PERFORMANCE ANALYSIS OF CONCRETE STRENGTH BY PARTIALLY ADMISSION OF GLASS POWDER IN CONCRETE WITH DIFFERENT DOSAGES

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ABSTRACT: Safe storage and disposal of waste and broken glass is a serious problem for our urban and rural areas in India. Wherever this problem is eliminated or consumed by the reuse of glass waste. In this experimental work, the effect of partial replacement of glass powder on concrete is examined. Cement in concrete is replaced by waste glass powder in 10%, 20%, 30%, and 40% increments of cement volume, respectively, and its effects on compressive strength, break strength, and workability are determined and in flexural strength. It can be seen that the compressive, flexural and tensile strengths of concrete initially increase as the percentage of cement replacement by powdered glass peaks reaches approximately 20% and then decreases. The workability of concrete decreases monotonically as the percentage of cement replacement with glass powder increases. Up to about 20% of cement can be replaced with glass powder without sacrificing compressive strength.

Key words: Concrete, glass powder, workability, compressive strength, flexural strength, tensile strength.

I. INTRODUCTION

One of the mostly used construction materials worldwide is concrete. However, the Portland cement production, important elements of concrete, leads to the release of a particular amount of CO2, a gases of greenhouse. A ton of Portland cement clinker production would produce about a ton of CO2 and other greenhouse gases (GHGs). Part of the cement needs to be replaced with pozzolan to reduce cement consumption, and contamination can be verified to some degree. Certain industrial wastes such as fly ash, silica vapor, blast furnace slag, etc. They have already established their use in concrete. Recent research has shown that waste glass in concrete can be used effectively as a glass aggregate or glass pozzolan. The glass used has certain properties of pozzolan if it is crushed into a very fine powder thanks to its silica content. Therefore, glass powder can replace cement to some extent and contributes to the development of strength and also improves durability properties.

GLASS POWDER REINFORCED CONCRETE

The use of recycled glass as an additive greatly improves the aesthetics of concrete. Recent research has shown that concrete produced from recycled glass aggregates has better long-term strength and better thermal insulation due to its better thermal properties. During tests of compressive strength values at 10%, 40% and 60% of aggregate replacement by used glass with particle size between 0 and 10 mm, they were 3%, 8% and 5% greater than the value Conventional concrete. It was concluded that 30% of glass powder can be incorporated in concrete as a substitute for cement without having a long-term negative effect.

GLASS POWDER USED

Concrete is a mixture of cement, sand, coarse aggregate, and water. The key factor that adds value to concrete is that it can be designed to withstand the harshest environments that matter. Today, global warming and environmental degradation have become evident damage in recent years. Today, concern about environmental issues and society's transition from mass production, consumption and mass production from the past to a lawless society is considered important. Generally, glass does not harm the environment in any way because it does not emit pollutants, but it can harm both humans and animals if not treated carefully, and is less environmentally friendly because it is not biodegradable.

PROPERTIES OF GLASS POWDER REINFORCED CONCRETE

Around 55,000 tons of fiberglass waste is currently produced in the UK and is expected to increase by 10 percent per year. Landfills and incineration are the most common methods used for the disposal of thermosetting polymeric compounds, including fiberglass composite wastes. In the UK, around 90% of fiberglass waste goes to landfills. Increasing technological innovations, sufficient market value, and global demand for fiberglass composites have sparked interest in optimizing the recycling of fiberglass waste.

GLASS POWDER MECHANISM

Scrap glass, like broken glass, is primarily used as an inert aggregate in the production of construction materials. However, fine-grained glass powder with its well-developed surface cannot be considered passive towards cement solutions, which has proven to be practical. Literary sources do not provide information on the chemical influence of fine-grained glass on the hardening process, especially at the beginning of its hydration period before induction, a period that greatly influences the formation of the glass structure. cement stone and its properties.

Table- Chemical composition of cementing materials

Composition (% by mass)/ property	Cement	Glass powder
Silica (SiO2)	20.2	72.5
Alumina (Al2O3)	4.7	0.4
Iron oxide (Fe2O3)	3.0	0.2
Calcium oxide (CaO)	61.9	9.7
Magnesium oxide (MgO)	2.6	3.3
Sodium oxide (Na2O)	0.19	13.7
Potassium oxide (K2O)	0.82	0.1
Sulphur trioxide (SO3)	3.9	-
Loss of ignition	1.9	0.36
Fineness % passing (sieve size)	97.4(45 µm)	80 (45 µm)
Unit weight, Kg/m3	3150	2579
Specific gravity	3.15	2.58

II. OBJECTIVES OF STUDY

The cement is partially replaced by residual glass powder in the concrete. The samples are cast cubes, prisms, and cylinders that partially replace cement, such as 10%, 20%, 30%, and 40%. The tests were carried out and the test results were compared with the results of conventional concrete tests.

