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Experimental Investigation of Partial Replacement of Cement with Glass Powder

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***Abstract*: In present day scenario, concrete industry is the one of the largest consumer of natural resource. In the concrete industry, cement plays a vital role. Due to increased cement production, cement manufacturing industries have become the largest contributors of CO2 emission, which severely affects the environment. Hence it is necessary to find an alternative and sustainable replacement for cement in concrete. Glass powder, with cement-like properties can be used as a partial replacement for cement in concrete. Millions of tons of glass waste are being generated annually all over the world. Once glass becomes unusable, it is disposed in landfills, which cannot be decomposed by the environment. As obtained from Energy-dispersive X-ray Spectroscopy (EDXS), glass is principally composed of silica which can be used as a partial replacement of cement. In this project, M25 grade of concrete is used for testing the properties of glass-powder incorporated concrete. The cement in concrete is partially replaced with glass powder in various proportions like 0%, 10%, 20% & 30% and tested for its compressive, tensile and flexural strength up to 7 days, 14 days, 28 days and compared with the conventional concrete. A 20% replacement of cement with waste glass powder was found to be convincing considering cost and sustainability criteria.**

***Keywords*: Glass powder, EDXS, Compressive test, Tensile strength, Flexural strength.**

1. Introduction

The quantity of waste glass bottle has been increased over the year. As per 2006, the total global waste glass production can be estimate was 140Mt, in which China, and USA produced approximately 35Mt, respectively. The manufacture of the cement is the major greenhouse gas emissions as per now a day. Several industries have been used as a partial replacement of cement such as GGBS, Fly ash, Metakaolin. These materials which can be improve the durability, workability and also the economy. Glass is the very common product that can be found in the various forms such as glass bottle, jars, etc….. because glass bottle is the non – biodegradable material. Use of waste glass powder as a partial replacement of cement has been attempted by many investigators. Glass is the most versatile substances in the earth surface. The construction company has been used the waste and recycled glass bottle has a partial replacement of cement and aggregates. Glass has been used as an important inert material which can be recycled many times without changing its chemical properties. In the concrete industry to use glass powder as a partial replacement of cement. Glass powder has a very fine powder and it contains more silica content. Glass is an amorphous material with have high silica content making with pozzolanic when the particle size is less than 75 microns. Concrete is being the one of the most important and widely used material with high strength and sufficient workability. In the research various material can be used has a partial replacement of cement with glass powder, fly ash and metakaolin.

2. Materials and Methods

A. Materials

1) Cement

Ordinary Portland cement of 53 grade was used throughout the work.

2) Coarse Aggregate

Crushed granite metal is obtained from source was used as a coarse aggregate that can be passed through 21mm and retained in 16mm sieve was used.

3) Water

Portable water can be used for the mixing and curing properties for the specimen.

4) Fine Aggregate

M-Sand can be used as a fine aggregate in the method.

5) Glass Powder

Glass powder of grade 920-D of 20 kg was obtained.

Table 1
Chemical properties of cement

COMPOSITION %	CEMENT
SILICA	20.2
ALUMINA	4.7
IRON OXIDRE	3.0
CALCIUM OXIDE	61.9
MAGNESIUM OXIDE	2.6
SODIUM OXIDE	0.19
POTASSIUM OXIDE	0.82
FINENESS % PASSING (sieve size)	90 µm
UNIT WEIGHT Kg/m^3	3150
SPECIFIC GRAVITY	3.15

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Table 2
Chemical properties of glass powder

COMPOSITION %	CEMENT
SILICA	72.5
ALUMINA	0.4
IRON OXIDRE	0.2
CALCIUM OXIDE	9.7
MAGNESIUM OXIDE	3.3
SODIUM OXIDE	13.7
POTASSIUM OXIDE	0.1
FINENESS % PASSING (sieve size)	75 µm
UNIT WEIGHT Kg/m^3	2579
SPECIFIC GRAVITY	2.58

B. Objectives

- To evaluate the utility of Glass powder as a partial replacement of cement.
- To study and compare the performance of glass powder and the conventional concrete to understand the effectiveness and strength of glass powder

3. Methodology

1. Material collection
2. Material Study
3. Curing of Specimen
4. Casting of Specimen
5. Testing of Specimen
6. Result
7. Conclusion

4. Experimental Work

The waste glass powder can be collected from various places like industries and construction areas. These glass powder can be used has a partial replacement of cement. It can be obtained from various rates such as 10%, 20% and 30%. Different types of laboratory test can be conducted to determine the fineness test, specific gravity test, consistency test and also the initial and final setting time of cement. By the way of these result the mix design to be calculated and utilizing the glass powder as a partial replacement of replacement of cement. Now with the mixing of glass powder 18 cubes, 18 cylinders, 18 prism of 2 specimens for each combination. It can be casted for the room temperature. At the end of the curing period, each of the specimens can be tested for compressive test, flexural strength and tensile strength and the average can be recorded.

5. Testing Result

A. Percentage of Glass Powder

1ST RATIO -10% replacement of cement
2ND RATIO -20% replacement of cement
3RD RATIO -30%replacement of cement

B. Compressive Strength of Concrete

From the table 3, 4, 5 shows that the strength can be gain at the percentage of glass powder as a partial replacement of cement at 7, 14 and 28 days.

