Study of Properties of Concrete when its Fine Aggregate is replaced by Glass Powder

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Abstract— Use of waste material in concrete achieves a new height in the present construction world. In concrete all their ingredients are partially or fully replaced by many waste materials like Cement is replaced by Fly Ash, Rice Husk Ash, Wheat Straw Ash, etc., Fine aggregate is replaced by Saw Dust Ash, Quarry Fines, and Glass Powder etc. And coarse aggregate is replaced by cockle shell, tire rubber, recycle aggregate etc. In this paper study of Compressive strength, Split Tensile Strength, Workability and water absorption of concrete is done when its fine aggregate is replaced by Glass Powder. 150 * 150 * 150 mm cube and 150*300 mm cylinders are cased of M 25 grade of concrete.
Keywords: Concrete, Glass Powder, Fine aggregate

I. INTRODUCTION

In the today's construction world, the use of waste material achieves a new height. Concrete is a versatile material and it contain a mixture of Cement, Coarse aggregate, Fine Aggregate and Water. Many engineers, scientist and researchers introduced many of the waste material which can replace concrete ingredients. Aggregate is the natural material which we obtained naturally on earth, generally we use natural stone as coarse aggregate and river sand as fine aggregate, but in some region of the world availability of these natural is quite low and some region, it is not available, due to this waste material is introduced as a partial or full replacement of the natural aggregate. In this paper, glass powder is introduced as a partial replacement of fine aggregate.

G. Vasudevan, S.G.K. Pillay says Concrete with using waste glass powder has a very high workability from the control sample. This result achieved from the depression test that function of waste glass powder were will increase the workability of concrete. In terms of intensity level, concrete by using waste glass powder averagely have higher potency at 14 days, but once the concrete reached at 28 days the control mix give higher value compare to mix that contained waste glass powder [7]. M. Mageswari, Dr. B.Vidivelli says The SGP (Sheet Glass Powder) is suitable for use in concrete making, the water requirement decreases as the SGP content in- creases. The compressive strength of square blocks and cylinders of the concrete for all mix increases as the % of SGP increases, but decreases as the historic period of curing increases due to alkali Silica reaction. The Tensile strength of square blocks and cylinders of the concrete for all mix increases than that of conventional concrete age of curing and decreases as the SGP content increases. The Flexural strength of the beam of concrete for all mix increases with years of curing and decreases as the SGP content increases. 100% replacement of SGP in concrete showed better results than that of conventional concrete at 28 days and 45 days curing, but later it began to lessen its potency because of its alkali silica reactions. The density of SGP concrete is more that of conventional concrete. SGP is available in substantial quantities as a waste and can be used for producing concrete. This will move a long way to cut down the amount of waste in our surroundings. The optimum re- placement stage of fine aggregate with SGP is 10% [8]. Sunny O. Nwaubani1 and Konstantinos I. Poutos says the environmental drivers must not be overlooked as waste glass incorporation into concrete on an appropriate selective basis would provide solution to problems encountered in waste management. When applied as a finely ground powder to substitute Portland cement, this comprises a positive answer to global environmental problems such as high carbon dioxide emissions generated by Portland cement production. In addition, it would reduce extraction of natural fabrics such as limestone, The amount of incorporating waste glass largely influenced properties of the cement mortar. It is apparent from these results that ground glass could enhance the attributes of the final concrete product if applied at the right degree of replacement [9].

II. MATERIALS AND METHODS

A. Material Used

1) Cement

Ordinary Portland cement of Grade 43 conforming IS 8112 [1] was used in the work.

2) Aggregates

Fine aggregates used throughout the study comprised of white river sand and strictly pass from 4.75mm IS sieve, conforming to zone II as per IS383-1970 [2] with specific gravity of 2.61. Coarse aggregates used consisted of machine crushed stone angular in shape passing through 20mm IS sieve and retained on 4.75mm IS sieve with specific gravity of 2.72.

3) Glass Powder

Waste glass was collected from Swastik Glass Industry, Bhopal. Consisting of waste window glass (Soda Lime glass). It was pulverized in Los Angeles abrasion apparatus and then sieved through 1.18mm IS sieve. The specific gravity of waste glass was found to be 2.4.