- The main objective of this study is to reduce the amount of cement produced by partially replacing it with waste glass powder and to avoid the waste glass disposal problem.
- Use finely ground glass to increase strength without using additives that increase strength.
- Know the role of glass dust in the mechanical properties of concrete.
- Study of the properties of concrete containing finely ground glass residues.
- Determination of the adequate percentage of substitution for high resistance concrete.

III. LITERATURE REVIEW

Vikas Bagga, Ravi Kumar [1] Experimental Analysis of Glass Powder as partial replacement of Cement in Concrete with addition of Admixture (2019) To reduce the level of glass disposal and further discover the use of non-reused glass in new applications, the panel of experts is under pressure from natural associations, as a substantial part of the glass produced on the planet is eliminated. they arrive full or assorted. Glass is a widely used product throughout the world.

T O Ogundairo*, D D Adegoke, I I Akinwumi and O M Olofinnade [2] Sustainable use of recycled waste glass as an alternative material for building construction – A review (2019) Natural aggregates and cement in large quantities are required by construction industries for new development and maintenance of buildings and technical infrastructure. However, the extraction of these large amounts of natural resources has resulted in the continued depletion of the earth's natural resources, which can lead to environmental damage.

J.Premalatha, R.Srinivasan [3] Properties of Concrete with Waste Glass Powder (Gp) as Fine Aggregate Replacement (2019) In the present work, the feasibility of using waste glass as a substitute for natural river sand was investigated. Glass waste deposited in landfills constitutes environmental pollution and an investigation should be carried out on its reuse in the construction sector.

S. Rahman, M.N. Uddin [4] Experimental Investigation of Concrete with Glass Powder as Partial Replacement of Cement (2018) The effects of the partial substitution of cement by glass powder in concrete have been investigated and, therefore, it has been found that some level of substitution can be substituted, contributing to the development of strength. The cement was partially replaced with glass powder in varying percentages such as 10%, 20% and 30% and several concrete cylinders were poured with a single concrete sample.

Wasan I. Khalil, Nazar F. Al-Obeidy [5] Some Properties of High Strength Sustainable Concrete Containing Glass Powder Waste (2018) This research focuses on the use of glass waste after recycling to produce high-strength, durable concrete. The glass residue used is produced according to ASTM C618 as natural class pozzolana (N) with a fineness of approximately 7340 cm² / g. Numerous concrete mixes have been made with different percentages of residual glass dust as a partial replacement for cement by weight (10%, 15%, 20%, 25% and 30%) to study certain properties of concrete (compressive strength, resistance tensile at break), flexural strength and modulus of elasticity 60 days of age).
Elham Abd Al Majeed [6] Influence of Waste Glass Powder on Compressive Strength of Sulfate Resistance Portland Cement (2018) Today Glass is used in many ways and has a short life due to its brittleness and ease of breakage. Once broken, it is stored waiting to be reused or sent to the landfill because glass is not degradable, so storing it in a landfill is considered an unfriendly solution for the environment. Therefore, there is a great need to use waste glass as landfill mortar and cement as additives. sudhanshu kumar and dr. Bharat nagar [7] Effects of waste glass powder on compressive strength of concrete (2017) This study aims to investigate the effect of the behavior of glass waste in concrete using glass waste that is not biodegradable and not suitable for landfills. This study was carried out to take advantage of this waste in the construction sector so that our environment is free of one of the main pollutants produced by the manufacturing industry.

IV. PROGRAMME

Experimental setup

To achieve the stated objectives, this study was carried out in a few steps. In the initial phase, all necessary materials and equipment must be collected or verified for availability. Then the concrete is mixed according to the predefined proportions. Concrete samples were analyzed using concrete tests, such as the cube test. Finally, the results obtained were analyzed to draw conclusions

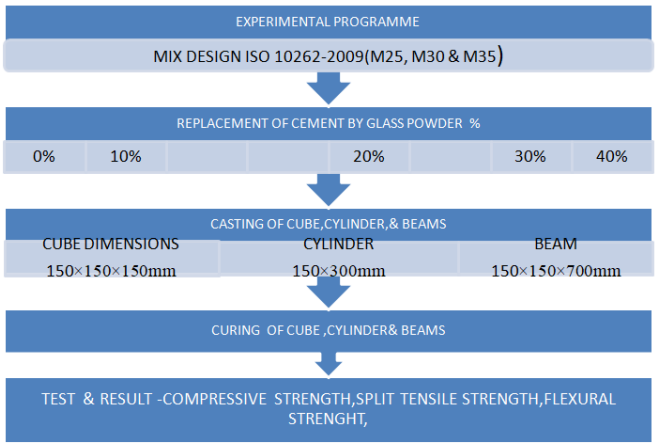

Fig- Experimental Process

EXPERIMENTAL INVESTIGATION

To study the effect of replacing cement in different compression ratios of industrial waste glass powder, 117 buckets, 13 beams and 13 cylinders were launched for bending and vacuuming. The experimental program was divided into four groups.

