EXPERIMENTAL STUDY ON THE EFFECT OF WASTE GLASS AS PARTIAL FINE AGGREGATE REPLACEMENT IN CONCRETE

Ayshin Noushad[1], Dr. Sunilaa George[2], Prof. Rajalingam. M[3]

[1]M.E Student, EASA College of Engineering and Technology, Anna University, Navakkarai P.O, Coimbatore, Tamil Nadu-641105
[2] Professor and Head, EASA College of Engineering and Technology, Anna University, Navakkarai P.O, Coimbatore, Tamil Nadu-641105
[3]Professor, EASA College of Engineering and Technology, Anna University, Navakkarai P.O, Coimbatore, Tamil Nadu-641105

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Abstract - *Solid waste management is one amongst the key environmental issues in worldwide. sadly, post-consumer glass represents a serious element of solid waste and issue in locating convenient markets that may settle for glass collected for usage. The presence and accumulation of this waste caused environmental issues. Therefore, exploitation waste glass as fine mixture replacement in concrete is a stimulating risk for economy on waste disposal sites and conservation of natural resources. To traumatize these issues, this study has been conducted through basic experimental analysis so as to analyze the probabilities of exploitation crushed waste glass as fine mixture replacement in concrete. An experimental work was performed to review the compressive strength, split tensile strength, flexural strength and water absorption under different curing age 7, 14 and 28 days. Four concretes mixes with 0%, 5%, 15% and 20% replacement by weight of sand with waste glass were ready. The compressive, split tensile strength and flexural strength and modulus of elasticity of specimens with 20% waste glass content were 5.28%, 18.38%, 8.92% and 9.75% respectively, that is over the controlled mix at 28 days.*

Key Words**:** ***Solid waste, Glass , Concrete, Compressive strength, Flexural strength***

1. INTRODUCTION

The recycle of the waste glass is one among the vital problems in several countries because of the increment in solid waste within the setting. The waste glass is taken into account as a very important solid waste that may be found within the majority of world's countries and is being not a lot of full of atmospheric condition and its existence resulting in environmental issues. So the appropriate solutions should be found to beat this drawback. consequently, valuable researches are conducted to indicate the chance of mistreatment the waste glass as a artefact and adding it as a partial replacement to the concrete mixture while not moving the concrete quality. So the concrete may be made inside acceptable properties.

1.1 Glascrete

Many studies aim to switch fine combination by sure proportion of crushed waste glass as a fine combination to be extra to the concrete mixture. Additionally, these studies concentrate on the chance of mistreatment the waste glass as partial or altogether different for the traditional concrete materials, that provides a double outcomes, the primary is reducing the depletion of the wealth of nature resources. Secondly, reducing the environmental risks by manufacturing non-conventional concrete that's referred to as the glascrete.

2. MATERIALS

The materials used in this study are cement, coarse aggregate, fine aggregate, crushed waste glass as fine aggregate replacement and water.

2.1 Cement

Ordinary Portland Cement of grade 53 was used for the preparation of specimen. The properties of the cement are shown in the Table 1

Table -1: Properties of cement

PROPERTY	VALUE
Specific Gravity	3.14
Fineness	97.5%
Initial Setting Time	30 min
Final Setting Time	600 min
Compressive Strength	43N/mm^2
Consistency	29%

2.2 Coarse aggregates

The natural crushed stone aggregate with maximum size of 19.5 mm and bulk density of 1530 kg/m^3. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The sieve analysis results of coarse aggregate are given in Table 2

Table.2 : Sieve analysis of 20 mm coarse aggregates

Sieve size (mm)	% Passing by Weight	ASTM Standard Specifications
19.5 mm	100	100
12.5mm	93.4	90-100
9.5 mm	67.1	40-70
4.75mm	9.38	0-15
2.36 mm	0.62	0-5

2.3 Fine Aggregates

The fine aggregate used for the experimental work was locally procured and the fine aggregate was natural sand of 4.75 mm maximum size. The used sand was sieved according to the requirements of the ASTM standard specification. The Sieve analysis results are presented in Table.3.

