International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Study on Strength Properties of Concrete by Partial Replacement of Fine Aggregate with Crushed Glass

[1]N. S. Gayathri, [2]M. Malikarjuna

[1] Post Graduate Student, Department of Civil Engineering, SVR Engineering College, Nandyal DT, A.P, India
[2]Assistant Professor, Department of Civil Engineering, SVR Engineering College, Nandyal DT, A.P, India

ABSTRACT

Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. 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. One of its significant contributions is to the construction field where the waste glass was reused for concrete production. With increasing environmental pressure to reduce solid waste and to recycle as much as possible, the concrete industry has adopted a number of methods to achieve this goal by replacement of waste glass with concrete composition materials. Due to differences in mixture design, placement and consolidation techniques, the strength and durability of conventional concrete is increased.

In this project, crushed waste glass powder is being used as a partial replacement for fine aggregate and cement. The maximum percentage of crushed waste glass used is about 30% of the mass of fine aggregate. The percentages in which the crushed waste glass was replaced were 5%, 10%, 15%, 20%, 25%, and 30%. The increase in the percentage of glass powder as a partial replacement for fine aggregate reduces the strength properties of concrete. In order to compensate for this reduction, 10 % silica fume is added to the concrete as a partial replacement for cement. The compressive, tensile and flexural strengths of concrete samples with crushed waste glass powder are higher than the control samples at all ages of 7, 28, 56 and 90days.

Keywords: Concrete, Crushed glass, Silica fume, compressive strength, Tensile strength. Flexural strength

I. Introduction

Concrete is a composite material composed mainly of water, aggregates, and cement. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, a fluid mass is formed which can be moulded into any desired shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. Concrete was widely used in the Roman Empire. Concrete is as old as 5600 BC. It was not invented by Romans, but much used by them. But, after the fall of Roman Empire, use of concrete became very less. In the mid-18th century, concrete was re-pioneered. Today, the most widely used man-made material is concrete, measured in tonnage.

It is estimated that the present consumption of concrete in the world is of the order of 12 billion tons every year. Humans consume no material except water in such tremendous quantities. The reason for such success is that the concrete has the ability to withstand the action of water without serious deterioration and making it an ideal material for building structures to control, store, and transport water. The other reason is the ease with which structural concrete elements can be formed into a variety of shapes and sizes. This is because freshly made concrete is of a plastic consistency, which permits the material to flow into prefabricated formwork. After a number of hours, the formwork can be removed for reuse when the concrete has solidified and hardened to a strong mass.

Concrete is one of the most durable building materials. It provides superior fire resistance compared with construction made with other materials and gains strength over time. Structures made of concrete can have a long service life. Concrete is used to make architectural structures, foundations, pavements, motorways, bridges, multi-story parking, walls, footings etc. Its biggest advantage is that it bonds together bricks and stones better than any other method known to mankind. Concrete is strong in compression but weak in tension. For some purposes it needs to be reinforced with steel rods. These rods can be galvanized to prevent rusting and corrosion.

Waste glass in Concrete

The difficulties encountered with glass processing lead to an ever increasing interest to use waste glass in alternative areas mainly in the construction industry especially in concrete. In the last decades concrete became one of the most attractive options due to the large quantities produced, relatively low quality of glass required and long term use. Reusing it in concrete converts a material which was a burden to society into a source. If we recycle the glass and use it, it will again become a waste after serving its purpose for a relatively short period of time. Rather if we use waste glass in concrete, it provides a long term solution.

Waste Glass as Fine Aggregate

Concrete is the most widely and extensively used material in the world. The fine aggregate used in the production of concrete is becoming highly expensive and scarce day by day. The construction industry is growing with major trust on infrastructure and the demand for sand is also increasing. The overuse of river sand for construction has many undesirable environmental and social consequences. The natural sand deposits are depleting and illegal sand mining is becoming uncontrollable issue. In-stream sand mining has become a common practice and resulted in a mushrooming of river sand mining activities which have given rise to various problems that require urgent action by the authorities. Sand is required for development of the country, but at the same time the threats posed due to sand mining cannot be ignored. Uncontrolled illicit river sand mining creates a level of damage to rivers that are ecologically irreversible even in the long run. Hence decisive steps have to be taken and alternate solutions are to be found out for sand mining, without disturbing the environment.

