

EXPERIMENTAL STUDY ON PHYSICAL PROPERTIES OF CEMENT WHEN PARTIALLY REPLACED WITH GLASS POWDER & GROUND GRANULATED BLAST FURNACE SLAG

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ABSTRACT

Cement is first need in civil engineering to make bond in the structural materials. The continue production of cement effect on the natural resources so the time to utilize the industrial waste in production of cement to save the natural resources as well as reduce the solid waste from ecosystem. The demand of cement is increased with the incensement of industries and real estate. In this paper represents the alternate material which is partial replaced with the cement to save the natural resources and also make same strength to structure. In this study used the waste glass powder and ground granulated blast furnace slag with 10 to 40 % variable proportions partially replaced with the cement and examine the effect on physical properties of cement. In the experimental work found that the 20 % glass powder and 30% ground granulated blast furnace slag provide approximately same strength to the constructional material as compared to 100 % cement contents.

Keywords: glass powder, cement, ground granulated blast furnace slag, consistency, fineness.

1. INTRODUCTION

Concrete is widely used material in the construction industry and cement is the main ingredients of concrete which work to bind the all ingredients in the concrete. [1] In the production of cement a lot of CO₂ is generated and which is directly effect on the ozone layer. The continue production of cement is effect the environment and also on the natural resources. Environmental problems are playing a significant role in the maintainable development of the cement and concrete industry. [2] So for the environmental issues time to use the alternate material which is partially replace with the cement. The recycling of every ton of glass keeps over one ton of natural resources, and recycling of each six tons of vessel glass results in the reduction of one tone of CO₂ emission. [3] The waste glass bottles and ground granulated blast furnace slag are type of the solid waste. The solid waste disposal is harder than the liquid waste and continue enhancement in the solid waste creating problems in the ecosystem. In present time to demand of ecosystem is utilizing the solid waste in construction industry and make green concrete. [4] The presence of the Pozzolanic Glass Powder in concrete could also intensify the plastic properties of concrete. [5] After discussing the all above parameters to decide the waste glass powder and ground granulated blast furnace slag i.e. (Industrial waste) used in the study and conduct different type of test on to check the effect of waste material when partially replaced with the cement content. The both the material having microscopic structure which help in easily mixed with the cement and also by the use of waste material decreasing the cost of construction.

2. MATERIALS AND ITS PROPERTIES

A. CEMENT- In this experimental study Ultratech 43 grade OPC cement was used and all of the cement testing as per Indian Standard 1489 part 1 code book. [6]

B. WASTE GLASS POWDER- The scrapyard bottles collected from nearest supplier and make powder in the los Angles Machine.

C. GROUND GRANULATED BLAST FURNACE SLAG- For the experimental study ground granulated blast furnace slag waste collected from Jindal steel industry Hisar Haryana.

D. WATER- The drinking water used in the mixing of cement.

2.1 PROPERTIES OF THE MATERIALS

Table 1 Physical Properties of the material

Sr. No.	Test Performed	Laboratory Values	Material
1	Consistency	32%	Cement
2	Initial setting time	43 minutes	Cement
3	Final setting time	362 minutes	Cement
4	Fineness	9%	Cement
5	Specific gravity	3.0	Cement

2.2 CHEMICAL COMPOSITION OF MATERIAL

Table 2 Chemical Properties of the material

Sr. No.	Properties	Cement value	Glass Powder value	ground granulated blast furnace Value
1	SiO ₂	21.8	59	27-38
2	AL ₂ O ₃	4.8	12.1	7-12
3	Fe ₂ O ₃	3.8	.2	0.2-1.6
4	CaO	63.3	22.6	34-43
5	MgO	2.5	3.4	7-15
6	NA ₂ O	0.21	0.9	0.15-0.76

3. PREPARATION OF SAMPLES AND TEST PERFORMED

For the experimental study the variable proportion are shows in the table number 3 and make 3 samples of each group to investigate the effect on physical properties of cement.

Table 3: The composition of GP & GGBS and Cement

Mix Designation	Cement (%)	Waste Glass Powder (GP) (%)	Ground Granulated blast furnace Slag (GGBS) (%)
M25			
CM	100	0	0
GG1	50	40	10
GG2	50	30	20
GG3	50	20	30
GG4	50	10	40

3.1 TEST PERFORMED

- **Consistency Test-** To check the consistency of cement used vicat apparatus and test conduct according to IS code 4031 part 4. [7]
- **Initial and Final Setting Time Test-** The initial and final setting test performed as per guidelines of Indian Standard code book 4031 part 5.
- **Fineness Test-** The fineness test determined by the sieve analysis and test conduct as per Indian standard 4031 part 1 code book.

