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PARTIAL REPLACEMENT OF FINE AGGREGATE BY GLASS POWDER IN CONCRETE

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Abstract— Concrete is a widely used material in the world. Based on global usage it is placed at second position after water. River sand is one of the constituents used in the production of conventional concrete has become highly expensive and also scare. In the backdrop of such a bleak atmosphere, there is a large demand for alternative materials from industrial waste. Some alternative materials have already been used as a part of natural sand. Similarly the waste glass are collected from the shops are used. The collected glasses are crushed to sand size and it could be used an alternate material for natural sand as partial replacement. In brief, successful utilization of glass as fine aggregate will turn this waste material into a valuable resource. In this research we are going to evaluate the utility of glass powder as a partial replacement of fine aggregate in concrete.

Performance of the various mixes is tested by the compressive strength and flexure strength. A cube specimen of size 150mmX150mm X150mm and beam specimen of size 150mm × 150 mm × 700mm were cast and demoulded after 24 hours then they allowed for normal water curing. The results show improvement in compressive strength in cement replaced mixes.

Keywords— Glass powder concrete (GPC).

I. INTRODUCTION

Concrete is a widely used material in the world. Based on global usage it is placed at second position after water. River sand is one of the constituents used in the production of conventional concrete has become highly expensive and also scare. In the backdrop of such a bleak atmosphere, there is a large demand for alternative materials from industrial waste. Some alternative materials have already been used as a part of natural sand.

Similarly the waste glass are collected from the shops are used. The collected glasses are crushed to sand size and it could be used an alternate material for natural sand as partial replacement. In brief, successful utilization of glass as fine aggregate will turn this waste material into a valuable resource. Much of the glass produced in the world is discarded and damped in land fill. Glass is widely used in our day to day life through manufactured products such as sheet glass, bottles, glassware and vacuum tubing. The amount of glass being discarded as well as find use to the non-cycled glass in new application, the waste glass can create more environmental problem. The glass is used in variety of application such as construction, automobiles, tube lights, bulbs, soft drink bottles, nose-diving submarines, doors and windows, waste containers, windows, wind screen, electronic equipments etc., hence, the usage of glass powder has increased considerably, Which results is increase of waste disposal. In addition, glass waste is considered as non-decaying material that pollutes the surrounding environment. From more research work has highlighted, the usage of glass in powdered form as a partial replacement of cement in concrete. The paper investigates the limitations of glass concrete and its properties and the test results shows increasing strength compared to conventional concrete. If glass could be incorporated in cement products, it would greatly reduce the disposal of recycled glass and/or its use in lower valued markets such as land fill material.

There is considerable interest in the use of recycled glass with Portland cement in making a variety of different types of cement products. Advantages of glass powder in concrete is better resistance to sulphate attack, Help to reduce the effects of Alikali silica reaction, increase compressive and flexural strength, Reduce the use of cement in concrete, Gives long term strength, Increase the chemical attack resistance.

In this research, fine aggregates were partially replaced by waste glass as 5%, 10%, 15%, and 20%by weight. Concrete specimens were tested for compressive strength. The results obtained were compared with results of normal M-25 concrete mix and it was found that maximum increase in compressive strength occurred for the concrete mix containing 10% waste glass as fine aggregate. With increase in waste glass content, water absorption decreased indicating increase in durability. Density of concrete decreased with increase in waste glass content thus making concrete light weight in nature. This paper summarized the behavior of concrete involving replacement of fine aggregates by waste glass as 5%, 10%, 15%, and 20% by weight which may help to reduce the disposal problems of waste glass and enhance properties of concrete.

II. MATERIALS USED AND THEIR PROPERTIES

Cement, fine aggregates, coarse aggregates, water, glass powder are used in casting of concrete Cubes. The specifications and properties of these materials are as under:

A. **Cement:** Ordinary Portland cement of grade 53 make from a single lot is used for the study. The physical properties of cement as obtained from various tests are listed in Table 4.1. All the tests are carried out in accordance with procedure laid down in IS 1489 (Part 1):1991, valid for ordinary portland cements.

B. **Fine Aggregates:** Locally available sand is used as fine aggregates in the preparation of the concrete mix. Which conforms to IS 383:1970.

C. **Coarse Aggregates:** Crushed stone aggregates (locally available) of 20 mm and 10 mm are used through-out the experimental study. Which conforms to IS 383:1970.

D. **Glass Powder:** Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down. Waste glasses are used as aggregates for concrete.

E. **Water:** The water, which is used for making concrete and for curing, is clean and free from harmful impurities such as oil, alkali, acid, etc, in general, the water, which is fit for drinking is used for making concrete.

III. EXPERIMENTAL PROGRAMME

A. Mix proportion

Table 1 Mix Proportion

GLASS POWDER (%)	CEMENT (kg)	FINE AGGREGATE (kg)	COARSE AGGREGATE (kg)	WATER CEMENT RATIO	GLASS POWDER WT (kg)
0	1.38	2.484	4.181	0.55	0
10	1.38	2.236	4.181	0.55	0.248
15	1.38	2.1	4.181	0.55	0.384
20	1.38	1.98	4.181	0.55	0.504
30	1.38	1.73	4.181	0.55	0.754

B. Specimen preparation and curing

Casting and testing of specimen was carried out as per IS codes IS:516-1959 for compression strength, split tensile and flexural strength. Materials are weigh batched, mixed in a mixer, cast into steel moulds and specimens were stored in room temperature for 24 hours, then removed from the moulds, and cured in normal water until tested.

