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PARTIAL REPLACEMENT OF AGGREGATES WITH GLASS

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ABSTRACT: Quantity of glass wasted has been on the rise in recent years due to an increase in industrialization, urbanization and the rapid improvement in the standard of living. Unfortunately, the majority of waste glass is not being recycled instead being wasted, and therefore it causes certain serious problems such as the wastage of natural resources and environmental pollution. Hence for these reasons, this study was conducted through brief experimental research in order to know the probabilities of recycling waste glass mixed as coarse aggregates for concrete. Test result of the fresh concrete show that the both slump and compacting factor are decreased due to shape and the air content is increased due to the involvement of much number of small-sized particles that are found in waste glasses. In addition the compressive strength of concrete has been decreased when the content of waste glass is increased. In conclusion, the results of this study indicate that waste glass when used below 30% in mixing concrete is practical along with usage of admixture to obtain workability and air content.

I. INTRODUCTION

GLASS

Ground waste glass was used as aggregate for mortars and no reaction was detected with fine particle size, thus indicating the feasibility of the waste glass reuse as fine aggregate in mortars and concrete. Estimated cost for housing is more and some construction materials like natural sand are also becoming rare. Waste glasses are used as aggregates for concrete. In this study, an extensive experimental work was carried out to find the suitability of use of waste glass in concrete with the following objectives:

1. To study the workability of concrete mode using glass waste as partial replacement of fine aggregate.
2. To study the compressive strength of concrete mode using glass waste as partial replacement of fine aggregate.

GLASS AS AGGREGATE FOR CONCRETE

The use of waste glass as aggregate for concrete has been attempted decades ago. Those early efforts were thwarted by the problem of alkali-silica reaction (ASR), which was not well understood then. Therefore, a high priority was assigned to gaining such an understanding, when a major research effort was initiated at Columbia University some six years ago. It was also expected that the glass aggregate would affect the mechanical properties of the concrete. The use of recycled glass in concrete opens a vast new market for mixed as well as colorsorted broken glass in a variety of specialty products or in local concrete operations. Recent research findings will make it possible to utilize glass also in regular concrete applications, thereby expanding and developing markets for recycled glass.

ADVANTAGES OF GLASS AS AGGREGATE IN CONCRETE

- Glass improves the fluidity of fresh concrete enabling the achievement of very high strength without use of super plasticizers.
- Improves the aesthetic value of the concrete in which it's used due to colour addition in the case of brown or green waste glass used, and light reflection.
- Glass has almost zero water absorption which results in more workable fresh concrete without adjusting the quantity of water used.
- Glass has excellent durability and chemical resistance.

DISADVANTAGES OF GLASS AS AGGREGATE IN CONCRETE

- Alkali silica reaction which compromises the durability of concrete by causing cracking.
- Challenge of acceptance in the construction industry as glass aggregate may be seen as inferior or unsafe.

II. LITERATURE REVIEW

Caijjun Shi et al (2009) reviewed glass chemistry, alkali silica reaction mechanism, expansion of concrete containing glass aggregates and micro structure of the interfacial transitional zone between cement paste and glass particles. The author suggested that it is necessary to control the pH of the concrete under 12 in order to avoid deleterious expansion and cracking of concrete containing large glass particles. Several research works have been carried out on the utilization of waste glass as coarse aggregate, fine aggregate, fibres as well as filler material. Bashar et al (2009) and Srinivasa Rao et al (2009).

Shi and Keren (2007) experimented about the effect of replacement of coarse aggregates with recycled glass on the fresh and hardened properties of Portland cement concrete at ambient and elevated temperatures. He expressed that concretes made with 10% glass coarse aggregates replacement to natural coarse aggregates replacement, had better properties in the fresh and hardened concrete states at ambient and high temperatures than those with larger replacement.

Sekar et al. (2011), experimented about the effect of

replacement of coarse aggregates with recycled glass on the fresh and hardened properties of Portland cement concrete at ambient and elevated temperatures. Based on the studies conducted on strength characteristics of concrete made with utilizing waste materials by Sekar et al. (2011), found that the compressive strength of concrete cubes made with glass concrete were found to be 16% and 26.34% lesser respectively than that of conventional concrete. It was also found that the flexural strength and tensile results were similar to that of compression strength test results.

