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CODEN: IAASCA **ORIGINAL ARTICLE**

A Critical Study of Effectiveness Of Waste Glass Powder In Concrete

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ABSTRACT
This experiment shown the property of concrete containing waste glass powder as a cement replacement material.The use of wastes or by-products in concrete production has advantages for improving some or all of the concrete properties.The economic incentives, and environmental benefits in terms reduced carbon footprint are also the reason for using wastes in concrete. These material can widely use to reduce the cost of construction as well as improved the strength of construction.This work is examines the effect of using of waste glass powder as a cement and sand replacement material into concrete.. Glass constitutes about 5% of the municipal solid waste stream, but only a small percentage of it is recycled. Therefore, tapping its potential as a cement replacement material is imperative. Waste glass contains about 72.5%, Sio_2, when it is ground to the fineness of around 600um, Sio_2 in it reacts with alkalis in cement to form cementitious products. Such products help contribute to strength and durability in concrete. Glass powder was partially replaced as 5%, 10%, 15%, 20%, 25% with sand and tested for it compressive strength, slump, workability and alkalis testand compared with those of conventional concrete, from the result obtained it is foundthatreplacementof 20% glass canbeMore beneficial and capable to increased strength up to 45% (for M20).
Keywords: Waste Glass, Concrete

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INTRODUCTION

Concrete is the most important substitute in building material. Strength, cost and durability of building is highly depended upon it. The main aim of the project is to reduce the amount of natural aggregate and mineral for concrete making, minimize the emission of $co_2$and reduce the total construction cost.Ithas been estimated that several million tons of waste glass is generated annually worldwide due to the rapid growth of the population, improvement in the standard of living, industrialization and urbanization.The term glass comprises several chemicals verities including alkali-silicate glass, boro silicate glass, and ternary soda-lime silicate glass. Glass is an inert material which could be use and recycle many times without changing its chemical property. The use of wastes or by-product in concrete production has advantages for improving some or all of the concrete properties. Waste glass contains about 72.5%, sio_2. When it was grounded to the fineness of around 600 µm (0.023 in.) sio_2 in it reacts with alkalis in cement (pozzolanic reaction) to form cementitious products. Such product help contribute to strength and durability in concrete.The test showed that the specimen containing 20% of glass powder as the cement replacement and the specimen containing 25% of glass powder as the fine aggregate (sand) replacement had the best strength and sulphate resistance (reference ICJ).

EXPERIMENTAL INVESTIGATION

Experimentedwereconducted on concrete prepare by partial replacement ofcement andsand by waste glass powder of particle size 150 µm (for cement) and 600 µm (for sand). Cement and sand are replaced by 5%, 10%, 15%, 20%, 25% of waste glass powder and mix design was prepared and compressive strength test, alkaline test, slump test, workability and cost is calculated.

Material used

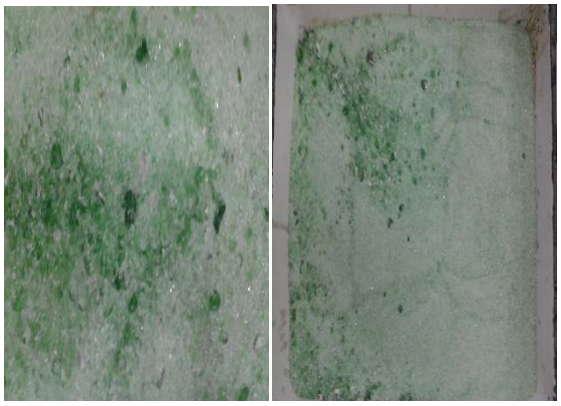
a) **Cement and water: -**Ordinary Portland cement of grade 43 is used to prepare the mix design of different grade. Water – cement ratio is 0.42 for this mix design.

b) **Fine and courseaggregate: -**clean river sand of maximum size 4.75 mm are used as a fine aggregate and angular aggregate of size between 4.75 mm to 20 mm are used as a course aggregate.

