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A Study Based upon the Usage Recycled Aggregate to Enhance the Strength Aspects of Conventional Concrete: A Critical Review

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Abstract: ***Recycled aggregates are those crushed cement concrete or asphalt pavement which comes out from the construction debris which is reused in construction. They are made from the reprocessing of materials which have been used in previous constructions. This paper discusses about the study of properties of recycled aggregates from the sources which has already been published. The results are that 100% replacement of natural aggregate by recycled concrete aggregate effect on chloride ions resistance, it plays negative effects on durability of recycled concrete aggregates, and addition of fiber in recycled aggregate concrete mixture gave more effective in the performance of concrete. On experimental study of recycled aggregate, compressive, flexural and split tensile strength of the recycled aggregate were found to be lower than that of the natural aggregate. Use of recycled aggregate in a new concrete production is still limited. Recommendation of introduction of recycled aggregates standard is required for the materials to be used successfully in future. Gaps in literature reviews are also included in this paper.***
Keywords: Recycled aggregate, Construction Waste, Demolition of Structures, Recycled Aggregate concrete, Waste Generated Concrete, Compressive strength

I. INTRODUCTION

For the sustainable development in the field of construction, researchers are trying to focus on using the waste concrete as a new material. The demolished waste has been wasted in landfill from the past so many years. The way to reduce such wastes is to adopt the recycled aggregate. Using of recycled aggregate will protect the natural resources and help in decreasing the waste material. The use of recycled aggregate has been found to be better than the original in cases such as the properties of recycled aggregate is best suited for using in road and sub base. Recycled aggregate has lower costs when compared to the natural aggregate, it helps in reducing consumption of energy by eliminating the fuel for the land-filling process. Till now, there is no specific codes, standards, guidelines for the recycled aggregate. They are of lower quality than the original aggregate. Water absorption property of recycled concrete aggregate is high.

Figure: Recycled Aggregate Concrete

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II. LITERATURE REVIEW

Safiuddin et al., (2013)[1] studied about use of recycled aggregate in concrete and found out that replacing 100% RCA is possible in order to produce concrete with an acceptable quality, it has a strength of generally 80 to 90% of the strength when compared with the strength of NCA concrete. Yehai et al., (2015)[2] conducted experiment on the suitability of producing concrete with 100% recycled aggregate and found that if high packing density is achieved then a concrete with acceptable durability and strength will produced. A study Ma Z et al., (2019)[3] on durability of RAC in china for the past 10 years found that adding RA plays negative effects on the durability of RAC. Pavan et.al (2018)[4] research show that the recycled aggregate which are obtained from concrete specimen are making a good quality concrete. It also proved in this research that with the addition of recycled aggregate the strength of concrete is affected. Jitender and Sandeep (2014)[5] compared the properties of recycled aggregate and natural aggregates, stated that 100% replacement of NA by RCA will effect on chloride ions resistance and recommended the introduction of recycled aggregates standards so that the materials can be used in future successfully. Under the experimental results carried out by Punitha (2019)[6] , it is found out that the slump test of RAC is same as compared to NAC, general properties of both are same in case of specific gravity, aggregate impact value and water adsorption. The compressive strength for the recycled coarse aggregate increased up to a replacement rate of 60% but it decreases at the replacement rate of 100%. A recycled aggregate of a replacement of 60% was appropriate for the recycled coarse aggregate for slump tests by Kim et al., (2019)[7]. Nakhi and Alhumoud (2019)[8] in their study found that the percentage of recycled aggregate on the compressive strength of a concrete values fluctuating slightly with the percentage of recycled aggregate from 24.63 to 21.68 MPa for 0% and 100% recycled aggregates and when reaching a maximum of 25.02 MPa for 40% recycled aggregates. This indicates that recycled aggregate can be used in concrete mixing. Senaratne S et al., (2017)[9] stated that the use of recycled aggregate in concrete provides a sustainable alternative to Natural aggregate and has proved to be successful in structural applications, however lack of utilization of Recycled aggregate as a structural material can be seen in industry applications.

Jin and Chen (2015)[10] conducted a survey and revealed that in the U.S., waste concrete had been largely recycled into aggregates and widely used in backfill and roadbase. Yet the use of recycled aggregate in a new concrete production is still limited. Murali et al., (2012)[11]conducted an experimental study on recycled aggregate and the results showed that the flexural , compressive and split tensile strength of the recycled aggregate concrete were found to be lower than that of natural aggregate , however the strength of the RCA can be improved by the water and acid treatments. Decent result can be seen when Recycled aggregate treated with nitric acid than the hydrochloric and sulphuric acid. Abdel- Hay (2017)[12] conducted tests and found that the compressive strength of concrete cured in water was higher than that cured in air when the recycled aggregates were 0% and 100%. In all cases of recycled aggregate ratios, he stated that curing in water causes the decrease in the permeability of concrete and curing with paint material is good in all cases than water or air curing except in the case of full replacement.

