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A review on Physical properties of Recycled Concrete Aggregate

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ABSTRCT

Recycling of construction waste is very important in the present time because it is produced in huge quantity. Construction wastes have very dangerous effect on environment. For the protection of environment, recycling of construction waste is very important. Waste produced by constructions and demolition can be reuse as recycled concrete aggregate (RCAs). Nowadays construction industry is using RCA in construction. RCA hasless cost of construction and has less harmful effect on environment. In this paper, there is a list of properties of concrete which is prepared by using recycled aggregate. To improve the properties of recycled concrete there are many material admixtures. Durability and mechanical properties of RCAs is very close to the conventional natural aggregate concrete (NAC). There are some methodologies and experiments which should be done to determine the physical characteristics of concrete waste.

***Keywords*: Construction and demolition waste, Recycled concrete aggregate, Natural concrete aggregate, Durability and mechanical properties.**

I.INTRODUCTION

Due to increase in industrialization and urbanisation of developing countries construction waste are generated in large quantity in each year. Construction and demolition waste affects environment exponentially with last 100 years. In the recent years use of natural resources in construction industries is very large and due to this it generated waste in large amount. The main constituents of concrete are cement, fine aggregate and coarse aggregate and water. In 2014 the production of cement was 4.3 billion tonnes in all over the world. In the present era about 20 billion of raw materials are used in the construction of concrete in every year. According to present condition demand of aggregate will be double over next two or three decades. According to environmental study China and India are at dangerous condition. India produces 7% of cement and China produces more than 50% of cement in all over the world.

1.1 Significance of recycled aggregates

There are many reasons for emission of carbon dioxide. Construction sectors have huge role in carbon dioxide emission. About 33% of the total CO_2 emission is due to construction industries and consumes about 40% of global energy. Due to this reason aggregates (occupying nearly 55-80% of concrete volume) have a great influence on the environment and sustainability of structures. Construction and demolition (C &D) waste generated by construction industries is also badly affects the environment. Thus, reuse of construction and demolition waste is very necessary. The World demands of aggregate reaches as 48.3billion tonnes annually after 2010. Thus, we can say that use of recycled aggregate by using industrial waste such as fly ash, silica fume; blast slag etc. as additional materials can be highly beneficial especially in pavement construction.

1.2 Properties of recycled aggregate

The characteristic of the RCA is different from NA. Adhered old cement mortar is the main reason behind this difference. If size of aggregate increases then the amount of adhered cement mortar reduces. According to Kisku, N.H. Joshi different size of recycled aggregate i.e. 4-8 mm size, 8-16mm size and 16-32 mm size the mortar content (percentage of volume)is 60%, 40% and 35% respectively. Due to porosity of adhered mortar the water absorption of RA is to be 2.3-4.6 times higher than the water absorption capacity of NA. These values not depend on the grade of parent concrete. If size of aggregate increases then the water absorption increases. If water absorption is very high then strength will be less. Same trend has been observed for density of RAs. Density and water absorption of RA is independent of the grade of parent concrete. Suryavanshi et.al reported that aggregate crushing value for RAs is higher than that of virgin aggregate. RAs crushing values were 33% and 45% more than that of virgin aggregates for 20-10 mm and 10-4.75 mm size aggregate respectively. Durability of RAs depends on its chemical properties which are quantified by sulphate soundness and chloride. Present value of sulphate soundness for NA is 9.1 (coarse) and 2.6 % (fine) and for RA it losses to be 29.1% to 49%. If crushing of RAs improved then performance of RAs is also improved. If chloride content is high then rapid corrosion of reinforced steel take place.

II.FRESH STATE PROPERTIES

If water content is same for both, RAC and NAC then the workability of NAC mix is higher than the RAC mix. Slump loss is poor for RAC as compared to NAC. More water is required for mix of RAC as compared to mix of NAC. The workability of RAC increases if super plasticizer is added to RAC. Due to addition of water repellent agents the slump of RAC can also be increased such as Silane. By using water repellent agent led to about 48% and 75%increase slump value for NAC &RAC respectively.

III.MECHANICAL PROPERTIES

3.1 Compressive strength

Increase in RA amount at the same water/cement ratio leads to decrease in compressive strength normally up to of plasticizer 10% lower than that of virgin aggregate concrete. Compressive strength can be improved by

using of variety of methods such as usage of admixture, increasing in cement content, usages and mixing method. Water content lowered up to 10% and cement content is needs to be increased by 10% for similar strength in RAC as compared to NAC. If replacement of RA increased then compressive strength will be decrease.

