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EFFECT OF WASTE GLASS ON MECHANICAL PROPERTIES OF CONCRETE: A REVIEW PAPER

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Abstract

A Climate is changing the most important issue of today's world is "GO GREEN". It is the convenient slogan of the century. As glass powder is waste material, non-biodegradable material and also has a disposal problem. Recycling of waste glass saves not only the landfill but also saves Energy. Glass is an ideal material for recycling as is been used in different sectors. In the construction field, waste glass was reused for concrete productions. This paper of partial replacement of fine aggregate with waste glass powder can help to reduce that problem and we add fly ash to reduce alkaline silicate reaction which develops in concrete when we add waste glass in concrete.

Index Terms—waste glass, recycling, strength parameters.

I. INTRODUCTION

Nowadays concrete material is one of the most used in building construction, concrete can be used for multipurpose e.g. bridge, house, tower, etc. Concrete is made by mixing cement with some aggregates like coarse aggregates and fine aggregates, and some quantities of water. By the technology of today, some engineers are making Concrete by using some other materials such as plastics, waste glasses and other waste materials from industries such as silica fume, fly ash, slag, blast furnace slag, rice husk ash and etc. are used to increase the performance of concrete. Etc, for the purpose of improving its properties .the concrete is really most needed in the market nowadays but many industries are facing the problem of high cost of the material which they can use in making those concrete, some materials such as cement which is very costly in the market today. This is due to the problem of emissions of CO_2 into the atmosphere and energy used to make that cement. The economic and environmental profits in the reuse of waste glass for making concrete can be very important according to the end uses and the quantity produced.[1]

As engineers, we have to work hard to minimize the cost of concrete because we know that this

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type of material is very important in each and every building construction. By our research we are going to replace the fine aggregates which are used in making concrete with the waste glasses with the purpose to decrease the quantity used in concrete such as cement and to increase the performance in concrete, we will reduce also the quantity of water which is used in making concrete because by using waste glass, concrete will absorb less quantity of water since glass is impermeable material, if it is used as construction material absorption of water in that material is very less. In concrete, we use waste glass to substitute a part of the fine aggregate. The waste glasses are very easily found in many places because glass is sometimes very hard to repair when it has been broken in many pieces, so in this case, we can use it in making some important things such as making concrete. Reduction and reuse of waste are the most necessary element for management of waste due to the increase in conservation of natural resources and the decreased space needed for valuable landfill, waste glasses are inorganic materials ,this type of waste material can cause many problems in environment exactly where they are deposed because glass cannot be decomposed . As we need an area of agriculture and good environment area for good health, we have to resolve those all kind of residues problem which are causing many problems, so we have to collect all that waste glass in purpose of using it in concrete because concrete is commonly used in each and every construction in large quantity. There are so many types of glass, some of them are soda lime glass type, float glass type, sheet glass type. While the composition of glass is aluminum oxide (Al_2O_3), calcium oxide (CaO), silica, and sodium oxide (Na_2O), those are the main composition of the glass. Waste glasses also possesses some most common properties which are similar to properties of some material such as plastic, cement, metal, sand, etc.For this reason, the properties of glass make the waste glass one of the most important material which we can reuse for making some valuable things (concrete).The waste glass with high qualities, need to be collected and sorted by following good methods, because some glass is collected and sorted depending on color and hardness, etc. so we need an experienced labor force which knows how to differentiate the glass materials and have technical know-how of which kind of glasses we are going to use according to properties of waste glass.

Table 1: Compositions and the uses of different types of glass

Type of glass	Composition (by weight)	Usages
Soda-lime-silica	73%soda-14%lime-9%-3.7%magnesia-0.3%alumina	Glass widows-bottles-jars
Boro-silicate	81%silicate- 12%boron oxide-4%soda-3%alimuna	Pyrex cookware-laboratory glassware
Lead (crystal)	57%silica-31%lead oxide-12%potassium oxide	Lead crystal tableware
Alimino-silicate	64.5%silica-24.5%alimina-10.5%magnesia-0.5%soda	Fiberglass insulation-halogen bulbs

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II. LITEATURE REVIEW

Abdullah et al: Effect of waste glass on compressive strength in concrete as we increase the amount of waste glass in concrete the compressive strength Is also increased. The maximum compressive strength is obtained 34.22Mpa at 28 days in a mix of 20% waste glass fine aggregate which represent an augmentation of 5.28% as compared to concrete without waste glass. This is caused by the pozzolanic reaction that appears at the time of hardening thus giving an improvement of compressive strength of 28 days. Effect of waste glass on flexural strength is decided by the quantity of waste glass added as it is augmented the flexural strength at 7, 14, 28 days. At 28 day the flexural strength is increased by 3.54% for adding 5% of waste glass, 5.03% and 8.92% to 15% and 20% respectively. The cause of which is the pozzolanic reaction which occurs in a lesser time offsetting hardening process which improves the flexural strength. Similarly, the modulus of elasticity of waste glass increase as the amount of waste glass is added at 7, 14, 28 days which show the higher modulus of elasticity compared to natural sand. [2]