As there is huge demand for the sand in the construction industry the river sand resources are depleting. Sand mining from our rivers has become objectionably excessive. It has now reached a stage where it is killing all our rivers day by day. So sand mining has to be discouraged so as to save the rivers. As natural sand deposits are depleting day by day, the use of alternatives to sands as a replacement fine aggregate in concrete is receiving increased attention. As a solution for this, various alternatives are explored and used.

II. Experimental Method

This project is done in total of two stages. In stage one, fine aggregate is replaced by different percentages of crushed waste glass and properties like workability, density, compressive strengths, split tensile strengths and flexural strengths were studied. In the second stage, cement was replaced by silica fume to compensate the reduction in the strengths of concrete with the increase in the percentages of crushed waste glass. This project consists of total of 24 concrete mixes. For each mix, compressive strength, split tensile strength and flexural strengths were studied. Cubes of size 150 mm X 150 mm X 150 mm were casted to measure the compressive strength of concrete, cylinders of diameter 150 mm and length 300 mm were casted to measure split tensile strength of concrete and beams of size 100 mm X 100 mm X 500 mm were casted to measure flexural strength of concrete.

Cement

Ordinary Portland cement of 53 grade and Zuari brand, satisfying the requirements of IS: 12269-1987 was used throughout this project work.

Fine Aggregate

Fine aggregate used in this project is natural river sand which was collected from the beds of river Tungabhadra. According to IS 383-1970, the fine aggregate used, conforms to Zone II.

Coarse Aggregate

Coarse aggregate used in this project were well graded angular crushed stones. The maximum nominal size of aggregates is 20 mm.

Crushed Waste Glass

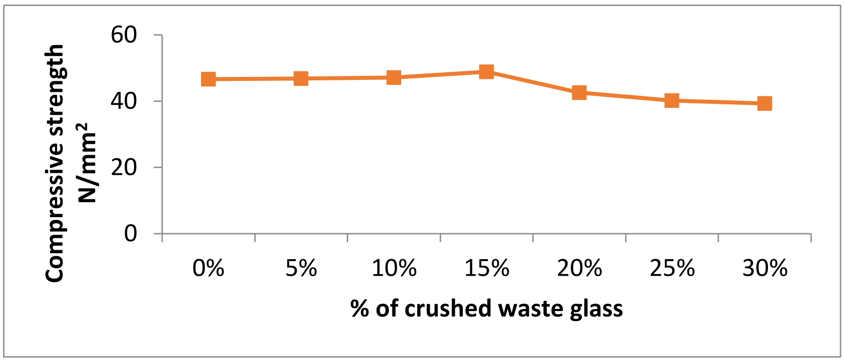
The waste glass used in this project is crushed waste bottles which was collected from the scrap. After collecting, all the unwanted materials, like labels, corks were removed. Then it was washed and crushed into required sizes. Glass powder passing through 1.18 mm sieve and retained on 150µ sieve is used as partial replacement for fine aggregate. Glass powder passing through 90µ is used as partial replacement for cement.

