

# Experimental Study on Use of Waste Glass Powder as Partial Replacement to Cement & Sand in Concrete

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**ABSTRACT:** Cement is the third most energy intensive material after steel and aluminum produced in tones. Cement industry consumes raw materials rich in silica, alumina, iron and calcium. Therefore this industry has been actively involved in finding ways to use waste products in the manufacturing of cement both as secondary fuel and raw material. Since the demand in the concrete manufacturing is increasing day by day, the utilization of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of the bridge piers, etc. as a common treat. An attempt has been made in using crushed glass as fine aggregate in the replacement of river sand. The crushed glass was also used as coarse aggregate in concrete production but due to its flat and elongated nature which enhances the decrease in the workability and attributed the drop in compressive strength. The present scenario demands identification of substitute materials for the river sand for making concrete. Recently, some attempts have been made to use ground glass as a replacement in concrete. The objective of this project is to present the results of experimental investigations on Physical and Mechanical properties of concrete made with waste Glass powder concrete. Natural fine aggregate, cement is substituted by weight by waste Glass Powder at rates varying from 5,10,15,20 and 25 percentages. Compressive, Tension, are evaluated and compared up to 28 days of ages. Specific Properties of concrete materials and Sheet Glass Powder are also studied.

**KEY WORDS:** Compressive strength, glass powder, concrete, partial replacement

## I.INTRODUCTION

Concrete is an inevitable material in the human being's life, because of its superior characteristics like strength and durability. The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction, the waste glass from in and around the small shops is packed as a waste and disposed as landfill. Glass is an inert material which could be recycled and used many times without changing its chemical property. Besides using waste glass as cullet in glass manufacturing, waste glass is crushed into specified sizes for use as aggregate in various applications such as water filtration, grit plastering, sand cover for sport turf and sand replacement in concrete.

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# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

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## II. RIVIEW OF LITERATURE

**Shayan Ahmad [2002]** concluded that 30% GLP could be incorporated as cement or aggregate replacement in concrete without any long-term detrimental effects. Up to 50% of both fine and coarse aggregate could also be replaced in concrete of 32 MPa strength grade with acceptable strength development properties.

**Her-Yung and Hou Tsung-Chin [2011]** carried out their study of Elevated Temperatures on the Strength Properties of LCD Glass Powder Cement Mortars and concluded that substituting 10% of cement by glass powder would gain a very promising compressive strength of the mortars, particularly when the added glass has a powder fineness  $\geq 4500$  cm<sup>2</sup>/g. In real practices, this amount of glass powder substituent could be suggestively used to replace cement.

**Patil Dhanraj Mohan and Sangle Kehav K. [2012]** studied the test results of waste glass powder particles ranging from size 150 $\mu$ m to 90 $\mu$ m and less than 90 $\mu$ m. He showed that initial strength gain is very less due to addition of GLP on 7th day but it increases on the 28th day. It is found that 20% addition of GLP gives higher strength. And also GLP size less than 90 micron is very effective in enhancement of strength.

**Vandhiyan R. et al [2013]** studied the replacement of cement by waste glass powder and concluded that the considerable increase in the early strength gain particularly at Specimen 15% GP gave a 29% increase in the strength at 7th day more than control specimen. At 28th day this difference in strength reduces to 23 %. The strength increment is optimal at 10% replacement.

**Chi sing lam, chi sun poon and Dixon chan [2007]**. Since the demand in the concrete manufacturing is increasing day by day, the utilization of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of the bridge piers, etc as a common treat. An attempt has been made in using crushed glass as fine aggregate in the replacement of river sand.

**C.Meyer, S.Baxter and W.Jin,[1996, Narayanan Neithalath and Nathan Schwarz,[2009]**. Selected properties of the glass powder modified mixtures are compared with the properties of conventional concrete. The ultimate aim of this work is to ascertain the performance of concretes containing glass powder and compare it with the performance of conventional concretes.

**VeenaV. Bhat, N.Bhavanishankar Rao, [2014]**. Glass is an amorphous material with high silica content(SiO<sub>2</sub>) i.e.72% wate glass when grounded to very fine powder (600 micron) reacts with alkali in cement (Pozzolana reaction) &cementations product that help to contribute to the strength development.

