International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
ISSN: 2457-0362

Experimental Study on Partial Replacement of Sand with Glass Powder as Fine aggregate in Concrete

G. LAKSHMI TANUJA, Email Id: lakshmitanuja1996@gmail.com
A. RAVI KUMAR, Email Id: ravi06081991@gmail.com
A.M REDDY MEMORIAL COLLEGE OF ENGINEERING AND TECHNOLOGY
Narasaraopeta

Abstract: Disposal of more than 300 tones waste glass daily derived from post-consumer beverage bottles is one of the major environmental challenges for India, and this challenge continues to escalate as limited recycling channels can be identified and the capacity of valuable landfill space is going to be saturated at an alarming rate. For this reason, in the past ten years, a major research effort has been carried out to find practical ways to recycle waste glass for the production of different concrete products such as concrete blocks, self-compacting concrete and architectural mortar. Some of these specialty glass-concrete products have been successfully commercialized and are gaining wider acceptance. This paper gives an overview of the current management and recycling situation of waste glass and the experience of using recycled waste glass in concrete products in India. 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. The application of glass in architectural concrete still needs improvement. Laboratory experiments were conducted to further explore the use of waste glass as fine aggregates for ASR (Alkali-Silica-Reaction) alleviation as well as the decorative purpose in concrete. The study indicated that waste glass can effectively be used as fine aggregate replacement (up to 40%) without substantial change in strength.

***Keywords** -Alkali-Silica-Reaction, self-compacting concrete, fine aggregate.*

1.INTRODUCTION

Concrete is an artificial conglomerate one made essentially of Portland cement, Water, and aggregates. concrete is the key material used in various types of construction, from the flooring of a hut to a multi storied high rise structure from pathway to an airport runway from an underground tunnel and deep-sea platform to a high rise chimneys and T V towers. In the last millennium concrete has demanding requirements both in terms of technical performance and economy while greatly varying from architectural masterpieces to the simplest of utilities. Concrete is the key component of civil constructions in the world.

This project aims to focus on the possibilities of using waste materials from different manufacturing activities in the preparation of innovative mortar and concrete. Glass powder stone industry generates both solid waste and stone slurry. Leaving the waste materials to the environment directly can cause environmental problems. Advance concrete technology can reduce the consumption of natural resources and energy sources, thereby less the burden of pollutants on the environment. We describe the feasibility of using the glass powder sludge dust in concrete production as partial replacement of cement. These materials, participate in the hydraulic reactions, contributing significantly to the composition and microstructure of hydrated product.

Presently large amounts of glass powder dust are generated in natural stone processing plants with an important impact on the environment and humans. This project describes the feasibility of using the glass powder sludge dust in concrete production as partial replacement of cement. In INDIA, the glass powder and granite stone processing are one of the most thriving industry the effects if varying glass powder dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated. The use of the replacement materials offers cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. In this project our main objective is to study the influence of partial replacement of cement with glass powder powder, and to compare it with the compressive strength of M40 concrete. We are also trying to find the percentage of glass powder powder replaced in concrete that makes the strength of the concrete maximum. Nowadays glass powder powder has become a pollutant. So, by partially replacing cement with glass powder powder, we are proposing a method that can be of great use in reducing pollution to a great extent.

Glass powder powder is collected from ceramic store in Ongole. The cost of the product is depending on the quantity of we taken from the store. After collecting the glass powder powder we should sieve the glass powder powder. We are using glass powder powder as a partial replacement of cement so we have sieved the glass powder powder with IS 90 Micron sieve. Cement we have taken for this project is 53 grade cement.

2. SCOPE OF WORK

The study of this project is to usage glass waste as fine aggregate in concrete in its preparation without loss in concrete properties by partially replacing it with glass powder powder is a waste material. So, the study leads to the managing the waste as well as sand usage reduction involving innovative steps taken by the works already done in this project.

3. MATERIALS USED

Cement:

Cement used in the investigation was found to be Ordinary Portland Cement (53 grade) confirming to IS: 12269 – 1987.

Fine Aggregate:

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

The fine aggregate used was obtained from a nearby river course. The fine aggregate confirming to zone – II according to Is 383-1970 was used.

Coarse aggregate:

The coarse aggregate used is from a local crushing unit having 20mm nominal size. The coarse aggregate confirming to 20mm well-graded according to IS:383-1970 is used in this investigation.