c) Waste glass powder: -Locally available glass is collected and converted into powder form. Glass powder is separated into two categories on the bases of its particles size –

Category	Particles size
I	Less than 90 µm
II	Between 90 –600 µm

Course Aggregate **Fine Aggregate**



Glass powder (600µm) **Glass powder (90µm)**

Chemical and physical property and chemical composition of cement, sand and glass powder are presented in table no. 1, 2& 3 –

TABLE NO 1:Physical & chemical properties of cement, sand and glass powder

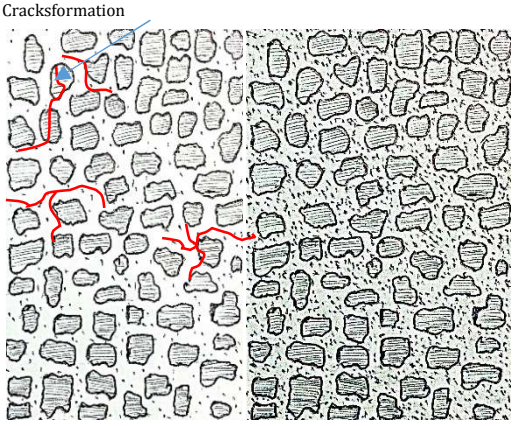
S. No.	Properties	Specific gravity	PH	color
1	Cement	3.15	9	Gray
2	Sand	2.65	7.0	Yellow
3	Aggregate	2.9	5.4	White
4	Glass	2.6	10.25	Grayish white

TABLE NO 2: Chemical composition of cement and glass powder

S. No.	Chemical Properties	% by mass	
		Cement	Glass
1	Sio_2	20.20	67.33
2	Al_2O_3	4.70	2.62
3	Fe_2O_3	3.00	1.42
4	Tio_2	------	0.157

5	CaO	61.90	12.45
6	MgO	2.60	2.73
7	Na_2O	0.19	12.05
8	K_2O	0.82	0.638
9	ZrO_2	------	0.019
10	ZnO	------	0.008
11	SrO	------	0.016
12	P_2O_5	------	0.051
13	NiO	------	0.014
14	CuO	------	0.009
15	Cr_2O_5	------	0.022
16	So_3	3.90	------

Research significance and mechanism: - Recent research finding have shown that concrete made with recycle glass aggregate have shown better long term strength and better thermal property of the glass aggregate. When concrete contain waste glass powder it gives high percentage of C_3S, low C_3A, C_4A_4, C_3S/C_2S content which result in production and offer greater resistance to the sulphate attack. Glass powder content SiO_2 when it reacts with alkalin in cement (pozzolanic reaction) to form cementation product such product helps contribute to strength and durability in concrete. Glass particle less than 90µm reacts and form cementation product and unreacted particles work as a filler and reduce the porosity of structure and make is dense thusthe main reason to developed extra strength in glass structure.



Cement structure (low dance) **Cement+Glass structure (high dance)**

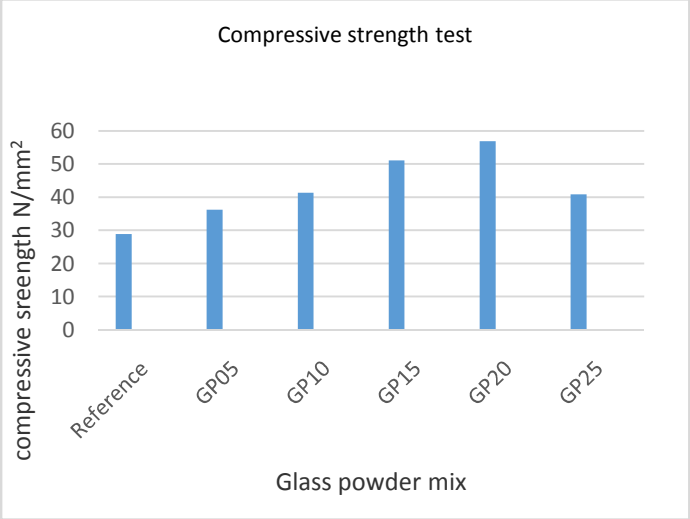
Mix design and Experimental work:-the concrete mix design was proposed according to Indian standard for control concrete. The grad was M20 and the ratio of cement, sand and aggregate is 1:1.5:3 and water – cement ratio is 0.43 which is constant for all mix design. Natural course and fine aggregate were use. The replacement level of sand to glass powder were used in the term of 5%, 10%, 15% and 20% in concrete.

