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Cost and Quality Analysis of Bio-Deposited Recycled Aggregates Concrete

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Abstract: ***Internationally, the utilization of concrete particularly high-strength concrete has been increasing day-by-day due to rapid industrialization and infrastructural developments. An enormous quantity of natural coarse aggregate is required for making concrete to meet the huge demand. Construction activities mainly depend on natural resources as a source of raw materials, leading to ecological imbalance & the natural resources of coarse aggregate are depleting rapidly all over the world and urgently need to be conserved. On the other hand, millions of tonnes of construction and demolition (C&D) wastes are being generated from different sources. So far the disposal of these huge quantity of (C&D) waste is posing a big problem to the local administration & environment. In this study, recycled aggregates were collected from a 20-30 year old demolished building at the university and recycled into fractions of 1.20 mm~2.45mm and 10 mm~20 mm and replaced for both fine aggregates and coarse aggregates. In this study, by surface treatments on coarse fractions of recycled aggregates were treated by microbes, and the properties of the RAC were studied with the combination of both surface-treated recycled coarse aggregates and un-treated recycled fine aggregates.***
Keywords: construction and demolition (C&D), FRC, recycled concrete aggregate (RCA), etc

I. INTRODUCTION

Aggregates are inert filler materials that comprise 60% to 80% of the total volume of concrete. Changes in various properties such as gradation, size, unit weight, and moisture content of aggregates can alter the performance of concrete. The use of larger coarse aggregate lowers the cost of the concrete mix by reducing cement content. As the cement content reduces, water content gets reduced, due to which the w/c ratio is kept constant. Therefore shrinkage and cracking phenomena get arrested. Mainly two types of aggregates are used in concrete, such as fine aggregate and coarse aggregate. Aggregates greater than 4.75 mm are coarse aggregate and those less than 7.5 mm is fine aggregate.

The use of recycled aggregates saves energy, reduces cost, and reduces disposal problems as well. Aggregates derived from the processing of inorganic material previously used in construction, mostly crushed concrete that has been cleaned and graded for use as an aggregate in the manufacture of new concrete. Recycled aggregate produced from concrete contains hydrated cement paste. This cement paste reduces the specific gravity and increases the porosity compared to virgin concrete. Higher porosity leads to higher water absorption of concrete.

A. Problem Statement

The mining of river sand and river gravel for its use in the construction possess the following ill effects:

1) Excess procurement of sand and gravel from the river bed creates an ecological imbalance.
2) The excavation along the sides of the river bed affects the groundwater table.
3) Excess procurement of sand and gravel promotes soil erosion and increases over some time.

Fig 1: Market for construction aggregates around the world

II. GENERATION OF CONSTRUCTION AND DEMOLITION WASTES

Construction and demolition (C&D) wastes are the wastes generated through demolishing buildings, repairing concrete structures, roads, railways, etc. It could be observed that C&D wastes are dumped on the sides of the road, causing traffic problems and affecting the environment's integrity. Besides, the additional workload on the safe disposal of C&D wastes was incurred on the local municipal bodies. Several options for managing the waste such as 3R (reduce, recycle and reuse), composting, incineration and landfill have been developed to reduce its impact on the environment. Nevertheless, many techniques are developed to manage waste; recycling is the optimal strategy to conserve natural resources and ensure sustainability. It is observed that the EU re-utilizes only 10% of C&D wastes, with the rest being dumped.

A. Recycling Of C&D Wastes

To produce high-quality of recycled products, only concrete fractions of C&D were recycled. The initial screening process becomes critical to separate the concrete fractions from the C&D wastes, thus removing fewer dense impurities. The screening of the concrete fractions of the C&D wastes was illustrated in the below figure. It is a mechanical method that involves disk screening, air classification, magnetic separation, bar screening, and final manual separation. Initially, vibrating screens separate bulk wastes such as rock, plastics, steel, and concrete. Other wastes such as sand, pebbles, and soil with less than the mesh size of vibrating screens were collected in disk screens. Air classifiers blow inert materials such as glass, wood, and ceramics. The different constituents of the separated C&D wastes were then sorted manually to collect only the concrete fractions.

On an average it could be observed that only 40% of the C&D waste were being utilized.