Goyal et al., (2016) [13] describes in their paper about the using of concrete aggregate instead of natural aggregate. The test conducted by them found that compressive strength of recycled aggregate is lower than that of natural concrete aggregate which were made from same mix proportion, the tensile splitting test which was performed to find out the tensile strength shows that with increase in recycled aggregate in concrete mix, decreases in the tensile strength. The slump test which was performed by them for workability showed that when the percentage of recycled aggregate increases, the workability of concrete mix is also decreasing. Vazquez (2016) [14]confirmed that the use of fly ash and other mineral admixtures in recycled aggregate concrete helps to reduce the cement content, the replacement of 100% of the natural aggregates depends on the porosity of the attached mortar in the recycled aggregate concrete which is an important decrease of the strength and elastic modulus of the new concrete. He suggested that in order to extend the use of recycled aggregate, we have to apply environmentally sustainable solutions which will be competitive, durability in strength with the normal concrete with only natural aggregates. Ghosn et al., (2020)[15] conducted test on Hemp and Recycled Aggregates Concrete and observed that when hemp fibers are introduced in the mix, the coarse aggregate content was reduced by 20% of the concrete volume, and 50% of the natural Coarse aggregates, therefore saving natural resources and solving the problem of waste disposal. From the mechanical properties tests, it was found out that HRAC has lower compressive strength and modulus of elasticity than the plain concrete while the flexural strength and splitting test are not affected.

Batham & Akhtar (2019)[16] discusses the use of recycled aggregate by replacing natural aggregate in portion and the effects on properties of new concrete produced, which they observed that replacement of recycled aggregate shows various performance in both physical and mechanical properties , and the RCA properties depends on the various sources from where they have been collected. Hence they concluded in their paper that if recycled aggregate used in a correct manner, then there is a variable options for structural use as an advantages. Compressive and tensile strength decreases by 50% when replaced by RCA in concrete and the strength of the concrete increases by 25% of RCA replacement with the addition of fly ash.

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Adding super plasticizer reduces the concrete's workability, increased compressive strength and tensile strength by 25%. Were observed by the experiments conducted by Stephen et al., 2020[17]. Recycled aggregate in concrete can be used with natural aggregates, higher ratio of replacement can worsen the properties and strength of concrete mix & improvement is required in the recycled aggregate cement , Manik and Hinoni (2018)[18].

Smitha and Snehal (2018) [19] examined the performance of recycled aggregate concrete made up by 60% recycled aggregates in terms of durability tests. The results showed that recycled aggregate concrete provides strength and durability, it provides high modulus of elasticity value, lower drying shrinkage strains. Jorge de Brito et al., (2019) [20], stated that there is a gap between research and industry practical applications and there is a need of subjects explored which will represent a new trends in the search for sustainable RAC. A study in which recycled aggregate concrete was added by nylon fibers conducted by Lee (2019)[21] and found that the addition of fibers in RAC mixes gave more effective in the performance of concrete, high content of NFs (1.2 kg/m^3) give beneficial effect on the concrete properties with respect to mechanical properties and permeability when RAC mixed. Mohsin khan (2018)[22] conducted experiments to determine the strength of RAP in application in high strength concrete, an alternative material to the fresh coarse aggregate in concrete. He observed based on properties of aggregates that specific gravity of fresh aggregate is in the range of 2.69 to 2.68 and that of recycled asphalt Pavement concrete is 2.49 which is 8.2% less than fresh aggregate. He also observed that water absorption of fresh aggregate is 0.5 and that of recycled asphalt pavement concrete is 1.3 which indicates that the workability of concrete mix will reduce the same as water cement ratio, properties of recycled aggregate pavement except for the bitumen content does not exceed the permissible limits according to IS Code : 383-1970, crushing value of Recycled asphalt and fresh aggregate were found to be 17.36% and !7.09% and Recycled asphalt pavement affected more in compressive strength than that of flexural strength. Based on compressive strength, he found that the minimum compressive strength of the concrete mix M30 made of Recycled asphalt pavement after 7 days was approx. 60% to that of fresh concrete mix. Based on flexural strength of concrete, the flexural tensile strength of recycled asphalt mixes after 28 days was found to be lesser by4.1%, 8.2%, 19% and 29.1%. Min. flexural strength of mix 30 which was made up by recycled asphalt pavement after 28 days was found to be approx. 70% to that of fresh concrete mix of M30. A Research paper which was aim to analyze the compressive strength, split tensile strength and Flexural strength of a concrete produced by replacing the cement wit Nano silica and coarse aggregate replaced by recycled aggregate were done by Vasanthi and Senthil Selvan (2020)[23]. The results which was found by them are as follows : A 13.5% higher compressive strength was found with the cement mortar containing Nano than the conventional cement mortar, 0.85% higher compressive strength was found with the concrete containing recycled aggregate, 6.07% higher split tensile strength and 7.63% higher flexural strength when compared with the natural aggregate concrete and a concrete which contain an optimum amount of Nano silica and recycled aggregate were found to be 20% higher compressive strength, 10.98% higher split tensile strength and 14 % higher flexural strength when compared with the conventional concrete.