Glass powder:

Glass powder is type of metamorphic rock that forms from limestone, dolomite, or older glass powder under certain conditions. These conditions are heat and pressure over a period of time inside the earth's crust.

The application of heat and pressure force the limestone to change. In a process called recrystallization, the limestone is altered to form coarse grained calcite. The composition of the resulting glass powder will be affected by the different impurities that may be present in the limestone before recrystallization takes place. Depending on the temperature and silica impurities, quartz, diopside or forsterite may be formed in the calcite. If water is present during the formation then talc, serpentine and a variety of other minerals may form. Should iron, alumina, and silica be present during the recrystallization, then this could result in the formation of magnetite and hematite.

Figure.1: Glass powder powder

Glass powder is composed primarily of calcite, dolomite, or perhaps serpentine and other similar minerals. The exact chemical composition of glass powder will greatly vary depending on the location and the minerals or impurities present in the limestone during recrystallization. Typically, glass powder is composed of the following major constituents:

Oxides	% of Content
Lime (CaO)	38-42%
Silica (SiO_2)	20-25%
Alumina (Al_2O_3)	2-4%
Various oxides (Nao and Mgo)	1.5-2.5%
Various carbonates ($MgCO_3$ and others)	30-32%

Table 1: Chemical composition of glass powder powder

In addition to the major constituents, glass powder can have many different mineral impurities of various percentages. These include: Chert, Garnet, Hematite, Microcline, Talc, Forsterite, Muscovite, Biotite, Tremolite Actinolite, and Quartz. The presence of some of these impurities are responsible for giving glass powder its color. Very pure calcite glass powder will

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
IJARST
ISSN: 2457-0362

always be white in color so if few impurities are present in the glass powder then it will typically be white. Impurities of hematite can give glass powder a reddish color. Limonite will give glass powder a yellow color and serpentine will give glass powder a green color. While glass powder is a strong material, there are some conditions that it cannot stand. Unlike granite, glass powder can't take chemical weathering such as acid rain or any type of acid. The glass powder will begin breaking down as a result of the acid. It is also not as easily mined as granite as it is difficult to cut into large sheets.

4. EXPERIMENTAL WORK

Adopted Mix design - M40

A. Mixed design proportions for Glass powdered Concrete

a. In this research work 15 Standard cubic specimens of size 150mm (6 sample for each percentage of glass powder) were casted for the compressive strength of concrete and it was kept under curing for 7 & 28 days of age. Total cubes for compressive strength testing were 36 (6 cubes * 6 proportions).
b. In this research work 10 standard beams of size were casted for flexural strength of concrete and it was kept under curing for 28 days of age. Total cubes for flexural strength testing were 18 (3 beams * 6 proportions).

Water (liters)	22.644
Cement (kgs)	53.582
Fine aggregate(kgs)	53.25
Coarse aggregate(kgs)	176.25
Glass powder powder(kgs)	7.654

Table .2: Total quantity for entire project

% glass powder	Glass powder (gms) for 6cubes
0%	0
5%	510.3
10%	1020.6
15%	1530
20%	2014.2
25%	2551.5

Table.3: Glass powder powder at different percentages

B. Sample Production

The cement, fine and coarse aggregates were weighted according to mix proportion of M40. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.45. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage

IJARST
International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

was taken out, loosened and again added to the mix.

For the second series of the mixture, the Glass powder was added at 5%, 10%, 15%, 20% and 25% by weight of Sand (Fine aggregates). Immediately after mixing, slump test was carried out for all the concrete series mixture. A standard 150×150×150mm cube specimens and 100×100×500mm beam specimen were casted.

The samples were then stripped after 24hours of casting and are then be ponded in a water curing. As casted, a total of (36) 150×150×150mm cubes and (12) 100×100×500mm beams specimens were produced.

C. Test for Fresh Properties of Concrete (Workability Test)

Slump Test:

which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the playability of the concrete. It is not a suitable method for very wet or very dry concrete. It does not measure all factor contributing to workability. The slump test was carried in accordance with B.S:1882 PART2:1970.

D. Test For Harden Properties of Concrete

a. Compressive Strength of Concrete

The compression test was conducted according to IS 516-1959. This test helps us in determining the compressive strength of the concrete cubes. The obtained value of compressive strength can then be used to assess whether the given batch of that concrete cube will meet the required compressive strength requirements or not. For the compression test, the specimen's cubes of 15 cm x 15 cm x 15 cm were prepared by using hwa concrete as explained earlier. These specimens were tested under universal testing machine after 7 days, 14 days and 28 days of curing. Load was applied gradually at the rate of 140kg/cm^2 per minute till the specimens failed. Load at the failure was divided by area of specimen and this gave us the compressive strength of concrete for the given sample.

