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# Strength and Durability Study of Concrete using Recycled Aggregates along with Silica Fume - A Critical Review

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***Abstract: To support the goal of "SAVE ENVIRONMENT", today's need is to use recycled materials as maximum as possible. As Concrete is the most demanded material after water in present developing countries. There is need of present globe to find the alternative materials for ingredients of concrete which can replace natural ingredients especially aggregates. Earlier researchers have presented good results of concrete using recycled coarse aggregates. Here an attempt will be made to prepare concrete using recycled coarse aggregates as well as fine aggregates. Replacement will be carried out in percentages of 0,10,20,30 and 40. Silica fumes will also used to improve the properties of the said concrete. Concrete will be prepared with and without silica fume to avail detailed comparative analysis. Proposed work will be helpful for the present as well as future research work.***
***Keywords: Cement Recycled Finr Aggregate Recycled Coarse Aggregare, Silica Fume***

## I. INTRODUCTION

Concrete is widely used construction material all over the world for various types of structures due to its strength and stability. The ingredients of concrete like cement, fine aggregates and coarse aggregates plays an important role in the strength and durability of structures. The ordinary Portland cement is one of the main ingredients used for production of cement causes various environmental problems involves emission of large amount of CO2 gas into the atmosphere, a major contribution for greenhouse effect and global warming. So to reduce these problems we use the supplementary cementations materials like fly ash, silica fume, ground granulated blast furnace slag, rice husk ash, metakaolin as a partial replacement material of cement. A number of studies are going on in India and other countries to study the effect of these materials as replacement materials. Silica fume is a mineral admixture and a very reactive pozzolan and it causes high strength and durability. Silica fume a byproduct of producing silicon metal or ferrosilicon alloys[1].

Coarse aggregates are the major ingredient of concrete and play an also important role in strength of concrete. But due to increase in population in India, the requirements of natural aggregates are not only required to fulfill the demand for the upcoming projects, but also are the needs of the extensive repairs or replacements required for existing infrastructure. So to reduce burden on natural resources, we can easily use recycled concrete aggregates which are easily available from demolished buildings or structures [1].

Furthermore, sustainable waste management is another major issue faced by countries all over the world. In order to minimize the environmental impact and energy consistency of concrete used for construction facilities, reuse of construction and demolition (C&D) wastes can be a beneficial way which leads sustainable engineering. approaches to concrete mix design[8].To achieve this, major emphasis must be laid on the use of wastes and byproducts in cement and concrete used for new constructions. The utilization of recycled aggregate is particularly very promising as 75 per cent of concrete is made of aggregates. The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. In general, RCA contains 65-70% of natural aggregate (coarse and fine) and 30-35% of cement paste by volume (Kong 2010)[16]. concrete strength decreases when RA is used and the strength reduction could be as low as 40%[4,16].The use of recycled aggregate generally increases the drying shrinkage, creep and water sorptivity and decreases the compressive strength and modulus of elasticity of recycled aggregate concrete compared to those of natural aggregate concrete [2]. The poor performance of the recycled aggregate concrete is associated with the cracks and fissures, which were formed in recycled aggregate during processing, thereby rendering the aggregate having weaker and more susceptible to permeation, diffusion and absorption of fluids [4,2]. Some authors have reported differences between NAC and RAC regarding carbonation rates , while others found that the carbonation depth decreases in concrete with high percentages of RA. Thomas et al. reported that there is no significant increase in the rate of carbonation with the RA incorporation. Pereira et al. used two types of superplasticizers (SP) in

