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Study on Variation of Strength of Recycled Glass Aggregate Concrete

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Abstract: ***Numerous environmental problems and natural disasters have occurred due to high extraction of natural resources, Now researchers are focused on recycled materials for future developments. Recycled glass could be easily used in concrete, moreover its low cost, availability and simple process makes it eco-friendly and low-cost material that can be significantly applied in the construction industry. Therefore, primary aim of this research is to explore the applicability and adaptability of glass as a recycled material for concrete. Various properties of concrete made from glass coarse aggregates were analysed. A total number of 66 cubes were casted and tested for compressive strength, and 18 cylinders were casted and tested for split tensile strength and slump test was also performed. the results have shown that upto 10% of replacement of Coarse aggregate by RGA will not affect strength of concrete significantly and hence This paper intends to recommend that recycle glass can be used as an alternate coarse aggregate in concrete and will also be beneficial in waste management.***

Index Terms: ***Coarse Aggregate, Compressive Strength, Concrete, Fine Aggregate, Recycled Glass Aggregate, Slump, Split Tensile Strength, w/c ratio,***

I. INTRODUCTION

CONCRETE industry uses various natural resources such as water rocks and gravel. And extraction of these natural resources can lead towards numerous natural disasters and environmental problems, environmental concerns have raised among government and locals hence a recycling consciousness that led to the development of nearly ten thousand municipal programs to collect recyclables. Alternative solutions for disposing of mixed-colour glass have been sought in the past, but none of these have proven to be economically successful

From past research it has been observed that on increasing the glass proportion there is a drastic decrease in strength of concrete. Various mechanical properties of CA such as impact value, crushing strength, Tensile strength is affected due to presence of glass in it. So, the question arises is at which proportion of RGA there is minimum decrease and minimum fluctuation is occurring in mechanical properties of aggregate and strength of concrete.

II. CITATIONS

"Topcu and Canbaz (2003) [1] studied the concrete containing glass and found that There is decrease in slump air content with increase in glass content"

"Park et al. (2004) [2] used amber, flint, green bottle glass in the replacement of fine aggregate to study mechanical properties of concrete with the ratio of 30%,40%,50%,70% and used styrene butadiene reagent as Polymer. they found that 30% replacement gives the highest value of strength."

"Shyan and Xu (2005) [3] performance of glass as a pozzolanic material in concrete they replaced natural sand with glass in 0, 20, 30, 50% the result indicated that 40-50% of natural sand should be replaced by glass sand."

"Castro & Brito (2012) [4] evaluating the durability of concrete made with crushed glass aggregate. They replaced coarse aggregate with glass aggregate came from building and car window in ratio of 5, 10 and 20% of total aggregate. They found that durability increases with increase in the proportion of glass."

III. COLLECTION OF MATERIALS

Materials for concreting such as Cement, Coarse Aggregate, Fine Aggregate have been collected from Pauri Market with following quantity:

Portland Pozzolana Cement (PPC) cement Fly Ash based (35% Fly Ash) = 150 Kg (3 Bag)

Fine Aggregate (Sand) = 160 Kg

Coarse Aggregate (maximum size 20mm) = 300 Kg

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IV. TESTING ON MATERIALS

Testing is done on various mechanical and physical properties of coarse and fine aggregates

A. Mix Design of Concrete

Mix design has been done for M15 grade of concrete as per IS 10262: 2009 with following conditions:

1) *Type of Cement:* PPC Fly Ash Based
2) *Maximum Nominal Size of Aggregate:* 20 mm
3) *Workability:* 100 mm (Slump)
4) *Exposure Condition:* Moderate
5) *Type of Aggregate:* Crushed angular aggregate

By considering these conditions following proportion has been derived - 1: 1.3: 2.32 with w/c = 0.4

B. Casting Of Concrete Cubes And Cylinder

Once the optimum mix is determined, it was used to produce concrete with 0%, 2%, 4%, 6%, 8%, 10%, 15%, 20%, 30% replacement of CA by RGA. For each concrete mixture, cubes were casted to determine the Compressive Strength and cylinder were casted to determine the Split Tensile Strength of concrete, and 18 cubes were casted (for w/c ratio 0.3, 0.5, and 0.6) All the specimens were casted in steel moulds. The specimens were cured in a water-curing tank at 27±1°C until the age of testing.

C. Properties Of Material Used

1) *Coarse Aggregate*

a) fineness modulus= 6.8952
b) Water absorption of NA = 0.987%
c) Specific Gravity of NA = 2.61

2) *Fine Aggregate*

a) fineness modulus = 2.315
b) As per IS 383-1970 specifications, test results of sieve analysis of FA confirm ZONE III.

The specific gravity of both sands and coarse aggregates are considered to be around 2.6 to 2.9.

