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Partially Replacement of Cement by Waste Glass Powder in Concrete

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ABSTRACT

Storage and safe disposal of waste glass is a huge problem for municipalities everywhere. Reuse of waste glass eliminates/reduces this problem. In this experimental work, the effect of partially replacing cement in concrete by glass powder is studied. The cement in concrete is replaced by waste glass powder in steps of 5% from 0%, 5%,10%,15%,20% by volume and its effects on compressive strength and flexural strength are determined. It is found that the compressive strength of concrete increase initially as the replacement percentage of cement by glass powder increases, become maximum at about 15% and later decrease.
Keywords : Concrete, Glass powder, Compressive strength, Flexural strength

I. INTRODUCTION

Concrete is one of the world's most used construction material due to its versatility, durability and economy. India uses about 7.3 million cubic meters of ready-mixed concrete each year. It finds application in highways, streets, bridges, high rise buildings, dams etc. Greenhouse gas like co2 leads to global warming and it contributes to about 65% of global warming. The global cement industry emits about 7% of greenhouse gas to the atmosphere. To reduce this environmental impact alternative binders are introduced to make concrete. Glass is an amorphous material with high silica content making it potentially pozzolanic when particle size is less than 75μm. The main problem in using crushed glass as aggregate in port land cement concrete are expansion and cracking caused by the glass aggregate due to alkali silica reaction. Due to its silica content ground glass is considered a pozzolanic material and as such can exhibit properties similar to other pozzolanic material. In this study, finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. Concrete mixtures were prepared with different proportions of glass powder ranging from 0% to 20% with an increment of 5% and tested for compressive strength after 7 and 28 days of curing.

Objective and scope

Objective

Experiments were conducted on concrete prepared by partial replacement of cement by waste glass powder of particle size 600 micron and downwards. The main objective of this investigation was to evaluate the effect of waste glass powder on the compressive strength and the other properties of concrete and to evaluate the possibility of using glass powder in concrete without sacrificing the strength. The following were also considered.

- Partial substitute for the ordinary port land cement.
- The objective to study the effect of the use of glass powder as a replacement of cement to

know the percentage of glass powder can replaced in concrete.

- To determine the percentage of glass powder which gives maximum strength when compared to control concrete
- To evaluate the utility of glass powder as a partial replacement of cement in concrete.
- To study and compare the performance conventional concrete and glass powder concrete.
- To study fresh and hardened properties of concrete mixes replacing 10%, 20%,30%,40% of cement by glass powder.

Scope of the study

This scope of study is part of comprehensive program where in experimental investigations have been carried out to evaluate the effect of partially replacement of cement by waste glass powder on compressive strength 7 and 28 days. M25 grade of concrete was considered for experimental study with specimens prepared along with partially replacement of cement by waste glass powder.

Methodology

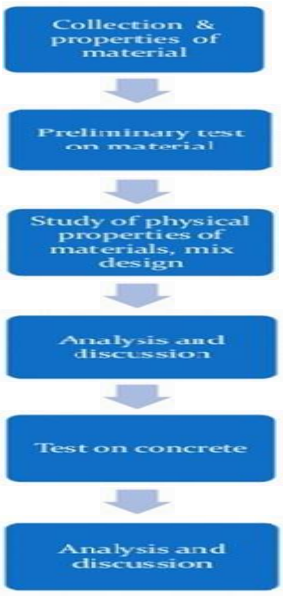

Chart 1:Flow Chart

Materials

Cement:

The cement used in this study was 53 grade ordinary port land cement (OPC) confirming to IS: 269-2015 as a basic ingredient of concrete. Compressive achieved by the cement at end of the 28th day should not be less than 53mpa or 53 kg/mm3 the color of cement will be grey.

The BIRLA 53 grade brand cement available in the local area in local market was used for investigations. Care should be taken to see the procurement was made from single batching in air tight containers to prevent it.

Table 1 : Physical properties of cement

Sl. No.	Test Conducted	Results	Requirements as per IS: 269-2015
1	Brand of cement	BIRLA SUPER	-
2	Type of cement *	OPC 53 Grade	-
3	Consistency	28.5 %	Not specified
4	Initial setting time	130 Minutes	Shall not be less than 30 Minutes
5	Final setting time	235 Minutes	Shall not be more than 600 Minutes
6	Finesse of cement	7.6%	Shall not be more than 10%

FINE AGGREGATE:

Fine aggregate: sand is available of river for construction purposes sand the crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of sand (River Sand) is less than 4.75mm. Locally available clean, well graded River sand was used as fine aggregate. The properties of the fine aggregate are represents the particle size distribution curve of the river- sand.