C. Testing

Cubes of size 150 mm × 150 mm × 150 mm were tested to compute compressive strength, and beam of size 150mm × 150 mm × 700mm were tested to compute flexural strength of concrete. Specimens were tested under the Compression testing machine of 3000 KN capacity. Average of 3 cubes compressive strength and 3 beams flexural strength are tabulated.

IV. RESULTS AND DISCUSSION

A. Mechanical properties

The test results of compressive strength, and split tensile strength, flexural strength and theoretical modulus of elasticity for corresponding mixes are tabulated.

1) Compressive strength

Cube specimens of size 150mmX150mm X150mm were cast for compressive strength as per Indian standard specifications BIS: 516-1959. Compressive strength test results are shown in table 2 and fig no 1.

Table 2 Compressive Strength Test

Mix Type	Compressive strength(MPa)	
	7 Days	28 Days
0%	14.92	22.71
10%	16.62	24.023
15%	17.53	20.92
20%	14.11	16.89
30%	12.75	16.71

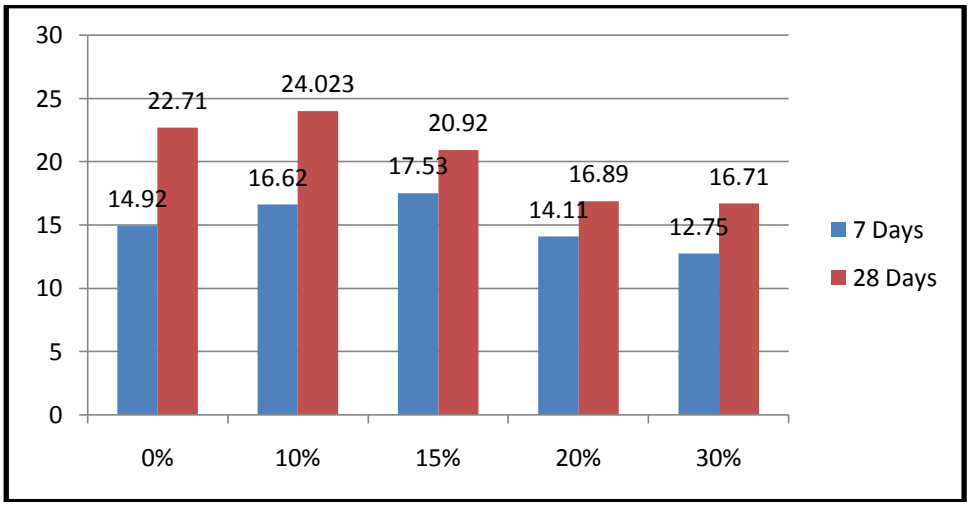

Figure 1 Compressive Strength

2) Flexural Strength

Flexural strength results are shown in table 7 and fig no 4. The Flexural Strength of GRPC is more than that of conventional concrete. It was recorded that maximum split tensile strength is 19.85 MPa for Standard mix (M). Effect of Fly ash + GGBS on flexural strength is very small or negligible as compared to compressive strength.

Table 1 Flexural strength test

Mix Type	Flexure strength (MPa)
	28 Days
0%	6
10%	6.4
15%	5.5
20%	5

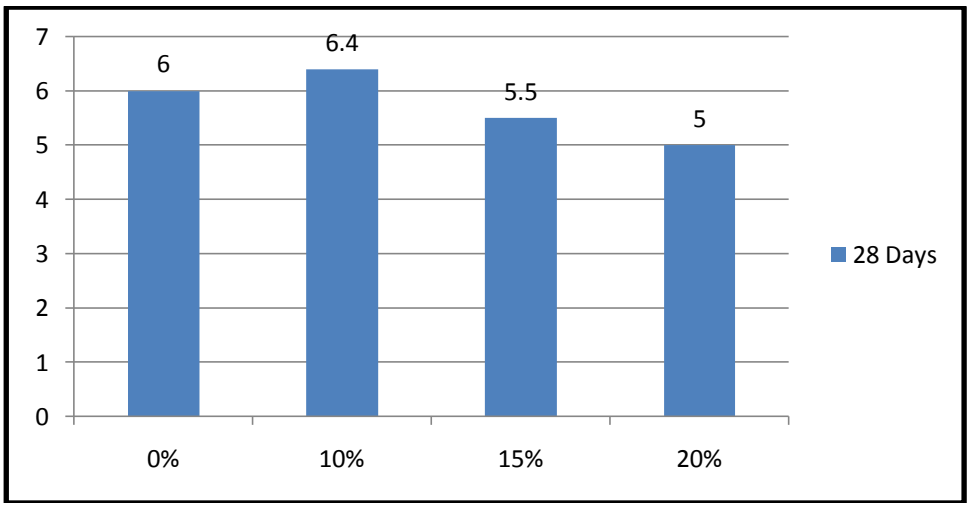

Figure 1 Flexural strength

V. CONCLUSIONS

Following are the conclusions drawn from the detailed investigation carried out in this study:

1) Waste glass, if ground finer than 100µm shows a Pozzolanic behavior

2) The results obtained from the present study shows that there is great potential for the utilization of best glass powder in concrete as replacement of sand.

3) On comparing the mixes of same glass replacement, it was found that the design mix with glass replacement of 10% gives the best result on strength

4) The compressive strength of control mix glass replacement= 0% shows the highest results but it has very poor workability.

5) From the study of graphs it can be concluded that Glass replacement= 10% mix is the optimum glass mix. There was a consistent growth in strength for this mix. It also has shown good workability without using super-plasticizers.

6) The usage of glass powder in concrete helps in maintaining the moisture of the mix because the glass particles don't absorb the water.

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