The collected coarser concrete wastes were crushed into suitable handling sizes in the locally available crusher. The fractions of concrete wastes obtained from the crusher were sent into a jaw crusher machine with blades of different thicknesses to recycle concrete fractions of various sizes. The concrete fractions were then passed into the first separating screen to obtain recycled aggregates of size greater than 20 mm. The concrete fractions were then crushed again and passed into the first separating screen to obtain recycled aggregates of size greater than 20 mm and less than 30 mm. The crushed concrete fractions passing through 22.5 mm sieve and retained on 20 mm and passing through 12.5 mm and retained on 10 mm was used as recycled coarse aggregates (RCA).

Two different fractions of RCA were used to ensure better particle packing to the concrete mixes. The concrete fractions were then crushed further to reduce the particle size and passed into the 2nd separating screen to obtain recycled fine aggregates (RFA) of less than 4.75 mm. The crushed concrete fractions passing through 4.75 mm sieve and retained on 2.36 mm and passing through 2.36 mm and retained on 1.18 mm was used as recycled fine aggregate (RFA).

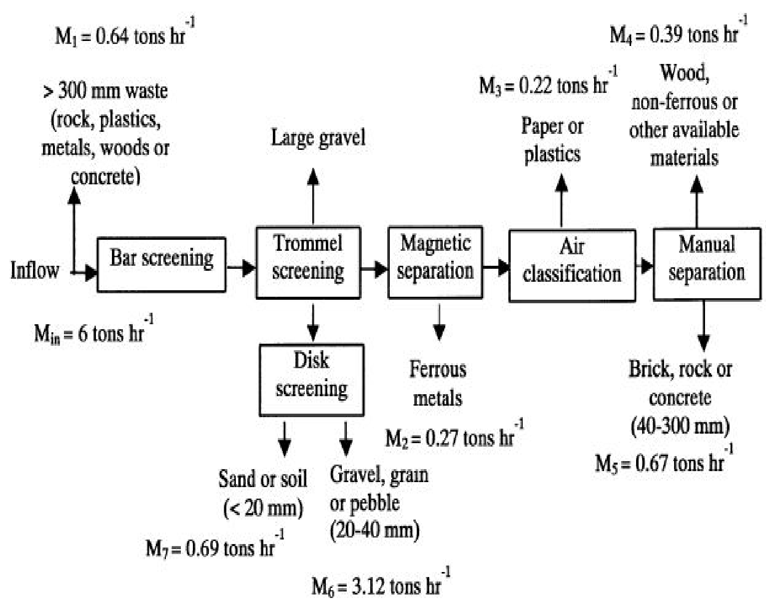

Fig 2: The process of recycling the concrete fractions of construction wastes

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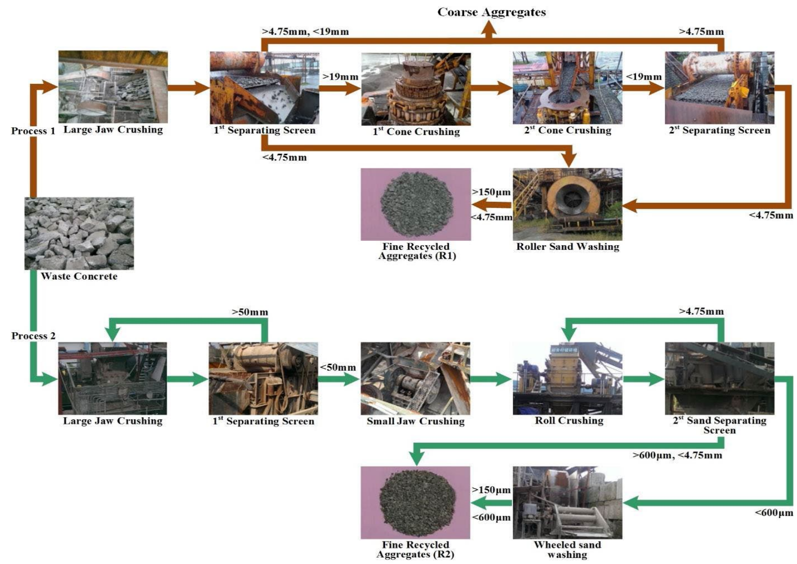

Fig : Process of recycling of C&D wastes

III. CHARACTERISTICS OF RECYCLED AGGREGATES

The recycled aggregates differ from the natural aggregates concerning their physical properties and chemical characteristics. Recycled aggregates are concrete fractions of C&D wastes comprising of natural aggregates with cement particles smeared on their surface.

