Studies on properties of concrete with fluorescent waste glass powder

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Abstract:--Concrete is a construction material composed of cement, aggregates (fine and coarse aggregates) water and admixtures. Today many researches are ongoing into the use of Portland cement replacements, using many waste materials like pulverized fly ash (PFA) and ground granulated blast furnace slag (GGBS). This work examines the possibility of using Fluorescent Glass powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 6%, 8%, 10%, 12%, 15% 20% and 25% and tested for its compressive, Tensile and flexural strength up to 28 days of age and were compared with those of conventional concrete from the results obtained, it is found that glass powder can be used as cement replacement material up to particle size less than 75µm to prevent alkali silica reaction. For study of size effect of glass powder the powder is divided in to two grades one is glass powder having size less than 90 micron and another is glass powder having particle size ranges from 90 micron to 150 micron. It is found from study, Initial strength gain is very less due to addition of GLP on 7th day but it increases on the 28 day. It is found that 10% addition of GLP gives higher strength. And also GLP size less than 90 micron is very effective in enhancement of strength.

Keywords- waste glass powder; concrete; strength; replacement

1. INTRODUCTION

The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction, the waste glass from in and around the small shops is packed as a waste and disposed as landfill. Glass is an inert material which could be recycled and used many times without changing its chemical property .Besides using waste glass as culletin glass manufacturing waste glass is crushed into specified sizes for use as aggregate in various applications such as water filtration, grit plastering, sand cover for sport turf and sand replacement in concrete. Glass is amorphous material with high silica content, thus making it potentially pozzolanic when particle size is less than 75µm. Studies have shown that finely ground glass does not contribute to alkali – silica reaction. In the recent, various attempts and research have been made to use glass as a replacement in conventional ingredients in concrete production as a part of green house management. A major concern regarding the use of glass in concrete is the chemical reaction that takes place between the silica – rich glass particle and the alkali in pore solution of concrete, which is called Alkali – Silicate reaction can be very detrimental to the stability of concrete, unless appropriate precautions are

taken to minimize its effects. Selected properties of the glass powder modified mixtures are compared with the properties of conventional concrete. The ultimate aim of this work is to ascertain the performance of concretes containing glass powder and compare it with the performance of conventional concretes.

II. MATERIALS

The ingredients of concrete consist of Cement, fine aggregate, coarse aggregates and water. When the reaction of water with cement takes place hydration process is done and a hard material is formed. In this research we used waste glass powder as a partial replacement and filler material. The ingredients are used in proper proportion. Also the cement is replaced at 6%, 8%, 10%, 12%, 15% 20%, and 25% by weight of cement. They are described in details with their properties are as follows

1. Cement

Ordinary Portland cement of 43 grades conforming to IS 8112 was used throughout the work.

2. Fine aggregates and coarse aggregates

The fine aggregate used in this investigation was clean river sand, whose maximum size is 4.75 mm, conforming to grading zone III. Machine crushed blue granite stone angular in shape was used as coarse aggregate. As per IS: 2386 – 1963 recommendations were used.

3. Glass powder

Waste glass available in local shops is been collected and made into glass powder. Glass waste is very hard material. Before adding glass powder in the concrete it has to be powdered to desired size. In this studies glass powder ground in ball/ pulverize for a period of 30 to 6o minutes resulted in particle sizes less than size 150 µm and sieved in 75 µm Fig.1. The physical, chemical properties and chemical composition are given in the table 1, 2 & 3.

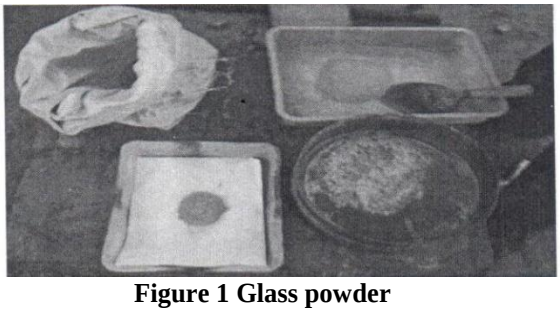

Figure 1 Glass powder

Table 1: Physical properties of glass Powder

S.NO	Physical properties of glass Powder	
1	Specific gravity	2.7
2	Fineness passing 90mm	98