III. 3. MATERIALS AND PROPERTIES

3.1 MATERIALS USED

In this investigation, the following materials were used:

- Ordinary Portland Cement of 53 Grade cement conforming to IS: 169-1989
- Fine aggregate and coarse aggregate conforming to IS: 2386-1963.
- Water.
- Glass.

Table 3.1 Properties of Cement

S.No	Description of Test	Results	IS Limits	Remarks
1.	Fineness	98%	>90%	Good
2.	Specific gravity	3.1	3.15	Good
3.	Standard consistency	32%	26-33%	Acceptable
4.	Initial setting time	43 min	>30min	Acceptable
5.	Final setting time	420 min	<600 min	Good
6.	Compressive strength	35.51 N/ mm²	>27N/mm²	Good

Table 3.2 Properties of Fine Aggregates

S.No	Description Test	Result
1	Sand zone	Zone III
2	Specific gravity	2.59
3	Free moisture	1%
4	Bulk density (poured density) Bulk density (tapped density)	1385.16 kg/m3 1606.23 kg/m3

Table 3.3 Properties of Coarse Aggregates

S.No	Description type	Result
1	Nominal size used	20mm
2	Specific gravity	2.9
3	Water absorption	0.15%
4	Sieve analysis	20mm
5	Bulk density (poured density) Bulk density (tapped density)	1687.31 kg/m3 1935.3 kg/m3

IV. MIX DESIGN FOR M15 GRADE CONCRETE

M15 – M represents Mix and 15 N/mm2 is the characteristic compressive strength of concrete cube at 28 days.
W/C ratio = 0.57
Cement quantity = 336.14Kg = 337kg
Fine aggregate quantity = 673.52kg = 674kg
Coarse aggregate Quantity = 1120 kg
Mix proportion = Cement: F.A: C.A = 1: 2: 3.3

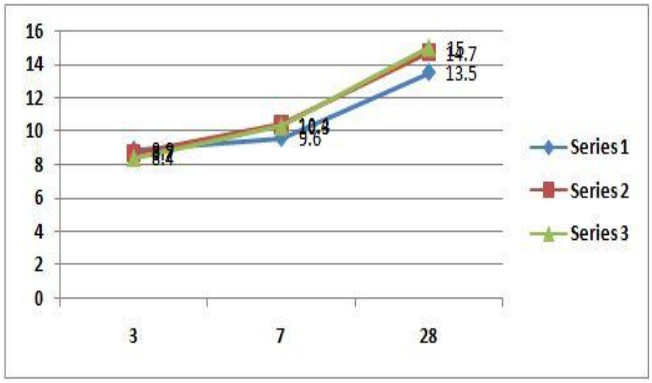
V. RESULTS

5.1 Compressive Strength Results on concrete

5.1.1 For Normal Concrete

Table 5.1 Compressive Strength Result

S.NO	No. of days	% of replacement	Result
1	3	0	8.9
2	3	0	8.7
3	3	0	8.4
4	7	0	9.6
5	7	0	10.4
6	7	0	10.3
7	28	0	13.5
8	28	0	14.7
9	28	0	15.0