3.2 Flexural strength

Flexural strength depends on RAC replacement ratio, moisture condition of aggregate and curing of concrete and water binder ratio etc. If RA replacement ratio increases then flexural strength is decreased. Baragiet. al found that the RAC made with 25% and 50% RA had the flexural strength around 6-13% less than that natural concrete. If 100% replacement take place then the flexural strength was about 26% lesser than that of normal concrete. By using ordinary Portland cement flexural strength can be increased. Prasad and kumar found that the flexural strength is increased by using of glass fibres. Add of fly ash in place of OPC in specific quantity has important role in the flexural strength of RAC. Flexural strength of RAC is increased by use of fly ash.

3.3 Split tensile strength

There are some factors which are responsible for the split tensile strength of RAC as RA replacement, mixing methods, water binder ratio type of cement, curing age and RA quality. Split tensile strength of RAC is decreases with increase in RA replacement ratio. If RA replacement is 25%,50% and 100% then tensile strength of RAC are 6%,10% and 40% respectively which is less than NAC.

3.4 Modulus of elasticity

According to Kou et al if replacement ratio is 50% then the modulus of elasticity is decreases by 12.6% and it is decreases by 25.2% for 100% replacement ratio. Modulus of elasticity is increased by using of lignosulphate based super plasticizer it lead about 27%.If we use polycarboxylate base super plasticizer then the modulus of elasticity increased by 33%.

3.4 Techniques to improve RAC properties

By treating silica fume of RA give an increase of 23-33% and 15% in compressive strength of RAC at 7 days and 28 days respectively.Compressive strength of RAC can be vary with mixing approach. There are two stages of mixing in the first stage of mixing water is added and due to this the formation of thin layer of cement slurry on the surface of RA take place. In the second stage the remaining water will be added to RAC for complete process. Due to absorption of acidic solution, the strength of RAC increases. Li et al. Suggested a new technique in which RAs surface were coated with the pozzolana powder (flyash,silica, fume and blast furnace slag).due to this process the properties of RA increases. Approach of two stage of mixing is good because it is cost effective. Therefore these methodologies provide a way for improving the quality of RAC. RAC is good in performance point of view which is acceptable level. Performance of RAC is nearly to the NAC.

IV. DURABILITY PROPERTIES

4.1 Introduction

The durability properties of RAC are dependent on the ingredients of RAC, their mixing proportion, admixture and curing conditions etc. By adopting different mixing approaches we can improve the durability of RAC. There are some properties which are responsible for the durability of RAC.

4.2 Carbonation depth

In the carbonation process CO_2 interacts with hydrated $Ca(OH)_2$ on the set cement in the concrete. Due to carbonation the alkalinity of RAC decreases and carbonation depth increases in concrete. If the quantity of water increases then the resistance to carbonation get influence. Carbonation resistance of concrete is depends on the size of RA.

4.3 Deformation

Creep and drying shrinkage are the two factors which described the deformation of concrete. If reduction of water take place then it leads to the shrinkage and therefore reduction in volume ultimately. If stress is acting for a long time then the creep or increase of strain take place. Drying shrinkage of RACs is higher than the NACs it is due to the increase in old adhered mortar and new cement paste volume in RAC. Due to addition of plasticizer the shrinkage of RAC increased. It is because of increase in the entrapped air. The Formation of micro bubble is the main reason behind this phenomenon. If RA content is increased then the creep will also increases. The rate of shrinkage reduces with time.

V.SCOPE AND FURTHER RESEARCH

1. Determination of Physical, chemical and durability properties of RAC for long term is the topic for future studies.
2. Definite relationship among different characteristic of RAC such as split tensile strength, compressive strength and flexural strength is the scope of further research.
3. There is no proper mix design procedure for RAC.
4. Effects of various environmental exposure on RAC is the scope for further research.
5. There is a scope of addition of admixtures such as glass, sanitary waste and rubber crumbs for improving the quality of structural element which are made of RAC.
6. Effects of seismic loading on the structure made of RAC is the area for further studies.

VI.SUMMARY AND CONCLUSION

Generation of construction and demolition waste in large amount have major problem of disposal and its final treatment and it is ultimately going to affect the environment. Due to this serious problem, it is necessary to recycle the construction and demolition waste. There are following conclusions for above reference;

1. The fresh properties and mechanical properties of RAC are below as compared to the NAC. By using the surface treatment of RA and by adding of suitable percentage of admixtures (silica flume, fly ash, GGBS, metakaolin etc.) properties of RAC can be maximise.
2. By improving the mixing methods the properties of RAC can be improved.
3. Properties of structural member made by RAC and properties of structural member made by NAC have comparable properties.
4. RA is also a valuable building material which is recycled by construction and demolition waste. There are many possibilities of research to improving the use of RAC in better way.

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