4. RESULTS AND DISCUSSION

A. CONSISTENCY TEST-

The untreated cement sample consistency was 32 % examined in the laboratory and when partially replaced with glass powder and ground granulated blast furnace slag found that firstly decreased but on the proportions of GP 20% and GGBS 30% was same consistency as compared to untreated sample. The similar and increased result was also stated in the previous research articles when partially replaced with the industrial waste. [8]

Table 4 Effect on Consistency Test with partially replaced with GP & GGBS

Mix Designation	Cement (%)	Waste Glass Powder (GP) (%)	Ground Granulated blast furnace Slag (GGBS) (%)	Consistency
M25				
CM	100	0	0	32%
GG1	50	40	10	26%
GG2	50	30	20	28%
GG3	50	20	30	31%
GG4	50	10	40	37%

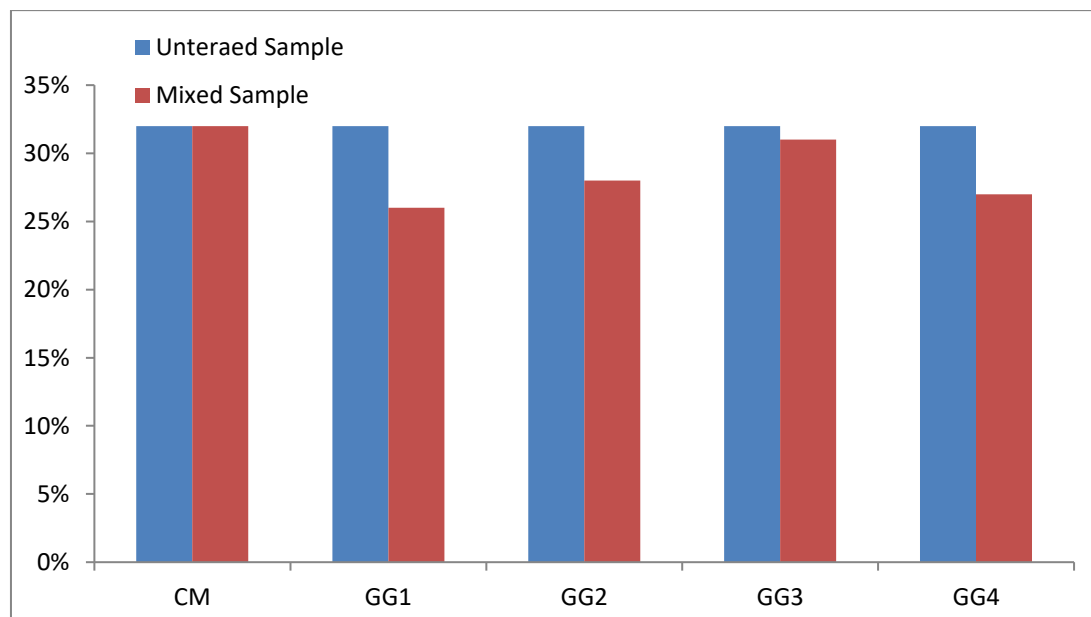


Fig.1 GP, GGBS effect on consistency partially replaced with the cement

B. INITIAL & FINAL SETTING TIME

The initial and final setting time of GG3 sample was approximately equal to the untreated samples and other sample decreased and increased results shows in the table 5. The reason of GG3 sample was GGBS % more than glass powder and fine particles of GGBS. [9]

Table 5 Effect on Initial and final setting time with partially replaced with GP & GGBS

Mix Designation	Cement (%)	Waste Glass Powder (GP) (%)	Ground Granulated blast furnace Slag (GGBS) (%)	Initial Time	Final Time
M25					
CM	100	0	0	43 minute	362 minute
GG1	50	40	10	32 minute	316 minute
GG2	50	30	20	39 minute	336 minute
GG3	50	20	30	42 minute	365 minute
GG4	50	10	40	49 minute	370 minute

