USING OF RECYCLED WASTE GLASS AS COARSE AGGREGATE IN CONCRETE

[1] B. Parthiban, [2] S. Thirugnanasambandam,
[1] Research Scholar, Civil and Structural Engineering, Annamalai University, Annamalai Nagar, India
[2] Associate Professor, Civil and Structural Engineering, Annamalai University, Annamalai Nagar, India

Abstract: The use of recycled waste glass as aggregate in concrete has become popular in modern days, with large scale research output. Glass can be recycled indefinitely without any loss in quality. This paper presents M 20 grade concrete is the suitability of recycled waste glass as an alternative for conventional coarse aggregate. Laboratory experiments are conducted to determine the compressive strength, splitting tensile strength, flexural strength and modulus of elasticity of concrete made with recycled waste glass coarse aggregate and compared them with those of control mix concrete made with crushed stone coarse aggregate. The physical properties of recycled waste glass coarse aggregate are compared with crushed stone coarse aggregate. The study indicated that recycled waste glass can effectively be used as coarse aggregate without substantial change in strength.

***Index Terms*– Recycled waste glass (RWG), Compressive strength, Splitting tensile strength and Flexural strength.**

I. INTRODUCTION

The increasing awareness of glass recycling speeds up inspections on the use of waste glass with different forms in various fields. Recent research findings have shown that concrete made with recycled glass aggregates is better long term strength and better thermal insulation due to its better thermal properties of glass aggregates [1]. One of the significant contributions is to the construction field where the waste glass was reused for value added concrete production [2]. Literature survey indicates glass being non-bio degradable, is one such material that is not suitable for addition to land fill. Huge amount of natural resource are being consumed in cement concrete production. To minimize these, researchers have concentrated on the use of waste materials as potential alternatives in the construction industry especially in concrete manufacturing. The successful use of recycled waste glass aids in reducing the environmental and health problems related to the disposal of waste glass and the scarcity of land area needed for disposal. At present, utilization of waste materials ie. slag, fly ash, ceramics etc., in concrete manufacturing is one of the prime research interests to reach the goal of achieving sustainable construction. Waste glass is a very cheap material compared with all other concrete constituents and is much less expensive than crushed stone aggregate [3]. Thus the idea is to replace as much of the stone aggregates as possible to save money and to reduce the amount of disposable wastes. In this research white colour recycled waste glass stones are effectively used as coarse aggregate for concrete manufacturing [4]. In this study, compressive strength, splitting tensile strength, flexural strength and modulus of elasticity of concrete made with recycled waste glass coarse aggregate and compared them with those of control mix concrete made with crushed stone coarse aggregate. The properties of recycled waste white colour glass coarse aggregate and the test results are not significantly varying from those of control mix concrete using crushed stone as coarse aggregate.

Objective of this project

This research experimental work has carried out to find out suitability of use of recycled waste glass as coarse aggregate in concrete with the following objectives.

1) To study the chemical properties of recycled waste glass.
2) To study the mechanical properties such as compressive strength, splitting tensile strength and flexural strength of concrete using recycled waste glass as coarse aggregate and the results are compared with control concrete.
3) To study the modulus of elasticity of concrete using recycled waste glass as coarse aggregate and the results are compared with control concrete.

II. EXPERIMENTAL WORK

2.1 Materials

The materials used for the experimental work are OPC 43 grade cement, river sand, recycled waste glass as course aggregate, water and admixture. The nature of the materials are discussed below.

2.1.1. Cement

In this research work, OPC 43 grade is used and it is conforming to IS 12269 – 1987 [5]. The physical properties of cement is tabulated in Table 1.

Table 1
Physical Properties of Cement

Sl.No	Property	Result
1.	Specific Gravity	3.15
2.	Fineness	2%
3.	Standard Consistency	29%
4.	Initial Setting Time	60 minutes
5.	Final setting Time	600 minutes
6.	Compressive strength	43 MPa

2.1.2 Fine Aggregate

Locally available river sand is used in this research. According to 383-1970 [6] the fine aggregate used conforms to Zone III. The physical properties of fine aggregate are given in Table 2.