B. Mix Design

Mix design of the concrete is done strictly as per the specification of the IS 10262 : 2009. According to IS code specification mix of M25 grade is designed, 5 different types of mix are prepared with different percentage of Glass powder as Partial Replacement of Fine Aggregate. CC mix is prepared with 0% of Glass Powder or we can also pronounce it is controlled concrete, GP10 mix contains 10% of the Glass Powder. While GP20, GP30 and GP40 contains 20,30 and 40 percentage of Glass Powder respectively.

C. Test Performed

1) Test on Fresh Concrete

Slump Test The workability of all concrete mixtures was determined through slump test utilizing a metallic slump mould. The difference in grade between the height of mud and that of the highest level of the subsided concrete was measured and described as a depression. The slump tests were executed according to IS 1199- 1959 [3].

2) Tests on hardened concrete: From each concrete mixture, cubes of size 150mm x 150mm x 150mm and 150mm x 300mm cylinders have been shed for the determination of compressive strength and splitting tensile strength respectively.

The concrete specimens were cured under normal conditions as per IS 516-1959 [5] and were tested at 7 days and 28days for determining compressive strength as per IS 516-1959 [6]. Water absorption test The average dry weight of cube specimens after removing from molds was measured and the mean weight of cube specimens after submerging in water for curing was measured at 28 days of age. The percent of water absorption was assessed for each concrete specimen and it gave indirect measure of strength.

III. Result And Discussion

A. Fresh concrete

Table 1 represents the slump value of the all concrete mix. The slump increased with the growth in waste glass content. Waste glass particles absorbed less water as compared to sand and hence improving the workability of concrete admixture. The depression was the maximum for the concrete mixture containing 40% waste glass in lieu of fine aggregates. The variance of a slump with waste glass content is described in Fig. 1.

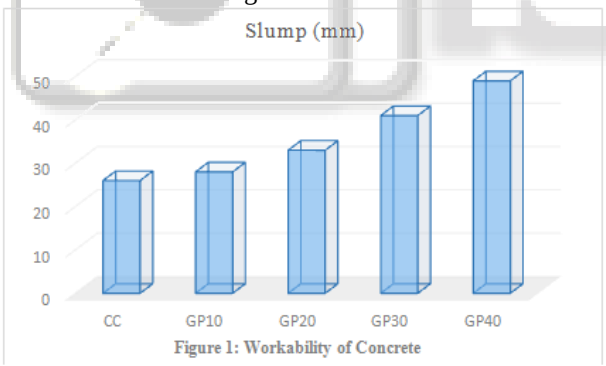

Figure 1: Workability of Concrete

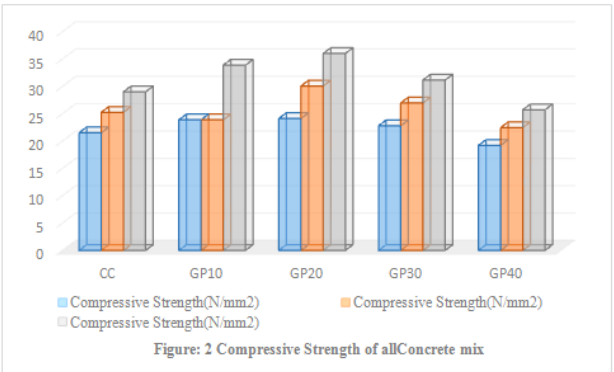

Figure: 2 Compressive Strength of allConcrete mix

S.No.	Mix	Slump (mm)
1	CC	26
2	GP10	28
3	GP20	33
4	GP30	41
5	GP40	49

Table 1: workability of Concrete

S.No.	Mix	Compressive Strength(N/mm2)		
		7 Day	14 Day	28 Day
1	CC	21.52	25.26	29.01
2	GP10	23.89	23.89	33.89
3	GP20	24.12	30.07	36.02
4	GP30	22.8	26.98	31.16
5	GP40	19.21	22.47	25.72

