Strength of Concrete Partially Replacing Fine Aggregates by Glass Powder

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Abstract- **Concrete is used as the major material in construction industries. As the population of world increase rapidly, worlds faces the problem for habitation and waste by-product. As the waste is proportional to the population and there are restriction of natural resources used in concrete , this construction industry need some attention to use some other material so that they can be mix in concrete to get the new product which physical properties are same as the conventional one. Every year there is several tons of waste glasses created all over the world. Waste glass can be re-used as a raw material and it presents an option to save natural and non-renewable materials. The use of waste glass powder in concrete production can make the construction industry more ecological. In this research an attempt is taken to bring into play the waste glass in various proportions so that the final product property of concrete mixture is same as the control mix. Waste glass material was replace with aggregate in various percentages such as 2 , 5 , 7 and 10%. Reference concrete mix is also made for comparative reasons. Test results indicated that on 10% Replacement of Waste glass material intofine aggregate for M30 grade concrete, the compressive strength, observed were greater than the target mean compressive strength of normal M30grade concrete.**

I. INTRODUCTION

Concrete is versatile structural material in the modern construction industries. Now a day's concrete is utilized in abundance as man utilizes water for its survival. It has no doubt that with the development of world civilization the concrete will be the major construction material in the coming future.

The quality concrete will only perform best if it improves mainly upon workability, flow ability, durability& resistance to chemical attack/corrosion and reduction in uses of natural resources, w/c ratio& segregation in addition to the strength characteristic. Many researchers have performed research on mix design of concrete (normal and high strength concrete) for improving performance and strength but no researchers have performed for conventional so as to study the variation/ influence/ improvement/ enhance performance of it by using waste glass material has been replace in to aggregate for M30grade of concrete which grades are very much in use now a days.

Waste glass is a transparent material produced by melting admixture of materials such as silica, soda ash, and CaCO3at high temperature followed by cooling where solidification occurs without crystallization. Waste glass is widely used in our lives through manufactured products such as sheet waste glass, bottles, waste glassware, and vacuum tubing. Waste glass is an ideal material for recycling. The use of recycled waste glass saves lot of energy and the increasing awareness of waste glass recycling speeds up focus on the use of waste glass with different forms in various fields. One of its significant contributions is the construction field where the waste glass was reused for concrete production. The application of waste glass in architectural concrete still needs improvement. Several study have shown that waste glass that is crushed and screened is a strong, safe and economical alternative to sand used in concrete. During the last decade, it has been recognized that sheet waste glass waste is of large volume and is increasing year by year in the shops, construction area sand factories. Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down. The amount of waste glass is gradually increased over the years due to an ever-growing use of waste glass products. Most of the waste glasses have been dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. There is huge potential for using waste glass in the concrete construction sector. When waste glasses are reused in making concrete products, the production cost of concrete will go down.

Crushed waste glass or cullet, if properly sized and processed, can exhibit characteristics similar to that of gravel or sand. When used in construction applications, waste glass must be crushed and screened to produce an appropriate design gradation. Waste glass crushing equipment normally used to produce a cullet is similar to rock crushing equipment. Because waste glass crushing equipment in waste glass sector has been primarily designed to reduce the size or density of the cullet for transportation purpose sand for use as a waste glass production feedstock material, the crushing equipment used

is typically smaller and use less than conventional aggregate or rock crushing equipment .Waste glasses are used as aggregates for concrete However, the applications are limited due to the damaging expansion in the concrete caused by ASR between high-alkali pore water in cement paste and reactive silica in the waste glasses. The chemical reaction between the alkali in Portland cement and the silica in aggregates forms silica gel that not only causes crack upon expansion, but also weakens the concrete and shortens its life .Ground waste glass was used as aggregate for mortar sand no reaction was detected with fine particle size, thus indicating the feasibility of the waste glass reuse as fine aggregate in mortars and concrete. Estimated cost for housing is more and some construction materials like natural sand are also becoming rare. Waste glass is one of the main causes of environmental pollution as it cannot be used as land filling in low lying areas. Recycling is one of the main solutions to use such type of waste so that it is safely converted and we can save our motherland.Aggregate is mainly finding from river and now a day's become highly expensive. In this investigation aggregate is replaced with the waste glass powder in certain known quantity and compare the results with the standard known control mix. This waste glass is collected from local market and dumped sites of Chaksu, Jaipur city, Rajasthan. The waste glass is crushed in Los Angles machine in concrete laboratory. The waste glass material was replace with aggregate in various percentages such as 2, 5, 7, and 10%. Reference concrete mix is also made for comparative reason. Waste glasses are used as fine aggregates for concrete. In this study, an extensive experimental work was carried out to find the suitability of use of waste glass in concrete with the following objectives:

1. To study the workability of concrete mode using waste glass as partial replacement of coarse aggregate.
2. To study the compressive strength of concrete mode using waste glass as partial replacement of coarse aggregate.

