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EXPERIMENTAL STUDY ON WASTE GLASS AS A PARTIAL REPLACING MATERIAL IN CONCRETE FOR FINE AGGREGATE

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Abstract- ***Concrete industry is one of the consumers of natural resources due to which sustainability of concrete industry is under threat. In this paper, the issues of economic concern are addressed by the use of waste glass as partial replacement of fine aggregates in concrete. Fine aggregates were replaced by waste glass powder as 0%, 10%, 20%, and 30% and by weight for M-20 mix. The concrete specimens were tested for compressive strength, splitting tensile strength at the 7th and 28th days of age and the results obtained were compared with those of normal concrete. The results conclude the permissibility of using waste glass powder as partial replacement of fine aggregates up to 30% by weigh for particle size of range 0-1.18mm. In during phase-II, their flexural strength and durability study is being carried out.***

Keywords- Cement (OPC), Fine aggregate, Waste Glass Powder, Coarse aggregate.

I. INTRODUCTION

In order to make concrete industry sustainable, the use of waste materials in place of natural resources is one of the best approaches. In India, 0.7% of total urban waste enervated comprises of glass. UK produces over three million tons of waste glass annually. 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 inconcrete. Concrete is most widely used man made construction material and its demand is increasing day by day. The use of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of bridge piers and erosion of river bed. If fine aggregate is replaced by waste glass by specific percentage and in specific size range, it will decrease fine aggregate content and thereby reducing the ill effects of river dredging and thus making concrete manufacturing industry sustainable.

II. MATERIAL USED

A. *Cement*

Cement is a binding material that sets and hardens independently, and can bind other materials together. It hardens and attains strength from chemical reaction with the water known as hydration. The grade 53 ordinary Portland cement is used for this research work.

B. *Fine Aggregate*

Normal dry river sand is used as a fine aggregate, the sand passing through IS 4.75mm sieve with fineness modulus of 3.36 and specific gravity of 2.67 is used as a fine aggregate.

C. *Coarse Aggregate*

Gravel of 20mm size is used as a coarse aggregate which have impact value of 36.6% and crushing value of 33.5%.

D. *Waste Glass*

Glass is widely used in our lives through manufactured products such as soda lime glass, bottles and glassware. Glass is an ideal material for recycling. The use of recycled glass helps in energy saving. The increasing awareness of glass recycling speeds up inspections on the use of waste glass with different forms in various fields.

Preparation of Glass Powder

Glass powder is prepared by crushing the waste glasses using Los Angeles abrasion testing machine which is similar to ball mill.

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a) Crushing of waste glasses


b) Glass Powder in Sieves

Fig.1-Waste Glass Powder

III. MATERIAL PROPERTIES

A. Property of Cement

The property of the cement and GGBS is tabulated below,

Table I – Property of cement

Property	Value
Initial setting time	30 minutes
Final setting time	9 hours
Specific gravity	3.11
Consistency	30%

B. Property of Fine aggregate and waste glass powder

The property of the Fine aggregate and Waste glass powder is tabulated below,

Table II - Properties of Fine Aggregate

Property	River sand	Waste glass powder
Specific gravity	2.67	2.65
Fine modulus	3.36	3.65

C. Property of Coarse aggregate

The property of the coarse aggregate is tabulated below,

Table III - Properties of Coarse aggregate

Property	Value
Specific gravity	2.78
Water absorption	1.5%
Fineness modulus	4.39

IV. TEST ON FRESH CONCRETE

A. Slump cone test on fresh concrete

Slump cone test is conducted on the fresh concrete , the workability of the different mixes having 0%, 10%, 20% & 30% of waste glass powder is observed and it is compared with the workability of the conventional concrete mix. The results are tabulated below,

Table IV – Slump Cone test on fresh concrete

Waste Glass powder in (%)	Slump value in (mm)
0%	65
10%	68
20%	**73**
30%	60

B. Compaction factor test on fresh concrete

Compaction factor test is conducted on the fresh concrete, the workability of the different mixes having 0%, 10%, 20% & 30% of waste glass powder is observed and it is compared with the workability of the conventional concrete mix. The results are tabulated below,

Table V- Compaction factor test on fresh concrete

Waste Glass powder	Compaction factor

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in (%)	
0%	0.83
10%	0.85
20%	**0.88**
30%	0.82

IV. MIX PROPORTION

In the project work, the mix proportion for Strength of concrete of M20 grade are carried out according to IS:10262-1982. The detailed mix design is presented in the appendix. The mix proportion obtained and the quantity of materials required for one cubic meter of concrete is presented in Table V.