1) Nearly 20% of cement mortar will get adhered to the surface of aggregate while recycling. The recycled aggregates prepared from low strength concrete will have fewer adherences than those prepared from high strength concrete
2) The adherence of mortar on the surface of recycled aggregates lacks bonding characteristics, so rough textured aggregates (angular) should be preferred compared to smooth textured aggregates (rounded).
3) The adherence of mortar on the surface of recycled aggregates lacks bonding characteristics, so rough textured aggregates (angular) should be preferred compared to smooth textured aggregates (rounded).
4) The water absorption rate of recycled aggregate is more compared to natural aggregate. The recycled aggregates absorb 75% of the 24hour absorption capacity during the first 30minutes of soaking.
5) Los-Angeles abrasion value for the recycled aggregates produced from high strength concrete is more for smaller sized aggregates compared to larger sized aggregates.

A. Mechanical Properties

In terms of mechanical properties, the strength of RAC was observed to be 14% lesser compared to NAC at 28 days. The authors infer that a decrease in RAC strength is due to the inferior properties of RCA.

Thus, the use of 100% of RCA tends to decrease the strength of RAC

The study also infers that the density of the recycled aggregates was greatly influenced by the crushing strength and less by the shape and surface texture. The results also indicate that slump loss in the concrete is attributed to the adherence of mortar, type, and geometry of the aggregates.

The finer fraction of recycled aggregates tends to absorb more water, decreasing RAC strength. However, the crushing stages involved in reducing the fractions of recycled aggregates tend to influence the properties of RAC.

The study also infers that the density of the recycled aggregates was greatly influenced by the crushing strength and less by the shape and surface texture. The results also indicate that slump loss in the concrete is attributed to the adherence of mortar, type, and geometry of the aggregates.

RCA having 24-hour water absorption of 5.6%, 3.2%, and 2% with surface modifiers of 1:5,1:20, and 1:35 concentration. It is observed that improvement in the strength and elastic modulus signifies the RCA's better bonding characteristics (3.12% of water absorption) compared to others. The study also concludes that the surface modification has no effect on the compressive strength of the RAC, but it does minimize slump loss, leading in a more flexible and uniform concrete mix.

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B. Durability Properties

This section reviews the durability properties of RAC with RCA considering different influencing factors such as replacement level, type of recycled aggregates, w/c ratio, etc.

