

EXPERIMENTAL INVESTIGATION ON CONCRETE BY PARTIAL REPLACING OF COARSE AGGREGATE WITH RECYCLED COARSE AGGREGATE AND FINE AGGREGATE WITH CRUSHED GLASS

Salahuddin Shakeeb S M¹, Mohammed Abdul Raof², Shamsad Hussain³ Mohd Kabeer⁴

¹ Assistant Professor, Department of Civil Engineering, NSAKCET, Hyderabad, Telangana, India

² BTECH Student, Department of Civil Engineering, NSAKCET, Hyderabad, Telangana, India

³ BTECH Student, Department of Civil Engineering, NSAKCET, Hyderabad, Telangana, India

⁴ BTECH Student, Department of Civil Engineering, NSAKCET, Hyderabad, Telangana, India

Abstract - Concrete is a widely used construction material for building of various civil engineering structures. Concrete will give better durability and also its costs during construction as well as maintenance are very low. But when it comes to the tensile property it is very weak and tends to fail because of its deficiencies such as low tensile strength, low strain at fracture. The weakness of concrete is due to the presence of micro cracks at mortar aggregate interface. The present experimental work has been carried out for M₂₀ mix proportion and the mechanical properties such as compressive strength, flexural, tensile strength, impact strength tested by hybridizing the concrete with RCA and Crushed Glass. Crushed Glass are hybridized and added in the percentages of 10%, 20%, 30% and 40% the results are compared with controlled concrete. RCA (recycle coarse aggregate) having aspect same percentage as comparing to crushed glass. The test results and variations in mechanical properties are discussed. In this experimental investigation we have the dramatically increase in the compressive strength while comparing it with the 0% of concrete specimen.

Key Words: RCA, Crushed Glass, Compressive Strength, Split Tensile Strength...

1. INTRODUCTION

Concrete is the world's second most consumed material after water, and its widespread use is the basis for urban development. In India 27% of the total waste generated is construction and demolition waste (C&DW). Many countries have recycling schemes for C&DW to avoid dumping to landfill, as suitable landfill sites are becoming scarce particularly in heavily populated countries. Aggregate typically processed from demolition waste concrete is termed as Recycled Concrete Aggregate (RCA). Recycling or recovering concrete materials has two main advantages. It conserves the use of natural aggregate and the associated environmental costs of exploitation and transportation, and it preserves the use of landfill for materials which cannot be recycled. Waste glass is a major component of the solid waste stream in many countries. Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and CaCO₃ (calcium carbonate) at high

temperature followed by cooling during which solidification occurs without crystallization. It is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. The use of recycled glass helps save of energy.

1.1 RCA (Recycled Concrete Aggregate)

In India, a huge quantity of construction and demolition wastes is produced every year. India is presently generating construction and demolition waste of 23.75 million tons annually and these figures are likely to double in the next 7 years. . And the continuous use of natural resources for making conventional concrete leads to the reduction in their availability and results in the increase of the cost of the coarse aggregate and fine aggregate. The possible use of recycling demolition waste as coarse aggregate in the construction industry is thus increasing importance. When recycled coarse aggregate is used in structural concrete, the assessment of physical, mechanical and durable characteristics of recycled coarse aggregate is very important. The physical and mechanical properties of concrete with the recycled coarse aggregate (RCA) are to be evaluated to assess its application as structural concrete. Properties of the recycled concrete aggregates depend on the source, quality of the waste material, percentage ratio of components and also on the sieve-fraction of aggregate.

1.2 Crushed glass

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 during which solidification occurs without crystallization. It is widely used in our day today life. It can be found in many forms, including container glass, flat glass such as windows, bulb glass and cathode ray tube glass. The use of glass as aggregates in concrete has a great potential for high quality concrete development. Its shape and size have potential benefit in obtaining a good particle size distribution in glass concrete.

2. Objectives

The main objective of this experimental investigation is to study the performance of RCA & Crushed Glass in concrete under variable amplitude loading by varying the percentages of RCA Crushed Glass by the weight of coarse aggregates and fine aggregate respectively. Experimental investigation include the basic tests carried out to check the physical properties of material used and properties of concrete in fresh state like Compaction factor test, Slump test, Vee-Bee test. Testing on hardened concrete like compressive strength for cubes and split tensile for cylinders is carried out.