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RAC with fine recycled aggregate. They found that the performance of RAC with incorporation of RA was poorer than the performance of NAC. However, the mechanical performance of RAC was generally increased when SP was utilized in the mixture. They observed that the compressive strength of RAC was affected by RA; because fine ingredients decreased the compressive strength[4]. Also, it was observed that high water absorption had a negative effect on the strength of RAC. These drawbacks limit the utilization of the recycled aggregate with higher percentages (>30%) in structural concrete[2].It is reported in an experimental study carried out by Corinaldesi and Moriconi, that the compressive strength of RAC can be improved to equal or exceed that of natural aggregate concrete (NAC) by adding mineral admixtures. Moreover, replacements used as mineral admixtures are fly ash, silica fume (SF) and ground granulated blast furnace slag (GGBFS)[8]. Addition of silica fume to concrete has many advantages like high strength, durability and reduction in cement production[4]. The optimum silica fume replacement common cement percentage for obtaining maximum 28- days strength of concrete ranged from 10 to 20 %. When pozzolanic materials are incorporated to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate (C – S – H), which improve durability and the mechanical properties of concrete. In this paper suitability of silica fume has been discussed by replacing cement with silica fume at varying percentage and the strength parameters were compared with conventional concrete.

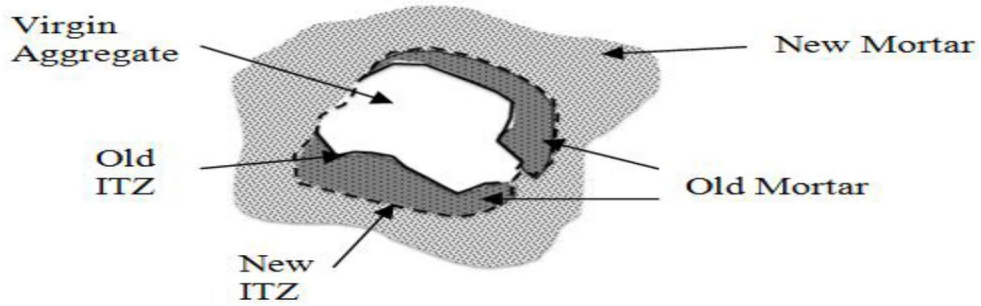



Fig Ref [13]

*A. Formar Experimental Work*

In this study, the possibility of reducing the strength loss caused by different pecentege ratio of replacement of virgin aggregates with recycled aggregates was examined. A partial substitution of the recycled aggregate with silica fume was also studied.

In this study the behavior of concrete under various percentage replacements for natural aggregate (NA) (*both fine and coarse*) with recycled aggregate (RA) is examined for its structural property. Properties of recycled aggregate concrete (RAC) such as compressive strength, splitting tensile strength, flexural strength and modulus of elasticity were examined[14]. This gives a correct perception of RAC to be used as a structural material in comparison with the natural aggregate Concrete (NAC). Properties of recycle aggregate as shown in below table

| Characteristics | Natural Coarse Aggregate | Recycle Coarse Aggregate | Fine Aggregate |
|---|---|---|---|
| specific gravity | 2.65 | 2.27 | 2.6 |
| bulk modulas kg/m$^3$ | 1614 | 1356 | 1690 |
| water absoption,% | 1.31 | 5.64 | 0.84 |
| fineness modulas | 6.2 | 5.96 | 2.36 |
| impact value,% | 9.88 | 17.36 | - |

*B.* COMPETESSIVE STRENGHT

The compressive strength of the RCA concrete gradually decreases as the amount of RCA increases.[4,5]

At 100% of the replacement level, the concrete strength decreases about 24% at 28 days. At over 50% of the replacement level, the strength reduction is more significant[4,16]

The compressive strengths of the concrete mixture RA50 and RA100 were reduced by 18%, and 24%, respectively, in comparison to the strength of NA[4]
It is reported in an experimental study carried out by Corinaldesi and Moriconi that the compressive strength of RAC can be improved to equal or exceed that of natural aggregate concrete (NAC) by adding mineral admixtures[4].
The compressive strength of concrete mixture NA with SF was increased up to 8.7%[4]
It is found that the compressive strength of concrete mixture RA25 with 5% and 10% of SF was increased by 0.8% and 3.4%[4]
compressive strength of concrete mixture RA50 with SF was increased by 2.6% and 3.1% and compressive strength gain (10.9%)of concrete mixture RA100 with highest of both NCR and RCA concrte incorporating 10%SF [4]
RCA samples with the addition of 10% silica fume did however result in a concrete with comparable strength to conventional mix concrete at 28 days [13].