III. Results and Discussion

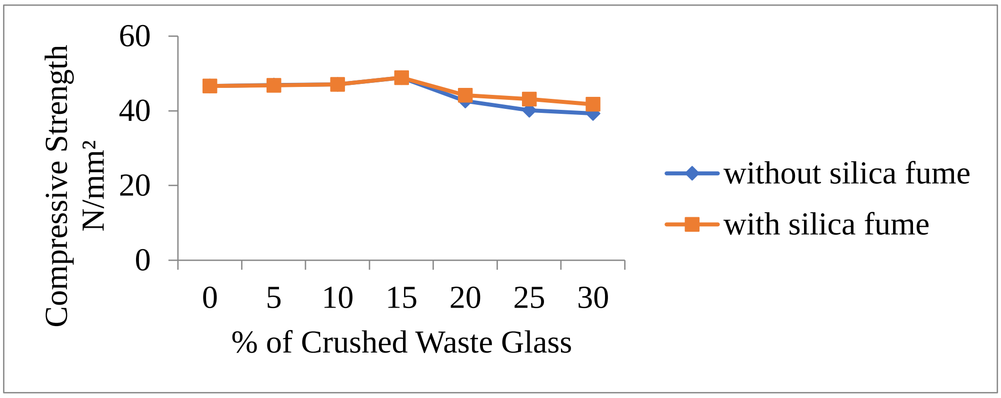
Compressive Strength

Compressive strength of concrete increased from 0% to 15% replacement and thereafter decreased, when fine aggregate was replaced by crushed waste glass from 0% to 30%. When cement was replaced by glass powder from 0% to 30%, compressive strength increased up to 10% replacement and thereafter decreased.

Compressive Strength of concrete after 28days of water curing for FA replacement



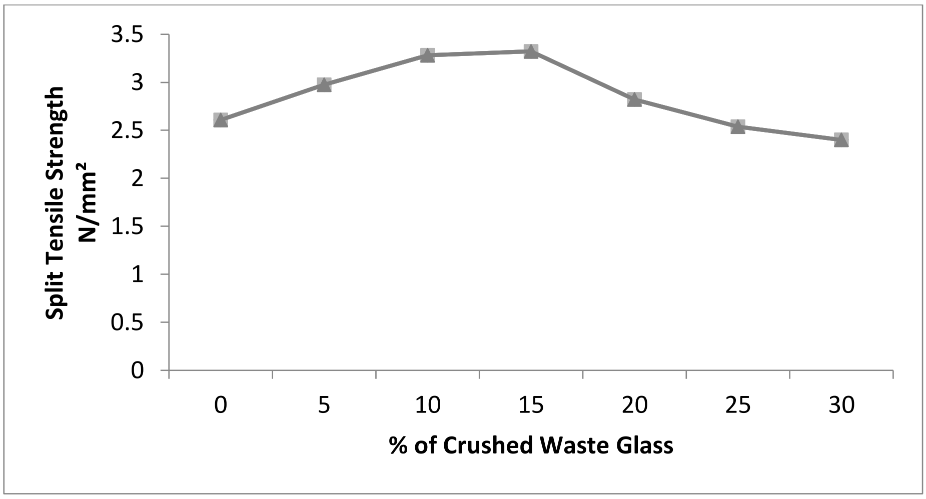
Compressive Strength of concrete after 28days of water curing for fine aggregate replacement by adding silica fume



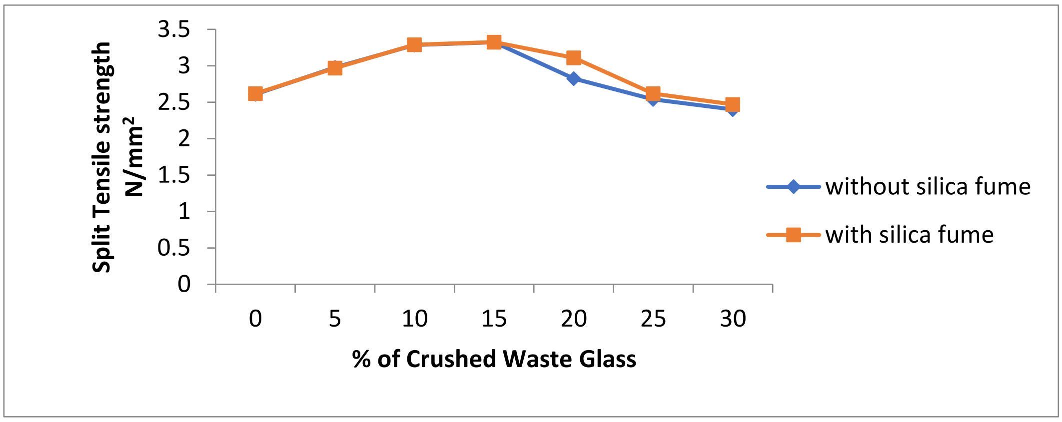
SPLIT TENSILE STRENGTH

Split tensile strength increased up to 15% replacement of fine aggregate by crushed waste glass and then decreased gradually up to 30%. Silica fume is added as partial replacement for cement from 20% replacement of crushed waste glass and split tensile strength is enhanced.