Table 2: Compressive Strength of all Concrete Mix

B. Hardened Concrete

The compressive strength tests and splitting tensile strength tests are shown in TABLE 3. Compressive strength tests and splitting tensile strength tests were carried out at 7 and 28 days. An increase in compressive strength was observed up to 30% replacement of fine aggregates of waste glass and thereafter decreasing. The maximum compressive strength measured was 25% more than that of a reference mix at 28 days corresponding to concrete mixture containing 20% waste glass in lieu of fine aggregates. Compressive strength for concrete mix with 40% waste glass content was found to be less than that of reference mix. Splitting tensile strength decreased with increasing waste glass content. Fig. 4 and 5 present compressive strength of all mixtures at 7 and 28 days respectively. Fig. 6 and 7 present splitting tensile strength of all mixtures at 7 and 28 days respectively.

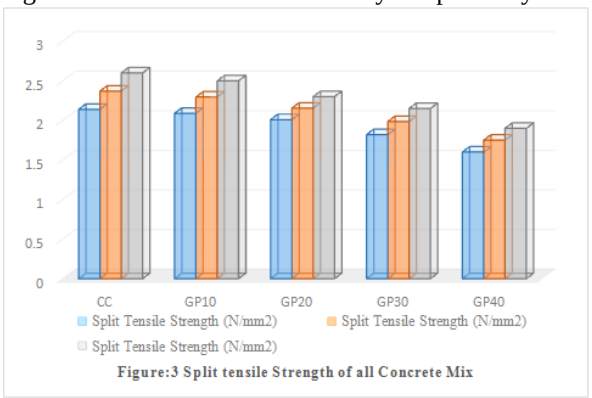

Figure:3 Split tensile Strength of all Concrete Mix

S.No.	Mix	Split Tensile Strength (N/mm2)		
		7 Day	14 Day	28 Day
1	CC	2.14	2.37	2.6
2	GP10	2.09	2.295	2.5
3	GP20	2.01	2.155	2.3
4	GP30	1.82	1.985	2.15
5	GP40	1.6	1.75	1.9

Table 3: Split Tensile Strength of Concrete Mix

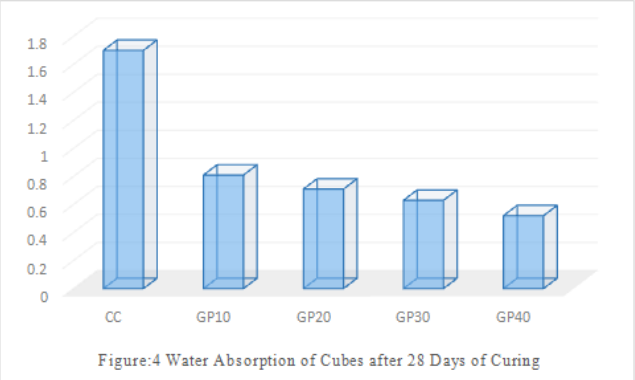

Figure:4 Water Absorption of Cubes after 28 Days of Curing

C. Water absorption

Water absorption test was carried out for all mixtures and percentage water absorption was measured. The percentage water absorption decreased with an increase in waste glass content. The lowest value of water absorption was found for concrete mix with 40% waste glass content. TABLE 4 depicts the percentage water absorption for all varieties.

S.No.	Mix	Water Absorption
1	CC	1.7
2	GP10	0.81
3	GP20	0.71
4	GP30	0.63
5	GP40	0.52

Table 4: Water Absorption of Cubes after 28 Days of Curing

IV. CONCLUSION

On the base of outcomes received, the following conclusions can be made:

(1) 20% replacement of fine aggregates by waste glass showed a 15 % increase in compressive strength at 7 days and 25% increase in compressive strength at 28 days.
(2) Fine aggregates can be replaced by waste glass up to 30% by weight showing a 9.8 % increase in compressive strength at 28 days.
(3) With an increase in waste glass content, percentage water absorption decreases.
(4) Workability of concrete mix increases with an increase in waste glass content.
(5) Splitting tensile strength decreases with an increase in waste glass content.
(6) Utilization of waste glass in concrete can turn out to be economical as it is no useful waste and spare of cost.
(7) 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.
(8) Utilization of waste glass in concrete will keep natural resources, particularly river sand and therefore constitute the concrete construction industry sustainable.

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