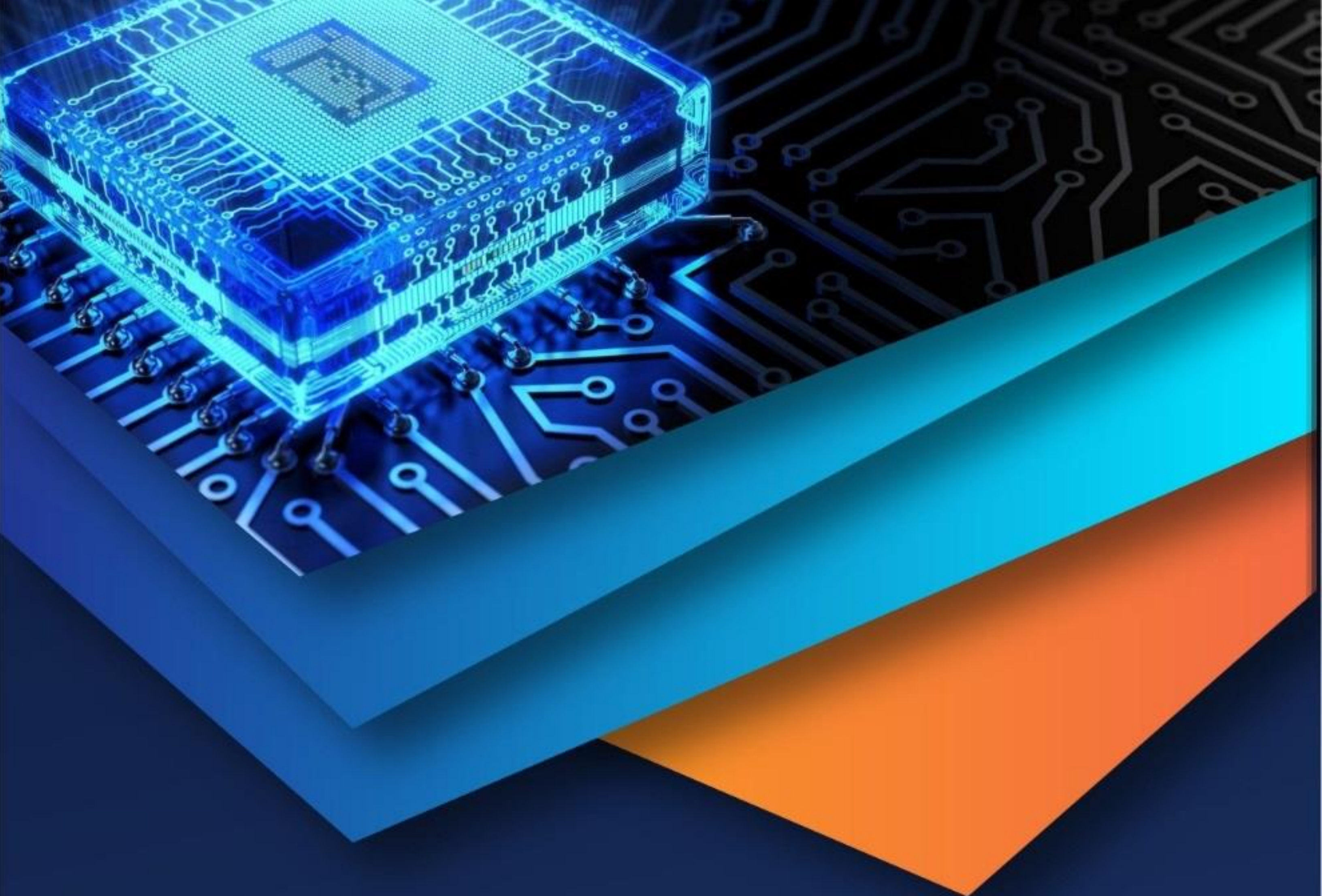
capillary absorption test was done to investigate the water permeability of RAC and found that increasing the replacement of RCA improves the water permeability of RAC. The water absorption of RAC was 1.32 to 1.52 times more compared to NAC with 30% to 100% of RCA. Similarly, Olorunsogo [35] observed that sorptivity of RAC increases with an increase in the RCA at the same curing ages. The sorptivity of the RAC with 100% of RCA was found to increase by 47%, 43%, 38%, and 29% compared to NAC at 3, 7, 28, and 56 days. It could be observed that as the curing period increase, the sorptivity of RAC decreases.

IV. RESULTS

1) The optimal replacement of RCA was observed to be 20%, and the porosity of RAC increases beyond the optimal replacement level, but with the increase in the curing period and reduced w/c ratio, the porosity of the RAC decreases.
2) The water absorption was increased by 20% and 29.41% with 50% and 100% of RCA, and thus the study infers that durability properties of RAC decrease with an increase in the RCA content.
3) Thermal properties.This section reviews the influence of elevated temperature on the behaviour of RAC with RCA considering different influencing factors such as replacement level, type of recycled aggregates, varying elevated temperatures, etc
4) Comparison of recycled aggregate concrete with recycled fine aggregate. It could be observed that specific parameters that influence the properties of RAC, such as size, w/c ratio, and source, are interdependent.