Table V- Mix Proportion of Waste Glass Powder

Materials	**Quantity of Materials / m^3 of Concrete**	**Mix Proportion**
Cement	383.2 Kg/m3	1
Fine Aggregate (waste glass)	654 Kg/m3	1.71
20 mm Coarse aggregate	1162 Kg/m3	3.1
Water	191.6 Litres	-
W/C Ratio	0.5	0.5

V. TESTING OF SPECIMENS

Totally 24 cubes and 24 cylinders were prepared for the 7th & 28th day testing with 0%, 10%, 20%&30% constant replacement of fine aggregate by Waste glass powder

Table VI – Specimens

Waste glass powder	**No.of Cubes**	**No.of Cylinders**
0%	3	3
10%	3	3
20%	3	3
30%	3	3

A. Compressive Strength Test

Determination of compressive strength of the concrete is an important parameter. For each, set nine standard cubes were casted to determine 7th and 28th days compressive strength after curing and also nine number of control cubes are casted to know the original strength of the concrete. The cube size is 150X150X150mm as per the IS 10262 –1982 the 7th and 28th days compressive strength value are given the Table VII.

Table VII - 7th & 28th days Compressive Strength Value

Waste glass powder in (%)	**Cube Compressive strength (N/mm^2)**	
	7 days	**28days**
0%	14.66	30.33
10%	**15.87**	**31.33**
20%	15.32	31.00
30%	14.3	29.66

B. Split Tensile Strength Test

It is very difficult to directly measure the tensile strength of concrete; therefore the splitting tensile test, an indirect method, was adopted. To determine the split tensile strength the cylinders were cast. The size of the cylinder is 150mm of diameter and 300mm of length. The cylinder are cured properly and tested on 7th and 28th day. Control concrete cylinder specimen is also cured and tested as per IS specification. Combinations of test results are compared with control concrete specimens.

$$\textbf{\textit{Split tensile strength}}(ft) = \frac{2P}{\pi DL}$$

where,

P is the maximum load on the cylinder (N)

L is the length of cylinder (mm)

D is the diameter of cylinder (mm)

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Table VIII - 7th & 28th days Split Tensile Strength Value

Waste glass powder in (%)	Tensile strength in (N/mm^2)	
	7 days	28 days
0%	1.85	2.30
10%	2.23	2.52
20%	**2.54**	**3.21**
30%	2.35	3.10

VI. RESULTS AND DISCUSSIONS

The results and discussions about the various tests are as follows,

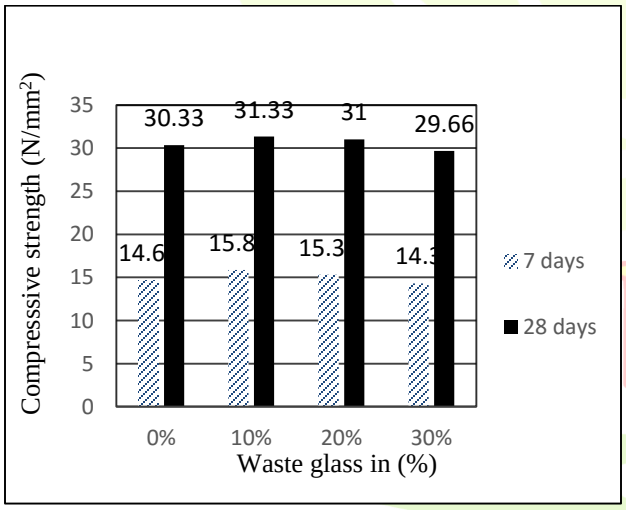

Fig.2- Variation of Compressive Strength of cubes

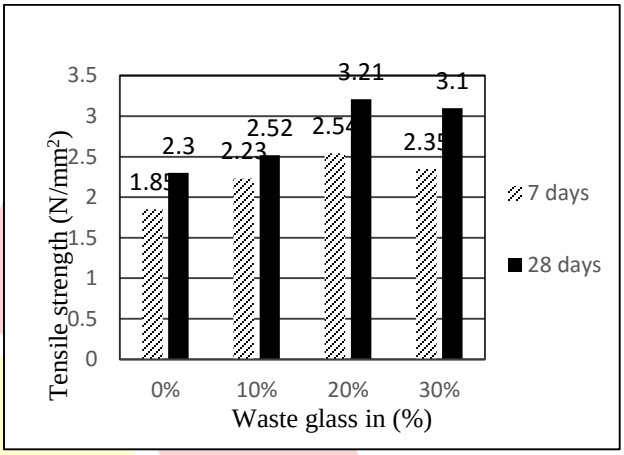

Fig.3 - Variation of Tensile Strength of Cylinders

From the above findings, the following conclusions may be made out of the study:

- While using waste glass as fine aggregate replacement, 7th days and 28th days compressive strength is found to marginally increase up to 10% replacement level.
- While using waste glass as fine aggregate replacement, 7th days and 28th days Tensile strength is found to marginally increase up to 20% replacement level.
- 3.3% increment in the compressive strength is found at 10% replacement of fine aggregate by Waste Glass at 28th days when compared to normal concrete.
- 39.55% increment in the split tensile strength is found at 20% replacement of fine aggregate by Waste Glass at 28th days when compared to normal concrete.
- Waste glass can effectively be used as fine aggregate replacement.
- The optimum percentage at which the waste glass powder is replaced by the fine aggregate is found to be 10%, beyond which the strength decreases.
- The optimum replacement level of waste glass as fine aggregate is 20% of Tensile Strength.

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