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STUDY OF UTILIZATION OF WASTE GLASS POWDER AS FINE AGGREGATES TO ACHIVE HIGH STRENGTH CONCRETE

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ABSTRACT
Waste glass is one materials when ground to a very fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete. In this paper, an attempt has been made to find out the strength of concrete containing waste glass powder as a partial replacement of cement for concrete. Glass is used in many forms in day-to-day life. It has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses. Many efforts have been made to use waste glass in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. Its performance as a coarse aggregate replacement has been found to be non-satisfactory because of strength regression and expansion due to alkali-silica reaction. The research shows that there is strength loss due to fine aggregate substitution also. The aim of the present work was to use glass powder as a replacement of fine aggregates to assess the pozzolanic activity of fine glass powder in concrete. A series of tests were conducted to study the effect of 10%, 15%, 20%, 30% replacement of fine aggregates with waste glass powder. The present study shows that waste glass if used as a fine aggregates can increase the strength of concrete if used up to some percentage.

1. INTRODUCTION

The concrete is a composite material which is mostly used all over the world. The strength characteristics of concrete depend upon the properties of component material and their collective action. Fine aggregate is one of the important constituent materials as far as strength characteristics of concrete are concerned. Increase in demand and decrease in natural sources of fine aggregate for the production of concrete has resulted in the need to identify news sources of fine aggregate. River and which is most commonly used as fine aggregate in the production of concrete and mortar poses the problem of acute shortage in many areas. Due to industrialization, infrastructure development and soft housing policy of Government of India, the construction industry is in full bloom due to which within short span of time there is a tremendous increase in the utilization of cement and concrete for various construction activities. It is expected that the same rate will continued in the next decade and this may invite the threat to the environment. Availability of raw material required for manufacturing of cement and production of concrete are limited in nature. This increased demand will lead to fast depletion of natural resources and will cause big threat to environment. So as to overcome this problem it is very much essential to utilize the industrial waste materials and by-products generated in manufacturing of cement and in concrete construction.

2. CONSTITUENT MATERIALS USED

The constituent materials used are cement, fine aggregate, coarse aggregate, stone dust and water. The recommended materials have been described below.

Cement
Various types of cement can be used in concrete with stone dust. The cement should be fresh, free from foreign matters and of uniform consistency. Usually ordinary Portland cement is used in normal conditions.

Fine Aggregate
The most common fine aggregate used in concrete is sand. The sand should be clean, hard, strong and free from organic impurities and deleterious substances. It should be capable of producing a sufficiently workable mix with a minimum water-cement ratio.

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Coarse Aggregate

The aggregates are formed due to natural disintegration of rocks or by artificial crushing of the rock or gravels. The properties of coarse aggregate are chemical and mineral composition, spectrographic description, specific gravity, hardness, strength, physical and chemical stability, pore structure and color. Some other properties of the aggregate not possessed by the parent rocks are particle size and shape, surface texture and absorption etc. All these properties may have a considerable effect on the quality of concrete in fresh and hardened states.

Waste Glass Powder

The glass powder (less than 90 micron) used in the present study is brought from Panchkula market. This material replaces the cement in mix proportion. Theoretically, glass is a fully recyclable material; it can be recycled without any loss of quality. There are many examples of successful recycling of waste glass: as a cullet in glass production, as raw material for the production of abrasives, in sandblasting, as a pozzolanic additive, in road beds, pavement and parking lots, as raw materials to produce glass pellets or beads used in reflective paint for highways, to produce fibre glass, and as fractionators for lighting matches and firing ammunition.

Water

Mixing water should be fresh, clean and potable. Water should be free from impurities like clay, loam, soluble salts which lead to deterioration in the properties of concrete. Potable water is fit for mixing or curing of concrete.

3. MIX DESIGN

The specimens are to be cast with concrete of characteristics strength 20 N/mm2 .The physical properties of constituent materials are investigated and presented as follows.

