RESEARCH ARTICLE OPEN ACCESS

Effective Utilisation of Waste Glass in Concrete

Sameer Shaikh[*],S.S.Bachhav[**],D.Y. Kshirsagar[***]

[*]Master of Engineering Student, (Department of Civil Engineering, S.S.V.P.S. Collage of engineering Dhule, Maharashtra, India)

[**]Associate Professor, (Department of Civil Engineering, S.S.V.P.S. Collage of engineering Dhule, Maharashtra, India)

[***]Head of Department, (Department of Civil Engineering, S.S.V.P.S. Collage of engineering Dhule, Maharashtra, India)

ABSTRACT

Glass is a widely used product throughout the world; it is versatile, durable and reliable. The uses of glass ranges drastically, therefore waste glass is discarded, stockpiled or land filled. About million tons of waste glass is generated and around large percent of this glass is disposed of in landfills. This pattern has influenced environmental organizations to pressure the professional community to lower the amount of glass being discarded as well as find use to the non-recycled glass in new applications. In relation, the recycling of waste glass as a component in concrete gives waste glass a sustainable alternative to land filling and therefore makes it economically viable.The proposed study of utilising waste glass powder(GLP) in concrete as partial replacement of cement as well as the use of crushed glass particles(CGP) retained on 1.18mm & 2.36mm IS sieve as a partial replacement to sand, which offers important benefits related to strength of concrete as well as it is eco-friendly. Recycling of mixed-colour waste glass possesses major problems for municipalities, and this problem can be greatly eliminated by re-using waste glass as sand/cement replacement in concrete. Moreover, re-using waste materials in construction can reduce the demand on the sources of primary materials.In this project the attempts have been made to partially replace the cement as well as sand by waste glass powder and crushed glass particles with equal combination by 5% interval up to 20% replacement and observe its effect on the strength of concrete after 7 days and 28 days of curing.

***Keywords*:** -compressive strength,crushed glass particles, flexural strength, Glass powder,partial replacement, split tensile strength,

I. INTRODUCTION

Concrete is a stone like material obtain by designing a carefully proportioned mixer of cement, sand and gravel or other aggregates and water to harden in forms of shape and dimensions of desired structure. Sand is one of the main constituents of concrete, it acts as filler in concrete. Concrete is most widely used man made construction material and its demand is increasing day by day. The interest of the construction community in using waste or recycled materials in concrete is increasing because of the more stress is given on sustainable construction the waste glass from in and around the small shops is packed as a waste and disposed as landfill.When mixed-color waste glass, is crushed to about the particle size of cement and used in concrete as replacement for about20% of cement, improves the moisture barrier qualities, durability, and mechanical performance of concrete [1]. Glass is an inert material which could be recycled and used many times without changing its chemical property [2]. Besides using waste glass as cullet in glass manufacturing waste glass is crushed into specifiedsizes for use as aggregate in various applications such

as water filtration, sand cover for sport turf and sand replacement in concrete. Since the demand in the concrete manufacturing is increasing day by day, the utilization of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of the bridge piers, etc as a common treat. Attempts has been made in using crushed glass as fine aggregate in the replacement of river sand and glass powder as a partial replacement to cement. The crushed glass was also used as coarse aggregate in concrete production but due to its flat and elongated nature which enhances the decrease in the workability and attributed the drop in compressive strength, since waste glass still gave us a problem, maybe we try to use it in the concrete mix and find the result whether because if the results gives us a good value, then it will benefit to our earth because we can reduce one portion of our waste that cannot dissolved by natural or normal recycling ways [5].The use of recycled waste glass in Portland cement and concrete has attracted a lot of interest worldwide to the increased disposal costs and environmental cement. Glass used for containers, jars

and bottles is soda lime silica counts for 80% of the recycled glass [6].Glass is a fully recyclable material. It can be recycled without any loss of quality. There are many examples of successful recycling of waste glass, as a cullet in glass production, as raw material for the production of abrasives, in sand-blasting, as a pozzolanic additive, in road beds, pavement and parking slots, as raw materials to produce glass pellets or beads used in reflective paint for highways, to produce fiberglass, and as fractionators for lighting matches and firing ammunition.[7]During the last decades it has been recognized that Sheet Glass waste is of large volume and is increasing year by year in the Shops, construction areas and factories. Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down [8] Glass is amorphous material with high silica content, thus making it potentially pozzolanic when particle size is less than 75µm.Studies have shown that finely ground glass does not contribute to alkali – silica reaction. [9].Glass is very valuable to be 'thrown away' as aggregate: glass should be recycled as glass.' Closed loop recycling is thought to be a more viable option in terms of sustainability and cost. Meanwhile demand for waste glass aggregate largely depends on location, transport costs and scarcity of natural aggregates [10].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 [11].