Figure: Production Of Concrete Blocks From Recycled Aggregate Concrete

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III. CONCLUSION

A. From the above literature reviews it is found out that fully replacement of natural aggregates by recycled aggregates affects the durability of concrete and decreases the compressive, flexural and tensile strength of concrete.

B. Recycled aggregates which are obtained from concrete specimen are making a good quality concrete. Slump test of recycled aggregate concrete is same as compared of natural aggregate concrete. General properties of both are same in case of specific gravity, aggregate impact value and water adsorption.

C. It needs to study more about the effect of RCA on splitting tensile strength, drying shrinkage, creep of concrete, plastic shrinkage, shear, and impact and bond strength of concrete. More investigation required in assessing the effect of RCA on the water absorption, chloride penetration resistance & thermal expansion of concrete.

D. There is a lack to study about the effect of Supplementary cementing materials (SCM) & high packing density on strength and durability of concrete with recycled aggregate (RA).Alkali- silica reaction of concrete with various types and quality of RA needs to be investigated.

E. Proper design mixes with different percentage of recycled concrete aggregates with natural aggregates should be prepared to achieve the adequate strength of the concrete. Study on mechanical and durability characteristic of recycled aggregate concrete with varying density and various absorption rates should be explored.

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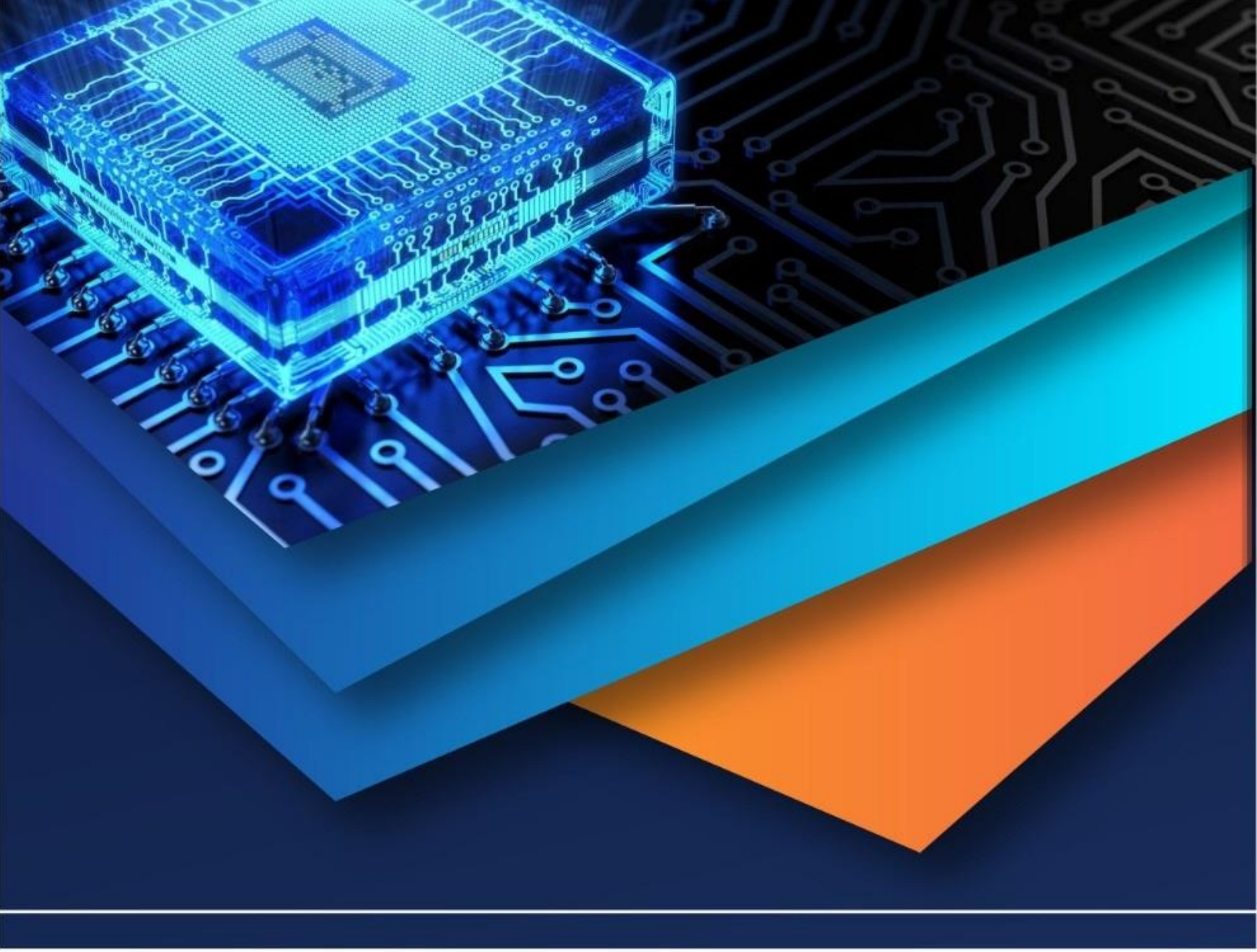

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