Table 1: Variation of aggregate impact value with %RGA

S.No.	% Glass aggregate	Aggregate Impact value (in %)
1	RG0	12.07
2	RG2	14.81
3	RG4	15.45
4	RG6	16.26
5	RG8	16.42
6	RG10	16.7

D. Tests On Hard Concrete

1) *Slump Test*

Table 2: Variation of Slump value with %RGA

S. No.	Percentage RGA (%)	Slump value (in mm)
1	RG0	28
2	RG2	32
3	RG4	35
4	RG6	36
5	RG8	39
6	RG10	41

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2) Compressive Strength at 7th day

Table 3: 7-Days compressive strength variation with %RGA

S. No.	Percentage RGA (%)	Compressive strength (MPa)
1	RG0	14.3
2	RG2	12.74
3	RG4	13.77
4	RG6	12.59
5	RG8	12
6	RG10	11.5

3) Compressive Strength at 28th day

Table 4: 28 Days compressive strength variation with %RGA

S. No.	Percentage RGA (%)	Compressive strength (MPa)
1	RG0	21.32
2	RG2	19.414
3	RG4	17.84
4	RG6	16.63
5	RG8	15.56
6	RG10	15.23
7	RG20	14.89
8	RG30	12.34

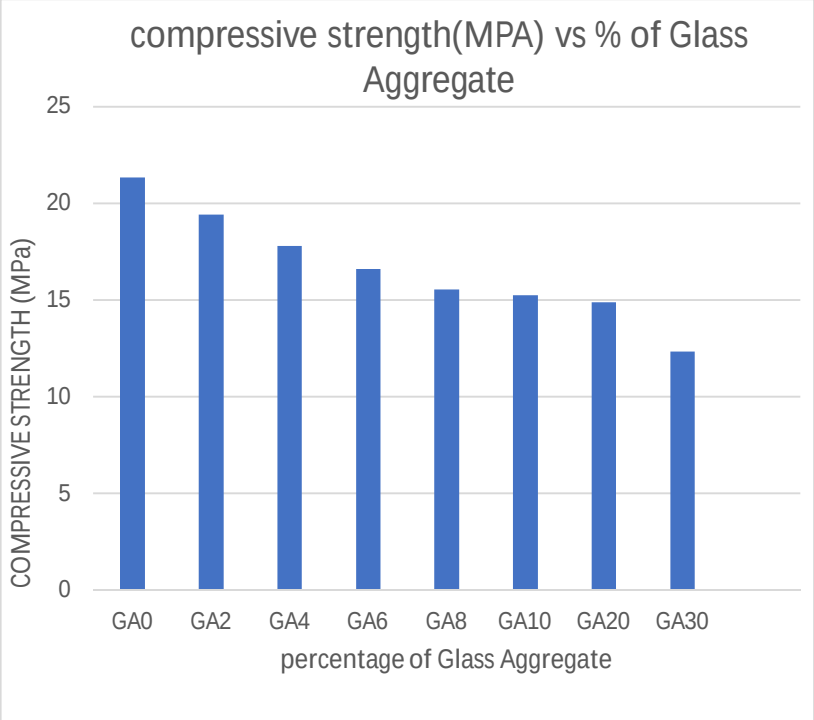

Figure 1: Compressive strength variation with %RGA

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E. Split Tensile Strength

Table 5: Split tensile Strength variation with %RGA

S. No.	Percentage RGA (%)	Split tensile strength (MPA)
1	RG0	2.6
2	RG2	2.48
3	RG4	2.4
4	RG6	2.3
5	RG8	2.28
6	RG10	1.7

Figure 2: Split Tensile Strength setup and splitted sample

F. Compressive Strength at Different w/c Ratio

Table 6: Stregth at 0% and 10%RGA for different w/c ratios

S. No.	W/C ratio	Strength at RGA 0% (MPa)	Strength at RGA 10% (MPa)
1	0.3	16.89	12.32
2	0.5	19.64	15.32
3	0.6	17.12	14.14

