



A STUDY ON CEMENT REPLACEMENT WITH GLASS POWDER

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ABSTRACT

In daily life we use glass in many forms. Glass is non-biodegradable material so it does not provide an environment friendly solution. Because of this, there is strong need to use waste glasses. The aim of this present work was to use glass powder as a replacement of cement to assess the pozzolanic activity of fine glass powder in concrete. This paper summarizes information on the mechanical & durability properties of cement containing a fine glass powder. It is shown on this paper that concrete mixtures could be proportioned to achieve similar or higher compressive strengths. This investigation looks at the partial replacement of cement by waste glass powder. Glass powder is replaced separately for both 200 microns and 400 microns for every 10%, 20%, 30% and 40%. These results are compared with nominal concrete (0% replacement of glass powder).

Keywords: Glass powder, Fine aggregate, Coarse aggregate, Compressive strength, Split tensile strength Flexural strength.

[1] INTRODUCTION

Concrete is a blend of cement, sand, coarse aggregate and water. Today global warming and environmental devastation have become manifest harms in recent years. Normally glass does not harm the environment in any way but it can harm humans as well as animals, if not dealt carefully and it is less friendly to environment because it is non-biodegradable. The term glass contains several chemical diversities. The introduction of waste glass in cement will increase the alkali content in the cement. As useful recycled materials, glasses and glass powder are mainly

used in fields related to civil engineering, for example, in cement, as pozzolana (supplementary cementations materials), and coarse aggregate. Their recycling ratio is close to 100%, and it is also used in concrete without adverse effects in concrete durability.

Recently, Glasses and its powder have been used as a construction material to decrease environmental problems. The coarse and fine glass aggregates could cause ASR (alkali- silica reaction) in concrete, but the glass powder could suppress their ASR tendency, an effect similar to supplementary cementations materials (SCMs). Therefore, glass is used as a replacement of supplementary cementations materials.

[2] LITERATURE REVIEW

Many works have been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete.

- **M.D.A. Thomas, M.H. Shehata: March 2002 “Cement and Concrete Research”** All have studied the ternary cementations blends of Portland cement, silica fume, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement. Sandor Popovic’s have studied the Portland cement-fly ash - silica fume systems in concrete and concluded several beneficial effects of addition of silica fume to the fly ash cement mortar in terms of strength, workability and ultra-sonic velocity test results. **Jan Bijen** have studied the benefits of slag and fly ash added to concrete made with OPC in terms of alkali-silica reaction, sulphate attack.
- **Lam, L., Wong, Y.L. and Poon, C.S. (1998) “Effects of Fly Ash and Silica Fume on Compressive and Fracture Behavior of Concrete”:** In their studied entitled Effect of fly ash and silica fume on compressive and fracture behaviors of concrete had concluded enhancement in strength properties of concrete by adding different percentage of fly ash and silica fume.
- **Susan Bernal, Ruby De Gutierrez, Silvio Delvasto, Erich Rodriguez (2010):** Carried out Research work in Performance of an alkali-activated slag concrete reinforced with steel fibers. Their conclusion is that the developed AASC present higher compressive strengths than the OPC reference concretes. Splitting tensile strengths increase in both OPCC and the AASC concretes with the incorporation of fibers at 28 curing days.
- **O. Boukendakdji, S. Kenai, E. H. Kadri and F. Rouis, “Effect of Slag on the Rheology of Fresh Self-Compacted Concrete,” Construction and Building Materials,** Carried out Research work in Effect of slag on the rheology of fresh self-compacted concrete. Their conclusion is that slag can produce good self-compacting concrete.

[3] MATERIALS

▪ CEMENT:

Cement is the most demanded construction material which is easily available in the local market all over the world. Good cement not only provides higher strength to mortar or concrete, but it will also help to resist moisture and provides lifelong durability to the structure. Hence it is necessary to understand the properties of cement before you understand the mortar or concrete

or its properties and uses. Properties of cement can be classified in two categories; one is physical properties of cement and second is chemical properties of cement. The properties of cement mostly depend on its composition i.e., raw materials, carefulness while burning and grinding process.

