancement of RCA properties. Producing durable and moderate strength concrete using RCA and admixtures.
- To achieve economy in construction.
- To reduce the impact of mining works on environment

III. SCOPE OF WORK

- It would completely or partially replace the conventional aggregate.
- Reclamation of usable concrete from debris and construction waste.
- To avoid problematic landfills and avoid soil infertility.

IV. METHODOLOGY

Concrete mix design calculation as per is 10262-2009 is adopted to calculate appropriate and relative quantities with the objective to manufacturing m30grade of concrete to achieve necessary strength, durability, and workability. M30 grade of concrete is prepared and the tests are conducted for various substitutes of rca. Natural coarse aggregate has been replaced with 20%, 30% and 40% by recycled coarse aggregate.

Method of hand mixing used to mix the ingredients homogeneously and quantities are taken by weigh batching method

V. EXPERIMENTAL RESULTS

Based on the results of this experimental investigation, the following conclusions are drawn:

1. The peak strain value of RAC generally increases with the increase of the RCA content. For the RCA replacement ratios of 80%, 90% and 100%, the peak strain values increase by about 15% compared to that of the NAC.
2. The compressive strength of RAC including the prism compressive strength at the standard age and at two years, the flexural strength and the cube compressive strength generally increase with the increase of RCA content
3. The prism compressive strength of RAC at two years is higher than that of the specimens at the standard age.
4. Poisson's ratio of RAC ranges from 0.17 to 0.24.
5. The strength in RAC structures can be predicted by our proposed analytical expression of normalized stress-strain relation of RAC.

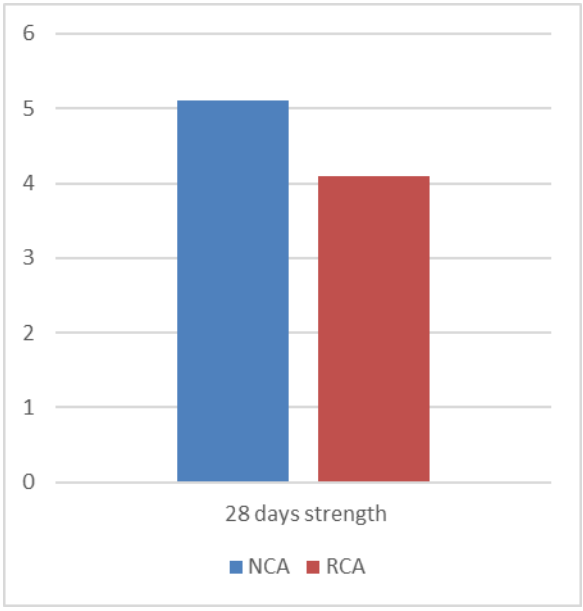
Table 1 Physical properties of natural and recycled concrete aggregate.

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%

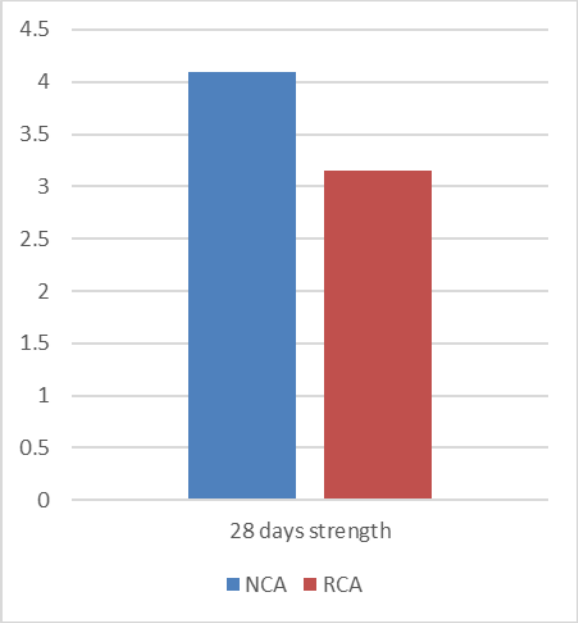
Table 2: Compressive strength

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

Graph 01. Flexural Strength Comparison



Graph 02. Splitting Strength Comparison



CONCLUSION

Recycled concrete aggregate made from construction and demolition waste will have porous nature than NCA. Cement stone, dust particles present on the surface will make them smooth, resulting reduction in bond strength. High water absorption capacity will require more amount of water will increase w/c ratio. Higher water cement ratio decreases compressive strength of concrete. Workability of concrete also reduces due to RCA.