II. Experimental Investigation

Experiment were conducted on concrete prepared by partial replacement of cement by waste glass powder of particle size 90 micron and crushed glass particles retained on 2.36mm and 1.18 mm IS Sieve. The waste glass powder (GLP) and crushed glass particles (CGP)were replaced by 5%, 10%, 15% and 20% of the cement and natural sand respectively in the same mixture of concrete.

2.1. Materials used

I. Cement, water and Aggregates:Concrete is prepared by mixing various constituents like cement, aggregates, watered which are economically available. Ordinary Portland cement of 43grade conforming to IS 8112 was used throughout the work. The coarse aggregate used in this investigation was 20mm size crushed stone. Two size of fine aggregate was used; one retained on 2.36 mm and second retained on 1.18 mm IS sieve.

II. Glass powder:The Land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. So we use the waste glass in concrete to become the construction economical as well as eco-friendly [3].Waste glass available locally in Dhule shops is been collected and made into glass powder. Glass waste is very hard material. Before addingglass powder in the concrete it has to be powdered to desired size. In this studies glass powder was made manually by using impact container and then passing through 90 micron IS sieve.in table no. 1 &2 the physical and chemical properties are presented.

Fig-1Glass powder and crushed glass particles

Table No- 1

Physical properties of glass powder

Sr.No.	Physical properties	Values
01	Specific gravity	2.7
02	Fineness Passing 150µm	100 %
03	Fineness Passing 90µm	98 %

Table No- 2

Chemical properties of glass powder

Sr.No.	Chemical properties	Values
01	pH	10.30
02	Colour	white

2.2 Mix proportion and of Testing specimens

I. Mix Design:The concrete mix design was proposed by using Indian Standard for control concrete. The grade was M20. The mixture will be prepared with water to cement ratio of 0.50.The mix proportion of materials is 1:2.6:3.7 as per IS 10262-2009.

The replacement levels of cement by glass powder, and natural sand by crushed glass particles were used in terms of 5%, 10%, 15% and 20% in concrete. The limit of percentage replacement is restricted up to 20 % because in most of research paper the maximum result was obtained up to 20% replacement. Chemical admixture is not used here.

II. Durability Test:The concrete prepared with various percentage replacement of the cement such as 5%,10%,15% and 20% was cured under normal condition as per IS recommendation and were tested at 7 days and 28 days for determining the

compressive , tensile and flexural strengthand also compared with the test results of conventional concrete Fig.2,3,&4.

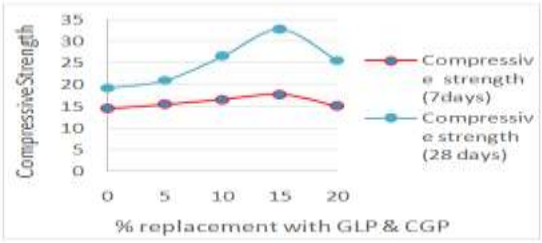

Fig-2Comparative compressive strength of various percentagereplacement of GLP & CGP

From Fig. 2, it is observed that the concrete has achieved its maximum compressive strength at 15% replacement of GLP & CGP after 28 days of curing.

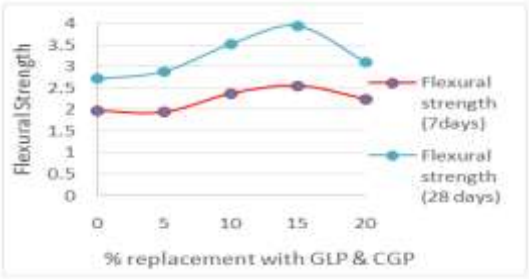

Fig-3Comparative flexural strength of various percentage replacement of GLP & CGP

From Fig. 3 it is observed that the concrete has achieved its maximum flexural strength at 15% replacement of GLP & CGP after 28 days of curing.

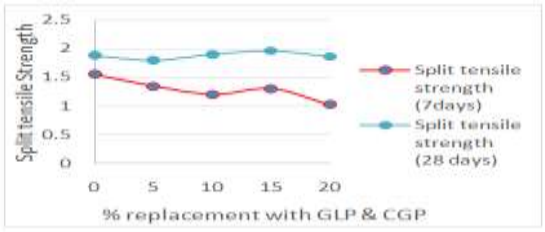

Fig-4Comparative split tensile strength of various percentage replacement of GLP & CGP

From Fig. 4 it is observed that the concrete has achieved its maximum split tensile strength at 15% replacement of GLP & CGP after 28 days of curing.
III. Workability Test:Workability is the property of freshly mixed concrete that determines the ease with which it can be properly mixed,placed, consolidated and finished without segregation. The workability of fresh concrete was measured by means of the conventional slump test as per IS; 1199(1989). Before the fresh concrete was cast into moulds, the slump value of the fresh concrete was measured using slump cone. In this project work, the slump value of fresh concrete was in the range of 95mm to 100mm.