In this work, Ordinary Portland cement (OPC) grade 43 obtained from a single batch was used. The cement satisfies the requirement of IS: 8112-1989. The specific gravity was 3.15.



Fig.1: Cement

▪ **GLASS POWDER:**

Glass sand increased mixture workability, bleeding and segregation, whilst it decreased density. Glass increased chemical and fire resistance. At long terms, it increased carbonation resistance.

Million tons of waste glass is being generated annually all over the world.

Glass powders and glass precursors are used in a wide variety of applications, so they come in a range of particle sizes and particle distributions. The glass powder is obtained by crushing and grinding the glass in a jar mill in the laboratory, and by sieving the ground glass to the desired particle size. Coarser glass particles are used as blasting abrasives; rounded particles as grinding or milling media; and finer particles are used as fillers or modifiers in paints, resins, and adhesives. The specific gravity of glass powder was found to be 2.69.



Fig.2: Waste Glass

[4] METHEDODOLOGY:

The aim of this study is to replace cement by glass powder for utilization the waste glass and to use it in concrete mixtures to achieve similar or higher compressive strengths. In order to achieve the objective of the study a comprehensive laboratory investigation is planned. Some experimental program is taken to investigate the effect of glass powder on engineering properties of concrete mixture are following:

- Compressive Strength Test
- Tensile Strength Test
- Flexural Strength Test

For this investigation a fix mixing proportion of cement and glass powder are taken.

Table 1: Mixing proportion

S.No.	CEMENT	GLASS POWDER	SIZE OF GLASS POWDER
1.	100%	0%	-
2.	90%	10%	200 μ
			400 μ
3.	80%	20%	200 μ
			400 μ
4.	70%	30%	200 μ
			400 μ
5.	60%	40%	200 μ
			400 μ

[5] RESULT & DISCUSSION

In order to study the effect on the engineering properties of glass powder of different size such as 200 μ & 400 μ when mixed in concrete mixture laboratory tests were conducted. Various tests such as Compressive Strength Test, Tensile Strength Test and Flexural Strength Test were conducted and the observed Results were recorded.

A. COMPRESSIVE STRENGTH TEST RESULTS

Table 2: Compressive Strength Test Results

S.No.	CEMENT	GLASS POWDER	SIZE OF GLASS POWDER	COMPRESSIVE STRENGTH (N/mm ²)
1.	100%	0%	-	22.21
2.	90%	10%	200 μ	24.02
			400 μ	23.16
3.	80%	20%	200 μ	26.58
			400 μ	24.85
4.	70%	30%	200 μ	28.82
			400 μ	26.5
5.	60%	40%	200 μ	29.77
			400 μ	25.06

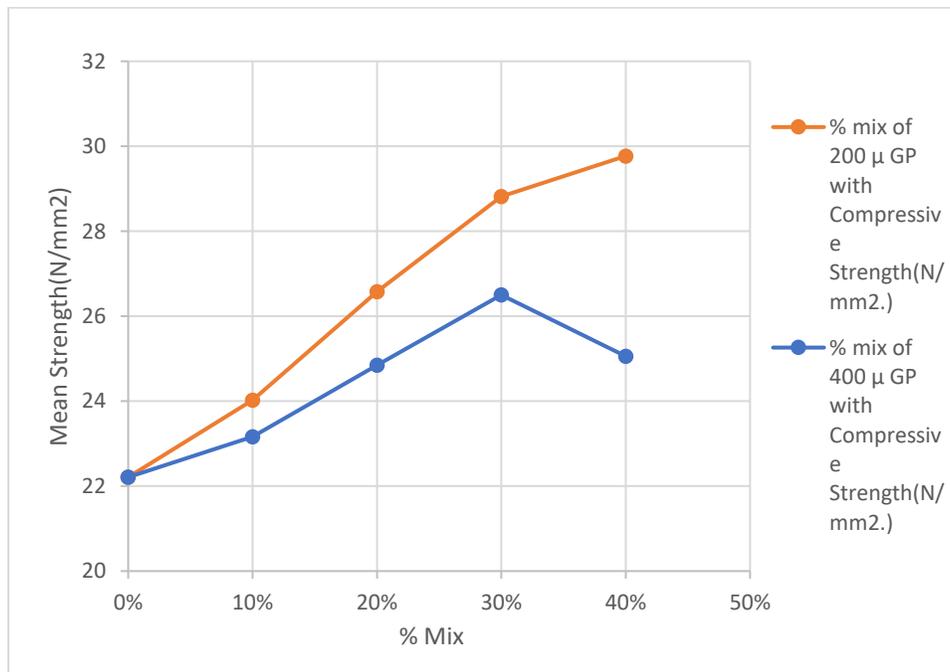


Fig. 3: Compressive strength of concrete mix with glass powder (GP)