Table 2: Chemical properties of glass Powder

S.NO	Chemical properties of glass Powder	
1	Ph	10.42
2	Colour	Grayish white

Table 3: Chemical Composition of glass Powder

S.NO	Chemical properties of glass powder	% by weight
1	SiO_2	67.330
2	Al_2O_3	2.620
3	Fe_2O_3	1.420
4	TiO_2	0.157
5	CaO	12.450
6	MgO	2.738
7	Na_2O	12.050
8	K2O	0.638
9	ZrO2	0.019
10	ZnO	0.008
11	SrO	0.016
12	P2O5	0.051

III. MIX PROPORTION

The concrete mix design was proposed by using Indian Standard for control concrete. The grade was M_{20}. The mixture will be prepared with the cement content of 360kg/m3 and water cement ratio of 0.50. The mix proportion of materials is 1:1.62:3.4 as per IS 10262-2009.Then natural fine aggregate was used. The replacement levels of cement, glass powder were used in terms of 6%, 8%, 10%, 12%, 15%, 20, and 25% in weight of cement. Chemical admixture is not used.

IV.TESTING

The concrete prepared with various percentage replacement of the cement such as 6%,8%,10%, 12%, 15%, 20% and 25% was cured under normal condition as per IS recommendation and were tested at 7 days and 28 days for determining the compressive , tensile and flexural strength and shows the test results of Glass powder replaced concrete Fig 2,3&4

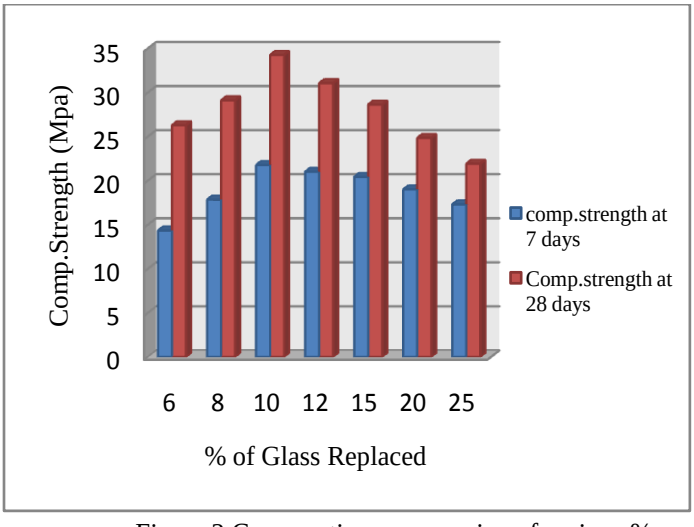

Figure 2 Comparative compressive of various % Replacement of Glass powder with cement.

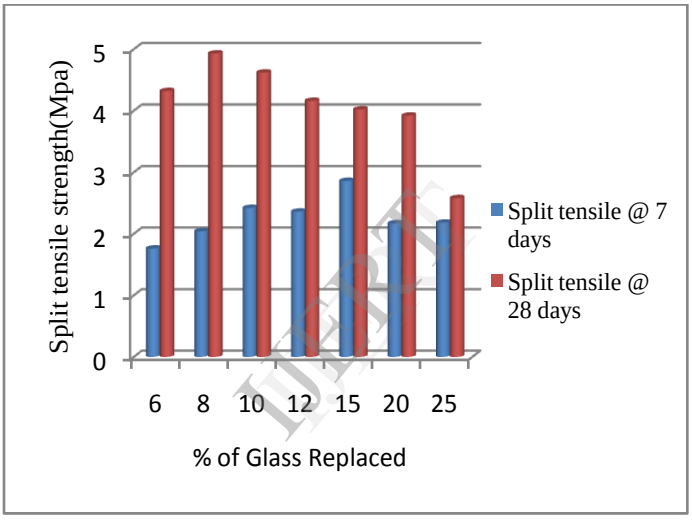

Figure 3 Comparative tensile strength of various % Replacement of Glass powder with cement