II. LITERATURE REVIEW

Used waste glass waste, which is cylindrical in shape, prevents crack propagation in concrete structures. Their search carried out on waste glass powder by the authors, it was found that waste glass of particle size 1.18 to 2.36 mm produced the highest expansion where as low expansion was observed at smaller particle sizes(Idir.R,Cyr.M and Tagnit–Hamou.A,2009). It was observed that with a 30%replacement of cement by amber waste glass content of particle size 75µm along with fly ash, the compressive strength of concrete increase 25% at 7 days and 35% when tested for 28 days strength (Pereira de Oliveira. L.A, J.P.castro – Gomes, P. Santos, 2008). This effect provide sample evidence that both flyash and waste glass sand cane used together to produce concretes with relative high strength without any adverse reaction. Particle sizes under that threshold had no effect on length variations. Waste glass was ground to a particle size of 300mic.or smaller, the alkali silica reaction (ASR) induced expansion could be reduced. In fact, data reported in the literature show that if the waste glass is finely ground, under 75 µm. this effect does not occur and mortar durability is increased (Mageswari.L.M and B.Vidivelli,2010).The tensile and flexural strength are adversely affectedly the addition on waste to replace the virgin aggregate, at replacement level of 30 % for the fine aggregate, the tensile strength decreased by 3%, in comparison to the control conventional concrete. The use of recycled waste glass as aggregate greatly enhances the aesthetic appeal of the concrete. Recent research findings have shown that concrete made with recycled waste glass aggregate have shown better long term strength and better thermal insulation due to its better thermal properties of the waste glass aggregates(Samtur.H.R,1974, Seung Bum Parkand Bong-Chum Lee,2004). When tested for the compressive strength values at the 10 %,20%and 30% fine aggregate replacement by waste glass with 75mic.-4.75mm particle size were 3%, 8% and 5% above the value of conventional concrete. It has been concluded that 30%waste glass powder could be incorporated as cement replacement in concrete without any long-term detrimental effects. Upto50% of both fine and coarse aggregate could also be replaced in concrete of 40MPa strength grade with acceptable strength development properties by mixing the super plasticizer in it. Better results are achieved when the waste glass powder replaced either30 % or 40% of the sand with particles sizes ranging between 50 µm and 100 µm (Federio.L.M and ChidiacS.E,2001).

III. EXPERIMENTAL INVESTIGATION

As concrete is strong in compression stresses and weak in tension stresses, the present experiments are done to check the performance of concrete in compression flexural and split tensile strength. Experiments are done with reference to the IS 2386-1963, IS 516-1959 and IS 5819-1999 to check the performance with the control mix. In present study nominal mix taken is M30 and glass powder is replaced with 2, 5, 7, and 10% with the coarse aggregate.

A. Material Used

Cement- Ordinary Portland cement,43 grade specified as per the is 8112-2003 was used for casting the different grade of concrete. Potable water with pH value 7the water cement ratio w/c is fixed to 0.48 according to mix design code IS 10262:2009 and to maintain the slump KavassuPlast SP-431/ Shaliplast SP-431 admixture is used 0.8% by weight of cement. The initial and final setting time was observed by Vicat apparatus and it was found 32 and 590 minutes respectively. The soundness tested by Le-Chetelier was 8 mm.

Fine aggregate- Fine aggregate size range 150mc to 4.75mm.in present work Banash River (from district Tonk) sand was used with % finer 99.3 with specific gravity 2.62.

Coarse aggregates- Coarse aggregates are particles greater than 4.75mm, but generally range between 9.5mm to 37.5mm in diameter. In this case consider aggregate range 20mm and 10mm particles size was used with specific gravity 2.73.

Waste glass material: Waste glass available from nearby of locality is been collected and made into waste glass cullet in very fine. Waste glass waste is very hard material. Before adding fine waste glass cullet in the concrete it has to be crushed to desired size. Glass waste specific gravity is 2.58 and particle size is in the range of 300 micron to 75 micron.