## III.MATERIALS USED

### **Cement, Aggregates:**

Concrete is prepared by mixing various constituents like cement, aggregates, water etc. which are economically available. Ordinary Portland cement of 53 grades conforming to IS 8112 was used throughout the work. The fine aggregate used in this investigation was river sand, whose maximum size is 4.75 mm, conforming to grading zone I. Machine crushed stone angular in shape was used as coarse aggregate. Two size of coarse is used; one 16 mm passing through 12.5 mm retained and other 25 mm passing through 20mmretained. As per IS: 2386 – 1963 recommendations the following properties of coarse aggregates were determined.

### **Glass powder:**

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Waste glass available locally in Pondicherry shops is been collected and made into glass powder. Glass waste is very hard material. Before adding glass powder in the concrete it has to be powdered to desired size. In this studies glass powder ground in ball/ pulverized for a period of 30 to 60 minutes .Resulted in particle sizes less than size 150  $\mu\text{m}$  and sieved in 75  $\mu\text{m}$ . The physical, chemical properties and chemical composition are presented.

**Table No1: Physical & Chemical properties of glass powder**

S.NO	Physical properties of glass powder	
1	Specific gravity	2.6
2	Fineness passing 150 $\mu\text{m}$	99.5
3	Fineness passing 90 $\mu\text{m}$	98
S.NO	Chemical properties of glass powder	
1	PH	10.25
2	Color	Grayish white

**Water:**

The locally available potable water, which is free from concentration of acid and organic substances, is used for mixing the concrete. Permissible limits as per is: 456-2000

**Table No 2: Permissible limits as per is: 456-2000**

S.NO	Parameter	Results	Permissible limits as per is: 456-2000
1	Organic	46 mg/lit	200 mg/lit
2	Inorganic	386 mg/lit	3000 mg/lit
3	Sulphates	40.32 mg/lit	400 mg/lit
4	Chloride	51.77 mg/lit	2000 mg/lit For concrete not containing RCC For RCC 500 mg/lit
5	Suspended matter	183 mg/lit	2000 mg/lit
6	p <sup>H</sup>	8.6	Not less than 6

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Vol. 5, Issue 12, December 2016

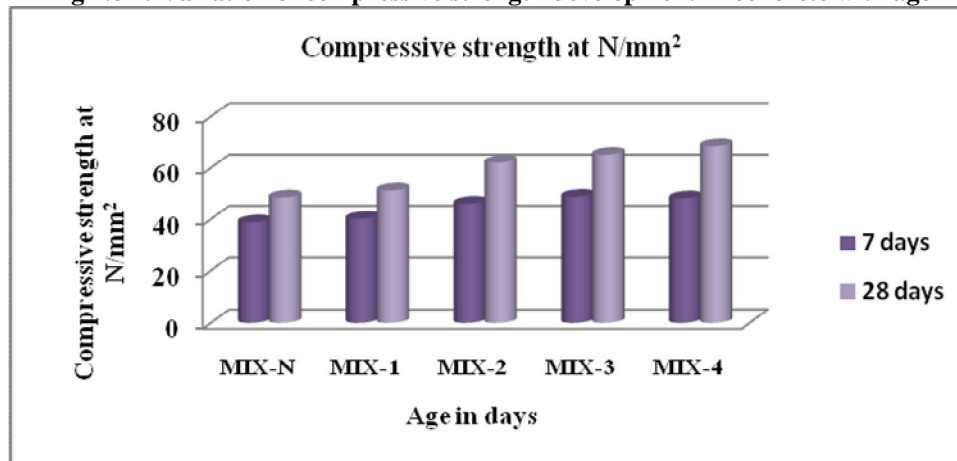
## IV. EXPERIMENTAL WORK

MIX N, MIX-N, MIX-1, MIX-2, MIX-3 & MIX-4 represent concrete containing glass powder less than 90 micron with replacement of cement 0%, 5%, 10%, 15% & 20% respectively. Total 30 cubes were casted 6 cubes for each mixture. Table and fig. shows the compressive strength of sample on the 7 days & 28 days.

**Table No3: Compressive strength of concrete with cement by glass powder**

S.NO	Mix ID	Compressive strength at (N/mm <sup>2</sup> )	
		7 days	28 days
1	MIX-N	38.83	48.62
2	MIX-1	40.22	51.34
3	MIX-2	46.17	62.14
4	MIX-3	48.90	65.30
5	MIX-4	48.26	68.63

**Fig No 1: Variation of compressive strength development in concrete with age**



It is found from above result that addition of GLP in reduces the 7th day strength of all samples. It is seen from above result that GLP is not taking part in earl strength gain in concrete. Also it is observed that mixture containing cement replaced by 20% GLP get higher strength to that of 10% & 20% replacement. The concrete containing glass powder give less strength as compare to that of normal concrete because the complete hydration process not completed at 7 days. After completion of complete hydration process the silica from glass powder reacts with cement hydrates and it gives strength.