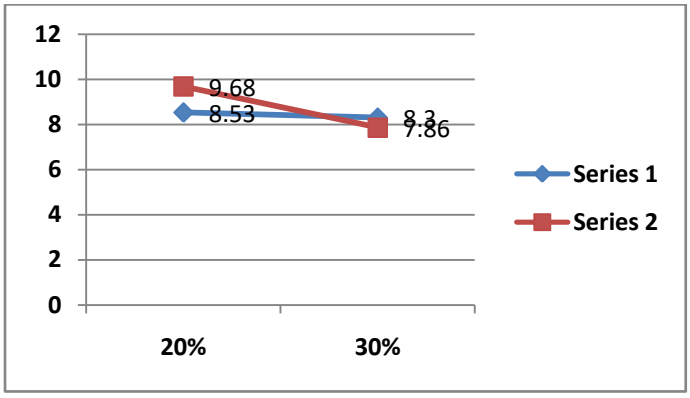
Graph 01

5.1.2For Replacement of Glass

5.1.2.1 Compressive strength results for 3-days

Table 5.2 Compressive Strength Results for 3-days

Replacement of glass	Strength 1	Strength 2
20%	8.53	9.68
30%	8.3	7.86

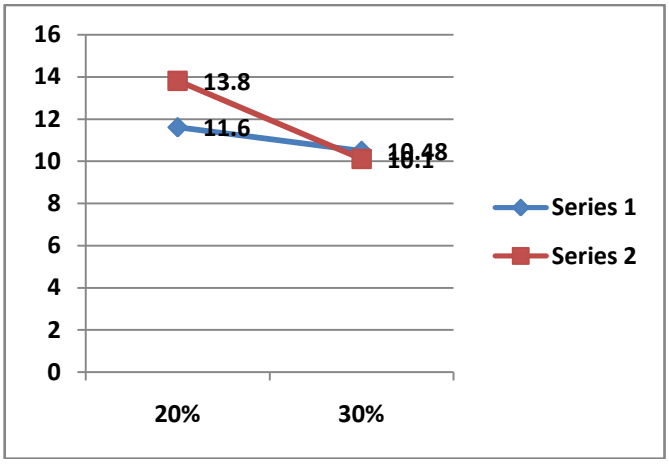


Graph 02

5.1.2.2 Compressive strength results for 7-days

Table 5.3 Compressive Strength Results for 7-days

Replacement of glass	Strength 1	Strength 2
20%	11.6	13.8
30%	10.48	10.1

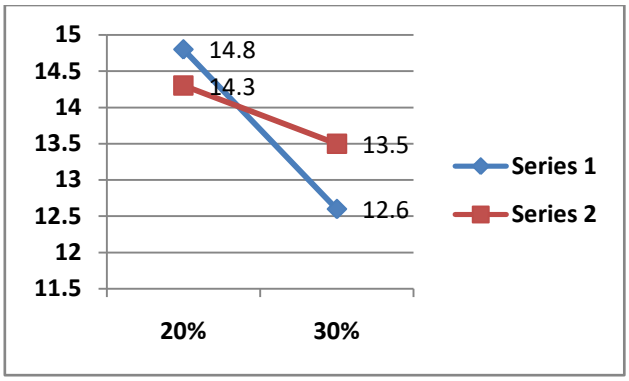


Graph 03

5.1.2.3 Compressive strength results for 28-days

Table 5.4 Compressive Strength Results for 28-Days

Replacement of glass	Strength 1	Strength 2
20%	14.8	14.3
30%	12.6	13.5



Graph 04

VI. DISCUSSION

It is observed that when coarse aggregate is replaced by 20% glass waste, the compressive strength at 3 days is found to increase by about 9.1% on average. The compressive strength at 7days is found to be 12.7%. However, it is evident that increase in compressive strength at 28 days is 14.55% at same replacement level.

It is observed that on replacing coarse aggregate by 30% glass waste on average there is an increase in compressive strength at 3 days by 8.08%, the compressive strength at 7 days is 10.29%. However, at 28 days, compressive strength is 13.05%.

It is seen that there is an increase in compressive strength for 20% respectively whereas a compressive strength is decreased marginally at 30% replacement level.

VII. CONCLUSIONS

- While using waste glass as coarse aggregate replacement, 28 days strength is found to marginally increase up to 20% replacement level.
- Marginal decrease in strength is observed at 30% replacement level of waste glass with coarse aggregate.
- Waste glass can effectively be used as coarse aggregate replacement.
- The optimum replacement level of waste glass as coarse aggregate is 10%.
- There is a decrease in compressive strength with increase in the percentage of the waste glass.
- With increase in waste glass content, percentage water absorption decreases.
- Workability of concrete mix increases with increase in waste glass content.
- Use of waste glass in concrete will eradicate the disposal problem of waste glass and prove to be environment friendly thus paving way for greener concrete.
- Use of waste glass in concrete will preserve natural resources particularly river sand and thus make concrete construction industry sustainable.

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