Compressive strength test:-

Cubes which prepared with different replacement of glass powder is tested after 28 days of curing for compressive strength value.For each mix three different cubes are prepare and average final value of compressive strength is calculated which is shown in table.

TABLE NO 3: Compressive strength value for different mix

Mix	GP, %	Compressive strength	Percentage change in compressive strength
Reference	00%	28.88	____
GP05	05%	36.20	+20.22 %
GP10	10%	41.33	+30.12 %
GP15	15%	51.11	+43.39 %
GP20	20%	56.88	+49.22 %
GP25	25%	40.88	+29.35%

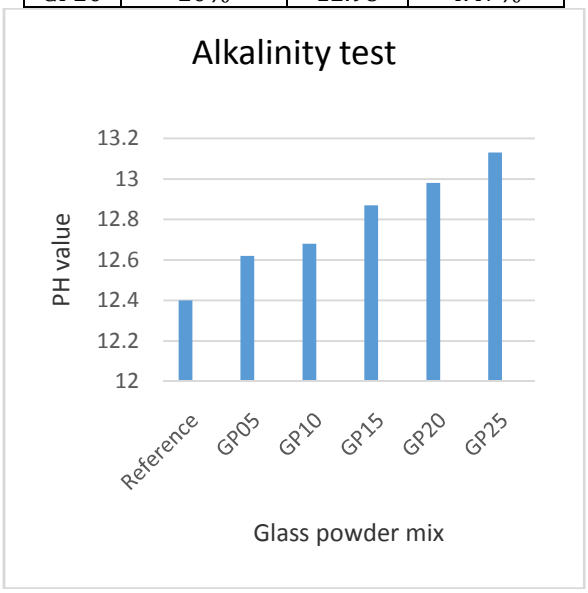


Alkalinity test:-

After 28 days specimen were taken out from curing tank and dried in oven at 105º C for 24 hour and after that cooled to room temperature, these dry specimens were broken and separated the mortar from concrete. This mortar is converted into powdered form and allow to passage from 150 µm sieve. 10 gm of powder mortar is taken and diluted into 50 ml distilled water and completely stirred it. Then the PH meter immersed into each solutionand ph value for different solution is noted.Table 4 shown the result of ph value for different grade of solution.

TABLE NO 4: Alkalinity test value for glass contain concrete

Mix	GP, %	PH value	Percentage change with respect to reference
Refce.	00%	12.40	---
GP05	05%	12.63	0.79%
GP10	10%	12.68	2.20%
GP15	15%	12.87	3.65%
GP20	20%	12.98	4.47%