Each group consists of 3 cubes, 1 cylinder and 1 bar, 15 x 15 x 15 cm, 15 (diameter) x 30 cm or 15 x 15 x 70 cm.

- The first group is control concrete (normal concrete) with 0% glass powder (PPC).
- The second group consisted of 10% glass powder with an aspect ratio that replaces cement.
- The third group consisted of 20% glass powder with an aspect ratio that replaces cement.
- The fourth group consisted of 30% glass powder with an aspect ratio that replaces cement.
- The fifth group consisted of 40% glass powder with an aspect ratio that replaces cement.

V. RESULT & DISCUSSION

In this chapter we will plot graph by the data which is obtained by conducting different test on the materials use.

Table RESULT OF CUBE (GRADE M-25) COMPRESSIVE STRENGTH IN N/MM²

% of glass powder	Compressive strength in N/mm²			Average compressive strength in N/mm²		
	After 7 days	After 14 days	After 28 days	7 days	14 days	28 days
0%	18.72	25.90	28.90	18.44	25.55	28.37
	18.82	26.0	28.80			
	18.92	25.80	28.70			
10 %	19.32	26.40	29.40	20.60	28.53	31.70
	19.12	26.60	29.20			
	19.22	26.20	29.30			
20 %	19.72	26.9	29.80	22.30	30.87	34.30
	19.82	26.9	29.90			
	19.92	26.9	29.70			
30 %	20.22	27.4	30.10	19.734	27.324	30.36
	20.32	27.5	30.20			
	20.12	27.3	30.00			
40 %	19.8	26.95	29.90	17.628	24.408	27.12
	19.7	26.85	29.80			
	19.9	27.05	30.00			

The result of the compressive strength of M-25 grade concrete in cube samples containing 0%, 10%, 20%, 30% and 40% glass powder mixtures is shown in the table and graph following . Table 4.1 shows the values of compressive strength of mixtures of concrete and powdered glass of quality M-25 and it is observed that its values with 0% of powdered glass from 18.44 to 28.37 N / mm², with 10% of 22.30 at 31, 70 N / mm² from 10% to 22.30 at 2 they vary from 34.30 N / mm² to 20%; 19,734 to 30.36 N / mm² with 30% and 17,628 to 27.12 N / mm² with 40% glass powder. The compressive strength of concrete for 7 days, 14 days, and 28 days initially increases as the percentage of cement replacement with glass powder increases, peaking at around 20%, and then decreasing.

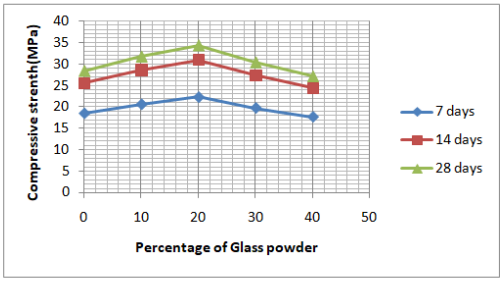

Fig - variation in compressive strength according to % of glass powder (Grade M-25)

Table - RESULT OF BEAM (GRADE M-25) FLEXURAL STRENGTH IN MPa

% of glass powder	FLEXURAL strength(N/mm²)	
	Specimen code	After 28 Days
0%	S1	3.7
10%	S2	4.2
20%	S3	4.9
30%	S4	4.4
40%	S5	3.5

The result of the flexural strength of M-25 class concrete in a cubic sample containing 0%, 10%, 20%, 30% and 40% of glass powder mixtures is shown in the table and graph following . Table 4.4 shows the flexural resistance values of M-25 grade glass and cement powder mixtures and their values are 3.7 N / mm² with 0% glass powder, 4.2 N / mm² with 10% 4.9 N / mm² they vary with 20%; 4.4 N / mm² at 30% and 3.5 N / mm² at 40% of glass powder. The flexural strength of concrete at 28 days initially increases as the percentage of cement replacement with glass powder increases, and the peaks are around 20% and decrease thereafter.