From Fig. 3 and Table 2 it is observed that when in mixture cement is replace by glass powder size 200 μ the mean strength are increases as compared to mean strength of without glass powder. It is increases from 22.21 N/mm² to 29.77 N/mm². When in mixture cement is replace by glass powder size 400 μ the mean strength are increases till 30% as compared to mean strength of without glass powder and after that decreases at 40% as compared to 30% mix. It is increases from 22.21 N/mm² to 25.06 N/mm² and decrease from 26.5N/mm² to 25.06N/mm².

B. TENSILE STRENGTH TEST RESULTS

Table 3: Tensile Strength Test Results

S.No.	CEMENT	GLASS POWDER	SIZE OF GLASS POWDER	TENSILE STRENGTH (N/mm ²)
1.	100%	0%	-	1.15
2.	90%	10%	200 μ	1.66
			400 μ	1.54
3.	80%	20%	200 μ	1.82
			400 μ	1.71
4.	70%	30%	200 μ	2.45
			400 μ	2.1
5.	60%	40%	200 μ	2.98
			400 μ	1.82

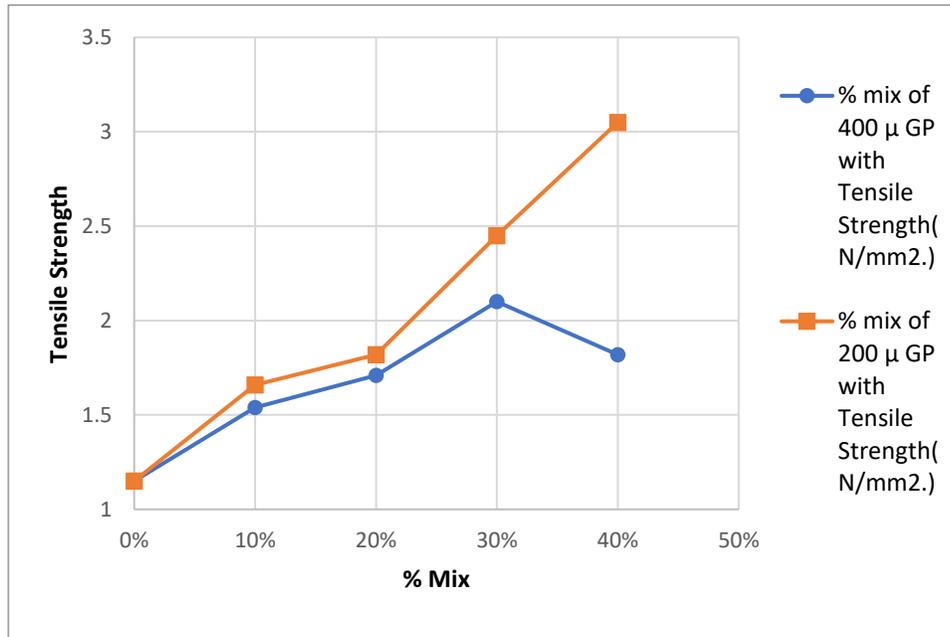


Fig. 4: Tensile Strength of Concrete mix with glass powder (GP)

From Fig. 4 and Table 3 it is observed that when in mixture cement is replace by glass powder size 200μ the mean strength are increases as compared to mean strength of without glass powder. It is increases from 1.15N/mm² to 2.98N/mm². When in mixture cement is replace by glass powder size 400μ the mean strength are increases till 30% as compared to mean strength of without glass powder and after that decreases at 40% as compared to 30% mix. It is increases from 1.15N/mm² to 2.1N/mm² and decrease from 2.1N/mm² to 1.82N/mm².

