Use of Recycle Aggregate as a Partial Replacement of Coarse Aggregate and Glass Powder as a Fine Aggregate

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Abstract— The amount of waste glass has gradually increased over the recent years due to an ever-growing use of glass products. Most of the waste glasses are being dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. There is huge potential for using waste glass in the concrete construction sector. On the other hand, with natural sand deposits the world over drying up, there is an acute need for a product that matches the properties of natural sand in concrete. In the last 15 years, it has become clear that the availability of good quality natural sand is decreasing. Environmental concerns are also being raised against uncontrolled extraction of natural sand. The arguments are mostly in regards to protecting riverbeds against erosion and the importance of having natural sand as a filter for ground when waste glasses are reused in making concrete products, the production cost of concrete will come down. Waste glass powder can exhibit characteristics similar to that of sand. In this report we are going to discuss how the waste glass will have its significant effect on concrete and its properties. Fine aggregate replacement levels by waste glass powder15, 20, and 25 % along with partial replacement of glass powder and coarse aggregate by Recycle Aggregate (40%). The compressive strength of concrete cubes is tested for 7, 14, 28, days were found and results obtained were compared with that of normal concrete.

Key words: Waste Glass Powder, Compressive Strength, Fine Aggregate, Durability

I. INTRODUCTION

In order to make concrete industry sustainable, the use of waste materials in place of natural resources is one of the best approaches. An enormous quantity of waste glass is generated all around the world. In India, 7% of total urban waste generated comprises of glass. UK produces over three million tons of waste glass annually. Concrete is most widely used man made construction material and its demand is increasing day by day. The use of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of bridge piers and erosion of river bed. If fine aggregate is replaced by waste glass by specific percentage and in specific size range, it will decrease fine aggregate content and thereby reducing the ill effects of river dredging and thus making concrete manufacturing industry sustainable. The amount of waste glass produced has gradually increased over the recent years due to an ever growing use of glass products. Most waste glass has and is being dumped into landfill sites. The land filling of waste glass is undesirable because waste glass is non-biodegradable which makes them environmentally less friendly. There is huge potential for using waste glass in the concrete construction sector. When waste glasses are reused in making concrete products, the production cost of concrete will go down. This move will serve two purposes; first, it will be environment friendly; second, it will utilize waste in place of precious and relatively costlier natural resources. The objective of this paper is to present the results of experimental investigations on Physical and Mechanical properties of concrete made with waste glass powder Natural fine aggregate was partially replaced by 15, 20, and 25 percentage and coarse aggregate and recycled aggregate (30%).

II. MATERIALS USED

Materials used to make concrete specimens were fine aggregate, coarse aggregate, cement, fly ash, waste glass powder, recycled aggregate and water.

A. Cement:

The cement used for research work was ordinary Portland cement of 43 grade conforming IS8112.

B. Coarse Aggregate:

The coarse aggregate was selected from natural stone, which was maximum 20 mm in size. The stone used had 2.87 (gr/cm^3) specific gravity in saturated surface state and 0.80 % water absorption. The grades distribution curves for coarse and fine aggregate are given.

C. Fine Aggregate:

Sand of Zone-II as per IS: 383-1970 was used as fine aggregate. It had the specific gravity of 2.75 (gr/cm^3) and 0.70% water absorption.

D. Glass Powder:

Waste glass has been collected from Govindpura Industrial area of Bhopal and then it has been converted to powdered form in a range of 90µ to 4.75 mm.the specific gravity of glass powder was 2.37,fineness modulus 3.89, and of grading zone 2.

E. Recycled Aggregate:

The recycled aggregate was obtained from the demolished concrete structure, from the remains of beams and columns. It was 20 mm graded aggregates as per IS: 383-1970. It had 3.20 (gr/cm^3) specific gravity in saturated surface state and 1.40 % water absorption.

F. Water:

Natural Municipal tab water is used in the study Conforming IS 456: 2000.