*C. Workability*

In general the workability of recycled aggregate concretes is affected by the absorption capacity of the recycled aggregates. The shape and texture of the aggregates can also affect the workability of the concrete[15].
partial replacement of recycle aggregate increase water absorption increase and workability of concrete decrease.
Water absorption by immersion increases with the replacement ratio of FNA by FRA, up to a maximum of 46% for concrete made solely with FRA, compared with a reference concrete using only FNA.FRA has a more detrimental effect on resistance to water absorption by capillarity than on water absorption by immersion; the sorptivity coefficient has a relative increase of 70.3% for concrete made with 100% FRA compared with the reference concrete.

*D. Tensile S***trength**

The tensile splitting strengths of the concrete mixture RA25 and RA50 were reduced by 5.9%, RA75 and RA100 were reduced by 23.5%, and 11.8%, respectively, in comparison to the tensile s plitting It can be seen that, the concretes made with RCA resulted in tensile strength reduced.
strength of NA[4].
As reported in studies by Lee and Choi and Padmini et, the tensile splitting strength of concretes containing RCA are lower than the tensile splitting strength of concretes made with NCA.
The tensile splitting strength of concrete mixture NA with 10% SF was increased by 2.9% but concrete mixture NA with 5% SF was reduced by 2.9% respectively, in comparison to the strength of the corresponding concrete.
Concrete mixture RA25 with 5% and 10% of SF was reduced by 3.1% and 6.2%,
On the other hand, the tensile splitting of concrete mixture RA50 with 5% and 10% of SF was increased by 3.1%[4]
The tensile splitting of concrete mixture RA75 with 5% and 10% of SF was increased by 7.7% and 11.5 Moreover, the tensile splitting of concrete mixture RA100 with 5% and 10% of SF was increased by 6.7% and 10%.
The tensile splitting strength gain of the concrete mixture RA75 with 10% SF was the highest than that of both the NCA and RCA concretes incorporating SF[4].

*E. Durability*

Durability performance was investigated by the different method
*1)* Oxygen Permeability Method
*2)* Rapid Chloride Penetration Test
*3)* Chloride Conductivity Test
*4)* Water Sorptivity Test
*5)* DIN Water Permeability Test and
*6)* Torrent Air Permeability test[17,18]
durability quality reduced with increase in the quantities of RA included in a mix; however, as expected, the quality improved with the age of curing[17]
At the age of 56 days, increases in index value of a concrete mix made with 100% RA over that made with 100% natural aggregate were 86.5% and 28.8%, respectively, for chloride conductivity and water sorptivity.[17]
The corresponding value of oxygen permeability index (OPI) for the same concrete mixes was a reduction of 10.0%.[17]

The durability characteristics of silica fume and fly ash cement concretes were better than those of plain cement concrete specimens. The increased amounts of fly ash content with concrete mixtures had acceptable compressive strength.[18]
30% fly ash concrete gave satisfactory result of Oxygen Permeability Index, Sorptivity and chloride Penetration durability tests[18].

