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Influence of Waste Glass Powder on Properties of Concrete

Amol M. Barhate [1], Suraj V. Pawar [2]

Department of Civil Engineering, G.H.Raisoni Engineering College, Ahmednagar, Maharashtra, India[1,2]

ABSTRACT: Cement is a standout amongst the most generally utilized development materials. Nonetheless, the generation of Portland bond, a basic constituent of solid, prompts the arrival of huge measure of CO2, an ozone depleting substance. One ton of Portland bond clinker generation is said to make roughly one ton of CO2 and other nursery gasses. Natural issues are assuming an imperative part in the feasible advancement of the bond and solid industry.

Today many inquiries about are continuous into the utilization of Portland bond substitutions, utilizing many waste materials like fly fiery debris and ground granulated impact heater slag. Like PFA and GGBS a waste glass powder is likewise utilized as a cover with incomplete substitution of concrete which take some piece of response at the time of hydration, additionally it is go about as a filler material. Concrete was supplanted by glass powder with the addition of 4% from 0% to 28%. It was tried and contrast those outcomes and the consequences of traditional blend.

KEYWORDS: Glass powder, waste material concrete, properties of concrete, Replacement for cement etc.

I. INTRODUCTION

Today many looks into are continuous into the utilization of Portland concrete substitutions, utilizing many waste materials and mechanical by items, for instance, pounded fly fiery debris (PFA) and ground granulated impact heater slag (GGBS). Like PFA and GGBS, a glass powder is likewise utilized as a folio with fractional substitution of bond which takes some piece of response at the season of hydration; additionally it is go about as a filler material. Typically glass does not hurt nature at all since it doesn't radiate toxins, however it can hurt people and also creatures, if not managed deliberately and it is less amicable to condition since it is non-biodegradable. In this way, the improvement of new advances has been required. The term glass involves a few substance assortments including parallel salt silicate glass, boro-silicate glass, and ternary pop lime silicate glass. Fractional supplanting of concrete with processed waste glass benefits the microstructure and steadiness of cementitious materials. A denser (not so much permeable) but rather more homogeneous structure is delivered when processed waste glass is utilized as halfway trade for bond, which benefits the imperviousness to dampness sorption and hence the long haul toughness of cementitious materials.

Fractional supplanting of concrete with processed waste glass additionally benefits the solidness of cementitious materials when possibly injurious responses between bond hydrates and the receptive totals is a worry. Blended shading waste glass, when processed to about the molecule size of bond and utilized as a part of concrete as swap for around 15% of concrete, enhances the dampness hindrance qualities, toughness, and mechanical execution of cement. The presentation of waste glass in concrete will expand the salt substance in the bond. It likewise help in blocks and clay fabricate and it jelly crude materials, diminishes vitality utilization and volume of waste sent to landfill. As valuable reused materials, glasses and glass powder are essentially utilized as a part of fields identified with structural building, for instance, in concrete, as pozzolana (supplementary cementitious materials), and coarse total. Their reusing proportion is near 100%, and it is likewise utilized as a part of cement without unfavourable impacts in solid solidness. In this way, it is viewed as perfect for reusing.

II. MATERIAL AND METHODS USED

The materials used in this present work are glass powder, Ordinary Portland cement (53 grade), coarse aggregates and fine aggregates and water.

2.1 Glass Powder

Glass is a straightforward material delivered by softening a blend of materials, for example, silica, pop fiery debris, and CaCO3 at high temperature took after by cooling amid which hardening happens without crystallization. Most waste

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glasses have been dumped into landfill locales. The Land filling of waste glasses is undesirable since they are not biodegradable, which makes them earth less inviting.

We use the waste glass in concrete to become the construction economical as well as eco-friendly. The glass powder used in the present study is brought from Mumbai market. This material replaces the cement in mix proportion.

The chemical composition, chemical and physical properties are presented in the table given below:

a) Chemical Composition of Glass Powder:

Sr. No.	Composition	Waste Glass Powder (%)
1	Silica	98.01
2	Lead Oxide	Nil
3	Copper Oxide	Nil
4	Alumina	0.33
5	Ferric Oxide	0.10
6	Titanium Dioxide	0.02
7	Magnus Oxide	Traces
8	Zirconium Oxide	Nil
9	Calcium Oxide	0.61
10	Magnesium Oxide	0.35
11	Potassium Oxide	0.05
12	Sodium Oxide	0.06
13	Matter Soluble in Aqua Regia	1.41
14	Matter Soluble in 14% Acetic Acid	0.64

2.2 Fine Aggregate:

Locally accessible sand from nearby waterway is utilized as a fine total complying with zone II of IS 383-1983.Maximum size of total utilized is 4.75 mm.

