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Partial Replacement of Fine Aggregates with Waste Glass

Ishan Srivastava
B. Tech (Civil),IPEC Ghaziabad
ishansrivastava27@gmail.com

Dushyant Gupta
B .Tech (Civil),IPEC Ghaziabad
guptadushyant78@gmail.com

Sukhvinder Singh Sehmi
B. Tech (Civil),IPEC Ghaziabad
sukhvindersinghsehmi@live.com

Kumar Shivam
B. Tech (Civil),IPEC Ghaziabad
PGP-ACM, NICMAR, Pune
kshivam4545@gmail.com

Jhalki Bharadwaj
B. Tech (Civil),IPEC Ghaziabad
PGP-ACM, NICMAR, Pune
jhalki.25@gmail.com

Abstract: ***The use of Waste Glass has recently gained popularity as a resource-efficient, durable, cost-effective, sustainable option for many types of Portland cement concrete (PCC) applications. The production of Portland cement is not only costly and energy-intensive, but it also produces large amounts of carbon dioxide. With the use of waste glasses available around the world at low costs, the use of Waste Glass seems to offer the best short term solutions for rising river bed and demand.***

Keywords: Waste Glass, Workability, Compressive Strength, Dry Density, Water Absorption.

I. INTRODUCTION

Concrete is one of the chief constituents of construction and also the most important. It is obtained by mixing calcareous & argillaceous materials with water, sand and coarse aggregate. It can be prepared by mixing them at adequate temperature and humidity thereafter by proper curing us get rock like structure.

But at present time the biggest issue is increasing CO2 and demolition waste. With the course of the time, the raw materials which are important for cement manufacturing are also depleting. This major issue can be solved by using alternative resources like fly ashes, blast furnace slag, coke breeze, waste glass etc. This is important because if we don't find the substitute material to accomplish need of this industry, with every year it will cause the strain on earth crust because all raw materials come from earth crust and it is limited in quantity.

II. GLASS AS ECO-FRIENDLY REPLACEMENT MATERIAL

The glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and CaCO3 at high temperature followed by cooling where solidification occurs without crystallization. The glass is an ideal material for recycling. The use of recycled glass saves a 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 the construction field where the waste glass was reused for concrete production. Several studies have shown that waste glass that is crushed and screened is a strong, safe and economical alternative to sand used in concrete. During the last decade, it has been recognized that sheet glass waste is of large volume and is increasing year by year in the shops, construction areas, and factories. 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. There is huge potential for using waste glass in the concrete construction sector. When waste glasses are reused in making concrete products, the production cost of concrete will go down (Topcu and Canbuz, 2004). Crushed glass or cullet, if properly sized and processed, can exhibit characteristics similar to that of gravel or sand.

III. WASTE GLASS & ITS USE IN CONCRETE

The use of waste glass in concrete is not in regular fashion. It is new in the manufacturing of environmental sustainable concrete. Due to the use of waste glass in concrete, various properties of concrete is enhanced.Such as it increases the compressive strength. The workability increases as it absorbs less amount of water.

IV. EFFECTS OF WASTE GLASS ON THE PROPERTIES OF CONCRETE

S. No.	Property	Effect of Waste Glass on Concrete
1.	**Workability**	Increases with increasing Glass content
2.	**Compressive Strength**	Increase up to certain proportion then start decreasing
3.	**Dry Density**	As the glass has lower specific gravity it results in lighter structure
4.	**Water Absorption**	Due to the not- hygroscopic behaviour of glass, it reduces water absorption nature of specimen

V. OBJECTIVES OF THE STUDY

1. To study the behaviour of concrete after the replacement of fine aggregate up to 10%, 20%, 30% & 40% replacement level.
2. To study the effect of waste glass on the workability of concrete.
3. To study the effect of waste glass on compressive strength of concrete.
4. To study the effect of waste glass on water absorption of concrete.
5. To study the effect of waste glass on the dry density of concrete.