Table 2
Physical Properties of Fine Aggregate

Sl.No	Property	Result
1.	Specific Gravity	2.56
2.	Fineness Modulus	2.13
3.	Grading Zone	Zone III

2.1.3 Recycled Waste Glass as Coarse aggregate

Glass does not degrade through the recycling process. The glass is washed to remove any impurities. In this research, recycled waste white colour glass used as coarse aggregate. The glass is then crushed and melted, which is then screened into required size for immediate use. In this research, the shape of the recycled glass is produced as angular shape and the size of the aggregate is maintained 8 mm up to 16 mm for making concrete. The sample of recycled waste glass coarse aggregate is shown in Fig.1

Fig 1: Recycled Waste Glass as Coarse Aggregate (RWG)

The properties of recycled waste glass coarse aggregate are given in Table 3. Scanning of Electron Microscope (SEM) images of recycled waste glass coarse aggregate are shown in Fig.2. The chemical composition of recycled waste glass coarse aggregate are given in Table 4.

Table 3
Properties of Recycled Waste Glass as Coarse Aggregate (RWG)

Sl.No	Property	Result
1.	Specific Gravity	2.50
2.	Size of the Aggregate	8mm to 16mm
3.	Shape of the Aggregate	Angular

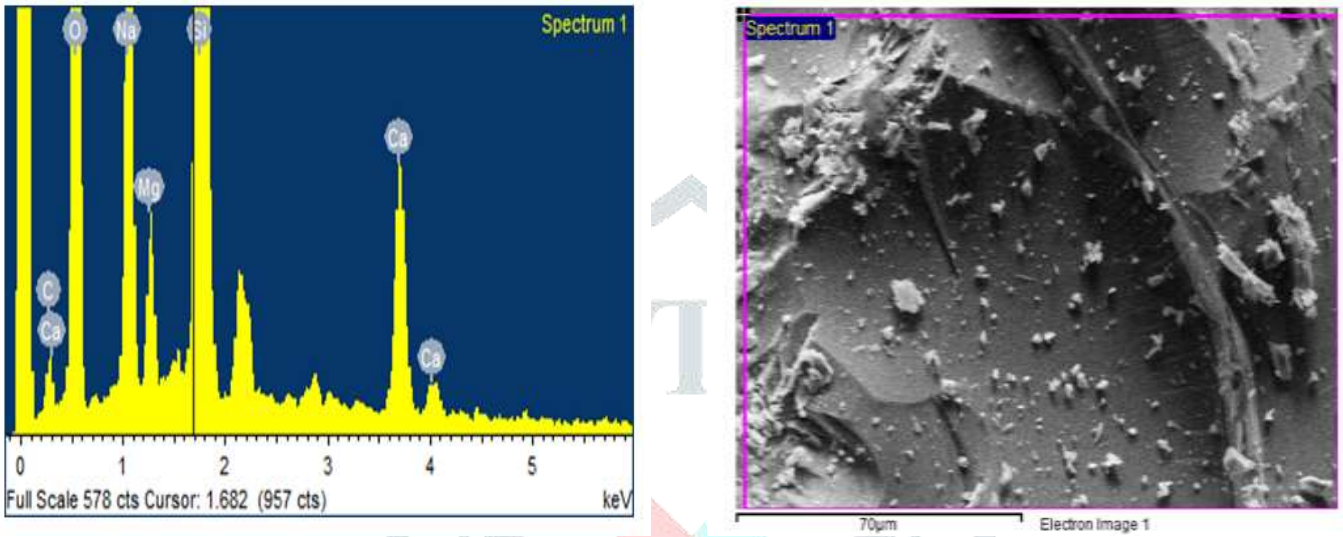

Fig 2: SEM Images of Recycled Waste Glass as Coarse Aggregate (RWG)

Table 4
Chemical Constituents of Recycled Waste Glass as Coarse Aggregate (RWG)

Constituent	SiO_2	$CaCo_3$	Na	MgO	Ca
In Percentage	78.80	5.44	8.39	1.84	5.53

2.1.4 Chemical Admixtures

In this research super plasticizer Fosroc conplast SP 430 is used to reduce the water content. The use of chemical admixtures improves and control the rate of hardening and slump loss and result in better workability as well as durability of concrete. In this mix design the quantity of admixture is used on 0.7% by weight of the cement.