3. Physical Properties of Crushed Glass

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 during which solidification occurs without crystallization. It is widely used in our day today life. It can be found in many forms, including container glass, flat glass such as windows, bulb glass and cathode ray tube glass. The use of glass as aggregates in concrete has a great potential for high quality concrete development. Its shape and size have potential benefit in obtaining a good particle size distribution in glass concrete. The present investigation, the crushed waste glass and RCA was used for the following tests:

- Specific Gravity
- Sieve analysis
- Bulk density

Chemical properties of crushed glass

Properties	Values
SiO ₂ %	70.22
CaO%	11.13
Al ₂ O ₃ %	1.64
Fe ₂ O ₃ %	0.52
Na ₂ O ₃ %	15.26
Loss of ignition%	0.80
Density	2.42

Properties of CG (crushed glass) aggregate	Values
Specific gravity	2.68

The result of the tests on crushed glass are given below in the table

4. Properties Recycled Coarse Aggregate:

S.NO.	TEST	VALUES OBTAINED (%)
1.	Specific gravity	2.4
2.	Water absorption	0.75
3.	Impact value	23

5. Results and Discussions

This part consists of two types of hardened concrete testing. They are compression test and tensile test. All the procedure used was according to the Indian Standard Code. Experiments were conducted on normal concrete and modified concrete by replacing natural coarse aggregate with recycled coarse aggregate with varying percentages of 0%, 10%, 20%, 30%, 40% and addition of crushed glass as same percentage adopted for RCA.

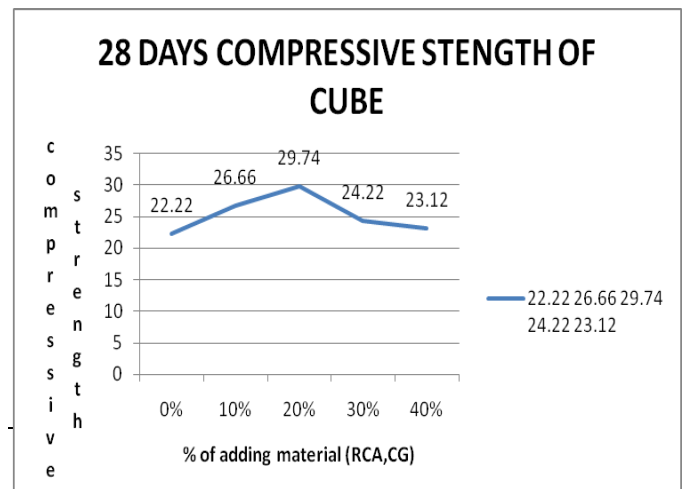
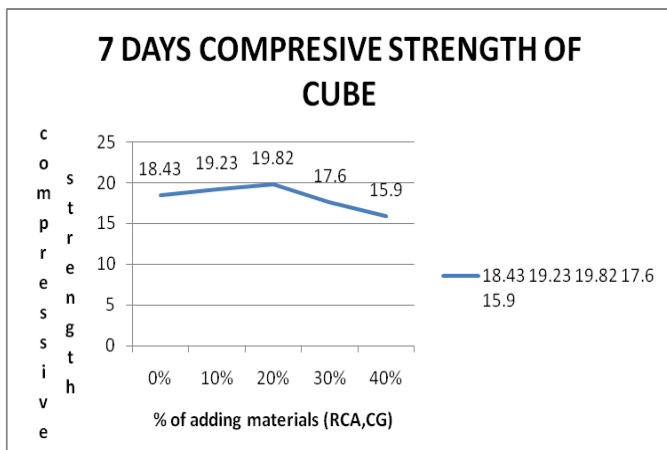
5.1 Compressive Strength

Compressive strength of concrete can be defined as the measured maximum resistance of a concrete to axial loading. Compression test is the most common test used to test the hardened concrete specimens because the testing is easy to make. The strength of the concrete specimens with different percentage of recycled aggregate replacement can be indicating through the compression test.

Recycled coarse aggregate was added to concrete at varying proportions (0%, 10%, 20%, 30%, 40%) and addition of crushed glass same as of RCA percentage, at a water cement ratio of 0.5 The desired compressive strength was obtained for conventional concrete at this ratio

S.no	Cube(7 days) (RCA+CG)	Compressive strength N/mm ²
1	0%	18.43
2	10%	19.23
3	20%	19.82
4	30%	17.60
5	40%	15.90

7 days compressive strength of cubes



28 days compressive strength of cubes

The value obtained for 10% and 20% addition of recycled coarse aggregate , crushed glass and water cement ratio 0.5 yielded highest results for compressive strength. However, the compressive strength decreased on the increase in RCA and CG addition. Therefore there is an optimum value of RCA , CG to cement ratio, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum RCA and CG content was taken as both 10% and 20% .