The aggregate was tested for its physical characteristics such as gradation, fineness modulus, specific gravity, moisture content, bulk density, water absorption in accordance with IS :383-2016

Table 2 : Characteristics of River-Sand

CHARACTERISTICS OF FINE AGGREGATE (CRUSHED STONE SAND)		
1.	a) Dry rodded bulk density	1805kg/m^3
	b) Loose bulk density	1686 kg/ m^3
2.	Specific gravity	2.57
3.	Water absorption	4.0 %
4.	Material finer than 75 microns	9.8 %
5.	Sieve Analysis	

IS Sieve Designation	Cumulative Percentage Retained	Passing	Specification as per IS:383-2016 (Percentage Passing) Zone I	Zone II	Zone III
4.75 mm	0.7	99.3	90-100	90-100	90-100
2.36 mm	9.4	90.6	60-95	75-100	85-100
1.18 mm	23.2	76.8	30-70	55-90	75-100
600 µm	55.8	44.2	15-34	35-59	60-79
300 µm	71.6	28.4	5-20	8-30	12-40
150 µm	84.9	15.1	0-10	0-10	0-10

REMARKS: 1). The sample supplied satisfies the requirements of grading Zone II as per IS:383-2016. According to IS: 383-2016 for Crushed Stone Sands, the permissible limit on 150 micron IS Sieve is increased to 20%. This does not affect the 5% allowance permitted in Cl. 4.3

2). As per Table 1, Sl. No. 3 of IS: 383 – 2016), for Crushed stone sands, the Material finer than 75 microns IS sieve is Maximum 15% by weight.

Coarse Aggregate:

Coarse aggregate used was 20MM and down size and specific gravity. Testing was done as per Indian standard specification IS: 383-2016. Crushed aggregate of 20mm and 12.5mm size produced from local crushing plants were used. The aggregate passing through 20mm sieve size and retained on 6.3mm sieve is selected. The aggregate were tested for characteristics or physical requirements such as fineness modulus, water abruption, specific gravity and bulk density and dry density , moisture content accordance with IS 383-2016.

Table 3: Properties of course aggregate

SL NO	Properties	Values obtained
1	Specific gravity	2.67
2	Fines modulus	3.59

GLASS POWDER

Waste glass available locally was collected and made into glass powder the specific gravity of 2.54 less than 90microns. Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and caco3 at high temperature followed by cooling during which solidification occurs without crystallization. Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. The amount of waste glass is gradually increased over the recent years due to an ever-growing use of glass products. Most waste glasses have been dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. So we use the waste glass in concrete to become the construction economical as well as eco-friendly. Composition of cement and glass powder is as shown in table 4

Table 4 : Chemical properties of cement and glass powder

Properties	Waste glass powder	Cement
Sio_2 (%)	70.22	23.71
Cao (%)	11.13	57.27
MgO (%)	-	3.85
Al_2O_3(%)	1.64	4.51
Fe_2O_3 (%)	0.52	4.83
SO_3(%)	-	2.73
Na_2O (%)	15.29	-
K_2O (%)	-	0.37
Cl (%)	-	0.0068
Loss on ignition (%)	0.80`	7.24

CONCRETE MIX DESIGN

The mix design is the practice of selecting appropriate constituents of concrete like cement, Fine aggregate, glass powder and coarse aggregate and water to optimize their relative proportion to meet the requirements of design. that is, it complies with the specification of structural strength required, the durability requirement in the

environmental in which it is used which also meets the workability requirements. That is it should be capable of being mixed, transported and compacted sufficiently and efficiently as possible and be economical without sacrificing the above requirement.