Table no 1: physical and chemical properties of different material

Material	Specific Gravity	Colour
Fine aggregate	2.62	Light brown
Coarse aggregate	2.72	Greyish white
Glass waste bottle	2.58	Dark grey
Water	PH- 7	Colourless

B. Mix Design and Experimental Work

In present study work the nominal mix is taken M30 and it is mix design code IS 10262:2009. As discuss earlier the W/C ratio is fixed to 0.45 and to maintain the slump a suitable 0.8 % by weight of cement admixture is used. The replacement level of glass waste cullets with fine aggregate were used in terms of 2, 5, 7, and 10% and it is shown in table no 2.

Table 2: Mix proportions for coarse Aggregate replacement for M30

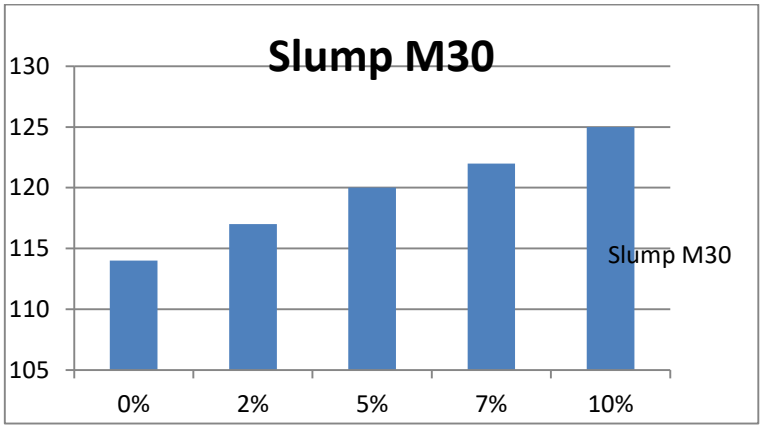
% of WGB	Cement Kg/m^3	Coarse aggregates Size, kg/m^3		Fine aggregates, Kg/m^3	WGB	Water, Kg/m^3	Admixture, Kg/m^3
		10mm	20mm				
0%	384	645.80	424.06	780.86	0	173	3.84
2%	384	581.30	424.06	765.24	15.61	173	3.84
5%	384	516.80	424.06	741.82	39.04	173	3.84
7%	384	452.30	424.06	726.20	54.66	173	3.84
10%	384	387.80	424.06	702.77	78.09	173	3.84

IV. RESULTS AND ANALYSIS

A. Workability Test

Table 3: Slump on Replacement of Waste glass material into Fine aggregate For M30 Grade

S.No.	Mix% (WGB + FA)	Slump (mm)
1	(0+100)	114
2	(2+98)	117
3	(5+95)	120
4	(7+93)	122
5	(10+90)	125



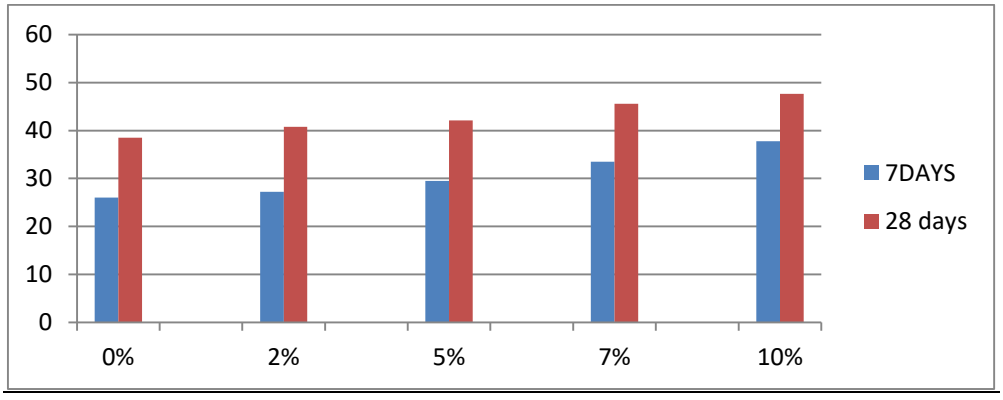
Graph 1: Effect of bottle waste glass material on Slump of Concrete (M30) on Replacement into Fine aggregate

B. Compressive Strength

The compressive strength of all the mixes was determined with cubical specimens of size 150mm(length) x 150mm(width) x 150mm(depth).The specimens were tested after curing period of both 7 days and 28 days fully submerged in water as per IS 516:1959 for the method of tests for strength of concrete.

