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INFLUENCE OF WASTE GLASS POWDER ON THE PROPERTIES OF CONCRETE

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Abstract— Concrete is most widely used construction materials. However, the production of Portland cement releases significant amount of CO2, a greenhouse gas. One ton of Portland cement clinker production releases approximately one ton of CO2 and other greenhouse gases. Environmental issues are playing vital role in the sustainable development of concrete industry.

Today many researches are ongoing for the replacement of Portland cement, using many waste materials like fly ash and ground granulated blast furnace slag (GGBS). Like Fly ash and GGBS a waste glass powder can also use as a binder with the partial replacement of cement which take some part of reaction at the time of hydration. Cement replacement by glass powder in the range 5% to 25% with an interval of 5% is to be study.

It was tested for compressive strength, flexural strength and Split tensile strength at the age of 7, 28 days and compared with the results of conventional concrete. The overall test results shows that Waste Glass Powder could be used in concrete as a partial replacement of cement.

Keywords: Concrete, Waste glass powder, Strength, partial replacement of cement.

I. INTRODUCTION

A vital component of concrete is cement, which has its own environmental and contributes largely to concrete. The cement industry is one of the primary industry which produces carbon dioxide (CO2), producing up to 5% of worldwide man-made emissions of carbon dioxide gas.

Glass is an amorphous solid which founds in various forms for thousands of years and has been manufactured by human since 12,000 BC. Glass is one the most versatile substance, used in many applications and in a wide variety of forms. The interest of the construction community in using waste or recycled material as a partial replacement in concrete is increasing now a days, because of the emphasis placed on sustainable construction. Glass is an inert material which could be recycled and used many times without disturbing its chemical properties.

Efforts have been made in the concrete industry to use waste glass powder in concrete as a partial replacement of cement. Waste glass when ground to a very fine powder shows pozzolanic properties as it contains SiO2 and therefore it can partially replace cement in concrete and may improve strength. Glass is an amorphous material which contains high silica, thus making it potentially pozzolanic when particle size is less than 90 micron. Experimental Studies have shown that finely ground glass does not leads to alkali –silica reaction. In this paper, finely powdered glasses are used as a partial replacement of cement in concrete and compared those with the results of conventional concrete. Concrete mixtures were prepared with different proportions of finely ground waste glass powder ranging from 5 to 25% with an interval of 5% and tested for compressive strength and flexural strength.

II. MATERIAL USED

A. **Cement:** The cement used was 53 grade Ordinary Portland Cement confirming to IS 8112-1989.

B. **Fine aggregate:** Locally available sand confirming to zone II with specific gravity 2.66 was used. The test on sand was conducted as per Indian Standard Specification IS: 383-1970.

C. **Coarse aggregate:** Coarse aggregate used was 20 mm and less size and specific gravity 2.70. Tests on coarse aggregate was conducted as per Indian Standard Specification IS: 383-1970.

III. Glass: In this experiments glass powder (GLP) having particle size less than 90 micron was used. Chemical composition of glass powder is as follows:

Composition	Glass Powder (%)
Sio2 Content	98.01
Lead oxide	Nil
Copper Oxide	Nil
Alumina	0.33
Ferric Oxide	0.10
Titanium Dioxide	0.02
Mangnous Oxide	Traces
Zirconium Oxide	Nil
Calcium Oxide	0.61
Magnesium Oxide	0.35
Boric Acid	Nil
Pottasium Oxide	0.05
Sodium Oxide	0.06
Loss on Ignition	0.46
Matter Soluble in Aqua regia	1.41

IV. EXPERIMENTAL WORK AND TEST

A. **Mix Design:** Mix design carried out for M30 grade of concrete by IS 10262:2009, resulting to a mix proportion of 1:1.52:2.04 with water cement ratio of 0.42. The replacement of cement by glass powder was 5% to 25% at increment of 5% each.

B. **Compressive and Flexure test:** Concrete prepared with different percentage replacement of cement by 5% to 25% at increment of 5% each was cured under normal condition and were tested at 7 days and 28 days for determining the compressive and flexural strength and compared those with the results of conventional concrete.

C. **Workability test:** The slump is a measure representing the consistency or workability of concrete. In this experimental work, the slump value of fresh concrete was in the range of 80 mm to 110 mm.

V. TEST RESULTS

A. Workability

Table 2 shows the results of workability of concrete with partial replacement of cement by glass powder in various percentages ranging from 5% to 25% in increments of 5%.

Table 2: Results of workability of concrete with partial replacement of cement by glass powder

Mix Designation	% replacement of cement by glass powder	Slump (mm)
A1	0	100
A2	5	95
A3	10	90
A4	15	87
A5	20	83
A6	25	75

B. Compressive Strength

The table gives the results of test conducted on hardened concrete with 0-25% glass powder for 7, 28. From table 3, results shows that the compressive strength increases with increasing curing time. Compressive strength obtained for concrete with 20% replacement by glass powder showed a higher value by 30%, 25% compared to conventional concrete for 7 days and 28 days respectively.

Table 3: Results of Compressive Strength of concrete with partial replacement of cement by glass powder

Mix Designation	% replacement of cement by glass powder	7 days Compressive Strength	28 days Compressive Strength
A1	0	21.08	27.07
A2	5	22.30	28.67
A3	10	23.37	29.87
A4	15	24.98	31.67
A5	20	27.34	33.24
A6	25	23.62	30.32

C. Flexural strength

Table 4 shows the variation of results for flexural strength of concrete with cement replacement by glass powder for 7 and 28 days. It is clear that flexural strength of concrete with 20% cement replacement by glass powder showed a higher value by 27%, 20% compared to control concrete for 7 days and 28 days respectively.

Table 4: Results of Flexural Strength of concrete with partial replacement of cement by glass powder.

Mix Designation	% replacement of cement by glass powder	7 days Flexural Strength	28 days Flexural Strength
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A4	15	24.98	31.67
A5	20	27.34	33.24
A6	25	23.62	30.32

VI. DISCUSSION ON TEST RESULTS

A. Workability

As the glass content in concrete increases workability decreases. As there is a reduction in fineness modulus of cementatious material, quantity of cement paste available for providing lubricating effect is less per unit surface area of aggregate.

B. Strength

As the percentage replacement of cement with glass powder increases strength of concrete increases up to 20%. The highest percentage increase in the compressive strength was 30% and flexural strength was 22% at 20%.

VII. CONCLUSIONS

Based on experimental observations, following conclusions can be drawn:

1) Glass powder concrete increases the compressive and flexural strength effectively as compared with conventional concrete.

2) Workability decreases as percentage of glass powder in concrete increases.

3) Use of waste glass in concrete will reduce the disposal problem of waste glass and prove to be environment friendly.

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