Split Tensile Strength of concrete after 28days of water curing for fine aggregate replacement



Split Tensile Strength of concrete after 28days of water curing for fine aggregate replacement by adding silica fume

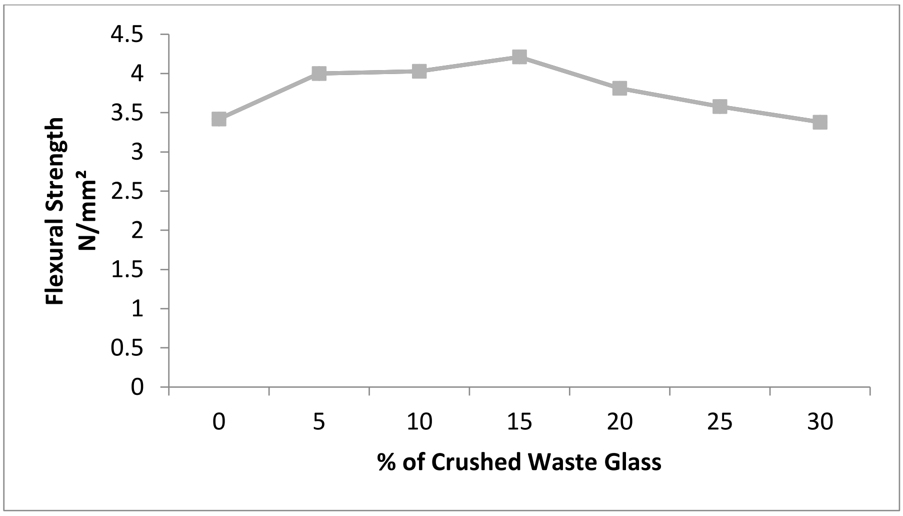


Variation of Split Tensile strength with & without Silica Fume after 28 days

FLEXURAL STRENGTH

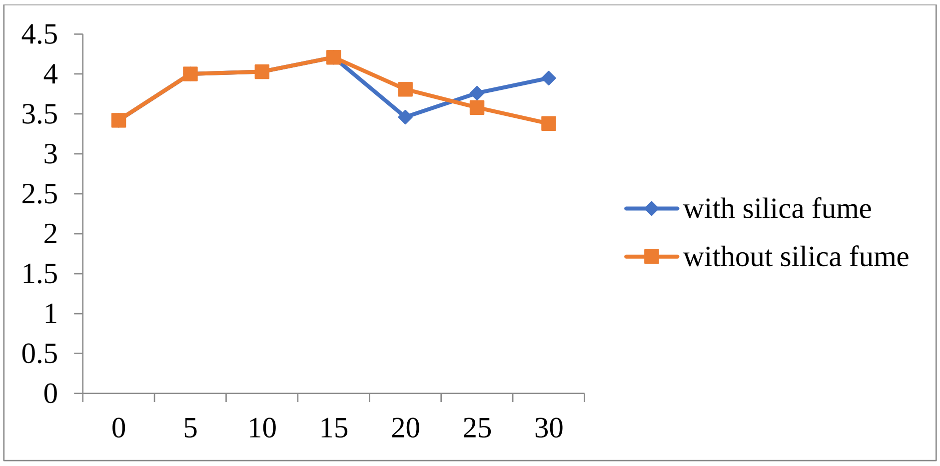
Flexural strength also increased up to 15% replacement and on further increase in the percentage of replacement, this strength got decreased. This strength has also enhanced by adding 10% silica fume as partial replacement for cement.

