International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

Alternatives to Coarse Aggregate in Cement Concrete - A Review

Batham Geeta[1], Akhtar Saleem[2]

[1]Associate Professor, Department of Civil Engineering, UIT-RGPV, Bhopal, India.
[2]Professor, Department of Civil Engineering, UIT-RGPV, Bhopal, India.

Abstract - *In this study, literature review has been conducted to study the characteristics strength properties of concrete using various alternative aggregates such as coconut shell aggregates, tire rubber aggregates, glass waste aggregates, plastic aggregates, palm kerenal shell aggregate, recycled brick ballast aggregate, recycled concrete aggregate, ceramic aggregates etc. for partial replacement of coarse aggregate . Review of work done by various researchers are studied and compiled here. Study reveals that incorporation of alternative coarse aggregates affects workability, strength and durability properties in significant manner. Therefore it can be easily said that incorporation of alternatives to coarse aggregates in concrete from agro-industrial wastes will help in conserving the natural resources and maintaining the ecological balance of the nature.*

Key Words: Coarse Aggregate, concrete, *compressive strength, split tensile strength, flexural strength.*

1. INTRODUCTION

Incorporation of more alternative and sustainable raw materials from suitable waste streams is the future challenge of the concrete industry. While common production fuels can be replaced by biomass or other kinds of wastes [1]. Investigation highlight that building sector offers the largest cost effective greenhouse gas mitigation potential. From this point of view, aggregate plays a core role as they account for about 80 % to 85 % of a typical concrete mixture and are responsible for an unsustainable local natural resources consumption [2].

Aggregate play important role in defining concrete compressive strength. They are usually divided into coarse and fine aggregates, with a diameter less than 4.00 mm. The different quality and kind of aggregates determine a different durability and workability that affect the concrete: great attention is given to avoid any chemical that can cause deterioration. The size of the aggregates depends on the final use of concrete and influence material proportions. If the aggregate diameters larger, smaller quantity of cement and water is needed. Crushed stone sand rock quarries and gravel are the most common materials used as aggregates, while recycled concrete and marine aggregates represent a possible, uncommon alternative[3,4].

Looking specifically to aggregates, use of alternative materials must consider the effect on both mechanical properties and durability, related to porosity and water absorption, as the most affected parameters: final specimens must comply technical requirements in terms of resistance [5].

2. CONCRETE INCORPORATING ALTERNAIVE AGGREGATES FOR REPLACEMENT NATURAL COARSE AGGREGATES.

Reuse of recycled or waste materials for the construction of civil structures is an issue of great importance in this century. Many studies have been conducted as alternative coarse aggregate to concrete [6 to 14]. The brief literature review of some of studies are as follows.

Rahate et. al. [6] conducted experimental program to investigate characteristics of concrete using coconut shell by partial replacement of coarse aggregate. Various mixed proportion and different percentage of coconut shell aggregate are prepared. Optimum percentage for compressive strength, split tensile strength and flexural strength were found at 40 % replacement. Coconut shell aggregate concrete gives 65 % compressive strength that of conventional concrete. Coconut shell aggregate was coated with rubber latex and other polymers to overcome the moisture content that reduces the water absorption of natural coconut shell aggregate from 20% to 12%.

Khan et. al. [7] carried out study to investigate characteristics of concrete using chipped tyre rubber, square in shape and of 20 mm size for partial replacement of coarse aggregate for grade M25. Replacement percentage were 0%, 10%, 20%, and 30%. Study reveals that higher content of waste tire rubber produces light weight concrete. Incorporation of recycled tire rubber aggregate in concrete results in increased water absorption, reduced density, slump, workability and flexural strength. Rubberized aggregate concrete can be used for non-load bearing members with medium strength requirement.