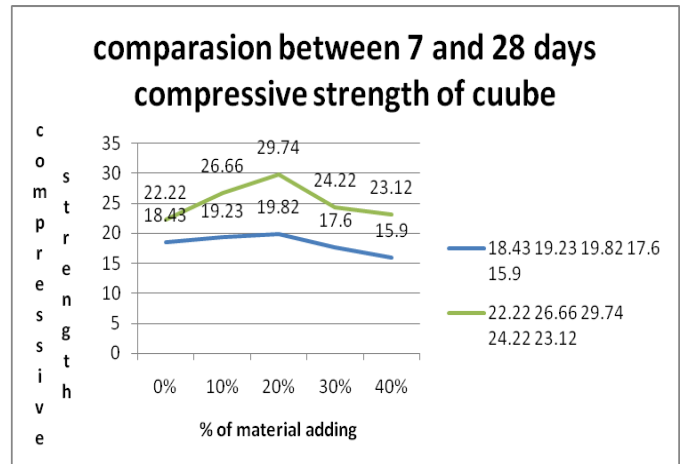
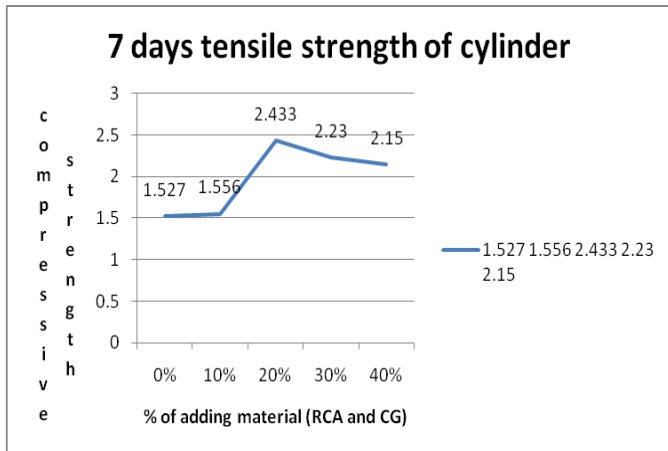
5.2 Split Tensile Strength

Split tensile strength tests were conducted on standard cylinders of dimension 15cm diameter and 30cm depth, specimens each for plain concrete, RCA and crushed glass concrete were casted at varying percentages of RCA+CG (0%, 10%, 20%, 30%, and 40%). For each case 7 & 28days strength values were obtained by loading under a compression testing machine.

S.no	Cube(28 days) (RCA+CG)	Compressive strength N/mm ²
1	0%	22.22
2	10%	26.66
3	20%	29.74
4	30%	24.22
5	40%	23.12

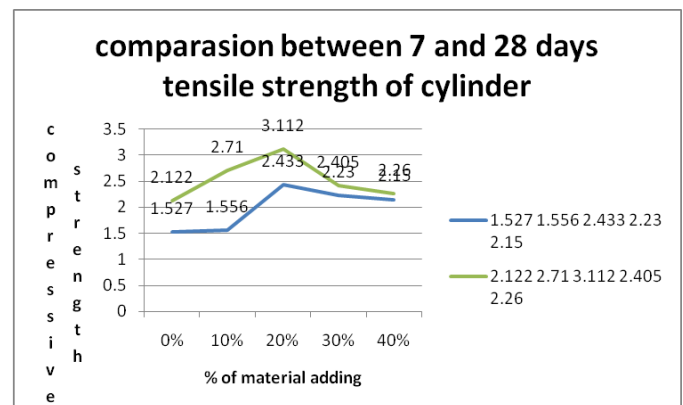
S.no	Cylinder(7 days) (RCA+CG)	Tensile strength N/mm ²
1	0%	1.527
2	10%	1.556
3	20%	2.433
4	30%	2.23
5	40%	2.15

Split tensile strength of Cylinders (7 Days)

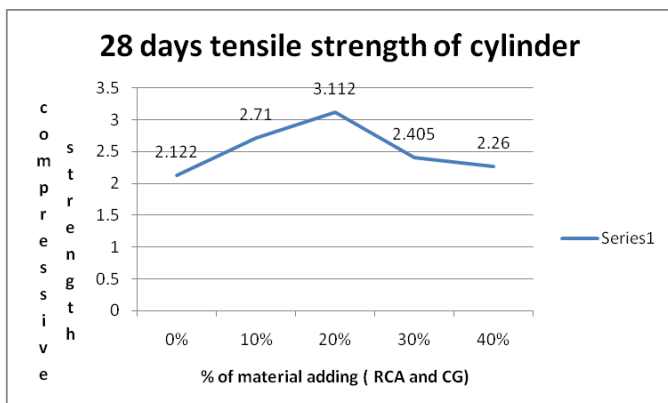


S.no	Cylinder	Tensile strength N/mm ²
1	0%	2.122
2	10%	2.71
3	20%	3.112
4	30%	2.405
5	40%	2.26

Graphs between 7 and 28 days Curing for Compressive Strength



Split tensile strength of Cylinders (28 Days)