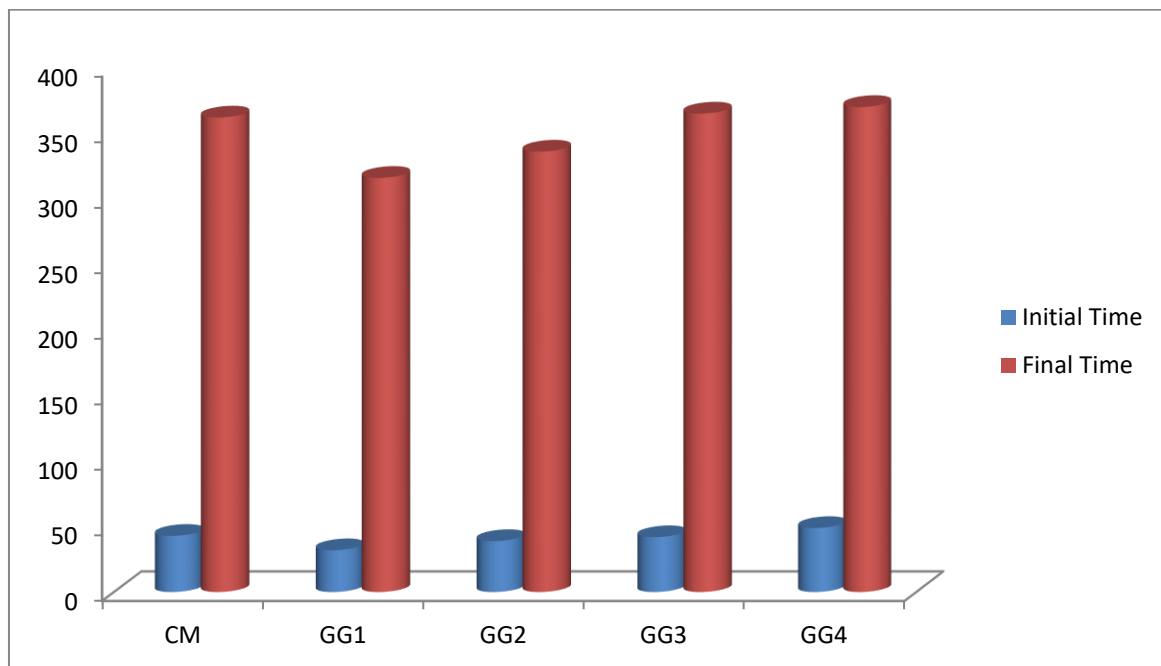


Fig.1 GP, GGBS effect on Initial and Final setting time partially replaced with the cement

C. FINENESS TEST

The fineness result was shows in the table no 6. The more fineness of cement particles are creating problems and produce lot of heat of hydration. [10] In this investigation the GG3 sample results was near about the untreated sample so the use of 20% GP and 30% GGBS was good response to partially replaced with the cement.

Table 6 Effect on cement fineness with partially replaced with GP & GGBS

Mix Designation M25	Cement (%)	Waste Glass Powder (GP) (%)	Ground Granulated blast furnace Slag (GGBS) (%)	Fineness
CM	100	0	0	9%
GG1	50	40	10	11%
GG2	50	30	20	12%
GG3	50	20	30	9%
GG4	50	10	40	6%

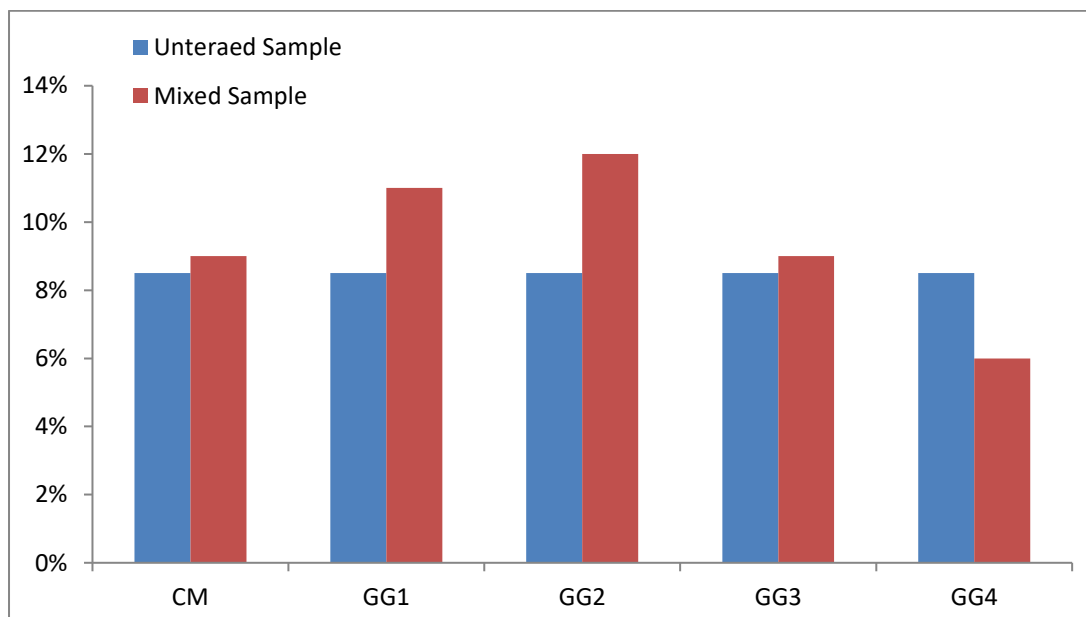


Fig.1 GP, GGBS effect on Fineness test partially replaced with the cement

5. CONCLUSIONS

From the experimental investigation concluded that the use of glass powder and ground granulated blast furnace slag was effective and also found in the study the 20 % Glass powder and 30% ground granulated blast furnace slag partially replaced with the cement results are approximately same as untreated sample. So from the study also a future scope introduces to utilize the waste glass and steel industry solid waste in the production of cement.

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