III. RESULT AND DISCUSSION

The compressive strength test on both conventional and glass added concrete was performed on standard compression testing machine of 3000kN capacity, as per IS: 516-1959.Totally 35 numbers of cubical specimens of size 150mm X150mmX150mm, and tested for the compressive strength, 35 number of cylinder of diameter 150 mm and length 300 mm was casted and tested for the Split tensile strength and 35 number of beam of size 100mm x100mm x500 mm was casted and tested for flexural strength at the age of 7 days and 28 days. Each of the strength test data corresponds to the mean value of the compressive strength of three cubes. At 28 days the GLP & CGP shows a compressive strength of 32.88N/mm^2, 3.94N/mm^2 flexural strength, and 1.96 N/mm^2 split tensile strength at 15% cement and sand replacement. No sudden increase in strength was seen after 7 days of curing. After 28 days of curing concrete hasgained more strength than theconventional concrete (zero percent replacement).

IV. CONCLUSION

As a conclusion, all the objectives of this study are achieved, concrete with using waste glass powder and crushed glass particles has a very high workability from control sample. This result achieved from the slump test that use of waste glass powder were will increase the workability of concrete. In term of strength, concrete with using waste glass powder averagely have higher strength at 28 days.
Conventional concrete shows at 7 days compressive strength as 14.51 N/mm^2, split tensile strength of 1.55 N/mm^2 and flexural strength of 1.97 N/mm^2.Conventional concrete shows at 28 days compressive strength as 19.25 N/mm^2, split tensile strength of 1.88 N/mm^2 and flexural strength of 2.72 N/mm^2.

1. Replacement of glass powder in cement as well as crushed glass particles in sand by 5%, 10%, 15% and 20% increases the compressive strength after 28 days by 9.25%, 38.50%, 70.80%, and 33.09% respectively.
2. Replacement of glass powder in cement and crushed glass particles in sand by 15% increases the split tensile strength after 28 days by 4.25%.
3. Replacement of glass powder in cement by 5%, 10% 15% and 20% increases the flexural strength after 28 days by 5.88%, 30% and 44.85%, and 13.97% respectively.
4. Glass powder concrete increases the compressive, tensile and flexural strength effectively at 15% combine replacement when compared with conventional concrete.
5. Very finely ground glass has been shown to be excellent filler and may have sufficient

pozzolonicproperties to serve as partial cement replacement, also crushed glass particles which is retained on 3.36mm and 1.18 mm IS sieve shows a good filler material as well.

REFERANCES

[1] Ahmad Shayan and AiminXu, Performance of glass powder as a pozzolanic material in concrete,A field trial on concrete slabs.*Cement and Concrete Research36* (2006) 457–468.

[2] AiminXu and Ahmad shayan, Value – added utilization of waste glass in concrete, *Cement and concrete research*, *volume 34*, 81- 89, (2004)

[3] Dhanaraj Mohan Patil, andDr. Keshav K. Sangle experimental Investigation of Waste Glass Powder as Partial Replacement of Cement In Concrete Issn: 2231 –5721, *Volume.-02, Issue-1*, (2013).

[4] GunalaanVasudevan,and Seri GanisKanapathypillay (2013). Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement.*Volume-02, Issue-12*,pp-175-181.

[5] J.M. Khatib, E.M. Negim,and H.S. Sohl and N. Chileshe. Glass Powder Utilisation in Concrete Production, *European Journal of Applied Sciences* (4) 173-176, (2012)*ISSN 2079-2077*.

[6] K.Madhangopal,B.NagakiranandS.R.Sraddha, and G.VinodkumaP.Thajun. Study the Influence of Waste Glass Powder on the Properties of Concrete.e-*ISSN:2278-1684,p-ISSN: 2320-334X, Volume11,Issue 2* Ver. VI (Mar- Apr. 2014), PP 34-38.

[7] M. Mageswari, and Dr. B.Vidivelli.The Use of Sheet Glass Powder as Fine Aggregate Replacement in Concrete.*The Open Civil Engineering* (Journal, 2010), 4, 65-71.

[8] EsraaEmam Ali, Sherif H. Al-TersawyRecycled glass as a partial replacement for fine aggregate in self compactingconcrete Construction and Building materials 35(2012) 785-791.

[9] 9.Sunny O. Nwaubani and Konstantinos I. Poutos. The Influence of Waste Glass PowderFineness on the Properties of Cement Mortars."*Volume 2, Issue 2*, (February 2013).

[10] M. Iqbal Malik, Muzafar Bashir Study of Concrete Involving Use of Waste Glass as Partial Replacement of Fine AggregatesIOSR Journal of Engineering *Volume 3, Issue 7* (July. 2013), PP 08-13.