Table 3
Compressive test on cube for 7 days

MIX RATIO	Compressive Strength in N/mm^2 7 Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	8.27	13.775	14.665	12.885

Table 4
Compressive test on cube for 14 days

MIX RATIO	Compressive Strength in N/mm^2 14 Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	13.775	20	20.9	19.335

Table 5
Compressive test on cube for 28 days

MIX RATIO	Compressive Strength in N/mm^2 14 Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	18.22	23.78	25.335	22.8

C. Split tensile strength of concrete

From the table 6, 7, 8 shows that the strength can be gain at the percentage of glass powder as a partial replacement of cement at 7, 14 and 28 days. It can be seen that a reduction of strength at the 20% replacement.

Table 6
Split tensile test on Cylinder for 7 days

MIX RATIO	Split Tensile Strength in N/mm^2 14Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	1.78	1.765	1.84	1.62

Table 7
Split tensile test on Cylinder for 14 days

MIX RATIO	Split Tensile Strength in N/mm^2 14Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	2.45	2.12	2.7	1.695

Table 8
Split tensile test on Cylinder for 28 days

MIX RATIO	Split Tensile Strength in N/mm^2 28Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	3.06	2.54	3.11	2.26

D. Flexural strength of concrete

From the table 9, 10, 11 shows that the strength can be gain at the percentage of glass powder as a partial replacement of cement at 7, 14 and 28 days. It can be seen that a reduction of strength at the 20% replacement.

Table 9
Flexural test on beam for 7 days

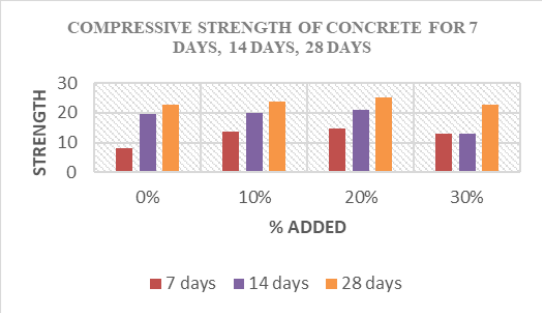
MIX RATIO	Flexural Strength in N/mm^2 7 Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	5.4	4.25	4.5	3.15

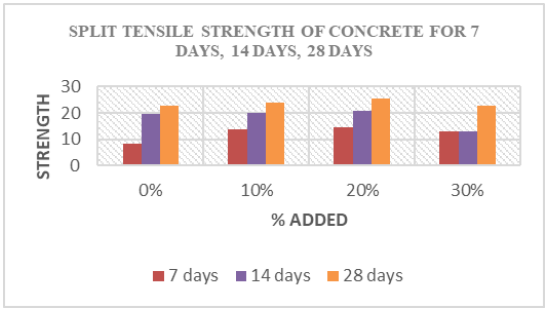
Table 10
Flexural test on beam for 14 days

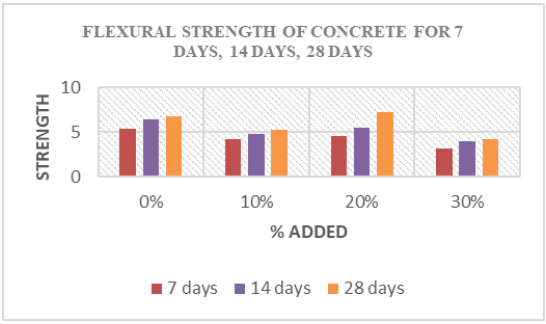
MIX RATIO	Flexural Strength in N/mm^2 14 Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	6.4	4.75	5.5	4

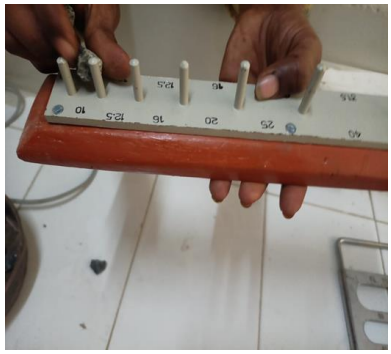
Table 11
Flexural test on beam for 28 days

MIX RATIO	Flexural Strength in N/mm^2 28 Days			
	CC	Various % of Glass powder		
	0%	10%	20%	30%
M25	6.8	5.25	7.25	4.25









6. Conclusion

By using the glass powder as a partial replacement of cement in concrete will reduce the greenhouse effect produced in the cement manufacturing industries. By using the glass powder, it will increase the Compressive Strength, Flexural Strength, Split Tensile strength of concrete. The strength can be increased at 20%. When compared to the conventional concrete glass powder can increase the strength of concrete.

References

[1] Glass ASR consideration", Cement and Concrete composites, vol. 29, pp. 616-625, 2007
[2] Method of test of Strength of concrete, IS 516:1959, Bureau of Indian standards, New Delhi.
[3] Warren, C.J., Reardon, E.J., 1994. The solubility of ettringite at 25ºC. Cem. Conr. Res. 24, 1515- 1524.
[4] Jin. W, Meyer. C, and Baxtert. S, "Glass concrete with Glass aggregate," ACI Materials Journal, vol. 97, pp. 208-213, 2000.

[5] Taha, B., Nounu, g., 2009. Utilizing waste recycled glass as sand / cement replacement in concrete. J. Mater. Civ. Eng. 21 (12), 709-721.
[6] Shi, C., Wu, Y., Riefler, C., Wang, H., 2005. Characteristics and pozzolanic reactivity of glass powders. Cem. Concrete. Res. 35 (6), 1145-1151.
[7] Siddique R, Khatib J, Kaur I (2008) use of recycled plastic in concrete: a review. Waste management 28(10): 1835-1852.
[8] Somayaji S (2011) Civil engineering materials. Pearson Education India.
[9] Handy RL (1995) The day the house fell. American Society of Civil Engineers.