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Experimental Analysis of Glass Powder as partial replacement of Cement in Concrete with addition of Admixture

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1. INTRODUCTION

To bring down the measure of glass being disposed of and in addition to discover use to the non-reused glass in new applications the expert group is being pressurized by the natural associations as a significant part of the glass created on the planet is disposed of, arrive filled or stored. Glass is a broadly utilized item all through the world; it is flexible, tough and dependable. The employments of glass runs radically, it is utilized by the electronic business really taking shape of PC and TV screens; by the development business in the state of windows and mirrors; by the therapeutic business really taking shape of medicinal gear and in particular by the sustenance and refreshment industry to make a large number of bundling bottles. Thus, industry has made of glass an attractive decent, as glass generation continues expanding all through the United States and the world.

2. OBJECTIVE OF THIS STUDY

- To mostly supplant bond content in concrete as it straightforwardly impacts economy in development.
- To give a natural neighborly transfer of waste glass.
- To think about its commitment in quality improvement and toughness of cement.
- To upgrade the utilization of such nonconventional materials which are normally of nearby or local birthplace.
- To give important information to cement and piece producers on the appropriateness of glass powder in concrete

3. LITERATURE REVIEW

(Bajad M.N. et al [2011]) [1] studied the strength properties containing glass when subjected to sulphate attack and showed that the peak compressive strength is achieved at 20% replacement of cement by waste glass powder both when concrete is not subjected to sulphate attack and when concrete subjected to sulphate attack and the increment continues upto 25% replacement beyond which it decreases.

(**Chikhalikar S.M. and Tande S.N. [2012]**) [2] investigated on the characteristics properties of fibre reinforced concrete containing waste glass as pozzolona and showed that the compressive strength increase is achieved upto 30% as compared to control mix, but the peak % increase is at 20% replacement**.**

(**Dali J.S. and Tande S.N. [2012]**) [3] studied the properties of concrete containing mineral admixtures, when it is subjected to alternative wetting and drying and high temperature and resulted that the compressive strength increment is upto 25% replacement of cement by waste glass powder, but the peak % increment is at 20% replacement in both the cases, i.e. concrete without subjecting to alternate wetting and drying, and concrete subjected to alternate wetting and drying**.**

(**Gopalakrishnan Ramasamy and Govindaraja Dharshnamoorthy [2011]**)[4] carried out tests on waste glass admixture cement and resulted that the compressive strength result is a confirmation of retarding effect of WG in the hydration of Portland cement.

(**Jangid Jitendra B. and Saoji A.C. [2012]**) [5] concluded that the upto 40% replacement of cement, compressive strength increase upto 20% and cement replaced beyond which decreases compressive strength.

(**Khmiri A. et al [2012]**) [6] proposed his experimental work containing clear and coloured glass of different sizes (100 and 80 µm, 80 and 40 µm and lower than 40 µm) and came to a result that compressive strength index of ground waste glass reaches more than 82% for sizes lower than 40 µm.

4. TESTING OF MATERIALS USED

4.1 **Super Plasticizer:** Super plasticizer MasterGlenium 8233 was used and was obtained from obtained from e-commerce website Indiamart. The properties are given below.

Aspect	Reddish brown liquid
Relative Density	1.08 ±0.02 at 25 °C
Ph	≥6 at 25 °C
Chloride ion content	0.2%

Characteristic Properties of Super Plasticizer

4.2 Waste Glass Powder: Materials such as silica, soda ash, and $CaCO_3$ all together making a mixture are melted at high temperature followed by cooling during which solidification occurs without crystallization and a transparent material is obtained named as "glass". Glass has an important role in our day to day life and is widely used in our lives through manufactured products such as, glassware, sheet glass, bottles and vacuum tubing. The amount of waste glass has gradually increased over the recent years due to an ever-growing use of glass products. The waste glass powder (WGP) used in our experimental study was procured from a chemical dealer at New- Delhi. The typical properties of glass powder have been reported by Jangid Jitendra B., Prof Saoji.

Product	Soda-lime glass
SiO_2	72%
Al_2O_3	2%
Cao	12%
MgO	1%
Na_2O	13%

Composition of Glass Powder

Characteristics	**Values**
Color	Grayish white
Moisture content (wet/dry) %	23.35/ 1.59
Specific Gravity	2.6
Fineness passing 90 µm	99

Physical Properties of Waste Glass Powder

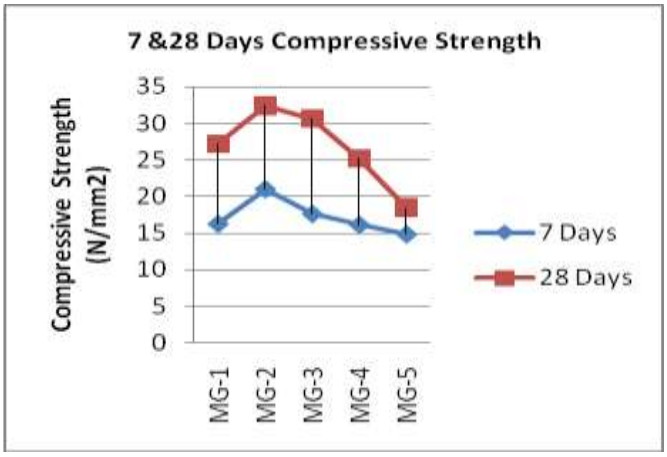
5. RESULT ANAYLSIS

Compressive Strength test:

An increasing trend in strength was observed with increasing replacement of cement with glass powder up to 20%. Beyond 20%, the compressive strength started to reduced. The increase in the strength upto 20% replacement of cement with glass powder may be due to the pozzolanic reaction of glass powder. However, beyond 20%, the dilution effect takes place over and the strength starts to drop.

Comparison of Compressive Strength after 7 days and 28 days

S .No	**Mix design**	**Avg. comp. st.**	**% inc. And dec. Avg. comp. st.**	**Avg. Comp. st.**	**% inc. And dec. Avg. comp. st.**
1	**MG-1**	16.26	_	27.22	_
2	**MG-2**	20.98	29.0%	32.42	29.0%
3	**MG-3**	17.62	8.36%	30.70	12.7%
4	**MG-4**	16.13	-0.8%	25.17	-7.5%
5	**MG-5**	14.85	-8.7%	18.42	-32.3%

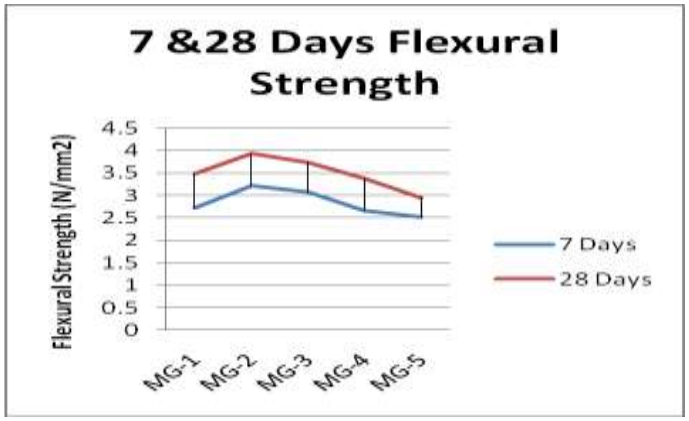


Compressive Strength Curve at 7 and 28 Days

Flexural Strength test:

S .No	Mix design	Avg. comp. st.	% inc. And dec. Avg. flex. st.	Avg. Comp. st.	% inc. And dec. Avg. flex. st.
1	**MG-1**	2.724	_	3.492	_
2	**MG-2**	3.215	18.0%	3.930	12.5%
3	**MG-3**	3.061	12.3%	3.733	6.9%
4	**MG-4**	2,666	-2.1%	3.379	-3.2%
5	**MG-5**	2.512	-7.8%	2.960	-15.2%

Comparison of Flexural Strength after 7 Days and 28 days

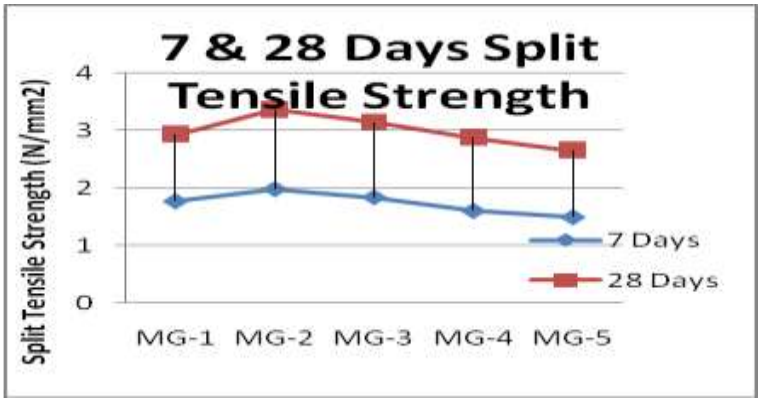


Flexural Strength Curve at 7 and 28 Days

Split Tensile Test:

S .No	Mix design	Avg. split tensile st.	% inc. and dec. Avg. split tensile st.	Avg. split tensile st. N/mm^2	% inc. and dec. Avg. split tensile st.
1	**MG-1**	1.775	_	2.928	_
2	**MG-2**	1.985	11.8%	3.360	14.7%
3	**MG-3**	1.844	3.9%	3.142	7.3%
4	**MG-4**	1.609	-9.3%	2.872	-1.9%
5	**MG-5**	1.497	-15.6%	2.652	-9.4%