Flexural Strength of concrete after 28days of water curing for fine aggregate replacement



Graph between Flexural strength and % of crushed waste glass after 28 days

Flexural Strength of concrete after 28days of water curing for fine aggregate replacement by adding silica fume



Variation of Flexural strength with and without Silica Fume after 28 days

CONCLUSIONS

The following are the conclusions obtained after doing this project work.

Conventional concrete shown at 28 days Compressive strength as 46.66 $N/mm^{2,}$ Split tensile strength of 2.61 N/mm^2 and Flexural strength of 3.42 N/mm^2.

- When fine aggregate was replaced by crushed waste glass in percentages of 0%, 5%, 10%, 15%, 20%, 25% and 30%, then compressive, split tensile and flexural strengths increased up to15% replacement and thereafter decreased up to 30% replacement.
- For 15% replacement of fine aggregate by crushed waste glass, the increase in the percentages of compressive strength, split tensile strength and flexural strength after 28 days with respect to reference mix is 4.75 %, 27.31 % and 23.10 % respectively.
- Density of concrete gradually increased up to 15% and then decreased, when fine aggregate was partially replaced with crushed waste glass.
- The optimum percentage of glass waste for fine aggregate replacement is 15%**.**

Future Scope of Study:

For many years, the recycling and waste management industry has struggled with the problem of identifying or developing reliable markets for broken glass. To date, only low value applications are available, which do not utilize the physical and other inherent properties of the glass. Recent research has made it possible to use such glass as aggregate in concrete, either in commodity products, with the only objective being to utilize as much glass as possible, or in value-added products that make full use of the physical properties of colour-sorted crushed glass. Not only as a waste management solution for glass but also as coarse aggregate conservation in the environment applicability of glass in concrete had been proved with this study. Data presented in this Project reveals that there is great potential for the utilization of waste glass in concrete in several forms, including fine aggregate. The future scope of the current study can be extended to the Coarse aggregate and other architectural forms with concrete. Also, it is anticipated that it would provide much greater opportunities for value adding and cost recovery, as it could be used as a replacement for expensive materials such as granite, marble and terrazzo.

References

1. Adnan Al-Sibahy, Rodger Edwards " Mechanical and Thermal properties of novel lightweight concrete mixtures containing recycled glass and metakaolin" January 2012, Elsevier Journal.

2.Ahmad Shayan, AiminXu "*Value-added utilisation of waste glass in concrete"* July 2003, Elsevier Journal.

3. AlaaM.Rashad "*Recycled waste glass as fine aggregate replacement in cementitiousmaterials based on Portland cement"* August 2014, Elsevier Journal.

4. Caijun Shi a,b, KerenZheng, "*A review on the use of waste glasses in the production of cement and concrete*" January 2007, Elsevier Journal

5. Diego Romero, Jacqueline James, Rodrigo Mora, Carol D. Hays, "*Study on the mechanical and environmental properties of concrete containing cathode ray tube glass aggregate"* March 2013, Elsevier Journal

6. Dr.A.Leema Rose, Megha.S.Saji "*Using Glass Waste as a partial replacement for Fine Aggregate on the strength of concrete"* Vol.3.,Issue.1.,2015, International Journal of Engineering Research.

7. Dr.G.Vijayakumar, Ms.H.Vishaliny, Dr.D.Govindarajulu " *Studies on Glass Powder as partial replacement of Cement in Concrete production*" Volume 3, Issue 2, February 2013, International Journal of Emerging Technology and Advanced Engineering.

8. Dr. Haider K. Ammash, Muhammed S. Muhammed, Ali H. Nahhab, "*Using of waste glass as fine aggregate in concrete*" Vol 2, 2009, Al-Qadisiya Journal For Engineering Sciences.

9. Faseyemi Victor Ajileye,"*Investigations on Microsilica (Silica Fume) As Partial Cement Replacement in Concrete",* January 2012, Global Journal of researches in engineering Civil And Structural engineering.

10. IS:10262-2009. Recommended guidelines for concrete mix design, New Delhi, India : Bureau of Indian Standard.