REFERENCES

[1] A. Katz, A, Treatments for the improvement of recycled aggregate, Journal of Materials in Civil Engineering, 16 (2004), 597-603.
[2] M. Pepe, A Conceptual Model for Designing Recycled Aggregate Concrete for Structural Applications, Springer International Publishing, Switzerland, 2015.
[3] P. Revathi, R. R. Amirthavalli and K. Lavanya, Influence of Treatment Methods on the Strength and Performance Characteristics of Recycled Aggregate Concrete, Journal of Materials in Civil Engineering, 27 (2014), Article No. 04014168
[4] Q. Like, L. Yong, D. Jun and T. Pengfei, Thermal stress distribution and evaluation of concrete particles under microwave irradiation, Journal of Engineering and Technology Review, 9 (2016), 148-154.
[5] H. K. Syati, P. K. Das, S. L. Tighe and H. Baaj, Evaluation of various treatment methods for enhancing the physical and morphological properties of coarse recycled concrete aggregate, Construction and Building Materials, 112 (2016) , 284-298.
[6] E. Pawluczuk, K. K. Wichrowska, M. Bołtryk, J. R. Jiménez and J. M. Fernández, The Influence of Heat and Mechanical Treatment of Concrete Rubble on the Properties of Recycled Aggregate Concrete, Materials, 12 (2019), 1-24.
[7] P. Saravanakumar, K. Abhiram, and B. Manoj, Properties of treated recycled aggregates and its influence on concrete strength characteristics, Construction and Building Materials, 111 (2016), 611-617.
[8] H. S. Kim, B. Kim, K. S. Kim and J. M. Kim, Quality improvement of recycled aggregates using the acid treatment method and the strength characteristics of the resulting mortar, Journal of Material Cycles and Waste Management, 19 (2017), 968-976.
[9] G. Pan, M. Zhan, M. Fu, Y. Wang and X. Lu, Effect of CO2 curing on demolition recycled fine aggregates enhanced by calcium hydroxide pre-soaking, Construction and Building
[10] V. Spaeth and A. Djerbi Tegguer, Improvement of recycled concrete aggregate properties by polymer treatments, International Journal of Sustainable Built Environment, 2 (2013), 143-152.
[11] W. M. Shaban, J. Yang, H. Su, Q. F. Liu, D. C. W. Tsang, L. Wang, J. Xie and L. Li, Properties of recycled concrete aggregates strengthened by different types of pozzolanic slurry, Construction and Building Materials, 216 (2019), 632-647.
[12] A. Grabiec, J. Klama, D. Zawal and K. Daria, Modification of recycled concrete aggregates by calcium carbonate bio deposition, Construction and Building Materials, 34 (2012), 145-150.
[13] V. W. Y. Tam, X. F. Gao and C. M. Tam, Micro-structural analysis of recycled aggregate concrete produced from two-stage mixing approach, Cement and Concrete Research, 35 (2005), 1195-1203.
[14] Y. C. Liang, Z. Ye, F. Vernerey and Y. Xi, Development of Processing Methods to Improve Strength of Concrete with 100% Recycled Coarse Aggregate, Journal of Materials in Civil Engineering, 27 (2015), Article no. 04014163.
[15] D. Kong, T. Lei, J. Zheng, C. Ma, J. Jiang and J. Jiang, Effect and mechanism of surface-coating pozzolanic materials around aggregate on properties and ITZ microstructure of recycled aggregate concrete, Construction and Building Materials, 24 (2010), 701-708.
[16] N. A. Abdulla, Effect of Recycled Coarse Aggregate Type on Concrete, Journal of Materials in Civil Engineering, 27 (2014), Article no. 04014273
[17] J. Xiao and L. Li, Review on Recycled Aggregate Concrete in the Past 15 Years in China, Third International Conference on Sustainable Construction Materials and Technologies, China 23. B. B. Mukharjee and V. B. Sudhirkumar, Influence of Nano-Silica on the properties of recycled aggregate concrete, Construction and Building Materials, 55 (2014), 29 – 37.
[18] M. Gomes, J. de Brito and M. Bravo, Mechanical Performance of Structural Concrete with the Incorporation of Coarse Recycled Concrete and Ceramic Aggregates, Journal of Materials in Civil Engineering, 26 (2014), Article no. 04014076.
[19] M. Surya, R. Kanta and P. Lakshmy, Recycled Aggregate Concrete for Transportation Infrastructure, Procedia - Social and Behavioral Sciences, 104 (2013), 1158-1167.
[20] S. Yehia, K. Helal, A. Abusharkh, A. Zaher and H. Istaitiyeh, Strength and Durability Evaluation of Recycled Aggregate Concrete, International Journal of Concrete Structures and Materials, 9 (2015), 219-239.



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