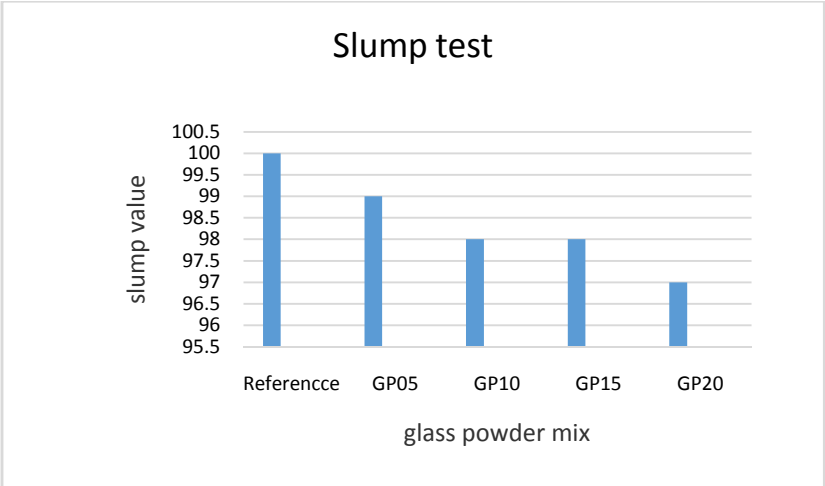


Workability test: -

Table 5 shows the results of workability of concrete with sand replacement by glass powder in various percentages ranging from 5% to 20% in increments of 5% (0%, 5%, 10%, 15% and 20%). It seems workability of concrete decreases as the glass content increases.

TABLE NO -5: Overall result of slump of concrete

Mix	GP, %	Slump (mm)	Percentage change with respect to reference mix
Refce	00%	100	---
GP05	05%	99	-1%
GP10	10%	98	-2%
GP15	15%	98	-2%
GP20	20%	97	-3%

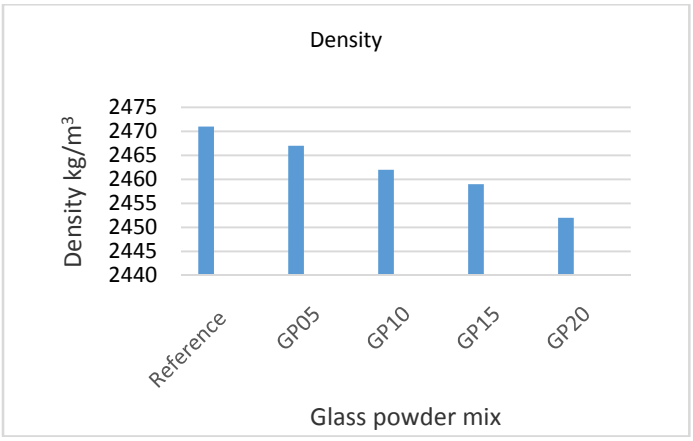


Density

Table 6 shows the results of density of concrete at 28 days with sand replacement by glass powder in various percentages. It seems unit weight of concrete increases as the glass content increases.

TABLE NO- 6: Overall value of density for different mix

Mix	GP, %	Density (at 28 Day in kg/m3)	Percentage change in density with respect to reference mix
Refce	00%	2471	----------
GP05	05%	2467	0.16%
GP10	10%	2462	0.36%
GP15	15%	2459	0.48%
GP20	20%	2452	0.76%



RESULT AND DISCUSSION

Compressive strength of reference mix is observed 28 mpa and further mixing of glass powder it would increase at 20% replacement of glass powder it gain maximum value which is observed 56 mpa(49% higher as compare to reference mix), further mixing of glass powder compressive strength is reduce(according to ICJ). The PH value observed from alkalinity test showed that the specimen tested found to be more alkaline and hence more resistance against corrosion and protect the steel bars in underwaterconstruction. Unit weight of concrete is observed to calculate density of concrete and it shown that unit weight of concrete is decrease to increment of glass powder in concrete.

CONCLUSION

Conventional M20 shown the compresive strength 28.88 N/mm^2. Replacement of glass powder with 5%, 10%, 15%, and 20% of sand-

- Decrease the value of construction cost by 20% to 31% in the compare of conventional mix of M25, M30 and M35.
- Increase the value of compressive strengtha by 20.22%, 30.12%, 43.39%, 49.22% respectively.
- Decrease the value of unit weight of concrete by 0.16%, 0.36%, 0.48%, 0.76% respectively.
- Increase the alkalinity property of concrete by 0.79%, 2.20%, 3.65%, 4.47% respectively.
- Decrease in the value of slump.
- Decrease the low value of So_4 when it was subjected to $MgSo_4$ solution (ref. ICJ).

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