Figure.2: Curing of cubes

b. Flexural Strength of Concrete (IS:516-1959)

The beam specimens were tested on universal testing machine for two-point loading to create a pure bending. The bearing surface of machine was wiped off clean and sand or other material is removed from the surface of the specimen. The two point bending load applied was increased continuously at a constant rate until the specimen breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. The modulus of rupture depends on where the specimen

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
IJARST
ISSN: 2457-0362

breaks along the span. Beam dimensions are 500mm×100mm×100mm. if the specimen breaks at the middle third of the span then the modulus of rupture is given by,

$$f_{rup} = \frac{Pl}{bd^2}$$

Where; P = load, d = depth of the beam, b = width of the beam.

5. RESULTS & DISCUSSIONS

A. Results for Cement, Aggregates & Glass powder

Properties	Results
Specific gravity	3.15
Standard consistency	31%
Initial setting time	38minutes
Final setting time	560minutes
Fineness	7%

Table .4: Properties of cement

Properties	Results
Specific gravity	2.78
Fineness modulus	2.71%

Table.5: Properties of fine aggregate

Properties	Results
Specific gravity	2.84
Water absorption	0.25

Table.6: Properties of coarse aggregate

Properties	Results
Specific gravity	2.65
Fineness modulus	2.7%

Table.7: Properties of glass powder powder

B. Workability of the concrete (Slump test)

Water cement ratio	Slump in mm
0.5	27
0.6	19
0.7	86

Table.8: Slump cone results

C. COMPRESSIVE STRENGTH

Three cubes of same mix proportion but different % variation of Glass powder powder. These are kept at a temperature of 27±2ºC for 24 hours. At the end of the period cubes are immersed in clean fresh

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
ISSN: 2457-0362

water. The cubes are kept in water until time of testing. These cubes are tested for their compressive strength after 7 and 28 days curing in a compression testing machine. The load at failure is noted and compressive strength is calculated. For 7 days and 28 days are as follows:

% of Glass powder	Compressive Strength	
	7 Days	28 Days
0	31	41.02
5	32.32	41.63
10	32.54	41.75
15	33.5	44.92
20	32.6	43.85
25	32.81	42.82

Table.9: Compressive strength values for 7 &28 days curing

Figure 3 graphically represents the compressive strength of concrete with partial replacement of fine aggregate with glass powder powder at 7 and 28 days respectively. Compressive strength of glass powder powder Concrete is higher than that of normal concrete at some percentages as shown below.

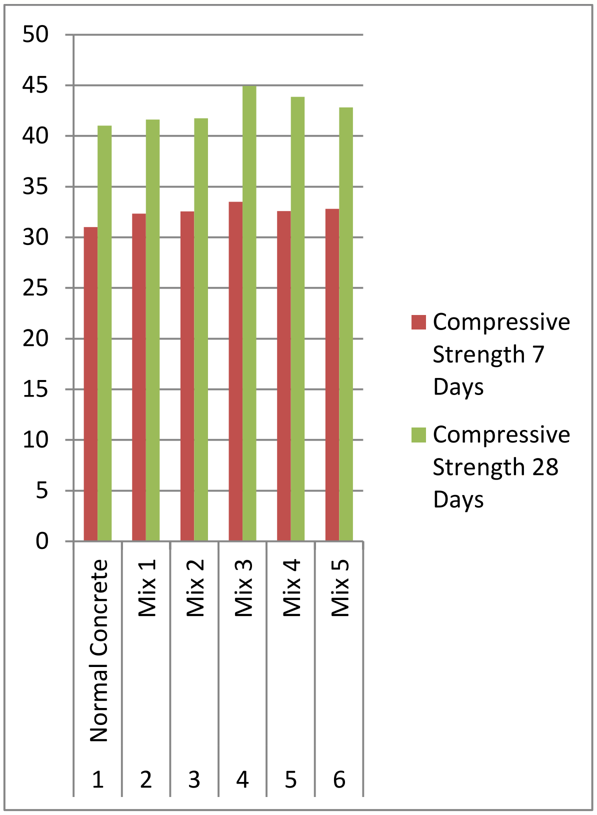

Figure.3: Compressive strength of concrete results at different % of glass powder powder.

