International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Comparative Study of Waste Glass Powder Utilized In Concrete

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Abstract: ***Every year approximately 2.35 billion tons of cement is produced - that is almost 1 m3 of cement for every person in the world. The carbon dioxide released into the atmosphere during the cement production process accounts for approximately 5-10% of the overall CO2 production in the world. Its release into the atmosphere contributes to the global warming and the development of holes in the ozone layer. If the CO2 production in cement factories could be decreased by 10%, the overall release into the atmosphere would decrease by 5.2%. Using waste glass as cement replacement in concrete construction sector is advantageous, as the production cost of concrete would decrease, and our industry would become more environmentally friendly. The large scale production of Portland cement and the acquisition of aggregates from dredging and quarrying have a dramatic impact on the environment. Consequently extensive research is ongoing into the use of Portland cement replacement. The concept of utilizing waste material for building applications has a long and successful history. These once problematic, land filled waste materials are now considered valuable commodities for use in enhancing certain properties of concrete, so the main purpose of this paper is to find out the strength of concrete containing waste glass powder as pozzolana. Cement replacement by glass powder in the range 5% to 20% in increments of 5 percentages (5%, 10%, 15%, 20 %, and 25%) has to be study.***

Keywords: Glass powder, Compressive strength, Tensile strength, Concrete.

1. Introduction

Concrete is a blend of cement, sand, coarse aggregate and water. Today global warming and environmental devastation have become manifest harms in recent years, concern about environmental issues, and a changeover from the mass-waste, mass-consumption, and mass production society of the past to a zero-emanation society is now viewed as significant. Normally glass does not harm the environment in any way because it does not give off pollutants, but it can harm humans as well as animals, if not dealt carefully and it is less friendly to environment because it is non-biodegradable. Thus, the development of new technologies has been required. The term glass contains several chemical diversities including soda-lime silicate glass, alkali-silicate glass and borosilicate glass. To date, these types of glasses glass powder have been widely used in cement and aggregate mixture as pozzolana for civil works. The introduction of waste glass in cement will increase the alkali content in the cement. It also helps in bricks and ceramic manufacture and it preserves raw materials, decreases energy consumption and volume of waste sent to landfill. As useful recycled materials, glasses and glass powder are mainly used in fields related to civil engineering, for example, in cement, as pozzolana(supplementary cementitious materials), and coarse aggregate. Their recycling ratio is close to 100%, and it is also used in concrete without adverse effects in concrete durability. Therefore, it is considered ideal for recycling.

Recently, Glasses and its powder have been used as a construction material to decrease environmental problems. The coarse and fine glass aggregates could cause alkali-silica reaction in concrete, but the glass powder could suppress their alkali-silica reaction tendency, an effect similar to supplementary cementations materials. Therefore, glass is used as a replacement of supplementary cementitious materials.

2. Materials

A. Cement:
The cement conforms to 53 Grade ordinary Portland cement as specified by the Indian Standard specification IS 12269:1987, for which minimum strength of 53 Mpa at 28 days is stipulated.

B. Fine aggregate
Naturally available sand from Mula river bed passed through 4.75mm IS sieve is used as fine aggregate is in the present work. As per IS383 the sand falls under zone 4.The specific gravity of sand is 2.82 and fineness modulus of 2.5.

C. Coarse aggregate
The Coarse aggregate are obtained from a local quarry is used. The coarse aggregate with a maximum size 20mm having a specific gravity 2.91 and fineness modulus of 1.9.

D.Glass Powder
The most familiar form of glass is the silica-based material used for windows, containers and decorative objects. Glass is biologically inactive material that can be found with very smooth and impervious surfaces. The specific gravity of glass powder is 2.58.

3. Experimental Program

The mix design is produced for maximum size of aggregate is 20mm conventional aggregate. The variation of strength of hardened concrete using glass powder as partial replacement of cement is studied by casting cubes and cylinders until 20%. The concrete was prepared in the laboratory using mixer. The cement, fine aggregate and coarse aggregate and glass powder are mixed in dry state and then the desired water quantity is added and the whole concrete is mixed for 5 minutes, the concrete is poured in the moulds which are screwed tightly. The concrete is poured

into the moulds in 3 layers by poking with tamping rod for cubes of 150×150×150 mm Size and cylinders of 150×300 mm size and Size was tested for compression and split tensile strengths. The cast specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7 and 28 days the specimens are removed and these are tested for compression and split strengths and the results are compared with conventional concrete.

4. Mix Proportions

Table 1: Mix Proportion

Water	Cement (kg)	F.A. (kg)	C.A. (kg)
191.6	435.45	541.88	1053.87
0.44	1	1.24	2.42

1. Required Water Content = 186 lit/m^3
2. Absolute Volume of Sand = 35%
3. Determination of Cement Content –

W/C ratio =0.4
Hence cement content = 186/0.44
= 422.73 kg/m^3

Then mix-0.44, 1:1.22:2.66
Extra quantity of water added for absorption in case of C.A at 0.5% by mass=0.5/100*133=0.66 lit
Quantity of water deducted for free moisture present in sand at 2% by mass=62*2/100
=1.24 lit
Actual quantity of water required= 22+0.66-1.24
=21.42 lit
Actual quantity of sand = 62+1.24= 63.24 kg
Actual quantity of C.A =121-0.66=120.34 kg

Quantity of Material
Cement Bag = 50 kg
Sand = 63.24 kg
C.A. = 120.34 kg
Water = 21.42 kg

Table 2: Quantity of materials

	Water	*Cement*	*F.A*	*C.A*
1m^3	186.74	435.45	550.87	1158.87
6 Cubes(0.0204m^3)	3.81	8.88	11.24	23.64
6 Cylinders(0.0318m^3)	5.94	13.85	17.52	36.85

5. Results and Discussions

An increasing trend in strength was observed with increasing replacement of cement with glass powder up to 20%. The highest percentage increase in the compressive strength was at 20% replacement level. When the cement replacement level was increased beyond 20%, the compressive strength decreased.

Table 3: 28 Days strength

Mixing %	*Compressive strength*	*Splitting tensile strength*
0%	28.69	2.68
5%	25.27	2.59
10%	27.05	2.91
15%	27.22	2.20
20%	28.50	2.50
25%	24.48	1.74

6. Conclusions

Based on experimental observations, the following points are concluded:

1. The maximum compressive strength, when 20% cement was replaced by glass powder in concrete.
2. The density of concrete reduces with the increase in the percentage of replacement of cement by glass powder.
3. The workability decreased as the glass content increase. Use of super plasticizer was found to be necessary to maintain workability with restricted water cement ratio.
4. According to strength criteria, the replacement of cement by glass powder is feasible.
5. It is recommended that the utilization of waste glass powder in concrete as cement replacement is possible.

7. Acknowledgement

Words are inadequate to express my deep sense of gratitude to Prof A.T. Babar, my guide, for his consistent guidance and inspiration throughout the project work, which I am sure, will go a long way in my life. I also owe sincere thanks to Prof A. T. Babar, Head of Civil Engineering Department and Dr. S. P. Patil, Principal, Karmayogi Engineering College, Pandharpur for their guidance throughout the project work. I express my sincere thanks to all those who have helped me directly or indirectly in completing this project.

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