1. From compressive strength test results it is observed that 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 upto 30% is feasible.
2. Cement stone/paste present on surface of the concrete may lead to chemical reactions like alkali aggregate reaction. Use of fly ash may reduce alkali aggregate reaction.
3. Strength of concrete increases linearly with the increase in percentage of fly ash upto the limit, further addition of fly ash reduces strength. Hence 30% fly ash is feasible to replacement of cement.
4. Cost of processing of recycled concrete aggregate and transporting it to the site will prove economical over production and transportation of natural aggregate. Natural aggregate requires mining, blasting, transporting and breaking of this material into required sizes along with transportation facility.
5. Rough surface of RCA will contribute to additional strength gain and hence care should be taken to achieve rough surface of RCA as discussed in the paper.
6. Silica fume is used to made concrete due to its extreme fineness and high silica content. Silica fume is added to make the concrete to improve its properties, in particular its compressive strength, bond strength and abrasion resistant.

REFERENCES

[1] Aditya G. Kutwad, Manoj B. Nikam, Mahav T. Wagare, Vinay B. Birajdar, Gaurav C. Vispute, A. A. Khalil, – “Study and Use of Recycled Aggregate with Fly Ash in Concrete”

[2] Enric “Recycled Aggregates for Concrete: Problems and Possible Solutions”.

[3] Janani Sundar, P Devadas “Impact of chemical admixture on Recycled Aggregate Concrete”

[4] Mirajana Malesev, Vlastimir Radonjanin and Snezana Marinkovie “Recycled Concrete as Aggregate for Structural Concrete Production”

[5] Parameshwar S. kori and Ramesh Bashetty “Methods of enhancing the performance of recycled aggregate concrete through the use of supplementary cementations materials”

[6] Sami W. Tabsh , Akmal S. Abdelfatah “Influence of recycled concrete aggregate on strength properties of concrete”

[7] Sandrine Braymand, Pierre FRCAois, FRCAoise Feugeas and Christophe Fond “Rheological Properties of recycled aggregate concrete using Super plasticizers’

[8] Sidam Gangaram, Vankadothu Bhikshma, Maganti Janardhana “Development of M30 Grade Recycled Aggregate Concrete by Replacing 100% Virgin Aggregate with Recycled Aggregates and Partial Replacement of Mineral Admixtures”

[9] Parekh D.N. & Dr. Modhera C.D. "Assesment of recycled aggregate concrete"

[10] D. KL. Ramadevi, Dr. R. Chitra "Concrete using recycled aggregate"

[11] Jitender Sharma, Sandeep Sinha "Study of recycled concrete aggregate"

[12] Atik Sarraz, Md. Hossain Nadim and A.F.M. Ashik Rahman "Comparative study of Recycled Concrete Aggregate as a Construction Material"

[13] M. Etxeberria. A. R. Mari'. E. Va'zquez "Recycled aggregate concrete as a structural material"

[14] Mahmud M. Abu Zeid, M. A. Atta, Mohammad Y. Abdellah – "Study of Recycled Aggregates in Casting of Shallow Foundation"

[15] Neeraj Jain, Mridul Garg and A. K. Minocha – "Green Concrete from Sustainable Recycled Coarse Aggregates Mechanical and Durability"

[16] Ashraf M. Wagih, Hossam Z. EI-Karamoty, Magda Ebid, Samir H. Okba – "Recycled Construction and Demolition Concrete Waste as Aggregate for Structural Concrete"

[17] Ahmed Shaban Abdel-hay "Properties of Recycled Concrete Aggregate Under Different Curing Conditions"

[18] Kirti Kanta Sahoo, Manoranjan Arakha, Pradip Sarkar, Robin Davis, Suman Jha - "Enhancement of Properties of Recycled Coarse Aggregate Concrete Using Bacteria"

[19] Zine-El-Abidine Tahar, Tien-Tung Ngo, El Hadj kadri, Adrien Bouvet, Farid Debieb, Salima Aggoun – "Effect of Cement and Admixture on The Utilization of Recycled Aggregates in Concrete"

[20] Valerie Spaeth, Assia Djerbi Tegguer – "Improvement of Recycled Concrete Aggregate Properties by Polymer Treatments"

[21] IS 10262 (2009): Guidelines foe concrete mix design.

[22] IS 516 (1959): Methods of tests for strength of concrete.

[23] IS 2386-3 (1963): Methods of test for aggregates for concrete.

[24] www.theconstructor.org

[25] www.ijera.com

[26] www.researchgate.net