A REVIEW PAPER ON USE OF RECYCLED CONCRETE AGGREGATE IN CONCRETE

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Abstract : **Concrete is widely used material in construction of infrastructures like building, dams, bridges ,roads ,runway etc. In present day construction industry having big role in pollution of environment. Different materials are used in construction having different ratio in environment pollution and concrete is one from them. To solve this problem people are following reusing of concrete in different ways. The use of recycled concrete aggregate (RCA) in concrete as full and partial replacements of natural coarse aggregate (NCA) is growing interest in the construction industry, as it reduces the demand for virgin aggregate. It helps to reduce negative environment impact of aggregate extraction from rock. This paper represents review of recycled concrete aggregate based on experimental data available from published research till date.**

Index Terms **- Recycled Concrete Aggregate, Recycled Concrete , Environment friendly concrete.**

I. INTRODUCTION

Population of world is increased day by day due to which infrastructural need is increased. Construction industry uses maximum natural resources which creates environmental issues. To minimize environmental issue , it requires recycling and reusing of construction materials. Concrete is a biggest used construction material worldwide, Due to which global aggregate production is almost doubled ,Now a days in concrete coarse aggregates are replaced by recycled concrete aggregate to save environment, present study focuses on researches done till date on recycled concrete aggregates and which types of study still required in this field.

Construction industry is a major consumer of natural resources and the global aggregate production almost doubled from 21 billion tons in 2007 to 40 billion tons in 2014. Countries such as China, India, Indonesia, Malaysia, Thailand, Gulf States, Turkey, Russia, Brazil and Mexico have recorded some of the strongest increases in the demand for waste recycling.

II. LITERATURE REVIEWS

Liang Wang et al studied Consolidating recycled concrete aggregates using phosphate solution and investigated that Recycled concrete aggregates (RCAs) have inferior qualities compared with natural aggregates (NAs)because of a layer of residual cement mortar coated on the surface of the NAs. The porous nature of this residual mortar introduces undesirable properties to the RCAs such as higher water absorption and lower strength. He used novel chemical method to consolidate this mortar layer using phosphate solution. To this end, RCAs are immersed in diammonium hydrogen phosphate (DAP) solution. DAP can react with the calcium-rich hydration products in the RCA to produce hydroxyapatite (HAP) precipitate ,which fills pores and seals cracks of the RCA, significantly improving the microstructure of the RCA. As a result, the compressive strength of the new concrete made with the RCA as coarse aggregate reaches that of the concrete made with the natural aggregate

Mahfooz Soomro et al studied a review of recycled aggregate in concrete applications and investigated that Use of recycled aggregate in concrete provides a promising solution to the problem of construction and demolishing waste. The major quantity of recycled aggregate at present is used in lower end applications, however in some developed economies; it is also used in structural concrete, due to its quality which is certified and bears Confirmite Europeenne (CE) Certificate.

The standards (normative documents) regulate and maintain the quality and provide producers as well as the users, an assurance of the consistent quality of the recycled aggregate. China and India at present are the major consumers of construction aggregate and hence have high potential for recycling and re-use of C&D waste, however, despite its potential, there is huge variation in the level of recycling and material recovery in various countries around the world e.g. Brazil (6.14%), Denmark (94%), Netherland (98%). This variation is due to vast differences in construction traditions, the legislation on landfills and due to the perception and acceptance level of constructors and builders.

Comparison in tabulation form of the Standards (normative documents) from various countries have been presented to provide producers, consumers as well as researchers a wider outlook on the characteristics of recycled aggregate which are desired and specified in legislation of those countries.

To alleviate the concerns of consumers related to durability performance of concrete produced from recycled aggregate, it is suggested that with further research and development, improvement in legislation and by inclusion of durability factors, such as deformation (shrinkage and creep) and permeability (carbonation, air and water penetration and chloride ingress) in the legislation, will help in improving the acceptance level and usage of recycled concrete applications and assist in turning recycling as one of the important components for sustainable development.