Table 5 : Mix proportion after adding glass powder

GLASS POWDER IN %	Cement (kg/m3)	Fine aggregate (kg/m3)	Coarse aggregate (kg/m3	Water content (kg/m3)	Mix proportion
0	340	750.95	1156.71	170	1 : 2.2 : 3.4
5	323	704.12	1193.54	170	1 : 2.7 :3.6
10	306	747.76	1160.83	170	1 : 2.44 : 3.7
15	289	851.06	1189.33	170	1 : 2.94 : 4.11
20	272	910.2	1420.08	170	1 : 3.35:5.2
30	238	919.6	1416.56	170	1 : 3.86:5.9
40	204	760.16	1144.3	170	1 : 3.9 : 4.8

Results and Discussions

The compressive strength of concrete with varying content of Glass powder at different ages, shown in Table 6 at 7 and 28 days, the strength generally decreases with glass powder content at 20%. The reduction in strength was observed for concrete with 20% of glass powder. And we can use glass powder upto 15% for construction purpose and its give good workability and strength compare to conventional concrete.

Table 5 : Compressive Strength

Sl No	% of Glass powder replacement	7 days compressive strength N/mm^2	28 days compressive strength N/mm^2
1	0	19.32	31.20
2	5	20.70	32.44
3	10	23.14	36.33
4	15	24	39.93
5	20	16.10	21.23

Concrete sample (Beam at 500*100*100*mm) of 7 days were tested for its flexural strength having different percentage of mixture of glass powder as replacement of cement. The level of replacement of Cement by mixture of Glass powder was 0%,5%,10%,15%, &20%. Ten sample of beam were tested by using universal testing machine and the average strength of these two beam were taken and final results represented in table 6

Table 6 : Flexural strength

Sl No	% of Glass powder	7 days Flexural Strength In N/mm^2	28 Days Flexural Strength in N/mm^2
2	0	5.6	6.6
2	5	5.7	6.9
3	10	6.42	7.15
4	15	6.5	7.4
5	20	4.8	5.1

Conclusion

- When used as additional supplementary cementitious material at 15% level, glass powder can be obviously reduces the porosity and the pore size distribution. Thus large increase in compressive strength, resistance to water and chloride penetration were observed.
- Its increasing 22% of compressive strength compare to conventional concrete
- It can used in rigid pavement construction
- It gives better fire resistance compare to conventional concrete
- An optimum cement replacement of 15% of glass powder was observed with respect to development of compressive strength of concrete after 7, 28 days.
- The additional of recycle green building material such as glass powder can increase the slump of concrete, but an excessive addition may result in surplus mixing water that could result in slight segregation that can reduce the overall strength
- Generally considered the similar performance with replaced material glass powder addition can reduce significant cost of cement production and co2 emission and save the environmental by reducing greenhouse gas and particulate production.

II. REFERENCES

[1]. Effect of using glass powder in concrete: (By shipa raju, Dr.PR Kumar (ISO 3297 2007 certified organization)(volume3,special issue5,july2014)

[2]. Influence of glass powder on the properties of concrete: (By veena v. Bhat, n Bhavani Shankar rav (N M institute of technology, nitte574110 Karnataka) (IJETI- VOL 16 NOV 5-OCT 2014).

[3]. A critical study of effectiveness of waste glass powder in concrete: (by goutham Singh, Ashish Kumar simgh, Akhil Bhaskar, ajit Singh attree (Iso9001-2008 certified organization) (volume 5(3) sept 2014:31-35).

[4]. Use of glass powder as fine aggregate in high strength concrete :(by jostin.p.josh , S

[5]. Suganya, Bhanu Priya (volume 2 issue 7july 2014).

[6]. Experimental investigation of waste glass powder as partial replacement of cement in concrete: dhanaraj Mohan patil1, dr. Keshav k. Sangle21 Structural Engineering Department, Veermata Jijabai Technological Institute,Matunga, Mumbai, India E- mail: patil.dhanaraj@gmail.com

[7]. Use of waste glass powder as a partial replacement of cement in fibre reinforced concrete : Mohammad Shoeb Sayeeduddin1, Mr. F.I. Chavan2 1 e-ISSN: 2278- 1684,p-ISSN: 2320-334X, Volume 13, Issue 4 Ver. IV (Jul. - Aug. 2016), PP 16-21

[8]. 'Cement use of waste glass powder as a partial replacement of cement in fibre reinforced concrete' Mohammad Shoeb Sayeeduddin and Mr. F.I. (2016)

[9]. Some studies have been conducted to characterize the pozzolanic activity of finely ground GP in concrete' Bhavani Shankar rao (2014)

[10]. Indian Standard, IS 456-2000 "Plain and Reinforced Concrete-Code of Practice," BIS, New Delhi, India.

[11]. IS:10262-2009 Concrete Mix Proportioning – Guidelines.