Srivastava et. al. [8] used glass waste for partial replacement of coarse aggregate in concrete. Mix proportion and replacement percentage of glass fibre were 1:1.67:3.33 and 0%, 10%, 20%, 30%, 40%, 50 % respectively with 0.50 w/c ratio. Study reveals that incorporation of glass waste coarse aggregate marginally reduces the compressive strength of concrete up to 50%. Optimum percentage for replacement of coarse aggregate by glass waste were found 10 %.

Osei [9] performed experimental study to investigate properties of concrete of mix proportion 1:2:4 using plastic waste aggregate by replacing natural coarse aggregate. Concrete were prepared with 25%, 50%, 75% and 100% plastic coarse aggregate. Study reveals incorporation of plastic coarse aggregate in concrete reduces strength and density. Author suggested that replacement of natural coarse aggregate more than 36 % is not suitable for structural concrete and can be used for light weight concrete.

Alengaram et. al. [10] prepared 30 grade light weight concrete using palm kerenel shell for partial replacement of natural coarse aggregate and properties were compared with normal weight concrete of same grade. 10 % silica fume were added to develop lightweight concrete. It was found that palm kerenel shell aggregate has higher impact resistance as compared to natural crushed aggregates therefor can be used as coarse aggregate to produce grade 35 palm kerenel shell concrete (PKSC). Study reveals that PKSC results in reduced density, modulus of elasticity, modulus of rupture, increased compressive strength, ductility, ultimate moment resistance as compared to normal weight concrete.

Jena et. al. [11] conducted research focusing on experimental investigation of concrete using recycled brick ballast aggregate for replacement of natural coarse aggregate for grade M10, M15, M20 and M25. Replacement percentage were 0%, 25%, 75% and 100%. It was observed that incorporation of brick ballast aggregate in concrete reduces workability and compressive strength for all four grades of concrete. Author concluded 25% brick ballast aggregate can be used for M20 and M 25 grade of concrete.

Exberria et. al. [12] carried out study using 0%, 25%, 50% and 100% recycled concrete aggregate for replacement of coarse aggregate. Result indicated marginal decrease in compressive strength, improved split tensile strength and lower modulus of elasticity as compared to conventional concrete. Author concluded that 25 % RCA can be replaced in concrete without significant change in compressive strength and w/c ratio, to obtain same strength for replacement range 50-100%, w/c ratio needed to be 4-10% lower.

Awoyera et. al. [13] conducted research to investigate individual effect of ceramic fine aggregate and ceramic coarse aggregate on concrete properties for replacement of sand and gravel respectively. Concrete were prepared with mix proportion 1:2:4 with constant w/c ratio 0.6. Replacement percentage for ceramic fine aggregates and ceramic coarse aggregate were 25 %, 50%, 75% and 100%. It was observed that workability of ceramic concrete ranged between medium to high. Maximum compressive strength and split tensile strength were obtained at 100 % ceramic fine aggregate and 100 % ceramic coarse aggregate when compared to conventional concrete individually.

Kore and Vyas [14] carried out experimental investigation to examine the feasibility of use of marble waste aggregate for replacement of conventional natural coarse aggregate in lean cement concrete. Replacement percentage of marble waste aggregate were from 0% to 100%. Various concrete mixes were prepared with constant w/c ratio of 0.60. Study indicated that workability and compressive strength of concrete containing marble waste aggregates increased by 14 % and 18 % respectively as compared to conventional concrete.

3. CONCLUSIONS

On the basis of study reviewed here it can be concluded that aggregate substitution in concrete have high impact on properties. Study reveals that various alternative aggregates such as coconut shell aggregates, tire rubber aggregates, glass waste aggregates, plastic aggregates, palm kerenal shell aggregate, recycled brick ballast aggregate, recycled concrete aggregate, ceramic aggregates have excellent properties and can be used for light weight concrete and low cost concrete. Utilization of these alternative coarse aggregates from agro-industrial wastes not only reduced environmental pollution but also results in reduced construction cost, possibility of achieving green construction, suitable application of wastes rather than dumping, optimum use of conventional material etc

4. FUTURE SCOPE OF THE WORK

After reviewing the various works done by different researchers, it can be inferred that there is a vast scope in improving the characteristics of concrete as well as reducing the cost of concrete. It is clear that utilisation of various alternative coarse aggregate also reduced environmental pollution, construction cost. Thus, future work lies in partial replacement of these alternative aggregates incorrect proportion and manner with suitable admixtures in combination for better results.