Enhancement of strength on addition of GLP is observed in all samples. It shows mixture containing cement replaced by 20% GLP have higher strength to that of 10% & 15% replacement. GLP size less than 90 micron shows higher strength. Finer particle present in the GLP size less than 90 micron react with cement compound to add strength and formation of stoney compound. As stated in mechanism, reaction with GLP enhances strength of concrete. The above figures shows that concrete containing cement replaced by 20% of glass powder gives higher strength than that of normal concrete, 10% & 15% replaced GLP concrete. Because some strength is gained by reaction with cement hydrates and some strength is gain by filling the voids in cement. Also the some strength is gain by glass powder, is seen from the strength of concrete containing less cement as compare to that of design mixture.

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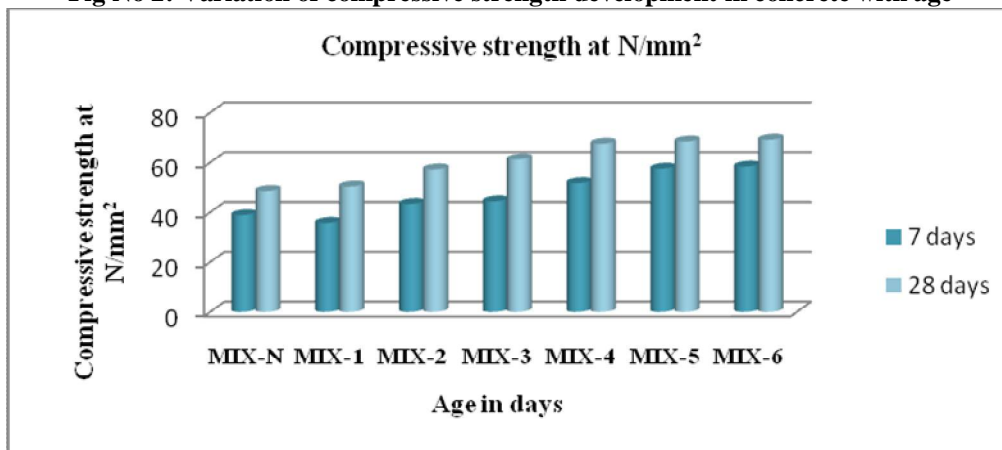
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MIX N, MIX-N, MIX-1, MIX-2, MIX-3, MIX-4, MIX-5 & MIX-6 represent concrete containing glass powder less than 4.75 mm to 150 micron with replacement of sand 0%, 5%, 10%, 15% , 20%, 25% & 30% respectively. Total 42 cubes were casted 6 cubes for each mixture. Table and fig. shows the compressive strength of sample on the 7 days & 28 days.

**Table No 4: Compressive strength of concrete with sand by waste glass powder**

S.NO	Mix ID	Compressive strength at ( N/mm <sup>2</sup> )	
		7 days	28 days
1	MIX-N	38.83	48.62
2	MIX-1	35.65	50.42
3	MIX-2	43.50	57.14
4	MIX-3	44.55	61.30
5	MIX-4	51.75	67.63
6	MIX-5	57.45	68.50
7	MIX-6	58.30	69.25

**Fig No 2: Variation of compressive strength development in concrete with age**



The compressive strength tests and splitting tensile strength tests are presented in TABLE. Compressive strength tests and were carried out at 7 and 28 days. An increase in compressive strength was observed up to 30% replacement of fine aggregates by waste glass and there after decreasing. The maximum compressive strength measured was 25% more than that of reference mix at 28 days corresponding to concrete mix containing 25% waste glass in place of fine aggregates. Compressive strength for concrete mix with 40% waste glass content was found to be less than that of reference mix.

## V. CONCLUSION

On addition of GLP initial the rate of gain of strength is low but at 28th day it meets required design strength. Addition of GLP increases the strength of concrete.

At the level of 20% replacement of cement by glass powder meets maximum strength as compare to that of normal concrete and other percentage of replacement of cement.

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As the size of GLP particle decreases in concrete the strength of concrete increases.

From results it is conclude that particle size less than 90 micron get higher strength than that of particle size ranges from 90 to 150 micron.

The cost of construction involved in the project will reduce and it becomes economical.

Some amount of environmental disturbances is reduced.

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