Mix calculation

The mix calculations per unit volume of concrete shall be as follows

*volume of concrete = 1 m3

Volume of cement = 350/3.15* 1/1000 = 0.111m3

Volume of water = 0.197

Mass of coarse aggregate = 0.692 *0.6*2.55*1000 = 1058kg

Mass of fine aggregate = 0.692 *0.4*2.279*1000 = 630 kg

Mass of cement = 356 kg/m3

Mass of water = 140 kg /m3

350/350: 630/350: 1058/350

The mix proportion for the above calculation is 1:1.8:3.03

Table 1 Mix Designation

GLASS POWDER (%)	CEMENT(kg)	Fine Aggregates(kg)	Coarse Aggregates(kg)	Water	Glass Powder(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
25	1.38	1.73	4.181	0.55	0.754

4. CASTING AND CURING

The partial glass powder and the aggregates were first mixed together for about 3minutes. The liquid component of the mixture and cement was then added to the dry materials and the mixing continued for further about 4min to manufacture the fresh concrete.

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Fig 1 Curing of cubes

Fig 2 Mixing of materials

5. TESTING OF SPECIMENS

The cubes were tested in compression testing machine after 7 and 28 days with uniformly increasing loads capacity compression testing machine. The loading was transmitted from loading machine to the specimen by rigid steel plates placed on both above and below the specimen. The load was applied until needle started deflecting backward after crushing of the specimen and the last reading was noted.

The beams were tested in a frame having varying capacity with two point load test. The specimens were divided in three parts equally and two point loads were kept at the end of middle third part of specimen and the load was applied through cylindrical iron piece kept below the dial gauge.

The cylinders were tested in compression testing machine with uniformly increasing capacity compression testing machine. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens

6. RESULT ANAYLSIS

- **Compressive Strength Of Specimens:** Compressive strength of the design mix was check by casting and testing of cubes after the curing period of 7 days, 14 days & 28days. Also it gives the percentage increase or decrease of compressive strength with respect to control mix (0%).

Compressive strength test for all mixes

Replacement (%)	Avg. 7-days Compressive strength of concrete (N/mm^2)	Avg. 14-days Compressive strength of concrete (N/mm^2)	Avg.28-days Compressive strength of concrete (N/mm^2)
0	12.76	17.42	21.92
10	12.98	17.89	22.15
15	13.45	18.00	24.39
20	14.42	19.19	26.66
30	13.67	18.07	25.135

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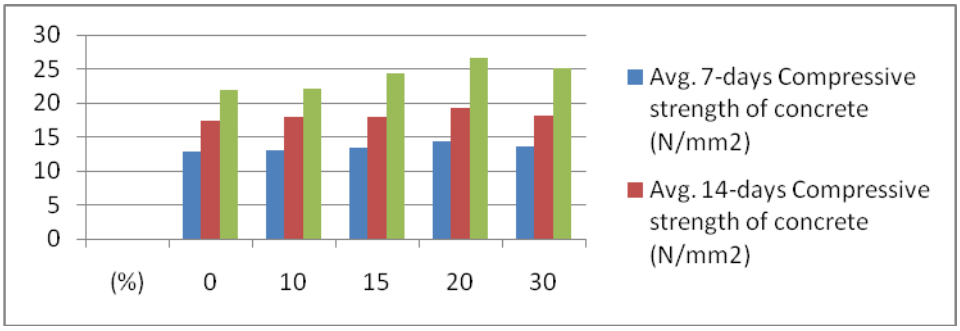
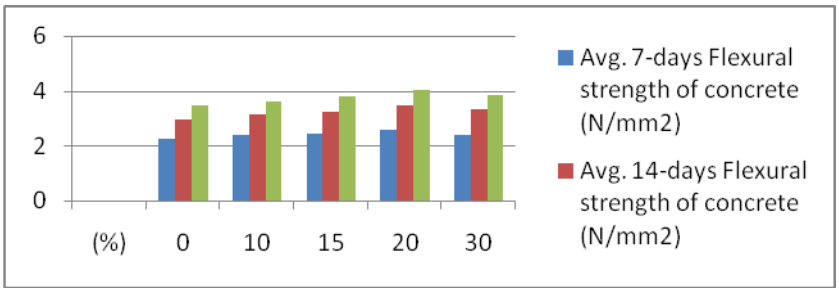