C. FLEXURAL STRENGTH TEST RESULTS

Table 4: Flexural Strength Test Results

S.No.	CEMENT	GLASS POWDER	SIZE OF GLASS POWDER	FLEXURAL STRENGTH (N/mm ²)
1.	100%	0%	-	6.94
2.	90%	10%	200 μ	6.98
			400 μ	6.95
3.	80%	20%	200 μ	7.02
			400 μ	5.40
4.	70%	30%	200 μ	6.24
			400 μ	6.20

5.	60%	30%	200 μ	5.34
			400 μ	4.85

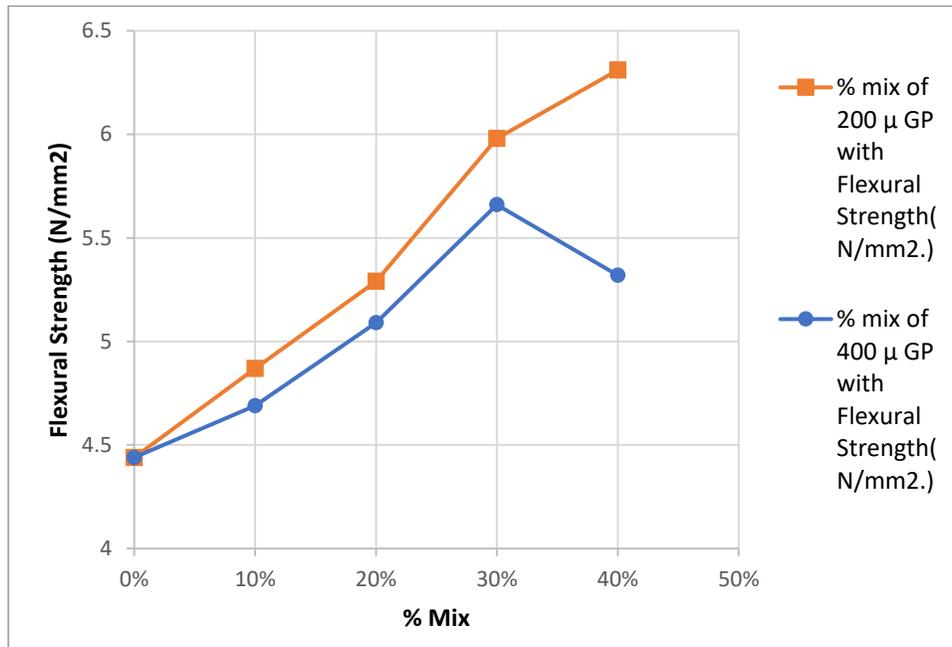


Fig. 5 Flexural Strength of concrete mix with glass powder (GP)

From Fig. 5 and Table 4 it is observed that when in mixture cement is replace by glass powder size 200 μ the mean strength are increases as compared to mean strength of without glass powder. It is increases from 4.44N/mm² to 6.31N/mm². When in mixture cement is replace by glass powder size 400 μ the mean strength are increases till 30% as compared to mean strength of without glass powder and after that decreases at 40% as compared to 30% mix. It is increases from 4.44N/mm² to 5.66N/mm² and decrease from 5.66N/mm² to 5.32N/mm².

[6] CONCLUSION

- 1) Average Compressive strength of the concrete containing Glass powder 200 μ size will increases up to 40% replacement of cement.
- 2) Average Compressive strength of the concrete containing Glass powder 400 μ size will increases till 30% and then decreases at 40%.
- 3) Average Tensile strength of the concrete containing Glass powder 200 μ size will increases up to 40% replacement of cement.
- 4) Average Tensile strength of the concrete containing Glass powder 400 μ size will increases till 30% and then decreases at 40%.

- 5) Average Flexure strength of the concrete containing Glass powder of size 200μ will increase up to 40% replacement of cement.
- 6) Average Flexure strength of the concrete containing Glass powder of size 400μ size will increase till 30% and then decrease at 40%.

So, according to above observations it shows that 40% replacement with 200μ gives good result.

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