A STUDY ON PROPERTIES OF CEMENT REPLACEMENT BY WASTE GLASS POWDER

Vinaya Shyam D, Priscilla M
Assistant Professor, Department of Civil Engineering SDMIT, Ujire

***Abstract*— 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. To realize this potential, waste glass needs to be milled to micro-scale particle size for accelerating its beneficial chemical reactions in concrete. The mix design for M20 concrete was done. Cement replacement by glass powder in the range of 5% to 45% in increments of 5 percentages was studied. Workability, water absorption test, density test, compression test, split tensile strength and flexural strength test of glass powder concrete was conducted and the results were compared with normal concrete. The workability has decreased with addition of glass powder. It further decreases with increase in percentage of glass powder. The density and water absorption of concrete reduces with the increase in the percentage of replacement of cement by glass powder. Target mean strength was achieved for Conventional concrete, 5%GPC, 10%GPC, 15%GPC, 20%GPC and 25%GPC. Even though 30% GPC, 35% GPC, 40% GPC and 45% GPC did not achieve target mean strength their value is more than the designed strength (20 N\mm2). Split tensile strength and Flexural strength decreased with addition of glass powder and it further decreases with increase of glass powder content in concrete. Since glass powder is disposed unscientifically, it is highly hazards, so one of the better ways of disposal is by using in suitable replacement material for cement.**

***Index Terms*— CC- Cement Concrete , GPC- Glass Powder Concrete, Waste Glass Powder, Compressive strength, Split tensile strength, Flexural strength, Modulus of rupture**

I. INTRODUCTION

Concrete is comprised of Portland cement, fine aggregate, coarse aggregate, water, Pozzolans and air. Portland cement is made by grinding a calcareous material such as limestone or shell with an argillaceous (clayish) material such as clay.

Glass is produced in many forms, including packaging of container glass (bottles, jars), flat glass (windows, windscreens), bulb glass (light globes), cathode ray tube glass (TV screens, monitors, etc), all of which have a limited life in the form they are produced and need to be reused/recycled in order to avoid environmental problems that would be created if they were to be stockpiled or sent to landfill. This paper deals with the recycling aspects of container glass, and the term ―glass‖ hereafter refers to this type only

Utilization of waste glass is very important for human development because huge amount of glass waste produce by human increases the need of precious land for dumping waste glass, decreasing possible area that can be used for landfills of other waste increasing the need to establish new expansive landfills, lactates and gas releases from the landfill site degrade communities living condition and harmful to human health, location of most recycling plants are built within low income neighborhoods because of cheap labour and strict regulation may affect respiratory system if breath in pollutants. Glass is non biodegradable (remains in our environment and do not decompose easily by itself) therefore do not have significant environmental and social impact could result in serious impact after disposal.

II. AIM OF THE PRESENT STUDY

1. The aim of the present investigation is to compare the strength characteristics of concrete made with waste glass powder as a replacement for cement.
2. To find the optimum percentage of waste glass powder as a replacement for cement.

3. Effect of curing period on development of compressive strength, split tensile strength and flexural strength for the concrete made with waste glass powder with different percentage and normal concrete.
4. Effect of quantity of waste glass powder added to concrete for development of compressive strength, split tensile strength and flexural strength of waste glass powder concrete.
5. Effect of water absorption of waste glass powder added to concrete for development of compressive strength, split tensile strength and flexural strength of waste glass powder concrete.
6. Effect of density on development of compressive strength, split tensile strength and flexural strength for the concrete made with waste glass powder with different percentage and normal concrete.

III. EXPERIMENTAL INVESTIGATION

A. Cement

The cement is tested as per IS 4031- 1988 and the test results are tabulated in Table 5.1 and 5.2. For this experimental investigation we used JK cement with 43 grade

Table 1. Test results of cement

Characteristics	Unit	Value	Requirement as per IS: 4031
Fineness (Retained on 90 Micron IS sieve)	%	2.20	Max.10.00%
Setting time Initial set Final set	 min min	 105.00 250.00	 Min 30.00 Max 600.00
Standard Consistency	**%**	31.00	-
Specific Gravity	-	3.13	-

B. Fine aggregates

The different test conducted on fine aggregate and the results obtained. The tests are conducted as per IS: 2386(part, 3) 1963(7). Specific gravity was found to be 2.65.Fineness modulus was found to be 4.97, water absorption 1.2% and confirming to zone I.

C. Coarse Aggregate

In this investigation we have used 20mm down size aggregates as coarse aggregates and they are tested as per IS 2386 and the results are as follows: Specific gravity 2.73, Fineness modulus- 8.01, Moisture content (%)- 0.23%, Abrasion value (%)- 12.53%
Impact value (%) - 18.28%

D. Water

The clean potable water was used for mixing and curing of concrete.