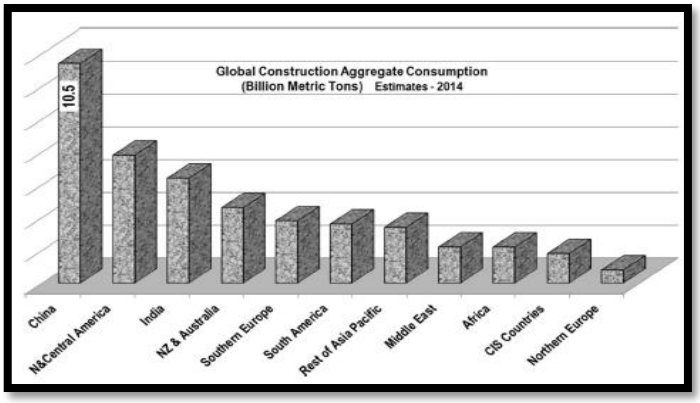

Fig-1:Worldwide Consumption of Recycled Aggregate.

Sallal R. Abid et al studied Expansion and Strength Properties of Concrete Containing Contaminated Recycled Concrete Aggregate and investigated that In the Middle East region, interior walls of buildings are mostly plastered with gypsum. Thus, the demolition wastes are probably gypsum contaminated, which may lead to internal sulfate attack in new concretes containing recycled concrete. The findings of an experimental investigation on concrete made with recycled concrete aggregates contaminated with construction gypsum (unhydrous calcium sulfate). For this, four groups of mixes were prepared.

In the first group, the natural sand was partially and totally replaced by contaminated fine recycled concrete aggregate. In the second group, the natural gravel was partially and totally substituted by contaminated coarse recycled concrete aggregate.

In the third group, both sand and gravel were substituted by contaminated recycled concrete aggregate, while the fourth group was directed to investigate the effect of silica fume on concrete made with recycled concrete aggregate. The measured properties were expansion, compressive strength, splitting tensile strength and modulus of rupture.

The results showed that the higher the percentage level of contaminated recycled aggregates the lower the strength and the higher the expansion. The best results were recorded for the second group of mixes. In all cases, the expansion did not exceed the limit of 0.05%.

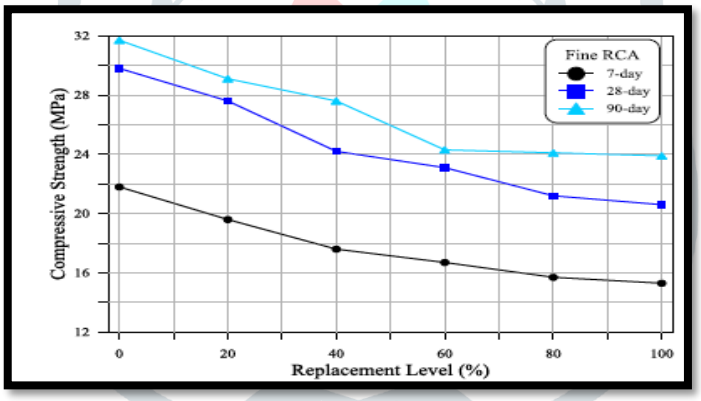

Fig-2:Variation of compressive strength with contaminated fine RCA

Bo Li et al studied Liquefaction characteristics of recycled concrete aggregates and they focused on the physical properties and shear strength responses of C&D materials. In this study, the dynamic behaviors (dynamic stress-strain behavior and liquefaction resistance) of recycled concrete aggregate (RCA) and quartz sand in an undrained condition were investigated through cyclic triaxial tests and compared.

It was observed that RCA has a higher liquefaction resistance than quartz sand, which had a beneficial effect on the earthquake response. Meanwhile, owing to its mineralogy, RCA was crushed during cyclic loading, which decreased the liquefaction resistance especially under a higher confining pressure. The effects of crushability of the RCA on the dynamic behavior were discussed. Finally, the sensitivity of liquefaction resistance to the B value was examined.

Fig-3:Recycled concrete and sand

Kho Pin Verian et al studied Properties of recycled concrete aggregate and their influence in new concrete production and investigated that the difference in properties of RCA with respect to NA is mainly driven by the presence of old mortars that adhere on the surfaces of RCA particles.

This remnant of mortar responsible for the lower specific gravity, higher absorption, lower abrasion resistance of RCA as compared to NA.

Assuring the quality of RCA (both fine and coarse) is crucial prior to its use as aggregate in the mixture in order to make a good quality concrete and mortar. One of the ways is by minimizing the amount of the attached old mortar on the surfaces of the coarse and fine RCA particles.