Table 5: Camparision for 7 Days and 28 Days Compressive Strength of Cube on replacement of Waste bottle glass crushed material into Fine Aggregate For M30 Grade

% of WGB replacement	**Average For Compressive At 7days**	**Average For Compressive At 28 days**
	At 7 days Strength (N/mm2)	At 28 days Strength (N/mm2)
0%	26.01	38.52
2%	27.22	40.75
5%	29.50	42.10
7%	33.50	45.58
10%	37.75	47.67



Graph 2: Effect of Waste glass repalcement on Concrete of M30 Grade for 7 Days, 28 days Compressive Strength of Cube

V. CONCLUSION

1. The workability of concrete shows as slump of the concrete mix increase up to 20% replacement of control mix.
2. With increase in waste glass content, percentage water absorption decreases.
3. For getting the proper workable concrete a super plasticizer was used up to 0.8% of Cement percentage by weight of cement.
4. Fine waste glass bottle crushed fine material shows a pozzolanicbehaviour.
5. Compressive strength in concrete was found to increase in strength with 10% replacement higher strength achieved.
6. Density of concrete mix with WGB is decreasing with increase in replacement values.
7. Use of waste glass in concrete will reduce the disposal problems of waste glass and is environment friendly thus paving way for greener concrete.
8. Use of waste glass in concrete will preserve natural resources particularly river sand and thus shall make concrete construction industry sustainable

REFERENCES

[1] MohdSyahrulHisyamMohd Sani, Ahmad Rasidi Osman, and FadhluhartiniMuftah "Investigation on Compressive Strength of Special Concrete made withCrushed Waste glass". MATEC Web of Conferences.Websitehttp://www.matec-conferences.org.

[2] KoliNishikant, AiwaleNachiket, InamdarAvadhut, Abhishek Sangar"Manufacturing of Concrete Paving Block by Using Waste glass Material". International Journal of Scientific and Research Publications, Website:www.ijsrp.org (ISSN 2250-3153), Volume 6, Issue 6, June 2016.

[3] M. Adaway& Y. Wang "Recycled waste glass as a partial replacement for fine aggregate in structural concrete – Effects on compressive strength". Electronic Journal of Structural Engineering.

[4] Bharat Nagar, Prof V. P. Bhargava "Effect of Waste glass Powder on Various Properties of Concrete"International Journal of Science, Engineering and Technology, (ISSN (Online): 2348-4098 ISSN (Print): 2395-4752), Volume 4 Issue 4 2016.

[5] Tomas U. Ganiron Jr "Use of Recycled Waste glass Bottles as Fine Aggregates in Concrete Mixture" International Journal of Advanced Science and Technology, (ISSN (ISSN: 2005-4238), Volume 61 2013.

[6] Dr. G.Vijayakumar1, Ms H. Vishaliny2, Dr. D. Govindarajulu "Studies on Waste glass Powder as Partial Replacement of Cement in Concrete Production, (ISSN 2250-2459, ISO 9001:2008 Certified Journal), Volume 3, Issue 2, February 2013.

[7] B.V. Kavyateja1, P. Narasimha Redd2, U.Vamsi Mohan "STUDY OF STRENGTH CHARACTERISTICS OF CRUSHED WASTE GLASS USED AS FINE AGGREGATE IN CONCRETE" IJRET: International Journal of Research in Engineering and Technology, (ISSN (eISSN: 2319-1163 | pISSN: 2321-7308), Volume: 05 Issue: 02 | Feb-2016.

[8] Aikulola O.A Sanni H.A "A Study of Strength Characteristics of Recycled Waste glass (Cullets) in Concrete Floor Tiles Prodution, "Civil and Environmental Research" (ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online), Vol.6, No.12, 2014.

[9] SoumendraMitra, AliptaSrimany,Braja Gopal Dey "A practical study on Effective Utilisation of Waste glass in Concrete, "International Journal of Science, Engineering and Technology Research (IJSETR)" ,Volume 5, Issue 3, March 2016.

[10] K. V Ramana, Shaik SummaiyaSamdani "Study on Influence of Crushed Waste glass on Properties of Concrete "International Journal of Science and Research (IJSR)" (ISSN (Online): 2319-7064),Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438.

[11] IS: 456-2000, "Plain and Reinforced Concrete - Code of Practice" Bureau of Indian Standards, New Delhi, India.

[12] IS: 9013-1978, "Method of making, curing and determining compressive strength of accelerated cured concrete test specimens", Bureau of Indian Standards, New Delhi, India.

[13] IS: 9103-1999, "Specification for Concrete Admixtures" Bureau of Indian Standards, New Delhi, India.