D. FLEXURAL STRENGTH

Three beams of same mix proportion but different % variation of Glass powder powder. These are kept at a temperature of 27±2ºC for 24 hours. At the end of the period cubes are immersed in clean fresh water. The beams are kept in water until time of testing. These beams are tested for their flexural strength after 28 days curing in a universal testing machine. The load at failure is noted and flexural strength is calculated. For 7 days and 28 days are as follows:

S.No	Type of	% of	Flexural

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

	Mix	Glass powder Powder added	Strength 28 Days
1	Normal Concrete	0	8.12
2	Mix 1	5	8.24
3	Mix 2	10	8.32
4	Mix 3	15	12.1
5	Mix 4	20	10.52
6	Mix 5	25	9.47

Table.10: flexural strength values for 28 days curing

Figure 4 graphically represents the flexural strength of concrete with partial replacement of fine aggregate with glass powder powder at 28 days curing . flexural strength of glass powder powder Concrete is higher then that of normal concrete at some percentages as shown below.

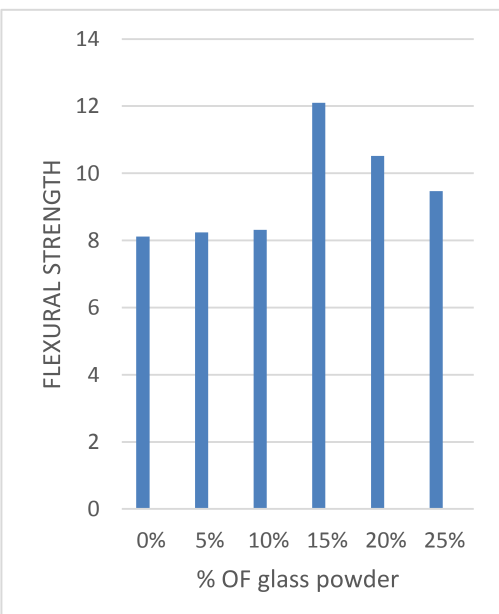

Figure. 4 Flexural strength of concrete results at different % of glass powder powder

6. CONCLUSION

a. Based on experimental investigation the following conclusion are done Addition of Glass powder to the concrete mix decreases the workability as compared to normal concrete mix. More than 15% GLASS POWDER POWDER added to the concrete mix decreases the workability of concrete compared to normal concrete mix.

b. Compressive strength of Glass powder concrete is higher than that of normal concrete mix at percentages above 15%. More than 15% of glass powder replacing in fine aggregate the compressive strength values decreasing.

c. flexural strength of Glass powder concrete is higher than that of normal concrete mix at percentages above 15%. More than 15% of glass powder replacing in fine aggregate the compressive strength values decreasing.

d. Adding partial replacement of Glass powder to concrete mix, the Cost of construction is less compared to normal concrete.

e. Due to glass powder dust, it proved to be very effective in assuring very good cohesiveness of mortar and concrete. From the above study, it is concluded that the glass powder dust can be used as a replacement material for fine aggregate and 15 to 20% replacement of glass powder dust gives an excellent result in strength aspect and quality aspect.

f. The results showed that the substitution of 15 to 20% of the cement content by glass powder dust induced higher compressive strength. Test results show that this industrial waste is capable of improving hardened concrete performance up to 20%, enhancing fresh concrete behavior and can be used in plain concrete.

7. FUTURE WORK

It is recommended for future studies that the research on use of glass powder powder as to require to extend to a wider perspective in order to know the actual behavior and effective utilization of glass powder powder which gives an idea to study more parameters and different governing effect of glass powder powder had engineering properties of fresh and hardened concrete. This study can show an alternative way of use of industrial wastes by incorporating them into concrete construction of course; the concept that the problem emerges from urbanization and the solution goes along with it can also be appreciated.

a. Therefore, the aim of this study is introduction of an environmentally friendly technology that can benefit the society and the nation.

b. this study, it is intended to arrive at a suitable mix proportion and percent replacement using industrial wastes locally available by partial replacement of the cement with glass powder powder.