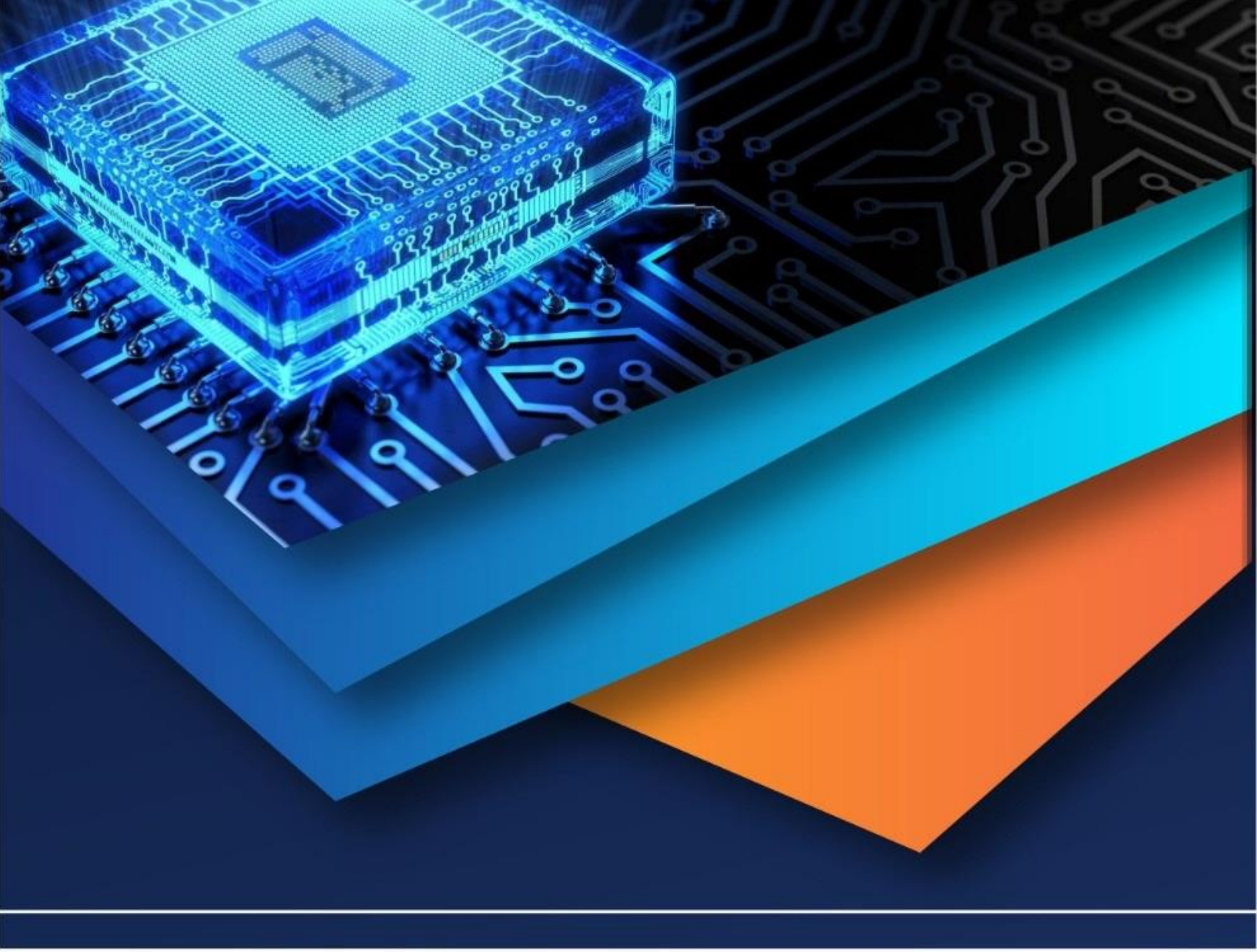
## II. CONCLUSION

After detailed literature survey we can critically conclude the following remarkable observation

*A.* Recycled coarse aggregate may be safely used upto a limit 30% in preparation of concrete.
*B.* When the percentage of RCA replacement is increased, compressive strength gets reduced. However when water/cement ratio of mix was decreased, the compressive strength increases.
*C.* The compressive strength of the RCA concrete gradually decreases as the amount of RCA increases. At 100% of the replacement level, the concrete strength decreases about 24% at 28 days.
*D.* At over 50% of the replacement level, the strength reduction is more significant.
*E.* The compressive strength of the specimens containing 5% and 10% SF increase for RCA at 28 days.
*F.* Addition of 10% silica fume was observed to be optimum resulting in an increased strength of 7% in compression when compared to a sample without silica fume.
*G.* Flexural strength is increased by 6% with a 10% addition of silica fume which seems to be the optimum replacement percentage when compared to the control sample
*H.* Ample study has been carried out for replacement of Coarse aggregate separately but another detailed study is required to replace fine aggregates along with coarse aggregates.

