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STUDIES ON STRENGTH CHARACTERISTICS OF CONCRETE WITH GLASS POWDER AS PARTIAL REPLACEMENT FOR CEMENT

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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 work, an attempt has been made to find out the strength of concrete containing waste glass powder as a partial replacement of cement for concrete. Finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. Cement was partially replaced by Glass powderwith 5%, 10%, 15%, 20%, 25%, 30%, 35%, and 40% and tested for its compressive, split tensile and flexural strength at 7 days, 28 days of age and were compared with those of conventional concrete. It is found from the results obtained, that glass powder can be used as cement replacement material up to 20 % and beyond 20%of glass powder, the strength decreases.

Keywords: Glass powder, Admixture, Compressive Strength, Flexural Strength, Split tensile Strength.

1. INTRODUCTION

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. Concrete has unlimited opportunities for innovative applications, design and construction techniques. It's great versatility and relative economy in filling wide range of needs has made it is very competitive building material. With the advancement of technology and increased field of applications of concrete and mortars, the strength workability, durability and other characters of the ordinary concrete need modifications to make it more suitable for all situations. Added to this is the necessity to combat the increasing cost and scarcity of cement. Under these circumstances the use of admixtures is found to be an important alternative solution.

Over decades, attempts have been made to obtain concrete with certain desired characteristics such as high compressive strength, high workability, and high performance and durability parameters to meet the requirement of complexity of modern structures. The properties commonly modified are the heat of hydration, accelerate or retard setting time, workability, water reduction, dispersion and air-entrainment, impermeability and durability factors. Though a lot of research is focused in the last decade on use of various admixtures in producing concrete, very little information is available on glass powder concrete. This new admixture has got lot of potential for use in concrete. Hence, there is need to study the strength and workability characteristics of glass powder as admixture in concrete. An admixture is a material other than water, aggregates, or cement that is used as an ingredient of concrete or mortar to control setting and early hardening, workability, or to provide additional cementing properties.

Glass is a non-crystalline amorphous solid that is often transparent and has widespread practical, technological, and decorative usage in, for example, window panes, tableware, and optoelectronics. Scientifically, the term "glass" is often defined in a broader sense, encompassing every solid that possesses a non-crystalline (that is, amorphous) structure at the atomic scale and that exhibits a glass transition when heated towards the liquid state.

Of the many silica-based glasses that exist, ordinary glazing and container glass is formed from a specific type called soda-lime glass, composed of approximately 75% silicon dioxide (SiO_2), sodium oxide (Na_2O) from sodium carbonate (Na_2CO_3), calcium oxide, also called lime (CaO), and several minor additives. A very clear and durable quartz glass can be made from pure silica, but the high melting point and very narrow glass transition of quartz make glassblowing and hot working difficult. In glasses like soda lime, the compounds added to quartz are used to lower the melting temperature and improve workability, at a cost in the toughness, thermal stability, and optical transmittance.

From the literature it is observed that the effect of adding Glass Powder to concrete is to improve the properties of concrete. The use of Glass Powder as an admixture will have an impact on the durability and the thermal insulation. The other benefit of addition of Glass Powder is to minimize the risk of the Environmental Pollution. The use of recycled glass as aggregate greatly enhances the aesthetic appeal of the concrete. Recent research findings have shown that concrete made with recycled glass aggregate have shown better long term strength and better thermal insulation due to its better thermal properties of the glass aggregates

OBJECTIVE The main objective of the present investigation is to investigate the suitability of glass powder as a partial replacement to cement. Accordingly, finely

powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete.

2. MATERIALS

GLASS POWDER: Glass is one of the oldest man-made materials. It is produced in many forms such as packaging or container glass, flat glass, and bulb glass, all of which have a limited life in their manufactured forms and therefore need to be recycled so as to be reusable in order to avoid environmental problems that would be created if they were to be stockpiled or sent to landfills. Quantities of waste glass have been rising rapidly during the recent decades due to the high increase in industrialization and the considerable improvement in the standards of living, but unfortunately, the majority of these waste quantities are not being recycled but rather abandoned causing certain serious problems such as the waste of natural resources and environmental pollution. Recycling of this waste by converting it to aggregate components could save landfill space and also reduce the demand for extraction of natural raw material for construction activities.

Figure 1. Typical Waste Glass powder

Waste glass available locally was collected and made into glass powder. Glass waste is very hard material. Before adding glass powder in the concrete it has to be powdered to desired size. In this study glass powder ground in ball mill/ pulverizer for a period of 30 to 60 minutes resulted in particle sizes less than size 150 μm and sieved in 75 μm.