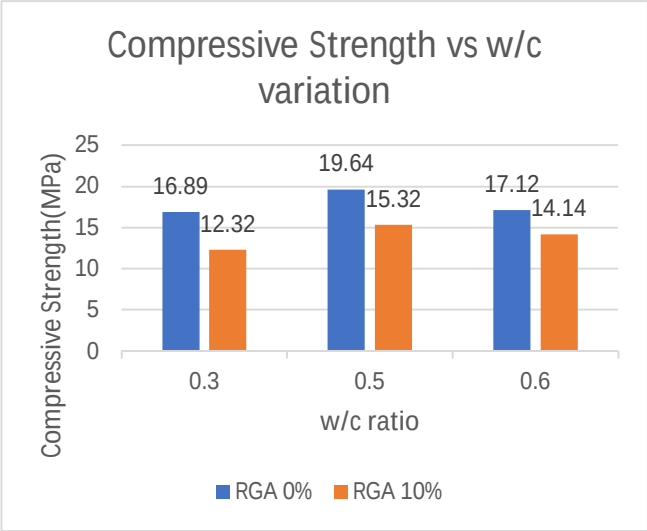

Figure 3: Compressive Strength variation with w/c ratio

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V. CONCLUSION

A. The hardness of RGA was found to be more than that of natural aggregate.
B. Compressive strength of 7 and 28-days cubes was found to be less but variations were not much significant.
C. Variation in Split tensile strength of 28-days cylinders was not much.
D. Decrease in strength was found to be prominent beyond 10% of glass aggregate.
E. 0.4 water cement ratio was found to optimum for RGA.
F. The use of glass as aggregate helps in reducing the consumption of natural resources, and helps in waste management.

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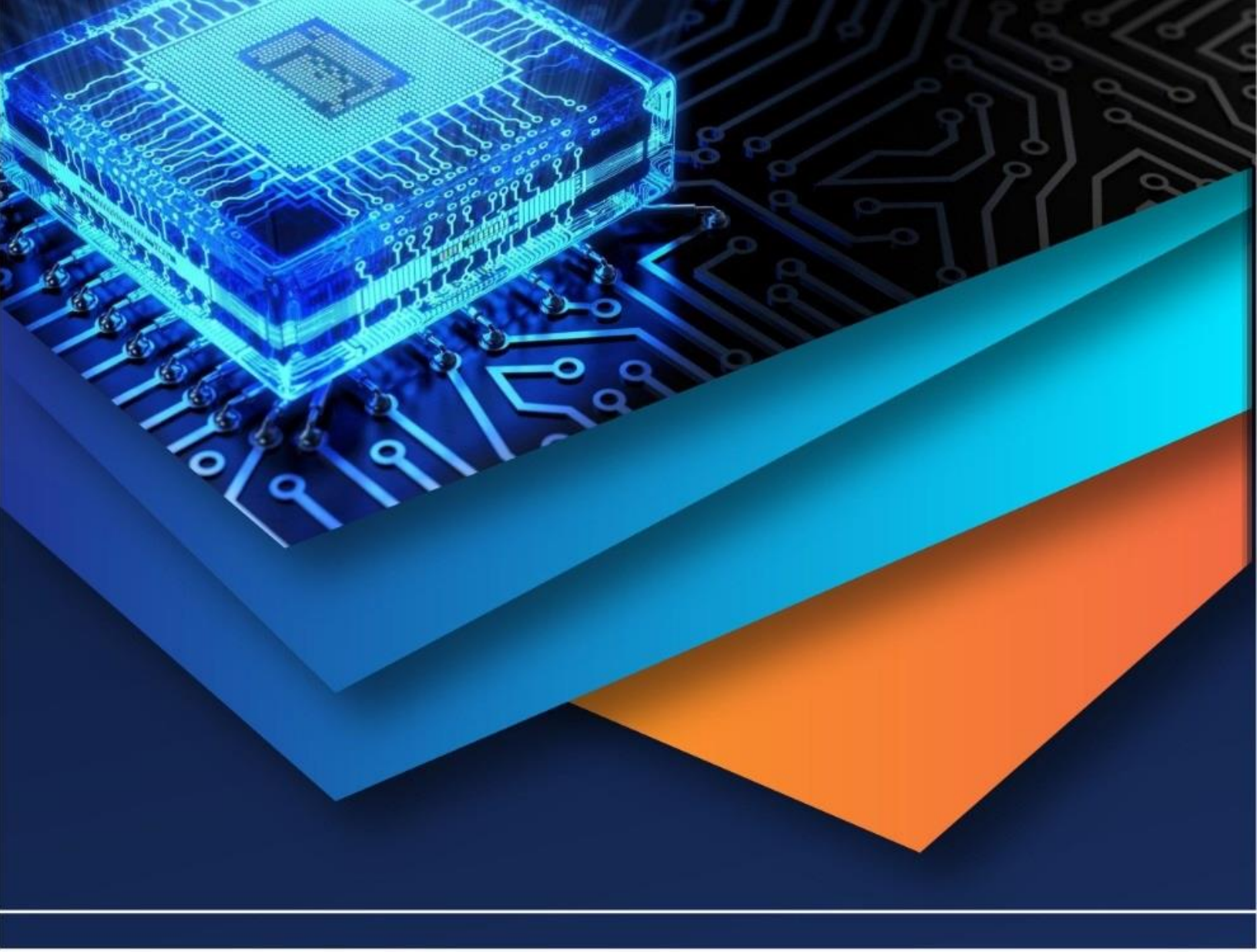

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