## REFERENCES

[1] Ranjodh Singh1, Sudhir Arora2, " Influence of Silica Fume & Recycled Concrete Aggregates on Mechanical Properties of Concrete" 2nd International Conference on Engineering Technology, Science and Management Innovation (ICETSMI-2017)
[2] S.C. Kou, "Enhancing the durability properties of concrete prepared with coarse recycled aggregate" Construction and Building Materials 35 (2012) 69–76
[3] M. Etxeberria, " Influence of amount of recycled coarse aggregates and production process on properties of recycled aggregate concrete" Cement and Concrete Research 37 (2007) 735–742
[4] O. Cakır, "Experimental analysis of properties of recycled coarse aggregate (RCA) concrete with mineral additives" Construction and Building Materials 68 (2014) 17–25
**[5]** Valeria Corinaldesi, "Influence of mineral additions on the performance of 100% recycled aggregate concrete" Construction and Building Materials 23 (2009) 2869–2876
[6] Adel Gorjinia Khoshkenari, "The role of 0–2 mm fine recycled concrete aggregate on the compressive and splitting tensile strengths of recycled concrete aggregate concrete" Materials and Design 64 (2014) 345–354
[7] E.F. Ledesma, " Properties of masonry mortars manufactured with fine recycled concrete Aggregates" Construction and Building Materials 71 (2014) 289–298
[8] P. Pereira, " The effect of superplasticizers on the mechanical performance of concrete made with fine recycled concrete aggregates" Cement & Concrete Composites 34 (2012) 1044–1052
[9] Roz-Ud-Din Nassar, " Strength and durability of recycled aggregate concrete containing milled glassas partial replacement for cement" Construction and Building Materials 29 (2012) 368–377
[10] Hasbi Yaprak1*, Huseyin Yılmaz Aruntas2, " Effects of the fine recycled concrete aggregates on the concrete properties" International Journal of the Physical Sciences Vol. 6(10), pp. 2455-2461, 18 May, 2011
[11] N. K. Amudhavalli1, Jeena Mathew2, "EFFECT OF SILICA FUME ON STRENGTH AND DURABILITY PARAMETERS OF CONCRETE" International Journal of Engineering Sciences & Emerging Technologies, August 2012. ISSN: 2231 – 6604
[12] P Huoth, "Effect of silica fume on recycled aggregate concrete" 23rd Australasian Conference on the Mechanics of Structures and Materials
[13] Bhatt Rushabh1 Prof. Y.V.Akbari2, "Behavior of Recycled Coarse Aggregate in Ternary Blended Concrete with Microsilica and Flyash" Department of Civil Engineering
[14] Sellakkannu N. & Subramani V, " Study On Properties Of Recycled Aggregate - A Review" Imperial Journal of Interdisciplinary Research (IJIR)
[15] Amnon Katz" , Properties of concrete made with recycled aggregate from partially hydrated old concrete "Cement and Concrete Research 33 (2003) 703 – 711
[16] . F.T. Olorunsogo, N. Padayachee (2002), "Performance of recycled aggregate concrete monitored by durability indexes", Cement and Concrete Research, vol.32 (2), pages 179–185.
[17] S Zulu, D Allopi (2014), "Influence of high content fly ash on concrete durability", International Journal of Engineering and Innovative Technology (IJEIT), Volume 3, Issue7.



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