Graph Comparison of Compressive strength test for all mixes

- **Flexure Strength Test:** Although the concrete is not designed to resist tension, the knowledge of tensile strength of concrete is of value in assessing the load at which crack will start appearing in concrete. Flexural Strength of specimen at 7 Days, 14 days and 28 days are shown in Table

Flexural strength test for all mixes

Replacement (%)	Avg. 7-days Flexural strength of concrete (N/mm^2)	Avg. 14-days Flexural strength of concrete (N/mm^2)	Avg.28-days Flexural strength of concrete (N/mm^2)
0	2.26	2.96	3.45
10	2.39	3.15	3.63
15	2.42	3.25	3.81
20	2.60	3.48	4.05
30	2.38	3.31	3.84



Graph Comparison of Compressive strength test for all mixes

- **Split Tensile Strength Test:** The split tensile strength of concrete was conducted on various mixes as per guidelines of IS 516-1970.Split Tensile strength of 7, 14 and 28 days are shown in Table

Average Split Tensile strength test for all mixes

Replacement (%)	Avg. 7-days Split Tensile strength of concrete (N/mm^2)	Avg. 14-days Split Tensile strength of concrete (N/mm^2)	Avg.28-days Split Tensile strength of concrete (N/mm^2)
0	1.81	2.46	3.24
10	1.92	2.59	3.29
15	2.01	2.76	3.54
20	2.43	2.92	3.98
30	2.35	2.68	3.58

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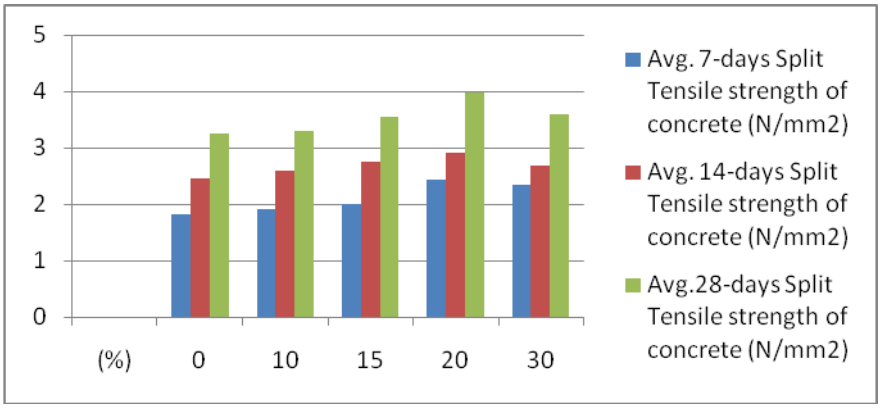

Graph Comparison of Split Tensile strength test for all mixes

7. CONCLUSIONS

A series of laboratory experiments was conducted to find the fresh properties of concrete like Workability and also the testing on hardened concrete is also done to find compressive strength, split tensile strength, and flexural strength of concrete with several percentage of marble powder. The effects of waste glass powder on these properties are studied. The following are the conclusions that can be drawn from the experimental investigation:

1) The compressive strength of the concrete increases up to 20% replacement of glass powder and then gradually decreases with increase of glass powder content.
2) Along with compressive strength, the flexural strength of the concrete increases up to 20% replacement and then decreases with increase partial replacement of glass powder.
3) The split tensile strength of the concrete increase up to 20% replacement of glass powder and decreases with further increase in glass powder.
4) Thus waste glasses are made in to glass powder and loaded in to concrete which makes it useful. The partial replacement of glass powder as fine aggregate Makes the concrete strengthen.
5) Thus our project states that concrete can be strengthen by glass powder replacement , which makes the waste in to useful, so the waste materials made in to use.

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