Life Cycle Analysis of Recycled Aggregate in Concrete Production

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Abstract

Recycling of concrete waste as an aggregate for new concrete construction saves huge disposal cost, conserves natural resources, and provides economic benefits also. Accordingly recycled aggregates when replace natural aggregates, reduce the unit cost of concrete and conserves energy. In addition, recycled aggregates when used improve the economy too. Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. The quality of concrete with recycled concrete aggregates is very dependent on the quality of the recycled material used. The experimental analysis has been divided in to two categories by comparing the quality of concrete produced by natural aggregates and crushed cubes aggregates. The concrete mix is designed for characteristic M 30 strength. The water/cement ratio is kept as variable. The qualities of these fresh concretes as regards to workability are accessed. The cost analysis for conventional as well as recycled aggregate concrete is the main aspect of this project for the optimized recycled aggregate.
Keywords: Concrete, Natural Coarse Aggregate, Recycled Concrete Aggregate, Fresh Properties, Hardened Properties, Durability

I. INTRODUCTION

Rapid growth in population and urbanization are pushing the growth in construction. Especially in the developed countries, old buildings are being demolished to be replaced with new one. But most of the construction and demolished waste is used in land filling of low laying area. But research in different countries has suggested the possibility of reusing hard inert material in recycled aggregate concrete. It may be point out that, the Asia alone produces about 760 million tons of construction waste every year. In India, the waste from construction industry is estimated to be about 12 to 14.7 million tons per annum. But this demolished part such as, broken concrete and bricks mostly from building can be used for recycled aggregate concrete.

II. LITERATURE REVIEW

S. Mandal, A.Chakraborty and A.Gupta investigated that the strength of RAC (Recycled Aggregate Concrete) is comparatively lower than that of similar mix of NAC (Natural Aggregate Concrete). However with the use of fly ash, it may be possible to produce RAC with an improvement in strength. Therefore, the results of this study provided a strong support for the feasibility of using recycled aggregates instead of natural aggregates for the production of concrete.

Dr. S. Chakraborty and Prof. P.G.Bhattacharya which deals with the statistical property of recycled aggregate concrete. They concluded that recycled aggregate concrete showed inferior qualities in respect of normal concrete strength. The compressive cube strength of RAC lies between 19.62 N/mm² and 23.65 N/mm² though the recycled aggregate concrete.

In evaluation of the recycled aggregate characteristics, it should be kept in mind that each recycled concrete aggregate particle is still a piece of concrete composed of the original coarse aggregate (OCA) and the adhered mortar (AM). The recombined form of these concrete particles with a new matrix is called recycled aggregate concrete. For a clear understanding of the recycled aggregate and to predict its possible effects on concrete, the constituents of these composite particles must be identified separately (Nagataki et al. 2000).

It is a believed concept that the quality of RAC is tied to the properties of the original waste concrete, the new composition, the mixing approach, and the deterioration conditions of the recycled aggregates. Initial investigations on the use of recycled aggregate usually focused on incorporating recycled coarse aggregate and its influence on mechanical and durability properties of the RAC. It was an adopted concept that although the use of recycled coarse aggregate may be viable, a decrease in the performance of the RAC should be regarded as a normal outcome which can be mitigated through various approaches such as increasing cement content in mixture, etc. (Bagragi et al. 1990).

Sagoe et al. (2001) observed no significant difference in the compressive strength of the specimens made with up to 100% replacement of coarse recycled aggregate with the reference concrete made with basalt coarse aggregates. The recycled aggregates were saturated before mixing.

Ravindrarajah et al. (1985) reported that the splitting tensile strength of RAC was consistently 10% lower than that of conventional concrete. Tabsh and Abdelfatah (2009) reported that about 25%–30% drop in the tensile strength was observed in concrete made with RCA.

Kou et al. (2012), observed that regardless of the type of the recycled aggregate used, the splitting tensile strength of the specimens decreased as a function of increasing RCA replacement ratio before the age of 28 days. However, for some types of the RCAs used, an increase in the splitting tensile strength at the age of 90 days is observed.

Sagoe et al. (2001), reported that there is no significant difference between the splitting tensile strength of the reference and the recycled aggregate concrete specimens.

Domingo-Cabo et al. (2009), found that the shrinkage of RAC increased after 28 days. The RAC with a RCA replacement level of 20% showed a similar shrinkage to the conventional concretes in the early stage. For a period of 6 months, the shrinkage in RAC was 4% higher. In the case of a RCA replacement level of 50%, the shrinkage was 12% greater than that of the conventional concrete after 6 months.

III. EXPERIMENTAL WORK

RCA with use of geopolymer with fly ash, aggregates, sand, aggregates. The test results are taken at 7days and 28 days with varying percentage of admixture with oven and natural curing method. It also provides the specification of the material that is to be used in concrete preparation. Properties of admixture are followed by effects of admixture on concrete. The mix proportion is also described required for making the RCA workable, flow able.