8. REFERENCES

a. Lilli Prajapati, I. N. Patel, V. V. Agarwal "Analysis of the Strength and Durability of the Concrete with Partially Replaced By the Ceramic Slurry Waste Powder". IJETAE: International Emerging Technology and Advanced Engineering, Vol. 4, Issue 3, March- 2014, PP .725-729.

b. Amitkumar D. Raval, Dr.Indrajit N. Patel, Prof. Jayeshkumar Pitroda, "Reuse of Ceramic Industry Wastes for the Elaboration of Eco-efficient Concrete". International Journal of Advanced Engineering Research and Studies, Vol. 2, Issue 3, April- June, 2013 PP. 103–105.

c. F .Pacheco Torgal, A. Shahsavandi, S. Jalali, "Mechanical Properties and Durability of Concrete with Partial Replacement of Portland Cement by Ceramic Wastes". 1St International Conference, September 12th – 14th 2011.

d. Electricwala Fatima, Ankit Jhamb, Rakesh Kumar, "Ceramic Dust as Construction Material in Rigid Pavement". American Journal of Civil Engineering and Architecture, 2013, Vol. 1, No. 5, 112-116.

e. Jay Patel, Dr. (Smt.) B. K. Shah, Prof. P .Patel, "The Potential Pozzolana Activity of Different Ceramic Waste Powder as Cement Mortar Component (Strength Activity Index)"

International Journal of Engineering Trends and Technology (IJETT) – Volume 9, Number 6, Mar 2014.

f. ASTM C 125, Standard Terminology Relating to Concrete and Concrete Aggregate, 1994 Annual Book of ASTM Standards

g. Piccolroaz, D. Bigoni and A. Gajo, An elastoplastic framework for granular materials becoming cohesive through mechanical densification. Part I - small strain formulation. European Journal of Mechanics A: Solids, 2006, 25, 334-357.

h. Ceramic Manufacturing Industry, EUROPEAN COMMISSION, August 2007

i. César Medina1, M.I.Sánchez de Rojas, MoisésFrías and Andrés Juan, "Using Ceramic Materials in Ecoefficient Concrete and Precast Concrete Products", Spain

j. C. Medina Martínez, M.I.Guerra Romero, J. M. Morán del Pozo and A. Juan Valdés, "use of ceramic wastes in structural's concretes", 1st Spanish National Conference on Advances in Materials Recycling and Eco – Energy Madrid, 12-13 November 2009

k. David Pearce and Giles Atkinson, "The c D. Bigoni, Nonlinear Solid Mechanics: Bifurcation Theory and Material 611Instability. 2012, Cambridge University Press.

l. Gérard Valenduc, Patricia VendraminScience, "Technological Innovation and Sustainable Development", International Conference "Science for a Sustainable Society "Roskilde, 27-29/10/97

m. Hasnat Dewan, "Re-Defining Sustainable Human Development to Integrate Sustainability and Human Development Goals"Thompson Rivers University, Canada.

n. İ.B.TOPÇU And M.CANBAZ, "Utilization of crushed tile as aggregate in concrete", Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 31, No. B5, pp. 561-565, 2007.

o. Philip J. Vergragt, "How Technology Could Contribute to a Sustainable World", GTI Paper Series, 2006.

p. P.K. Mehta, Pozzolanic and Cementitious by products as mineral admixtures for concrete, fly ash, silica fume, slag and other mineral byproducts in concrete, ACI SP (79)(01)(1983)

q. Sustainable Development: An Introduction, Internship Series, Volume-I, Centre for Environment Education, 2007.

r. Corinaldesi, V., Giuggiolini, M. &Moriconi, G. (2002). Use of the rubble from building demolition in mortars. Waste Management, Vol. 22, pp. 893899.

s. IS: 383-1970 Indian Standard Specification for Coarse and Fine aggregates from natural source.

t. IS: 2386-1963 (All parts), Methods of tests for aggregate of concrete.

u. IS: 10262-1982 (Reaffirmed 2004): Recommended guidelines for concrete mix design, Bureau of Indian Standard, New Delhi-2004

v. IS: 1199 – 1959 : the slump is carried out as per Indian code book .

w. Shahulhameed.Mand a. Sekar.S.S. "Properties of Green Concrete Containing Glass powder and Marble Sludge Powder As Fine Aggregate" ARPN Journal of Engineering and Applied Sciences Vol. 4, No. 4, June 2009.

x. VeeraReddy.M."Investigations on stone dust and ceramic scrap as aggregate replacement in concrete" International Journal of Civil and Structural Engineering Volume 1, No 3, 2010.

y. VenuMalagavelli and RAO.P.N."High Performance Concrete With GGBS and RoboSand" International journal of civil and structural engineering Volume 1, no 3, 2010.