E. Glass powder

Glass powder is collected from B.S.B Industries, located in Belagali village which is 11 km from Hubli town north Karnataka.

Properties of glass are as follows: Specific gravity- 2.73, Median particle size (μ)- 90μ, Moisture content (%) -0.1%

IV. DESIGN MIX FOR M20 GRADE CONCRETE

Table 2. Mix proportions for normal concrete

Grades	Cement (kg/m3)	Fine aggregates (kg/m3)	Coarse aggregates (kg/m3)	Water (lit/m3)
M20	383	727	1125	191.6

Table 3. Amount of waste glass powder replaced in concrete

Replacement of cement by glass powder %	Glass powder (kg/m3)
0	0
5	19.15
10	38.3
15	57.45
20	76.60
25	95.75
30	114.90
35	134.05
40	153.20
45	172.35

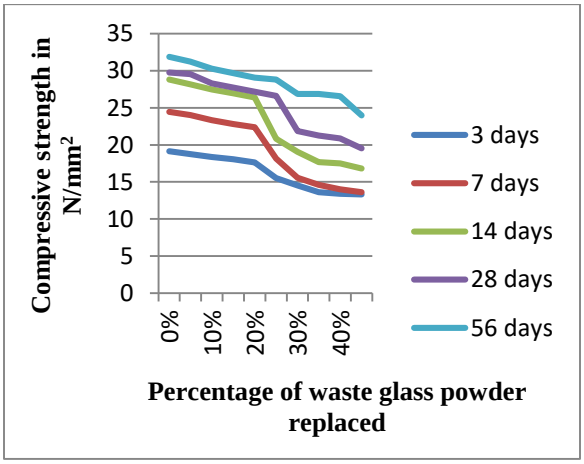
V. PREPARATION OF TEST SPECIMENS AND CURING

The steel moulds were coated with oil on their inner surfaces and were placed on plate. The amount of cement, sand, coarse aggregates required for required number of cubes were weighed. The materials were first dry mixed then mixed with total amount of water thoroughly to get homogeneous mix. The slump test was conducted to ascertain the workability of the mix, which required a slump of 50 -100mm. Concrete was poured into the moulds in three layers each layer being vibrated using mechanical table vibrator and the top surface was finished using trowel. After 24 hours concrete concrete moulds were demoulded and the specimens were kept for curing in water.

VI. TESTS FOR CONCRETE

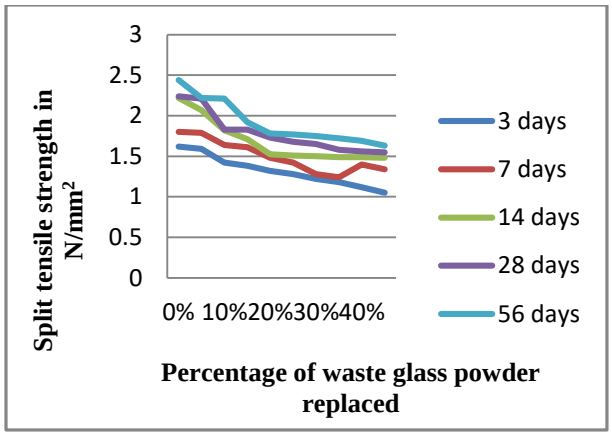
A. Compressive Strength Test

The Compression Strength test was done on cubes for conventional concrete, 5% GPC, 10% GPC, 15% GPC, 20% GPC, 25% GPC, 30%GPC, 35% GPC, 40%GPC and 45%GPC for 3, 7, 14, 28 and 56 days of curing and results obtained and line graph is plotted.



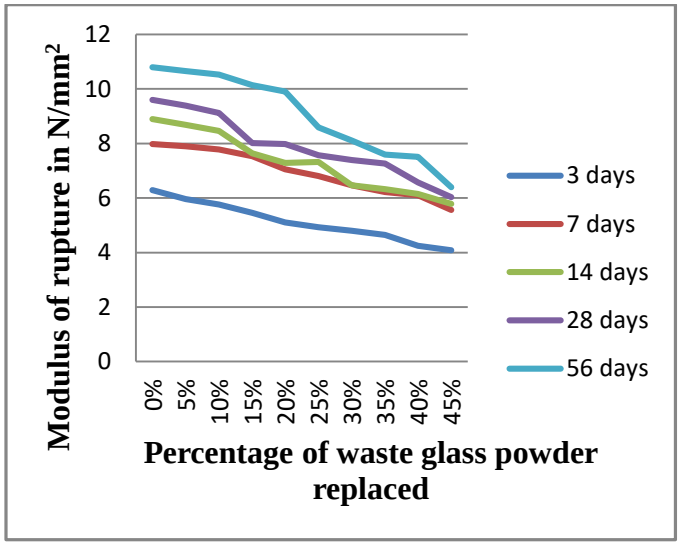
B. *Split tensile Strength Test*

The Split Tensile Strength test was done on cylinders for conventional concrete, 5% GPC, 10% GPC, 15% GPC, 20% GPC, 25% GPC, 30%GPC, 35% GPC, 40%GPC and 45%GPC for 3, 7, 14, 28 and 56 days of curing and results and line graph is plotted.