Graphs between 7 and 28 Days curing for Split Tensile Strength of Cylinder

6. CONCLUSIONS

Experimental works on the use of recycled aggregates and crushed glass have proven that good quality concrete could be produced with recycled aggregates and crushed glass. The use of construction waste and natural waste produced from demolition of buildings should be further promoted. Based on the experimental investigation reported in the work, the following conclusions are drawn:

- The workability of recycled aggregate and crushed glass concrete mix is satisfactory compare to natural aggregate, concrete mix with 10% and 20% recycled aggregate concrete and crushed glass has satisfied workable concrete.
- The recycled aggregate concrete has a convenient compressive strength and slight improvement in tensile strength, which means a convenient concrete for structural elements in concrete structures.
- Although recycled aggregate can be applied in the high strength structure, but one issue must not be neglected as recycled aggregate with reduce water

The value obtained for 20% and 30% for the 7 days curing addition of recycled coarse aggregate and water cement ratio 0.5 yielded highest results for tensile strength and 10% and 20% for 28 days curing. However, the tensile strength decreased on the increase in RCA and CG addition. Therefore there is an optimum value of RCA ,CG to cement ratio, beyond which the tensile strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum RCA and CG content was taken as 10% & 20% .

content would have low workability. Whenever recycled aggregate is applied, water content in the concrete mix has to be monitored carefully due to the water absorption capacity of recycled aggregate will vary. This type of concrete can only be used under the condition that does not involve a lot of handling works.

- At 10% and 20% of addition of crushed glass and RCA with a water cement ratio of 0.5, compressive strength tests yielded best results.
- There is an optimum value of RCA, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum RCA and CG content was taken as 10% and 20% .
- These crushed glass help in increasing the tensile property of concrete. The tensile properties and cracking pattern of concrete shows that it can be particularly useful in construction activities .
- In this experimental investigation we notice that how the adding of material like CG and RCA be beneficial to the compressive strength of the cube and tensile strength of the cylinder like we have replace that starting from 0% to 40% in that we have notify that the compressive strength is been increase up to one extend that is 10 % to 20% where as it will be decrease.
- In this investigation the results has shown a significant increase in percentage of various strength parameters such as compressive and split tensile strength.
Compressive strength up to 24%
Split tensile strength up to 8%

REFERENCES

- [1] Nelson and Shing Chai NGO Research Project "High-Strength Structural Concrete with Recycled Aggregates", submitted November 2004, University of Southern Queensland Faculty of Engineering Surveying.
- [2] Majid Ali, Anthony Liu, HouSou, Nawawi Chow, "Mechanical and Dynamic Properties of Coconut Fibre Reinforced Concrete. "Construction and Building Materials. Reed Business Information, Inc. (US). 2012. High Beam Research. 5 Sep. 2013.
- [3] Noor Md. Sadiqul Hassan, Habibur Rahman Sobuz (2012), "Use of coconut fibre in production of structural light weight concrete", Journal of applied sciences 12(9) 831- 839, 2012.
- [4] Mahapara Abbass "Coconut Fiber as Fiber Reinforcement: A Review" PG Research Scholar, Department of Civil Engineering, Swami Devi Dyal Institute of Engineering & Technology, Haryana, India.
- [5] Syed Ahmad Zuhud, "Performance of Recycled Aggregate Concrete," the Islamic University of Gaza Faculty of Engineering, November 2008.

- [6] S. K. Singh, Scientist, Structural Engineering Division, Central Building Research Institute, Roorkee "RECYCLED AGGREGATES IN CONCRETE".
- [7] Tiara Darshita et al. (June 2014), studied about the strength and workability of different grades of concrete by partial replacement of fine aggregate by crushed brick and recycled glass powder.

BIOGRAPHIES



SALAHUDDIN SHAKEEB S M¹
received Diploma in Civil Engineering from HKE Polytechnic Raichur, Karnataka and B.E Civil Engineering degree from Government Engineering College Raichur, Karnataka, India, and M.Tech in Construction Technology from VTU Belgaum, Karnataka. He is presently working as Asst Prof in Civil Engineering Dept, Nawab Shah Alam Khan College of Engineering and technology, Hyderabad, Telangana, India.



Mohammed Abdul Raof
He is presently pursuing B.Tech in Civil Engineering from Nawab Shah Alam Khan College of Engineering and technology, Hyderabad, Telangana, India.



Shamshad Hussain³
He is presently pursuing B.Tech in Civil Engineering from Nawab Shah Alam Khan College of Engineering and technology, Hyderabad, Telangana, India.



Mohd Kabeer⁴
He is presently pursuing B.Tech in Civil Engineering from Nawab Shah Alam Khan College of Engineering and technology, Hyderabad, Telangana, India.