III. PREPARATION OF TEST SPECIMEN

Concrete mixture proportioning was carried out according to the mix design method. Mix design of the concrete is done strictly as per the specification of the IS 10262: 2009.

According to IS code specification mix of M40 grade is designed, 4 different types of mix are prepared with different percentage of Glass powder as Partial Replacement of Fine Aggregate. A standard control mix (CC) was prepared with natural fine aggregates. The other three concrete mixes includes G15 that contains 15% of the Glass Powder, While G20, and G25 contains 20 and 25 percentage of Glass Powder respectively. The partial substitution of coarse aggregate by recycled aggregate (40%) was done by volume in the three mixes.

Mix Designation	Percentage replacement
CC (Control Concrete)	0% Glass Powder + 0% Recycle Aggregate
G15	15% Glass Powder + 40% Recycle Aggregate
G20	20% Glass Powder + 40% Recycle Aggregate
G25	25% Glass Powder + 40% Recycle Aggregate

Table 1: Designation of Various Mixes

The water to binder ratio was kept constant as 0.4. Same size, 150 x 150 x 150mm3was casted.The total mixing time was 20 minutes then the samples were casted and left for 24 hours. After that, samples were demoulded and placed in the curing tank until the testing time at the age of 7, 14, 28 days

IV. Experimental Investigation

A. Test on Fresh Concrete:

On fresh concrete workability test is performed of all concrete mixtures. Workanility is determined through slump test utilizing a metallic slump mould. The difference in level between the height of mould and that of highest point of the subsided concrete was measured and reported as slump. The slump tests were performed according to IS 1199-1959. Slump Cone test result is given in Table 2.

B. Test on Hardened Concrete:

Compressive Strength test is perform on all concrete mixture, cubes of size 150mm x 150mm x 150mm have been casted for the determination of compressive strength. Cubes were tested for compressive strength at an age of 7, 14, and 28 days from the day of start of curing. A constant loading rate of 150 kN/cm2/min was employed, and the quoted strength values are the averages of three cubes per test in accordance with IS 516-1959 standard test method.

The recycled aggregate is prepared by crushing the concrete material in Los Angeles Abrasion Test Machine and selecting the aggregate size as per IS standards. The specifications of recycled aggregate are shown in table. The maximum and minimum size of recycled aggregate according to IS codes is taken as 20mm and 4.75mm

Analysis of the physical properties of the natural aggregates was done according to IS standards. All aggregates met the specification of IS standard 383. The slump of the mixes are shown in Table 3.

Mix	Slump Value
CC	25 mm
G15	25 mm
G20	25 mm
G25	25 mm

Table 2: Slump Values

V. Results and Discussion

Table shows the compressive strengths of various mixes at 7 days, 14 days and 28 days from the day of curing.

Mix	Compressive Strength (in N/mm2)		
	7 days	14 days	28 days
CC	27.78	29.77	31.04
G15	22.98	28.37	32.50
G20	21.80	26.91	27.32
G25	25.37	29.73	33.78

Table 4: Compressive Strength Test Results.

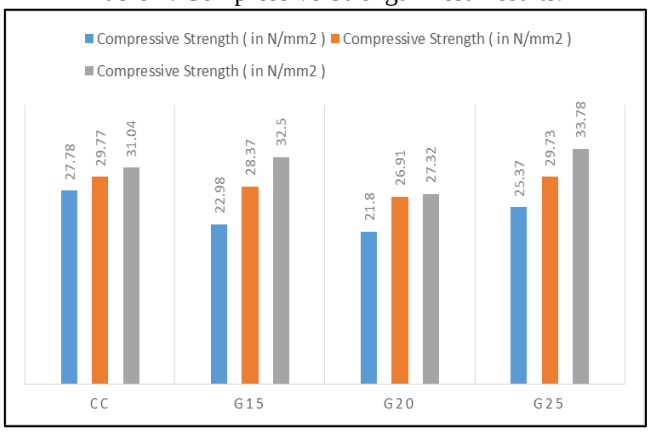

Fig. 1: Graph 1:

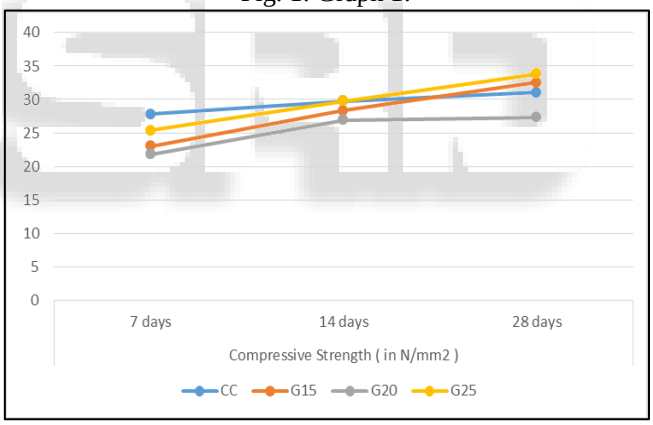

Fig. 2: Graph 2

Fig. 1& 2: Graph 1 & Graph 2: Compressive Strength of Concrete Cube

VI. Conclusion

The experimental results shows that compressive strength of G15 (15% glass powder as sand replacement) and G25 (25% glass powder as sand replacement) increases by 4.86% and 9.12% respectively as compared to normal standard concrete obtained at 28 days of age.

1) With an increase in waste glass content, percentage water absorption decreases.
2) Workability of concrete mix increases with an increase in waste glass content.
3) Utilization of waste glass in concrete can turn out to be economical as it is no useful waste and spare of cost.
4) Utilization of waste glass in concrete will eradicate the disposal problem of waste glass and essay to be

environment friendly, thus paving way for greener concrete.

5) Utilization of waste glass in concrete will keep natural resources, particularly river sand therefore constitute the concrete construction industry sustainable.

REFERENCES

[1] Asoka Pappu, Mohini Saxena, and Shyan R. Asolekar, "Solid Waste Generation In India And Their Recycling Potential in Building Materials", Regional Research Institute (CSIR) and IIT Bombay, India
[2] Concrete technology by M. Shetty, a book by Tata McGraw-hills.
[3] Dr. V. Vidivalli and M.Mageswari of Annamalai university, " The use of sheet glass as fine aggregate" in "The Open Civil engineering Journal 2010".
[4] Patel Dhirendra, Yadav R.K. and Chandra R. Department of Civil Engineering, Jabalpur Engineering College, Jabalpur, has published An article on "Strength characteristics of precast concrete blocks incorporating waste glass powder" which was published in "IS journal of Engineering Sciences" was considered as another reference.
[5] Ahmad SHAYAN Chief Research Scientist ARRB Transport Research Vermont South Vic Australia has published a paper on "Value-Added Utilization of Waste Glass in Concrete"
[6] The Islamic University of Gaza has published an article on Properties of Concrete Mixes with Waste Glass.
[7] Work Team, "Pollution caused by solid waste, rubble, and construction debris is a serious threat to the sea and the shore of the Gaza Strip", Ocha, 2009
[8] M. Iqbal Malik, Muzafar Bashir, Sajad Ahmad, Tabish Tariq, Umar Chowdhary, IUST, Awantipora, J&k, INDIA" Study of Concrete Involving Use of Waste Glass as Partial Replacement of Fine Aggregates".
[9] K.Madhangopal, B.Nagakiran, S.R.Sraddha, G.Vinodkumar, P.Thajun, S.A.KishoreSankeerth, T.V aralaksmi,"Study the Influence of Waste Glass Powder on the Properties of Concrete".
[10] Adarsh Dubey, Sanjav Saraswat, Devansh Jain, and Study of Properties of Concrete when it's Fine Aggregate is replaced by Glass Powder, SATI Vidisha and UITRGPV, Bhopal.

