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An Investigation on Flexutural Behaviour of Concrete Beam by Partially Replaced Cement Using Waste Glass Powder

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ABSTRACT-Glass is a transparent material produced by melting a mixture of materials such as silica 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, most waste glasses have been dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable. So waste glass can be used in concrete to make the construction economical as well as eco-friendly. Today many researches are on-going into the use of Portland cement replacements, using many waste materials like pulverized fly ash (PFA), silica fume and ground granulated blast furnace slag (GGBS). Like PFA and GGBS a waste glass powder (GLP) is also used as a binder with partial replacement of cement which take some part of reaction at the time of hydration, also it is act as a filler material. In this study, waste glass powder have been used as a replacement to the concrete ingredient i.e. cement and the mechanical properties like compressive strength, split tensile strength and flexural strength will be measured. For checking strength effect of replacement of cement by glass powder, the cement is replaced at 5%, 10%, 15% and 20% were in M30 grade of concrete and glass powder having particle size of 75 micron was used.

KEYWORDS: Waste glass powder, compression strength, flexural strength, tensile strength

I.INTRODUCTION

GENERAL

Concrete, as a constructive material, has been used in construction industry for about two centuries. Approximately, the whole bulk of the concrete is used in one year is more than one ton apiece. Therefore, doing research about using modern technologies in production concrete is of great importance. Furthermore, one of the most critical problems of the world has been related to remove the wastage and reusing of it. In all countries, large amount of wastage is produced annually. It has been estimated that several million tons of waste glasses are generated annually worldwide. The key sources of waste glasses are waste containers, window glasses, window screen, medicinal bottles, liquor bottles, tube lights, bulbs, electronic equipment etc. Only a part of this waste glass can be used in recycling.

The remaining waste glass cannot be used for any purposes. But recently the research has shown that the waste glass can be effectively used in concrete either as glass aggregate (as fine aggregate or as coarse aggregate) or as a glass pozzolana. The waste glass when grounded to a very fine powder shows some pozzolanic properties. Therefore the glass powder to some extent can replace the cement and contribute for the strength development.

OBJECTIVES OF THE WORK

- This research focuses on studying the effect of waste glass on the properties of concrete mixtures as a partial replacement of cement.

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- Study the influence of waste glass on hardened properties of concrete mixes such as compressive strength, flexural strength and split tensile strength.

II. CONSTITUENT MATERIALS

MATERIALS USED

The ingredients used in this work are same as those used in conventional concrete. But here we introduce waste glass powder as a partial replacement for cement. The materials used are cement, sand, waste glass powder, coarse aggregate and water.

CEMENT

In the present work, Ordinary Portland Cement of 53 grade conforming to IS: 12269-1987 has been used. The physical properties of the cement obtained on conducting appropriate tests as per IS: 269/4831.

Table .1: Properties of Cement

Grade	OPC 53
Specific Gravity	3.1
Initial Setting Time	60 min
Final Setting Time	440 min
Standard Consistency	33%
Fineness	4.95

FINE AGGREGATE

Table.2: Properties of Fine Aggregates

S.No	Particulars	Values
1	Specific Gravity	2.62
2	Fineness Modulus	2.37

WASTE GLASS POWDER



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Table .3: Chemical Properties of Waste glass powder

S.No.	Properties	Waste glass powder
1	SiO ₂ (%)	70.22
2	CaO (%)	11.13
3	MgO (%)	-
4	Al ₂ O ₃ (%)	1.64
5	Fe ₂ O ₃ (%)	0.52
6	Na ₂ O (%)	15.29
7	SO ₃ (%)	-
8	Loss of ignition	0.8
9	K ₂ O (%)	-
10	Cl (%)	-

COARSE AGGREGATE

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 is being use. The Flakiness and Elongation Index were maintained well below 15%.

Table .4: Properties of Coarse Aggregates

S.No	Particulars	Values
1	Specific Gravity	2.7
2	Fineness Modulus	8.26

WATER

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

MIX DESIGN

Table.5: Mix design : Materials for 1 m³ concrete

Symbol	Cement (Kg)	F.A (Kg)	C.A (Kg)	GP (Kg)	Water (litre)
0% GP	380	710	1280	0	171
5% GP	361	710	1280	19	171
10%GP	342	710	1280	38	171
15%GP	323	710	1280	57	171
20%GP	304	710	1280	76	171

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CASTING AND CURING INTRODUCTION

The mould specification, preparation of mould method of casting and curing are discussed below.