3. METHODOLOGY

To evaluate the strength characteristics in terms of compressive, split tensile and flexural strengths, a total of 9 mixes were tried with different percentages of Glass powder (0, 5, 10, 15, 20, 25, 30, 35 & 40%) In all mixes the same type of aggregate i.e. crushed granite aggregate; river sand and the same proportion of fine aggregate to total aggregate are used. The relative proportions of cement, coarse aggregate, sand and water are obtained by IS - Code method. M20 is considered as the reference mix.

For each mix, 6 cubes of size 150 x 150 x 150 mm and 6 cylinders of 150 mm diameter & 300 mm height and 6 flexural beams of size 500 x 100 x 100 mm were cast and tested. The test programmed consisted of conducting Compressive tests on Cubes, Split Tensile tests on Cylinders and Flexural strength on beams 28 days. All the materials used in this investigation i.e. cement, fine aggregate, coarse aggregate, and glass powderwere mixed thoroughly manually. Care has to be taken in mixing to avoid balling effect.

For all test specimens, moulds were kept on table vibrator and the concrete was poured into the moulds in three layers by tamping with a tamping rod and the vibration was effected by table vibrator after filling up moulds. The moulds were removed after twenty four hours and the specimens were kept immersed in clean water tank. After curing the specimens in water for a period of 28 days the specimens were taken out and allowed for drying under shade before testing.

4. RESULTS AND DISSUSSION

TEST RESULTS:
This section provides the results obtained from various tests conducted in this work. The different results obtained from Compressive Strength test for 28 days, and Split Tensile Strength tests for 28 days, and Flexural Strength test for 28 days are presented in tables 1, 2 and 3. Also the variations of strengths with percentage glass powder are graphically represented in the following Figures from 2 to 4.

COMPRESSIVE STRENGTH:

Table 1.Compressive strength in concrete with age

PERCENTAGE REPLACEMENT OF GLASS POWDER(GP)	COMPRESSIVE STRENGTH, MPa
	28 Days
0 % GP	23.05
5 % GP	23.57
10 % GP	24.77
15 % GP	25.21
20 % GP	25.62
25 % GP	24.68
30 % GP	23.45
35 % GP	23.89
40 % GP	23.71

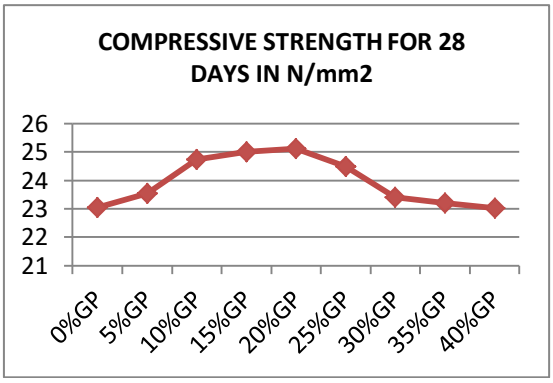

Figure 2. Variation of Compressive strength with % Glass Powder(GP) for 28 days

From the above figure 2, it is observed that there is an increase in compressive strength up to 20% replacement of glass powder and beyond that increasing percentage of glass powder decreases the compressive strength. Hence 20% replacement of glass powder is found to be optimum for 28 days compressive strength.

FLEXURAL STRENGTH

The variation of Flexural strength with percentage glass powder is shown in Figure 3for 28 days curing and presented in table 2.

Table 2.Flexural strength in concrete with age

PERCENTAGE REPLACEMENT OF GLASS POWDER	FLEXURAL STRENGTH, MPa
	28 Days
0 % GP	3.94
5 % GP	3.61
10 % GP	3.68
15 % GP	3.82
20 % GP	3.68
25 % GP	3.56
30 % GP	3.56
35 % GP	3.44
40 % GP	3.44

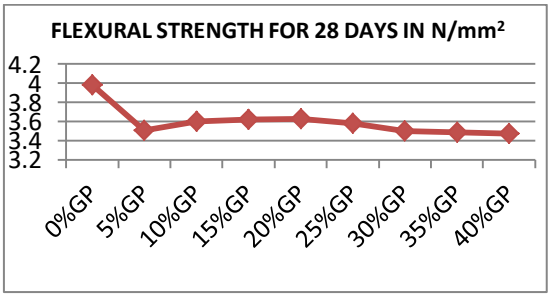

Figure 3. Variation of Flexural strength with % Glass Powder(GP) for 28days

From the figure 3, it was understood that flexural strength is lower when glass powder added, compared to conventional (0% GP) concrete. In above figure 3, there is an increase in flexural strength up to 20% replacement of glass powder and beyond that increasing percentage of glass powder decreases the flexural strength. So 20% replacement of glass powder is optimum for 28 days flexural strength.