REFERENCES

[1] Brussels, Belgium "The role of cement and concrete in the circular economy: TCI (The Concrete Initiative), 2018.

[2] Rock M., Sade M. R. M., Balouktsi M., F. N. Rasmussen, Birgisdottir H., Frischknecht R., Habert G., Lutzkendorf T. and Passer A, "Embodied GHG emissions of buildings-the hidden challenge for effective climate change mitigation", Applied Energy, Vol. 258 (114107), 2020.

[3] Kuo W. T. and Gao Z. C., "Engineering properties of concrete controlled low-strength materials containing bottom ash of municipal solid waste incinerator and water filter silt", Applied science, Vol. 8 (1377), 2018.

[4] Jang J. G., Park S. M., Chung S., Ahn J. W. and Kim H. K., "Utilization of circulating fluidized bed combustion ash in producing controlled low-strength materials with cement or sodium carbonate as activator", Construction Building Material, Vol. 159, pp 642-651, 2018.

[5] Maria Cristina Collivignarelli, Giacomo Cillari, Paola Ricciardi, Marco Carnevale Miino, Vincenzo Torretta, Elena Cristina Rada and Alessandro Abba, "The production of sustainable concrete with the use of alternatives aggregates: A review", Sustainbility, MDPI, Vol. 12 (7903), 2020.

[6] Kaushik Rahate, Rahul Kelkar, Sudhakar Singh and Mayuresh Khajan Wadkar, "Replacement of coarse aggregate by using naturally available materials", International Journal of Engineering Research and Technology, Vol. 6 (4), 2017.

[7] Imran Khan, Dr. Sanjay Sharma and Mir Aizaz "Effect of recycled waste tire rubber as coarse aggregate on the performance of concrete", International Journal of Engineering and Techniques, Vol. 4 (1), 2018.

[8] Vikas Srivastava, S. P. Gautam, V. C. Aggrawal and P. K. Mehta, "Glass waste as coarse aggregate in concrete", Journal of Environmental Nanotechnoloy, Vol. 3 (1), pp67-71, 2014.

[9] Daniel Yaw Osei, "Experimental investigation on recycled plastic as aggregate in concrete", International Journal of Structural and Civil Engineering research, Vol. 3 (2), 2014.

[10] U. Johnson Alengaram, Hilmi Mahmudand Mohd Zamin Jumaat, "Development of light weight concrete using industrial waste material , palm kerenell shell as lightweight aggregate and its properties", 2nd International Confrence on Chemical, Biological and Environmental Engineering, 2010.

[11] Rakesh Ku Jena, Pratap kumar Pani, Sudeep Kumar Singh and Prasant Kumar Nayak, "Workability and strength analysis of concrete with ballast as coarse aggregate", International Journal of engineering and advanced technology", 2019

[12] Exberria M. Vasquez E and Mari A. R., "Influence of amount of recycled coarse aggregates and production process on properties of recycled aggregate concrete", Cement and Concrete Research, Vol. 37, pp. 735-742, 2007.

[13] Paul O. Awoyera, Julius M. Ndambuki, Joseph O. Akinmusuru and David O. Omole, "Characterization of ceramic waste aggregate concrete", HBRC Journal, Vol. 14 (3), 2018.

[14] Sudarshan D. Kore and A. K. Vyas, "Impact of marble waste as coarse aggregate on properties of lean cement concrete", Case Studies in Construction Materials, Vol. 4, pp. 85-92, 2016.