Table 3: Sieve analysis of fine aggregate

Sieve size (mm)	% Passing by Weight	ASTM Standard Specification
4.75	98.56	95-100
2.36	91.31	80-100
1.18	62.15	50-85
0.60	33.12	25-60
0.30	8.6	5-30
0.15	0.85	0-10
Fineness modulus =3.05		

2.4 Glass Aggregates

The first step in preparing the glass aggregate was the crushing process, which was carried out using crushing machine. Sieve analysis for the glass particles as shows in Table.4. The specific gravity of glass aggregate was 2.23, while the absorption was negligible

Table 4: Grading of waste glass

Size	Mass retained	%retained	%passing	Cummulative %	ASTM Standarad
4.75	0	0	100	0	95-100
2.36	1.7	0.17	99.8	0.17	80-100
1.18	357.7	35.7	64.04	35.94	50-85
0.60	230.9	23.09	40.9	59.03	25-60
0.30	200.2	20.02	20.95	79.05	5-30
0.15	113.2	11.3	9.63	90.37	0-10
pan	96.3	9.63	0	0	0

Fineness Modulus of glass aggregate = $\Sigma F/100 = 264.56/100 = 2.6$

2.5 Water

The Water used for concrete mix for this experiment was taken from pipe in the laboratory. The water was ensured to be clean and free from impurities or reactive agent .

3. RESULTS AND DISCUSSION

3.1 Mixture Proportioning

Four types of concrete mixes were prepared. The grade of concrete was M25 with water-cement ratio of 0.55. The other mixes were contained waste glass aggregates of 5%, 15%, and 20% by weight as a partial replacement of natural fine aggregate. Both types of concrete mixes were cured for 7, 14, and 28 days.

3.2 Test Specimen

The moulds were coated with mineral oil to ensure that no water escaped during filling and to prevent adhesion of concrete and leave out ready to casting. Cubes of size 150mm x 150mm x 150mm, prisms of size 100mm x 100mm x 500mm and cylinders of size 300mm x 150mm were prepared. The samples were casted using different proportions of glass powder. After that they were removed from mould with care after 24hrs from casting, so that no edges were broken and were placed in the curing tank at the ambient temperature for curing. These specimen were tested for compressive strength, tensile strength and split tensile strength.

The following are the results of the compressive strength test, split tensile strength ,water absorption test and flexural strength test.

Table 6: Compressive strength (MPa) for all mixes

mix	Compressive strength (MPa) at		
	7 day	14 day	28 day
Control	24	29.2	32.4
5% glass	26	29.63	31.5
15% glass	24	29.87	31.8
20% glass	25	28.81	34.2

Table 7: Splitting tensile strength (MPa) for all mixes

mix	Split tensile strength (MPa) at		
	7 day	14 day	28 day
Control	2.3	2.39	2.58
5% glass	2.0	2.2	2.57
15% glass	1.3	1.7	2.93
20% glass	1.6	1.9	3.12

Table 8: Flexural strength (MPa) for all mixes

mix	Flexural strength (MPa) at		
	7 day	14 day	28 day
Control	3.3	4.13	4.9
5% glass	3.8	4.38	5.08
15% glass	3.5	4.25	5.12
20% glass	3.8	4.21	5.37

Figure 1: Flexural Strength Machine

Table 9: Water absorption for all mixes

mix	Water absorption % at		
	7 day	14 day	28 day
Control	5.8	5.3	4.9
5% glass	5.5	4.9	4.7
15% glass	5.2	4.7	4.4
20% glass	4.8	4.4	4.1

4. CONCLUSIONS

1. Compressive strength of the concrete with partial replacement of sand by finely crushed waste glass increased with the increment ratios of waste glass. Concrete containing waste glass shows higher compressive strength at the later ages. Compressive strength at 28 days of concrete age with 20% crushed waste glass replacement of sand by waste glass give 5.28% higher compressive strength than controlled concrete.

2. The 20% percentage of replacement finely ground waste glass by sand that gives the maximum values of compressive, tensile and flexural strengths at 28- days age.

3. Water absorption decreases with increase in waste glass aggregate ratio. The highest reduction is obtained with 20 % of glass aggregate replacement. The reduction is 14.68% at 28-day age, relative to control mix. On the other hand, all mixes showed decrease in water absorption with age, therefore the porosity of the concrete will decrease as well.

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