2.3 Coarse Aggregate:

The properties, for example, dampness content, water retention and so on would help in modifying nature of blending water for solid blend. Locally accessible pounded stone total with size 12.5 mm to 20mm and of most extreme size 20mm are utilized.

2.4 Water:

Water helps to form the strength giving cement gel, the quality and quantity of water is required to be looked into very carefully. Its PH value shall not be less than 6. Water that is suitable for drinking is satisfactory for use in concrete.

III. MIX DESIGN

The most elevated conceivable quality solid will from time to time be required so that the solid maker should choose a solid blend that satisfy all predefined prerequisite. The premise considers deciding the properties of the solid blend are talked about as takes after:

Design proportion for M_{35} grade of concrete = 1: 1.69: 2.28 (W/C = 0.42)

IV. TESTING OF SPECIMEN

In the present study test conducted on harden concrete were carried out by using Compressive Testing Machine(CTM) of capacity 3000 KN and Universal Testing Machine (UTM) of capacity 600 KN as per IS 516:1959. Following tests are performed glass powder concrete:

On Fresh Concrete:

a) Slump cone test to determine workability of concrete

On Hardened Concrete:

a) Compressive Strength Test

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b) Split Tensile Strength Test
c) Flexural strength Test
d) Alkalinity Test
e) Water Absorption Test
f) Carbonation Test

V. RESULTS

2.1 Results of Workability Test: (IS 10510:1983)

For checking workability of concrete slump cone method is used. Table 5.1 and graph 5.1a shows the results of workability of concrete with cement replacement by glass powder in various percentages ranging from 4% to 28% in increments of 4%.

Sr. No.	Mix Notation	% replacement of cement by glass powder	Slump Value (mm)
1	C1	0 %	62
2	C2	4 %	61
3	C3	8 %	56
4	C4	12 %	52
5	C5	16 %	50
6	C6	20 %	48
7	C7	24 %	45

Table 5.1

It is clear from table 5.1, workability of concrete decreases as percentage of glass powder in concrete increases.

2.2 Results of Compressive Strength Test: (IS 516:1959)

7 days compressive Strength Result:

According to IS: 516:1959 For the compression test the cubes of size 150 mm x 150 mm x 150 mm (According to IS: 10086-1982) are prepared and tested after 7 days and 28 days of curing.

Sr. No.	Mix Notation	% replacement of cement by glass powder	Compressive Strength in MPa (7 Days)
1	C0	0 %	28.80
2	C1	4 %	30.10
3	C2	8 %	33.22
4	C3	12 %	34.77
5	C4	16 %	36.10
6	C5	20 %	32.52
7	C6	24 %	29.01

Table 5.2

It is clear from table 5.2 compressive strength obtained for concrete with 16% replacement by glass powder showed a higher value of compressive strength 36.10 MPa for 7 days.

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Volume 4, Issue 5, May 2017

28 days compressive Strength Result:
Following table shows the compressive strength for all proportions after 28 days

Sr. No.	Mix Notation	% replacement of cement by glass powder	Compressive Strength in MPa (28 Days)
1	C0	0 %	44.10
2	C1	4 %	45.18
3	C2	8 %	48.21
4	C3	12 %	53.24
5	C4	16 %	56.82
6	C5	20 %	46.11
7	C6	24 %	44.28

Table 5.2.1

It is clear from table 5.4 compressive strength obtained for concrete with 16% replacement by glass powder showed a higher value of compressive strength 56.82 MPa in 28 days.

5.3 Results of Spilt Tensile Strength Test:
Following table shows the Split Tensile strength for all proportions after 28 days.

Sr. No.	Mix Notation	% replacement of cement by glass powder	Split Tensile Strength in MPa
1	C0	0 %	4.41
2	C1	4 %	4.53
3	C2	8 %	4.81
4	C3	12 %	4.92
5	C4	16 %	5.30
6	C5	20 %	4.32
7	C6	24 %	3.91

Table 5.3

It is clear from table 5.3 Split Tensile strength obtained for concrete with 16% replacement by glass powder showed a higher value of 5.30 MPa in 28 days.

