

Experimental Investigation of Waste Glass Powder as the Partial Replacement of Sand in Making Concrete

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Abstract -- The concrete industry is one of the largest consumers of natural resources due to which sustainability of concrete industry is under threat. The environmental and economics concern is the biggest challenge the concrete industry is facing. This is the prime time to develop alternative sustainable construction materials, to reduce greenhouse gas emissions, save energy, look to renewable energy sources and recycled materials, and reduce waste. The utilization of waste materials (slag, fly ash, plastic and so on) in concrete manufacturing is significant due to its engineering, financial, environmental and ecological benefits. Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. Glass is an ideal material for recycling. The use of recycled glass saves lot of energy and the increasing awareness of glass recycling speeds up focus on the use of waste glass with different forms in various fields. One of its significant contributions is the construction field where the waste glass was reused for concrete production. Several study have shown that waste glass that is crushed and screened is a strong, safe and economical alternative to sand used in concrete. The study indicated that waste glass can effectively be used as fine aggregate replacement without substantial change in strength.

Indexed Terms -- Glass, recycling, concrete, fine aggregate, waste glass.

I. INTRODUCTION

Concrete is a stone like material obtain by designing a carefully proportioned mixer of cement, sand and gravel or other aggregates and water to harden in forms of shape and dimensions of desired structure. Sand is one of the main constituents of concrete; it acts as filler in concrete. Concrete is most widely used man made construction material and its demand is increasing day by day. The interest of the construction community in using waste or recycled materials in concrete is increasing because of the more stress is

given on sustainable construction the waste glass from in and around the small shops is packed as a waste and disposed as landfill.

The using of waste glass as fine aggregate in concrete creates a problem in concrete due to ASR (Alkali Silica Reaction). The reaction between alkalis in Portland cement and silica in aggregates forms silica gel. This gel is prone to swelling. It absorbs water and the volume of the gel increases.

Ground waste glass was used as fine aggregate in concrete and no reaction was detected with fine particle size, thus indicating the feasibility of the waste glass reuse as fine aggregate in concrete. Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down. The amount of waste glass is gradually increased over the years due to an ever-growing use of glass products. Most of the waste glasses have been dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly.

II. OBJECTIVES OF STUDY

1. To study the compressive strength of concrete using glass waste as partial replacement of fine aggregate.
2. To study the workability of concrete using glass waste.

III. MATERIALS USED

1. Cement and Aggregates:

Ordinary Portland cement of 43 grade conforming to IS 8112 [8] was used throughout the work. Fine aggregates used throughout the work comprised of clean river sand with maximum size of 4.75mm conforming to zone II as per IS383-1970 [9] with specific gravity of 2.6. Coarse aggregates used consisted of machine crushed stone angular in shape passing through 20mm IS sieve and retained on 4.75mm IS sieve with specific gravity of 2.7.

2. Glass Powder:

Waste glass was collected from Ichalkarnji Sangli. It was pulverized in Los Angeles abrasion apparatus and then sieved through 1.18mm IS sieve. The specific gravity of waste glass was found to be 2.42.

IV. CASTING AND TESTING

The 150 mm concrete cubes were cast for compressive strength and 150 x150x 700 mm beams were cast for flexural strength according to the mix proportion and by replacing cement with glass powder (GP) in different proportion.

1. Strength Test:

Using a compression testing machine (CTM) of capacity 2000KN in accordance with the provisions of the Indian Standard specification IS: 516-1959, strength of specimens was tested at 7 and 28 days.

2. Workability Test:

Workability is the property of freshly mixed concrete that determines the ease with which it can be properly mixed, placed, consolidated and finished without segregation. Workability depends on water content, aggregate cementations content and age and can be modified by adding chemical admixtures. The workability of fresh concrete was measured by means of the conventional slump test as per IS: 1199-1989. Before the fresh concrete was cast into moulds, the slump value of the fresh concrete was measured using slump cone.

V. TEST RESULTS

Test results are presented in tubular forms and have been discussed under different categories:

1. Compressive Strength:

Cube Designation	Compressive Strength N/mm ²		Glass (%)
	7 Days	28 Days	
M ₂₅	13.33	29.66	0
M ₂₅	20.66	29.33	10
M ₂₅	17.33	30.00	20
M ₂₅	16.33	29.66	30
M ₂₅	16.33	29.33	40
M ₂₅	20.33	24.33	50

2. Workability:

Cube Designation	Percentage replacement of sand by glass powder	Slump (mm)
M ₂₅	0	100
M ₂₅	10	89
M ₂₅	20	81
M ₂₅	30	72
M ₂₅	40	68
M ₂₅	50	57

VI. CONCLUSION

1. The optimum replacement level of waste glass as fine aggregate is 10%.
2. Marginal decrease in strength is observed at 20 to 30% replacement level of waste glass with fine aggregate.
3. While using waste glass as fine aggregate replacement, 28 days strength is found to marginally increase up to 10% replacement level.

REFERENCES

- [1] T. S. Serniabat, M. N. N. Khan, M. F. M. Zain "Use of Waste Glass as Coarse Aggregate in Concrete: A Possibility towards Sustainable Building Construction" International Journal of Civil and Environmental Engineering Vol:8, No:10, 2014

- [2] C Meyer, N Egosi , C Andela - Concrete with Waste Glass as Aggregate, Recycling and Re-use of Glass Cullet”, Dhir, Dyer and Limbachiya, editors, Proceedings of the International Symposium Concrete Technology Unit of ASCE and University of Dundee, March 19-20, 2001
- [3] Johnson, C.D. 1998. Waste glass as coarse aggregate for concrete. *J. Testing Evaluation*. 2: 344–35
- [4] Topcu, I.B. and Canbaz, M. 2004. Properties of concrete containing waste glass. *Cement Concrete Res.* 34: 267–274.
- [5] M. Mageswari, and Dr. B.Vidivelli.The Use of Sheet Glass Powder as Fine Aggregate Replacement in Concrete.*The Open Civil Engineering* (Journal, 2010), 4, 65-71.
- [6] Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. IS: 383-1970, Bureau of Indian Standards, New Delhi.
- [7] Recommended Guidelines for Concrete Mix Design. IS: 10262-1982, Bureau of Indian Standards, New Delhi.
- [8] Methods of Sampling and Analysis of Concrete. IS: 1199-1959, Bureau of Indian Standards, New Delhi.
- [9] Methods of Tests for Strength of Concrete. IS: 516-1959, Bureau of Indian Standards, New Delhi.
- [10] Methods of Tests for Strength of Concrete. IS: 516-1959, Bureau of Indian Standards, New Delhi.