2.1.5 Water

Portable water which is free from organic impurities is used for this concrete manufacturing work.

III. Experimental Procedure

M 20 grade concrete with water cement ratio of 0.50 is designed for mix proportion by using IS Code 10262-2009 [7]. The mix proportions for control mix concrete obtained is given in Table 5. The same mix proportions is used with 100% replacement of recycled waste glass as coarse aggregate.

Table 5
Mix proportions for M 20 Control Mix Concrete

Description	Cement	Fine aggregate	Coarse aggregate	Water	Admixture
Ratio	1	2.75	3.36	0.50	0.7%

For each mix, six cubes of size 100 × 100 × 100 mm, are caste to determine compressive strength at 7days and 28 days. Three cylinders of size 100 mm diameter and 200 mm long, three prisms of size 100 × 100 × 500 mm and three cylinders of size 150 mm diameter and 300 mm long are caste to determine splitting tensile strength, flexural strength, modulus of elasticity at 28 days respectively. The specimens are demoulded after 24 hours and kept in curing tank 28 days for curing. After 28 days the specimens

are taken out and tested. All the above tests are carried out for control mix concrete and recycled waste glass as coarse aggregate concrete as per IS 516-1959 [8].

IV. RESULTS AND DISCUSSIONS

The mean value of compressive strength for 7 days and 28 days, splitting tensile strength and flexural strength and modulus of elasticity at 28 days for control mix concrete and recycled waste glass as coarse aggregate concrete are tabulated in Table 7.

A typical failure mode of the recycled waste glass coarse aggregate concrete tested for compressive strength, splitting tensile strength, flexural strength and modulus of elasticity were shown in Fig.3 a, b ,c ,d respectively. The properties of the recycled waste glass coarse aggregate is not significantly varying from the crushed stone aggregate. Due to the lower water absorption and smooth surface texture of the recycled waste glass coarse aggregate, workability is enhanced and more cohesive then control mix concrete. The absorption of water can affect the strength parameters. The higher water absorption leads to lower strength. Recycled waste glass coarse aggregate absorbs minimum quantity of water and hence the results of mechanical properties are higher than the control mix concrete.

The compressive strength of the recycled waste glass coarse aggregate concrete is 28.30 MPa and the control mix concrete is 28 MPa. The Splitting tensile strength of the recycled waste glass coarse aggregate concrete is 3.25 MPa and the control mix concrete is 3.20 MPa. The flexural strength of the recycled waste glass coarse aggregate concrete is 3.82 MPa and the control mix concrete is 3.70 MPa. The modulus of elasticity of the recycled waste glass coarse aggregate concrete is 2.52 X 10^4 MPa and the control mix concrete is 2.50 X 10^4 MPa. As far as strength properties are concerned, the variations are not significantly different from the control mix concrete.

Table 7
Strength Properties of Control Mix Concrete and Recycled Waste Glass Coarse Aggregate Concrete

Mix	Compressive Strength (MPa)		Splitting Tensile Strength (MPa)	Flexural Strength (MPa)	Modulus of Elasticity (MPa)
	7 days	28 days	28 days	28 days	28days
Control Concrete	18.83	28.00	3.20	3.70	2.500 X 10^4
RWG Concrete	19.00	28.30	3.25	3.82	2.520 X 10^4

Fig 3: (a) Crack Pattern of Cubes after Testing

(b) Crack Pattern of Cylinder after Testing

(c) Crack Pattern of Prism after Testing

(d) Crack Pattern of Cylinder after Testing

V. CONCLUSIONS

The paper presents the utilization of recycled waste glass as coarse aggregate in concrete and the properties of recycled waste glass, strength properties of recycled waste glass as aggregate in concrete is compared with control mix concrete. The results of mechanical properties of recycled waste glass as aggregate in concrete is higher than control mix concrete using crushed stone as coarse aggregate.. The performances of test results using of recycled waste glass as coarse aggregate in concrete is satisfactory. The recycling of waste glass in to aggregate will preserve the natural resources and the glass is found to be an alternative material for making concrete.

VI. REFERENCES

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