5.4 Results of Flexural Strength Test: (IS: 516:1959)
3 beams of each variation were casted for the conduction of test and cured for 28 days under water. Following table shows the compressive strength after 28 days.

Sr. No.	Mix Notation	% replacement of cement by glass powder	Flexural Strength in MPa
1	C0	0 %	4.04
2	C1	4 %	4.08
3	C2	8 %	4.21
4	C3	12 %	4.45
5	C4	16 %	4.80
6	C5	20 %	4.04
7	C6	24 %	3.88

Table 5.4

It is clear from table 5.4 Flexural Strength obtained for concrete with 16% replacement by glass powder showed a higher value of 4.80 MPa in 28 days.

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Volume 4, Issue 5, May 2017

5.5 Results of Alkalinity Test:

Following 28 days mortar from examples were pounded into powder frame. Alkalinity test results obtained from test are given as follows:

Sr. No.	Mix Notation	% replacement of cement by glass powder	pH Value
1	C0	0 %	10.70
2	C1	4 %	10.85
3	C2	8 %	10.90
4	C3	12 %	11.10
5	C4	16 %	11.25
6	C5	20 %	11.29
7	C6	24 %	11.40

Table 5.5

It is clear from table 5.5, alkalinity of concrete increases as percentage of glass powder in concrete increases.

5.6 Results of Water Absorption Test:

Water absorption test or the porosity test was carried to find out the percentage water absorption. 3 beams of each variation were casted for the conduction of test. The test results obtained are as follows:

Sr. No.	Mix Notation	% replacement of cement by glass powder	Wet weight (gm)	Dry weight (gm)	Water absorbed (gm)	% Water absorption
1	C0	0 %	8240	8068	172	2.13
2	C1	4 %	8132	7971	161	2.01
3	C2	8 %	8029	7882	147	1.86
4	C3	12 %	7993	7868	125	1.58
5	C4	16 %	7910	7789	121	1.55
6	C5	20 %	7872	7755	117	1.50
7	C6	24 %	7802	7692	110	1.43

It is clear from table 5.6, water absorption of concrete reduces as the percentage of waste glass powder in concrete increases. A decrease of 25% water absorption was observed for 16% replacement as compare to control mix.

5.7 Results of Carbonation Test:

3 cubes of each variation were tested and results obtained are given as follows:

Sr. No.	Mix Notation	% replacement of cement by glass powder	Indicator Used	Colour Changes To	Remark
1	C0	0 %	Phenolphthalein	Pink	Concrete is in Good Health
2	C1	4 %		Pink	
3	C2	8 %		Pink	
4	C3	12 %		Pink	
5	C4	16 %		Pink	
6	C5	20 %		Pink	
7	C6	24 %		Pink	

Use of Phenolphthalein indicator changed the colour of hardened concrete to pink which indicates that concrete was not affected by the atmospheric carbon dioxide.

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Volume 4, Issue 5, May 2017

VI. CONCLUSION

The influence of replacement of cement by glass powder has been studied. Based on the experimental work conducted, the following conclusions are drawn:

1) As the Percentage of glass powder in concrete increases, workability of concrete decreases.. As glass content increases, cement paste available is less for providing lubricating effect per unit surface area of aggregate which reduces the workability of concrete.
2) The replacement of cement by glass powder in concrete increases the compressive strength of concrete.
3) The replacement of cement by glass powder in concrete also increases the split tensile strength of concrete. When 4%,8% and 12% cement was replaced by glass powder in concrete when water/ cement ratio was maintained constant.
4) The flexural strength of glass powder concrete when compare with conventional mix.
5) The pH value observed from the alkalinity test showed that the specimen tested found to be more alkaline and hence more resistant towards corrosion. The high alkalinity forms a thin passivating layer around steel reinforcement and protect it from the action of oxygen and water. As long as steel is placed in a highly alkaline condition, it is not going to corrode.
6) Water absorption of concrete reduces as the percentage of waste glass powder in concrete increases.
7) Use of Phenolphthalein indicator changed the colour of hardened concrete to pink which indicates that concrete was not affected by the atmospheric carbon dioxide.
8) Replacement of cement by glass powder makes the pore structure of concrete denser. Glass powder concrete is less permeable which reduces the effect of chlorine on the reinforcement which helps to prevent the corrosion of reinforcement. Hence life of structure increases.

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