SPLIT TENSILE STRENGTH

The variation of Split Tensile strength with percentage glass powder is shown in Figure 4 for 28 days curing and presented in table 3.

Table 3. Split Tensile strength in concrete with age

PERCENTAGE REPLACEMENT OF GLASS POWDER	SPLIT TENSILE STRENGTH, MPa
	28 Days
0 % GP	2.15
5 % GP	2.6
10 % GP	2.64
15 % GP	2.60
20 % GP	2.36
25 % GP	2.72
30 % GP	2.78
35 % GP	2.28
40 % GP	2.28

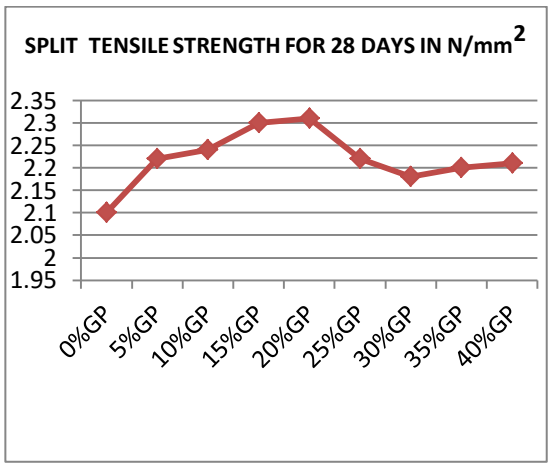

Figure 4. Variation of Split tensile strength with % Glass Powder(GP) for 28 days

In above figure 4, there is an increase in split tensile strength up to 20% replacement of glass powder and beyond that increasing percentage of glass powder decreases the split tensile strength. So 20% replacement of glass powder is optimum for 28days Split tensile strength.

5. CONCLUSIONS

Based on experimental observations, the following conclusions are drawn:
Waste Glass powder can be effectively utilized in concrete making and hence reduces the cement costs and pollution problem.

- Compressive strength increases with an increase in percentage of glass powder up to 20% replacement of cement and beyond 20% strength decreases.

- Flexural strength is low when glass powder is added to concrete.

- Flexural strength also increases with increase in percentage of glass powder upto 20% replacement and of cement beyond 20% strength drops down.

- Split tensile strength increases with an increase in percentage of glass powder up to 20% replacement of cement and beyond 20% strength decreases.

- Considering the strength criteria, the replacement of cement by glass powder is feasible. Therefore we can conclude that waste glass powder can be used as a partial replacement to cement up to 20%.

Scope for further studies:
The workability, durability and other aspects of concrete can be studied under varied environmental conditions.

REFERENCES

[1] Vijayakumar, G., Vishaliny, H. And Govindarajulu, D. (2013). "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production.", International Journal of Emerging Technology and Advanced Engineering, 3(2), 153-157.

[2] Naike, T R Kraus, R N (2003), "A New Source of Pozzolanic Material", American Concrete Institute, ISSN: 0162-4075, OCLC: 4163061, Vol.25, No.12, Pp.55-62.

[3] Rafat Siddique (2009), "Utilization of Waste materials and by-products in producing controlled low-strength materials", Resources, Conservation and Recycling, Vol.54, No.1, Pp.1-8.

[4] Bajad, M. N., Modhera, C.D. and Desai, A. K. (2011). "Effect of glass on strength of concrete subjected to sulphate attack.", International Journal of Civil Engineering Research and Development, 1(2), 1-13.

[5]. Dhanaraj, M. P. and Keshav, K. S.(2013). "Experimental Investigation Of Waste Glass Powder as Partial Replacement of Cement in Concrete.", International Journal Of Advanced Technology In Civil Engineering, 2(1), 2231 –5721.

[6]. Meenakshi, S.S. and Ilangovan, R. (2011). "Performance of copper slag and ferrous slag as partial replacement of sand in concrete.", International Journal of Civil and Structural Engineering, 1(4), 918-926.

[7]. Nathan, S. and Narayanan, N., (2008). "Influence of a fine glass powder on cement hydration: comparison to fly ash and modeling the degree o hydration," Cement and Concrete Research, 38, 429-436.

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