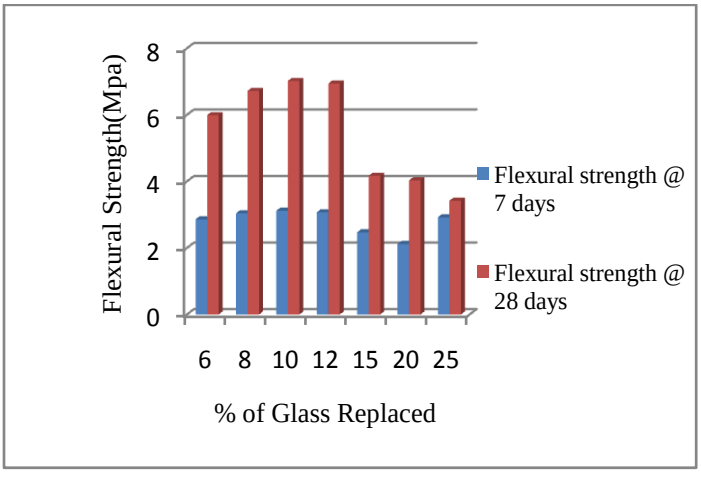

Figure 4 Comparative Flexural strength of various % Replacement of Glass powder with cement.

V.DURABILITY (CHLORIDE ATTACK)

After the completion of 28 days curing the initial weight of the specimens were noted. The specimens were immersed in chloride solution. After the specimens immersed the change in weight of specimens were taken at every 5 days interval of cyclic period up to 30 days. Finally the change in weight of specimens due to chloride attack and the strength deterioration factor also was calculated results are shown in table 4.

Table 4: The Durability test values for glass powder added concrete

% of glass powder replaced	Comp. Strength before curing	Comp. Strength after curing	% of deterioration
6	26.31	24.98	0.05
8	29.13	27.8	0.04
10	34.25	33.00	0.03
12	31.08	29.65	0.04
15	28.65	27.01	0.05
20	24.86	23.10	0.07
25	21.94	19.64	0.10

Table 5: Ultra sonic pulse velocity test value on glass impregnated concrete

% of powder added	Value(km/sec)
6	**6.81**
8	**5.76**
10	**6.52**
12	**6.50**
15	**6.21**
20	**6.79**
25	**7.12**

Table 6: Rebound hammer value

% of glass	Compressive Strength(N/mm^2)
6	**26**
8	**29.72**
10	**34.17**
12	**30.97**
15	**28.20**
20	**24.62**
25	**21.35**

VI. RESULT AND DISCUSSION

The compressive strength test on both conventional and glass added concrete was performed on standard compression testing machine of 4000kN capacity, as per IS: 516-1959. Totally 42 numbers of cubical specimens of size 150mmX150mmX150mm, and 14 number of cylinder was casted and tested for the compressive strength at the age of 7days and 28 days. Each of the compressive strength test data corresponds to the mean value of the compressive strength of three cubes. At 28 days the glass powder shows strength of 34.28N/mm^2, strength at 10% cement replacement. The flexural strength of glass powder added concrete at the age of 28 days. At 28 days, in 10% replacement the strength has been increased to 7.02N/mm^2.

VII. CONCLUSION

Conventional concrete shows at 28 days compressive strength as 23.1 N/mm^2, split tensile strength of 3.27N/mm^2 and flexural strength of 4.25N/mm^2

1. Replacement of glass powder in cement by 6%, 8%, 10%, 12%, 15%, 20%and 25% increases the compressive strength by 26.31, 29.13, 34.28, 31.08, 28.65, 24.86, and 21.94 respectively.
2. Replacement of glass powder in cement by 10% increases the split tensile strength by 4.62% respectively
3. Glass powder concrete increases the compressive, tensile and flexural strength effectively, when compared with conventional concrete.

REFERENCES

(1) Chi sing lam, chi sun poon and Dixon chan, "Enhancing the performance of pre – cast Concrete blocks by incorporating waste glass – ASR consideration", Cement and Concrete composites, vol: 29pp, 616-625, 2007.
(2) Christopher cheeseman, "Production of sintered light weight aggregate using waste ash And other industrial residues", Belgium, 2011.
(3) Victor Shevchenko and WojciechSwierad "A Mechanism Ofning In The Presence Of FinelyGrained Glass Powder" Journal of Chemistry and ChemicalTechnology, 2007, Vol. 1, No. 3, p.p.179-184
(4) M.S. Shetty, "Concrete Technology", S. Chand and companyltd., New Delhi.
(5) IS 10262:2009 Indian Standard Concrete Mix Proportioning-Guidelines (First Revision)