CASTING

During moulding, the human is formed and concrete is conveyed in pans from hand to hand. The concrete shall be put gently in the Ace shape mould thickness not exceeding 6cm and compacted by the mechanical compressive machine with help of unskilled labour.

The materials were weighed as per the designed mix proportion and they were mixed using concrete mixer. The mixing operation was continued till a good uniform, homogeneous concrete was obtained. General mixing time of 5 to 10 minutes was followed. Steel moulds were used for casting the specimens.

MOULD PREPARATION

The cube mould was placed in position on an even surface. All the interior faces and sides were coated with mud oil to prevent the sticking of concrete to the mould.

MIXING

The grade of concrete selected is M30 and water cement ratio adopted was 0.45. The selection of this low water content of 0.45 was done because of spherical nature of FAs. The mix proportion taken was and mixing satisfies the requirement of IS 456-2000. Concrete is mixed in roller type of mixing machine.

III. RESULTS AND DISCUSSION

Compressive strength

Concrete cube specimen used to find out the compressive strength of concrete.

Testing on concrete cubes



Fig . 2: compressive strength test for specimen cubes.

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Table .6: Testing results: compressive strength

WGP %	Ultimate load (kN)	Deflection (mm)	Energy absorption (kN-mm)	Ductility factor	Stiffness kN/mm
0	44	4.6	151	1.31	8.57
5	46	5.3	160	1.61	9.5
10	50	6.4	180.5	1.73	11
15	54	6.7	195	1.86	13.18
20	46	5.6	156	1.6	5

Compressive strength : Bar Charts

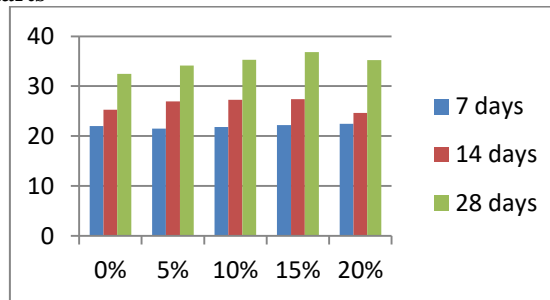


fig.3: Compressive strength (x) vs various mix design (y)

Flexural strength

The flexural strength test is conducted on the beam and results are shown in the table 8.



Fig. 4: Testing on beam

Table.7: Testing Results : Flexural Strength

%	7 days		14 days		28 days	
	Failure load (KN)	Compressive Strength (N/mm ²)	Failure load (KN)	Compressive Strength (N/mm ²)	Failure load (KN)	Compressive Strength (N/mm ²)
M30						
0	495	22.01	568	25.26	730	32.45
5	484	21.50	606	26.96	768	34.15
10	491	21.84	613	27.28	796	35.37
15	500	22.22	614	27.39	828	36.82
20	505	22.45	555	24.66	793	35.25

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Split tensile strength

The split tensile strength test obtained from 28 days of curing in water.



Split tensile strength : Bar Charts

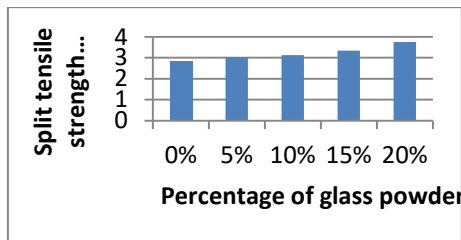


Fig.7 :Split tensile strength strength(x) vs various mix design (y)

Table.8: Testing Results

S.No.	Percentage of glass powder	Average split tensile strength in 28 days(N/mm ²)	Percentage increase in strength
1	0	2.81	-
2	5	3.02	7.4
3	10	3.12	11.1
4	15	3.33	18.5
5	20	3.75	33.3

V.CONCLUSIONS

The Safe effect on the workability of concrete can be seen for the partial replacement of cement with waste glass powder. Glass powder is used as a partial replacement for cement in this study. Replacement is done in the ranges of 5%, 10%, 15% and 20%. Various tests on fresh concrete and hardened concrete were carried out. From the test results compressive strength was found to be increased up to 13.5%. Split tensile strength was found to be increased up to 33.3%. Flexural strength was found to be increased up to 23%. Replacement was done gradually up to 20% and after 15% strength of the members are found to be reducing. From the study it was found that the optimum replacement level of waste glass as cement is 15%.

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