C. Flexural Strength Test

The Flexural Strength test was done on beams for conventional concrete, 5% GPC, 10% GPC, 15% GPC, 20% GPC, 25% GPC, 30%GPC, 35% GPC, 40%GPC and 45%GPC for 3, 7, 14, 28 and 56 days of curing and results obtained and the line graph is plotted.



VII. CONCLUSION

From the experimental analysis and obtained results, the following conclusions are drawn:

1. Waste glass, if ground finer than 100µm shows pozzolanic behaviour.
2. The workability has decreased with addition of glass powder. It further decreases with increase in percentage of glass powder. Use of super plasticizer may be necessary to maintain workability with restricted water cement ratio.

4. Split tensile strength and Flexural strength decreased with addition of glass powder and it further decreases with increase of glass powder content in concrete..
6. The density of concrete reduces with the increase in the percentage of replacement of cement by glass powder.
7. Water absorption also decreased with increase in percentage of glass powder replacement, this shows that glass powder concrete is less permeable than conventional concrete.
8. Glass powder gains strength slowly with age when compared to conventional concrete.
9. From this study we can understand that glass powder can be replaced for cement and used effectively in making concrete.
10. It can be concluded that up to 25% of cement can be replaced by glass powder of size less than 100µ without any unfavourable effect.

VIII. SCOPE FOR FURTHER WORK

1 . Durability, ductility, strain, impact strength, deflection and fatigue strength can be studied.
2. Various types of glass powder with their varying percentage can be used for further development.
3. Finally the investigation is made to find out the optimum percentage of glass powder content as a partial replacement of OPC Cement.
4. Using of waste glass powder in concrete by adding suitable chemical admixture to increase workability and to achieve high strength concrete.
5. Micro structural examination can be done which shows that glass powder produces a denser matrix which improves the durability property of concrete.
6. For further study glass powder can be used in concrete as a geo-polymer concrete
(100% cement replacement by glass powder) by adding some add mixtures to get desired workability

ACKNOWLEDGMENT

The authors are grateful to our guides and professors for their valuable guidance with their continuous encouragement during the course of this work. We are thankful to SDMIT for encouraging us to prepare this paper.

REFERENCES

[1] Ana Mafalda Matos , Joana Sousa Coutinho- Durability of mortar using waste glass powder as cement replacement- Construction and Building Materials 36 *(2012) 205–215-25 April 2012*.
[2] Hongjian Du, Kiang Hwee Tan- Use of waste glass as sand in mortar: Part II – Alkali–silica reaction and mitigation methods- Cement & Concrete Composites *(2012)-30 Aug 2012*
[3] Roz-Ud-Din Nassar, Parviz Soroushian-Strength and durability of recycled aggregate concrete containing milled glass as partial replacement for cement- Construction and Building Materials *29 (2012) 368–377-12 Oct 2011*
[4] A. Khmiri, B. Samet, M. Chaabouni- A cross mixture design to optimize the formulation of a ground waste glass blended cement-Construction and Building Materials *28 (2012) 680–686-9 Oct2011*.
[5] M. Aly , M.S.J. Hashmi , A.G. Olabi , M. Messeiry , E.F. Abadir , A.I. Hussain- Effect of colloidal nano-silica on the mechanical and physical behavior of wasteglass cement mortar- Materials and Design *33 (2012) 127–135-4 July 2011*.
[6] Mohammad Alizadeh Kharaazi and Eshmaiel Ganjian- Use of Iranian Industrial Waste for Cement Replacement in Low Strength Concrete and CLSM-*30 June 2010.*
[7] R. Idir, M. Cyr, A. Tagnit-Hamou- Use of waste glass as powder and aggregate in cement-based materials- SBEIDCO – 1st International Conference on Sustainable Built Environment Infrastructures in Developing Countries ENSET Oran (Algeria)-*12 Oct 2009.*
[8] M.S.Shetty, ―Concrete Technology and Theory of Practice‖, S.Chand & Co.ltd – *2004*.
[9] IS: 8112 – 1989, ―Specification for 43 Grade Ordinary Portland Cement‖.Bureau of Indian Standards, New Delhi.
[10] IS: 383 – 1970―Specification for coarse and fine aggregates from natural sources for concrete‖.Bureau of Indian Standards, New Delhi.
[11] IS: 2386 – 1963 part 1 to VIII―Indian standard methods of test for aggregate for concrete‖.Bureau of Indian Standards, New Delhi.