MIX PROPORTION FOR 150×150×150 mm CUBES FOR VARIOUS FIBER CONTENT:

Mix	Glass content (%)	Cement (kg)	Water (lit)	CA (kg)		FA (kg)	Glass (kg)
				20mm	10mm		
M1	**0**	1.445	1.04	2.502	1.668	2.82	0
M2	**10**	1.445	1.04	2.502	1.668	2.54	0.28
M3	**20**	1.445	1.04	2.502	1.668	2.256	0.564
M4	**30**	1.445	1.04	2.502	1.668	1.98	0.84
M5	**40**	1.445	1.04	2.502	1.668	1.7	1.12

VI. TESTS ON MIX

1. Slump Test

Aim-This test is done to determine the workability of fresh concrete

Experimental values of a slump for all mixes:

Mix Name	M1	M2	M3	M4	M5
Slump(mm)	100	112	118	128	140

2. Compressive Strength Test:

Aim: To find out the compressive strength of test specimens.

Note: Minimum three specimens should be tested at each selected age. If the strength of any specimen varies by more than 15 per cent of average strength, results of such specimen should be rejected. Average of their specimens gives the crushing strength of concrete.

Calculations: Size of the cube =15cm x 15cm x 15cm

Area of the specimen (calculated from the mean size of the specimen) =225cm

Calculations:

Compressive Strength = Maximum load/Cross Sectional Area (P/A)

Test Results of Compression Test

S.NO.	Mould Designation	Compressive Strength after 7 days (MPa)	Compressive Strength after 28 Days (MPa)
1	M1	22.5	36.25
2	M2	26.25	41.75
3	M3	26.75	42.25
4	M4	24.75	38.5
5	M5	21.5	34.25

3. Water Absorption Test

Aim: This test is to determine the susceptibility of an unsaturated concrete to the penetration of water. This test is to determine the rate of absorption of water by measuring the increase in the mass of a specimen resulting from absorption of water as a function of time when only one surface of the specimen is exposed to water.

Mould Designation	Avg. Dry wt. before Curing (g)	Avg. wet Wt. after 28 days of curing (g)	Water Absorbed (g)	Water Absorption (%)
M1	8628	8720	92	1.066
M2	8135	8213	78	0.958
M3	8121	8184	63	0.775
M4	8104	8159	55	0.678
M5	8086	8125	39	0.482

4. Light Weight Test

Aim: This test is done to determine the change in dry density of specimen due to partial replacement of fine aggregates by the glass.

Mould Designation	Avg. dry Wt. of the Cubes (g)	Dry Density (KN/m3)	Percentage Change in Wt. w.r.t reference M30 Cubes
M1	8628	25.07	0%
M2	8135	23.645	-5.68%
M3	8121	23.60	-5.683%
M4	8104	23.55	-6.06%
M5	8086	23.505	-6.242%

RESULT & DISCUSSION

1. Optimum percentage of replacement is 20%, as it provides maximum compressive strength.
2. By using waste glass as partial replacement of fine aggregate, compressive strength increases up to 20% by 16.665, but after that, it starts decreasing for 30% & 40%.
3. By using glass workability increases as the proportion of glass increases and its reaches by 42 % when replacement level is 40%.
4. Dry density of specimen is decreased as the proportion of glass increases and decreased by 6.242% at 40 % replacement level.
5. Water absorption of specimen decreases as glass content increases and it decreased up to 0.482 for 40% while for 0% level is 1.066 %

CONCLUSIONS

From all the experiments conducted, we concluded that:

1. With the increase in the Glass contents, the compressive strength increases up to 16.55% for 20% replacement and after that, it starts decreasing.
2. The sample with a glass content of 20% shows the optimum results in comparison with the other samples.
3. At same water content, workability increases, as we increased the amount of Glass waste.
4. As we know the glass has lower specific density than river sand, which results in lighter wt. of the specimen which is justified by performing Light Weight test.
5. As the glass content increases, the water absorption by the concrete is decreasing. This is due to non-hygroscopic nature of Glass Cullets.

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