A. *Production of Recycled Aggregate*

There are certain processes & equipment which are available for recycling of aggregates are given below. The following are the most commonly used processes for the production of recycled aggregates, which are,

1) Crushing
2) Grinding
3) Screening

B. *Mix Proportion for Recycled Geopolymer Concrete*

The primary difference between geopolymer concrete and Portland cement concrete is the binder. The silicon and aluminum oxides in the low-calcium fly ash reacts with the alkaline liquid to form the geopolymer paste that binds the loose coarse aggregates, fine aggregates, and other un-reacted materials together to form the geopolymer concrete. As in the case of Portland cement concrete, the coarse and fine aggregates occupy about 75 to 80% of the mass of geopolymer concrete. This component of geopolymer concrete mixtures can be designed using the tools currently available for Portland cement concrete. The compressive strength and the workability of geopolymer concrete are influenced by the proportions and properties of the constituent materials that make the geopolymer paste. Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of geopolymer concrete. Higher the ratio of sodium silicate solution-to sodium hydroxide solution ratio by mass, higher is the compressive strength of geopolymer concrete. The slump value of the fresh geopolymer concrete increases when the water content of the mixture increases.

C. *Material Used*

1) *Fly Ash*

In the present experimental work, low calcium, Class F were used.

2) *Aggregate*

Aggregate are used for making geo-polymer concrete are fine aggregate and coarse aggregate.

3) *Alkaline Activators*

To activate the fly ash, a combination of sodium hydroxide solution and sodium silicate solution was chosen as the alkaline activator. Sodium-based activators were chosen because they were cheaper than Potassium-based activators.

4) *Mixing & Casting*

It was found that the fresh fly ash-based geo-polymer concrete was dark in colour (due to the dark color of the fly ash), and was cohesive. The amount of water in the mixture played an important role on the behavior of fresh concrete. When the mixing time was long, mixtures with high water content bled and segregation of aggregates and the paste occurred. This phenomenon was usually followed by low compressive strength result of hardened concrete.

IV. RESULT & DISCUSSION

In the Recycles geopolymer concrete the conventional geopolymer cube were cast and tested for compressive strength. These cube were crushed, grind and screening for getting recycled aggregate. The percentage replacement of recycled geopolymer aggregate with natural aggregate such as 20%, 40%, 60%, 80%, 100%. These replacement were compare with natural recycled aggregate such as as 20%, 40%, 60%, 80%, 100%.

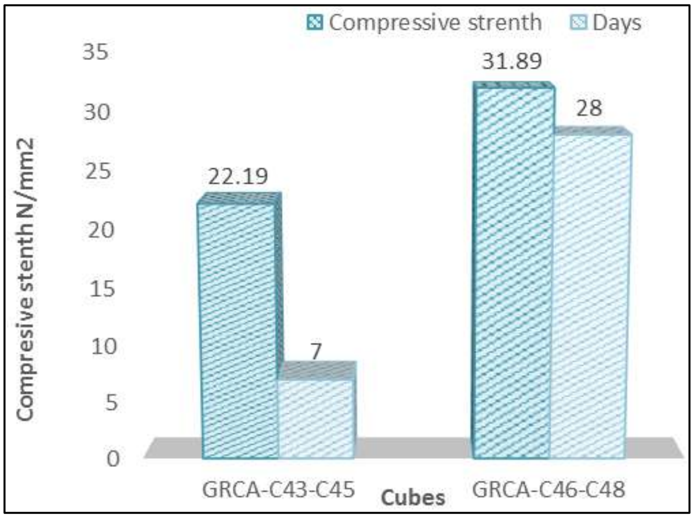

Fig. 1: Geopolymer Concrete with 100% Replacement of Recycled Aggeregate

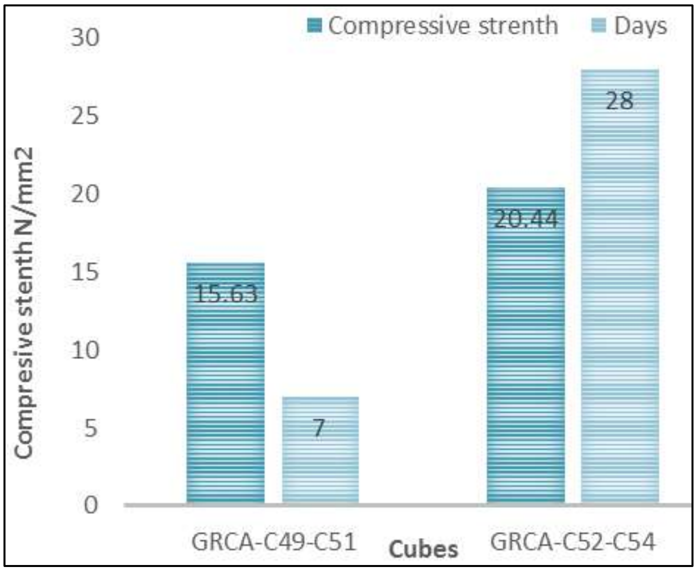

Fig. 2: Geopolymer Concrete with 80%R.C.A.