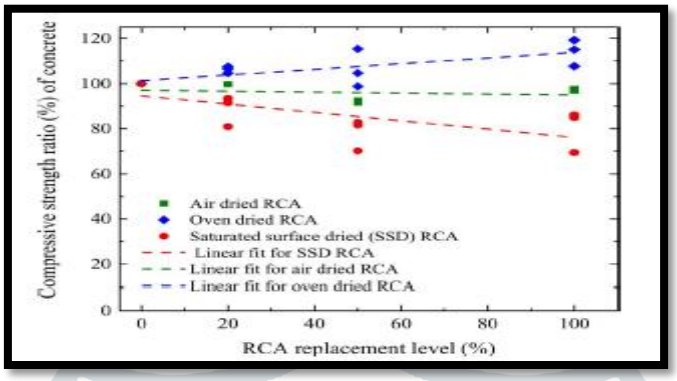

Fig-4: Compressive strength variation of concrete with RCA replacement levels for different initial moisture conditions

The handling of RCA prior to the mixing process influences the quality of the batched concrete. Combined with proper mix design and batching process, the use of partially saturated to fully saturated RCA has shown to improve concrete performance relative to that of concrete batched with dry RCA.

Michael J. McGinnis et al studied Strength and stiffness of concrete with recycled concrete aggregates and investigated that In particular, the strength, stiffness (Modulus of Elasticity), workability, and durability of concrete using RCA can be different than concrete that uses natural aggregate (NA).

Specific gravity, deleterious material content, residual mortar ,and absorption were measured for 13 sources of RCA around the U.S. – each had significant variability with no regional trends.

Characteristics of RCA depend on the processing methods applied to the materials, which may vary between the different recycling facilities, and of the triage process upon the collection of the materials during demolition, which also has a significant influence over the final products composition and thus quality.

Workability of RCA mixes (using the DVR method) was acceptable, with the most significant impacts being for PG mixtures (likely due to angularity differences).

Ahmed Shaban et al studied Properties of recycled concrete aggregate under different curing conditions and investigated the effects of recycled concrete aggregate (RCA) percentages under different curing conditions.

The percentages of recycled coarse aggregate to dolomite were (0:100%, 25:75%, 50:50%, 100:0%) respectively. The concrete properties which were studied were the mechanical properties (compressive and splitting strength) and mass transport properties.

The results showed that curing using paint material was the most efficient method of curing at all ages and percentages of recycling except at 100% recycling, where the maximum value of both compressive and tensile strengths was obtained using water curing.

Also, in moist curing, full replacement of coarse aggregates gave the highest compressive strength at age of 28 days. In all cases of recycled aggregate ratios, curing using water caused a decrease in the concrete permeability.

Ali A. Aliabdo et al studied Experimental investigation on permeability indices and strength of modified pervious concrete with recycled concrete aggregate and investigated that Pervious concrete is considered as a type of lightweight porous concrete with no fine or with small percentage of fine aggregate.
There are many advantages of this form of concrete like lower density, thermal conductivity, lower drying shrinkage and high permeability.

The considered percentages of recycled aggregate replacement were 50% and 100% by weight of natural coarse aggregate. The effect of aggregate size was studied. The considered aggregate sizes were 9.5 mm and 19 mm. In addition, the effect of using either crumb or fiber rubber, polypropylene fiber, silica fume and styrene butadiene latex
were investigated.

The properties of pervious concrete were investigated through permeability indices (water permeability, density, voids ratio) and strength indices (compressive, flexural, splitting tensile strengths in addition to pervious concrete degradation).

From the test results, the use of recycled aggregate, rubber fiber and crumb rubber slightly affected the permeability indices and negatively affected the strength indices. Based on the splitting tensile strength, the use of 50% and 100% recycled aggregate did not satisfy the typical limits of splitting tensile strength.

The use of polypropylene fibers had insignificant effect on the permeability indices and compressive strength but the use of polypropylene fibers enhanced the tensile strength and degradation of pervious concrete. Also, the addition of silica fume and styrene butadiene latex increased density and enhanced the strength indices of pervious concrete. Finally, general relations between studied variables were constructed.

III. CONCLUSIONS

Use of recycled aggregate in concrete provides a promising solution to the problem of construction and demolishing waste. China and India at present are the major consumers of construction aggregate and hence have high potential for recycling and re-use of C&D waste.

To alleviate the concerns of consumers related to durability performance of concrete produced from recycled aggregate, it is suggested that with further research and development, improvement in legislation and by inclusion of durability factors, such as deformation (shrinkage and creep) and permeability (carbonation, air and water penetration and chloride ingress) in the legislation, will help in improving the acceptance level and usage of recycled concrete applications and assist in turning recycling as one of the important components for sustainable development.

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