Comparison of Split Tensile Strength after 7 Days

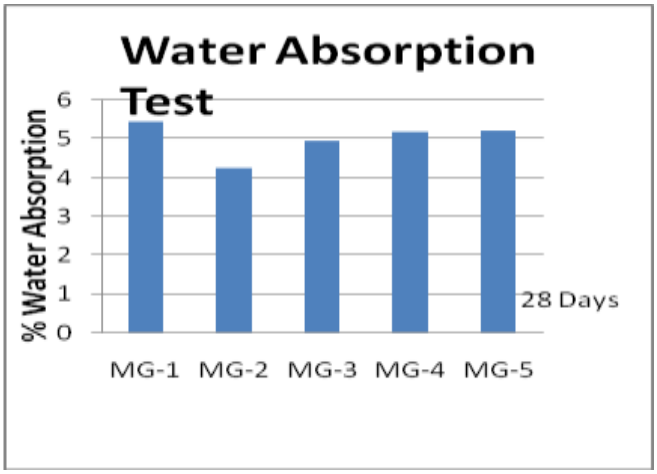


Split Tensile Strength Curve at 7 and 28 Days

Water Absorption Test:

S .No	Mix design	Avg. water absorption %	% inc. and dec. Avg. water absorption
1	**MG-1**	5.43	_
2	**MG-2**	4.23	-22%
3	**MG-3**	4.95	-8.8%
4	**MG-4**	5.19	-4.42%
5	**MG-5**	5.21	-4.0%

Comparison of Water Absorption after 28 Days



6. CONCLUSIONS

On the basis of experiments performed, following conclusions can be drawn:-

1. Use of waste glass in concrete can prove to be economical as it was non useful waste and free of cost.
2. Use of waste glass in concrete will eradicate the disposal problem of waste glass and prove to be environment friendly thus paving way for greener concrete.
3. Use of waste glass in concrete will preserve natural resources particularly river sand and thus make concrete construction industry sustainable

6.1 Slump Test

1. Workability of concrete mix increases with increase in waste glass content.
2. Slump of concrete mix increases from 52mm for the reference mix to 112mm for the mix containing 35% waste glass powder.

6.2 Compaction Factor Test

1. The compaction factor increased as the percentage of glass powder increases and increased in comparison with the conventional concrete.

6.3 Compressive Strength Test

1. The amount of incorporated waste glass largely influenced properties of the cement mortar. It was evident from these results that ground glass could enhance the properties of the final concrete product if used at the right level of replacement.
2. Cement can be replaced by waste glass powder up to 20% by weight showing increase in compressive strength at 28 days beyond which strength decreases.
3. At 20% and 25% replacement of cement by waste glass powder, the % increase in compressive strength at 7 days is about 29% and 8% respectively and the % increase at 28 days is about 19% and 12% respectively.
4. At 30% and 35% replacement, at 7 days the % decrease in the strength is measured to be 12% and 29% at respectively,and for 28 days decrease in the strength is measured to be 7% and 32% respectively

6.4 Flexural Strength Test

1. Flexural strength increases with increase in waste glass powder up to 20% as compared to conventional mix and then starts decreasing with further increase in WGP.
2. At 20% and 25% replacement, the percentage increase in flexural strength is measured to be 18% and 12% at the age of 7 days and 15% and 7% at the age of 28 days respectively.
3. At 30% and 35% replacement, the percentage decrease in flexural strength is measured to be 2% and 8% at the age of 7 days and 15% and 3% at the age of 28 days.

6.5 Split Tensile Strength

1. Splitting tensile strength increases at 20% of replacement of cement by waste glass powder as compared to conventional mix and then decreases with increase in waste glass content.
2. At 20% and 25% replacement, the percentage increase in split tensile strength is measured to be 12% and 4% at the age of 7 days and 15% and 7% at the age of 28 days respectively.
3. At 30% and 35% replacement, the percentage decrease in split tensile strength is measured to be 9% and 15% at the age of 7 days and 2% and 9% at the age of 28 days.

6.7 Water Absorption Test

1. With increase in waste glass content, durability of concrete increases.
2. The percentage water reduction at 20% is considered to be optimal as at this % of replacement, there is maximum decrease in absorption of water as compared to reference mix, beyond this replacement water absorption increases but is less than the reference mix.
3. The percentage decrease is about 22% for mix containing 20% glass powder, 9% for mix containing 25% glass powder, 4.42% for mix containing 30% glass powder and 4.0% for mix containing 35% glass powder replacement as compared to reference mix.

7. FUTURE SCOPE OF THE STUDY

1. From this research, to extend and to explore the usage of waste glass powder in concrete, there are few recommendations to improve:-
2. Add chemical activator into waste glass powder concrete mix for determining the compatibility by observing the compressive strength of the concrete.
3. ii. Combined replacement of cement and sand can also be the topic of interest.
4. iii. Utilisation of WGP can be done in Self Compacting Concrete (SCC).
5. iv. Higher grades of concrete can be worked upon using WGP as cement replacement.
6. v. Higher percentage replacement levels of WGP can be accounted.

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