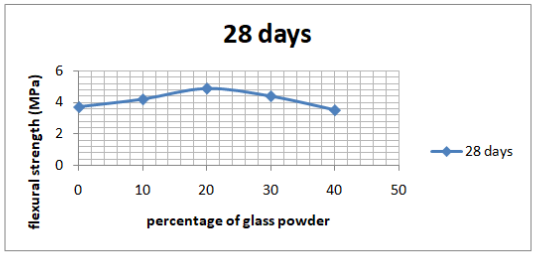

Fig-variation in flexural strength according to % of glass powder (Grade M-25)

TABLE - RESULT OF BEAM (GRADE M-25) SPLIT TENSILE STRENGTH IN MPa

% of glass powder	Split tensile strength(N/mm²)	
	Specimen code	After 28 Days
0%	S1	2.9
10%	S2	3.3
20%	S3	3.9
30%	S4	3.4
40%	S5	2.9

The result of the cracking resistance of M-25 class concrete in a cubic sample containing 0%, 10%, 20%, 30% and 40% glass powder mixtures is shown in the table and graph . Following. Table 4.6 shows the values of cracking resistance of mixtures of concrete and powdered glass of quality M-25 and it is observed that its values of 2.9 N / mm² with 0% of glass powder, 3.3 N / mm² with 10% 3 , 9 N / mm² vary with 20%; 3.4 N / mm² at 30% and 2.9 N / mm² at 40% of glass powder. . The 28-day crack resistance of concrete initially increases as the percentage of cement replacement with glass powder increases and the peak reaches approximately 20%, then decreases.

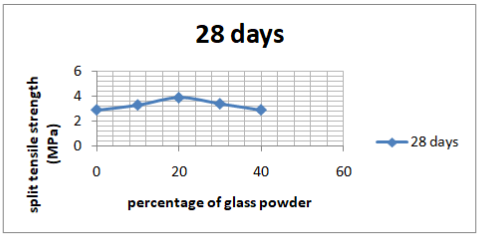

Fig- variation in split tensile strength according to % of glass powder (Grade M-25)

TABLE - SLUMP TEST (GRADE M -25) IN MM

% of glass powder	Slump in mm
0%	100
10%	88
20%	80
30%	72
40%	65

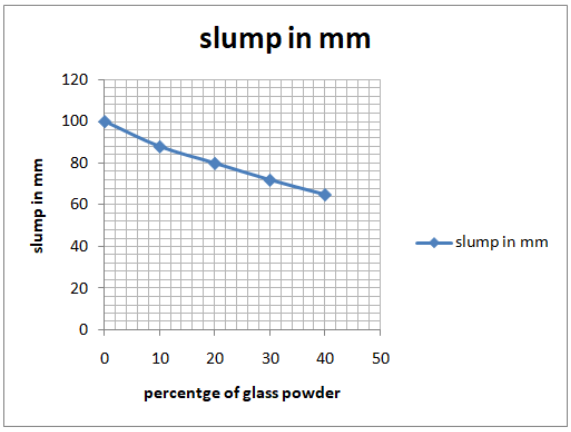

Fig- variation in slump according to % of glass powder (Grade M-25)

Figure and Table show that the workability of concrete decreases with increasing percentage of cement substitute with glass powder. The unit weight of concrete is seen to decrease monotonically as the ratio of cement replacement to glass powder increases, the lower specific gravity value of waste glass = 2.58 compared to that of cement = 3.15.

Analysis of Cost for using the Industrial WASTE GLASS powder as replacement of CEMENT:
Construction Location: Patna, Bihar

Glass Powder source: Patliputra Industrial Area at Cost of 2 Rs per kg
Cement Source: Various Distributors in nearby area at cost of 6 Rs per kg
Fine aggregate & coarse aggregate cost @ 1 Rs per kg

Table 4.13 COST ANALYSIS FOR PER CUBIC METER OF CONCRETE:

S.No.	Grade concrete	Replacement by 20% weight of cement(weight of cement)kg	Weight of glass used kg	Plain concrete cost/m^3 Rs	Glass powder concrete cost Rs	Save per m^3	% Saving
1	M-25	256 kg	53 kg	3600	3252	348	9.66 %
2	M-30	304 kg	61 kg	3723	3298	425	11.41%
3	M-35	320 kg	64kg	3880	3340	560	13.91 %

VI. CONCLUSION

The following conclusions are drawn based on the previous study:

- The compressive strength of concrete for 7 days, 14 days and 28 days increases initially as the percentage of cement replaced by glass powder increases and reaches a peak of around 20% and thereafter.
- The flexural strength of concrete initially increases as the percentage of cement replacement with glass powder increases, reaching a peak of around 20% and then decreasing.
- The tensile strength of concrete initially increases as the rate of glass powder cement replacement increases, reaching a peak of around 20% and then decreasing.
- Cement waste decreases monotonously as a replacement
- Increase the percentage of cement with glass powder. The workability decreases if the cement is partially replaced by glass powder.
- The present study shows that there is great potential to use powdered glass concrete as a partial substitute for cement. About 20% of cement can be replaced with glass powder without compromising compressive strength.
- The use of powdered glass waste in the local Patna construction area greatly reduces the cost of pouring 1 m3 for M-25, M-30 and M-35 concrete and saves around Rs 348, 425 and 560.

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