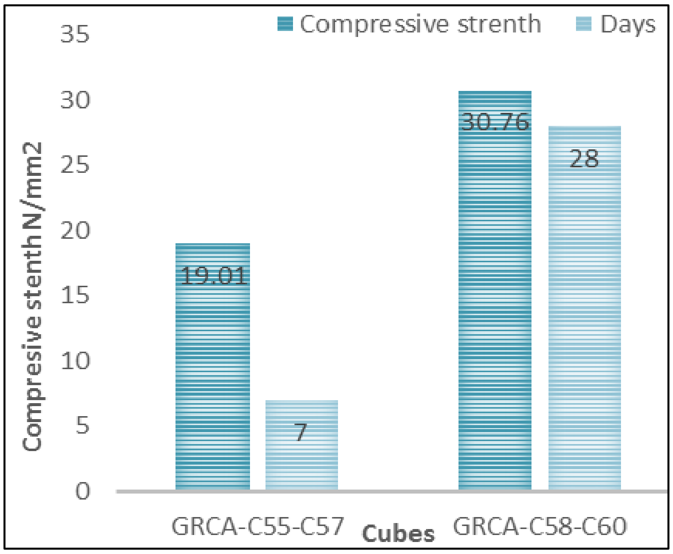

Fig. 3: Geopolymer Concrete with 60%R.C.A

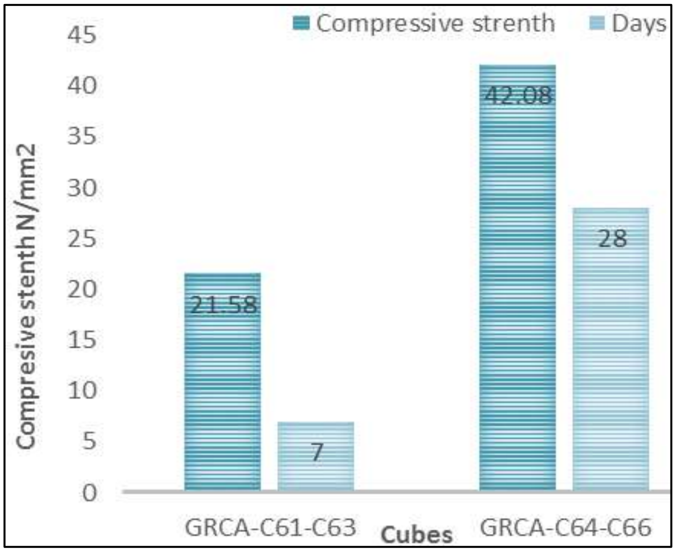

Fig. 4: Geopolymer Concrete with 40%R.C.A.

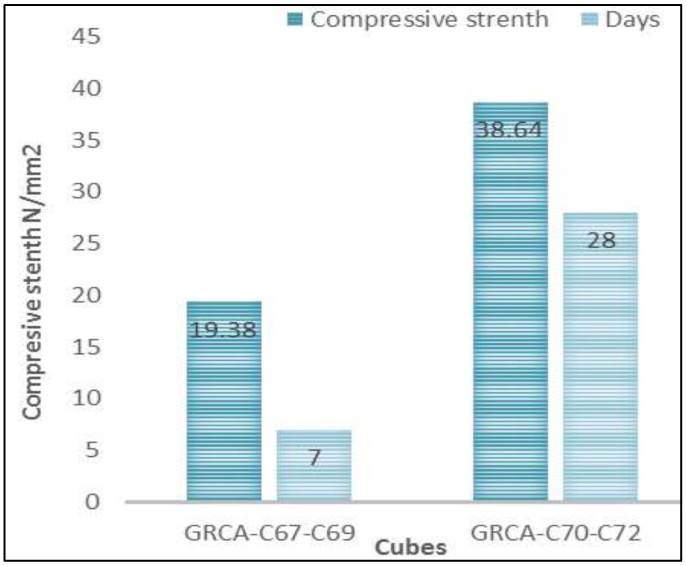

Fig. 5: Geopolymer Concrete with 20%R.C.A.

V. CONCLUSION

1) The absorption capacity of recycled coarse aggregate was 3.75 times higher than that of natural coarse aggregate.
2) The long term strength development of recycled coarse aggregate concrete is more favourable than natural aggregate concrete.
3) The durability performance of recycled concrete is affected by the higher absorption and porosity of Recycled Coarse Aggregate.
4) The optimum percentage replacement of recycled aggregate is 40%.
5) Due to use of recycled geopolymer aggregate in concrete the 20% cost saving in the Geopolymer concrete were evaluated. The cost saving observed in geopolymer concrete with 40% replacement of Recycled aggregate use in geopolymer concrete.

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