Castro et al: The durability of concrete made by crushing glass aggregate were weak compared to durability concrete made with normally aggregate. Some test as, absorption of water by capillarity and immersion, the resistance to carbonation, penetration of chloride and shrinkage test were used to prove the above result. Then 0%,5%,10%and 20% of glass aggregate has been used as normal aggregate, the result was changed according to the size of glass aggregate(fine and coarse aggregate), the experiment proves that the grain size affects very much the workability(slump test) of concrete. On basis of weak density(mass per unit volume) of glass aggregate, the mixtures with glass have been found that will have a smaller fresh density. Anyway, the concrete made by glass aggregate was found that there is no significant of durability, related to properties of concrete.[3]

Gautam et al (2012): The laboratory experiment shows that the A S R is present in concrete when we use waste glass as coarse and fine aggregate even if in decoration purpose. The same study illustrates that the glass should be utilized as fine aggregate up to 40% by not changing the strength. With the replacement of fine Aggregate at 20%waste glass, there will be an increase of compressive strength at 7 days and 28 days by 13.64% and 2.18% respectively, and at the replacement of 30% and 40%, it will give the decrease result.[4]

Her-yungwang (2008) : By replacing 0%,20%,40%,60% and 80% in concrete The Liquid crystal Display (LCD)glasses involved in properties of concrete and give a considerable effect, at 20% glass sand will give a good slump of 15 centimeters where slump loss from 7 to 11 centimetres at 60% and 80% of glass sand substitute. The compressive strength of LCD glass will be high much better compared to the compressive force of natural one. The durability of concrete formed of LCD at 20% has been given a good result. Resistivity surface for all different replacement of LCD glass sand is high than control mix for half to full curing ages. Sulfate(SO_4) attack in concrete is more in concrete made of glass sand, this can cause less reduction weight than in normal mix. The good concrete will be qualified by measurement of ultrasonic pulse (sound wave) velocity for LCD glass sand which has more than 4100m/s.[5]

Ismail et al : The crushing of waste glasses used in mixed concrete give the potentials of strength properties and ASR expansions by replacing sand at 10%,15%, and 20 %.AT 20% waste glasses contain the flexural and compressive strength were given 10.99% and 4.23% respectively higher than normally concrete at 28 days. The mortal bar test proves that the finely broken waste glass involved in decreasing expansion by 66% in comparison with the normal mix. By pozzolanic activity test, it shows that the glass powder is good pozzolanic material, In AST test at 20% there is a clear redaction of concrete which will be equivalent to 60 % comparing to control mix when it increases in waste glass content. Slump tests showed that as the waste glass is augmented the slump tends to decrease. Due to the bad shape of waste glass less fluidity occurs and reduction in fineness modulus hence the decreasing in a slump. Despite the decline in a slump, tests show that it can be used effectively. Dry density test, in fresh density we observe the decreasing ratio as we increase the waste glass. The decreasing ratio is due to the rather less specific gravity of the waste glass as compared to sand.
Compressive strength at 28 days was found to be 45.9 Mpa for 20% waste glass fine aggregate it gives an increase of 4.23 % as compared to normal mix. In other days the compressive strength increases except for the 14 day which is due to the decreasing of the adhesive bond between the area of cement and waste glass aggregate. Pozzolanic reaction at the stage of hardening helps the improvement of compressive strength at 28 days.
Flexural strength test shows that at 3, 7 and 14 days the flexural strength decrease as we increase waste glass, but at 28 days the flexural strength increase with waste glass. The pozzolanic reaction has increased as the time increases.[6]

Limbachiya et al: he evaluated on durability and a mechanical characteristic of concrete with waste glass replacing natural sand from o% to 50%. He found that there was a decline in slump and stability in the mix for ratio more than 30%. The compressive strength was not affected more by ratios lesser than 20%.same result was found for absorption of water and ASR(alkaline silicate reaction) for a ratio less or equal to 15%.[7]

Taha et al : The analysis of concrete with mix color waste glass as cement and sand substitute, soil granulated blast furnace slag (SGBS) and metakaolin(MK) take the place of Portland cement, the result proves that non effect on considerable compressive strength of concrete while recycling glass sand (RGS)in different blend cement . The RGS 's effect when we use sand or cement substitute in concrete were proved by using various experiment as: water absorption ,tensile strength, flexure strength and static modulus of elasticity the observation shows that negligible water absorption of glass and smooth surface, so the availability of RGS in any concrete will decrease the consistency and adhesive bond of the ingredient of concrete and some cracks developed in glass sand particular in crushing process, the result will be considered as source of weakness and strength of concrete.[8]

Mohammad j. terro: Evaluation of analysis of concrete with fine and coarse glass aggregate on the fresh and hardened of Portland cement at room and higher temperature. However by replacing 10% of fine waste glass ,coarse waste glass and fine and coarse waste glass (FCWG) in concrete ,the properties of this one will be much better comparing to large replacement which made by big amount of FWG(fine waste glass) ,CWG(coarse waste glass) and FCWG(fine and coarse waste

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glass) at room and higher temperature. At 700^{0}C the compressive strength will decrease by 20% of it is original at ambient temperature with recycling glass RG replacement. The slump value increased with augmentation of 10% replacement fine or coarse glass aggregate.[9]
Bum park et al: Mechanicals analysis of fresh concrete mixes with waste glass aggregate shows that slump and compacting factor is reducing because of the angular granular form(shape) and that air content is increasing due to more small size which is in the waste glass. The compressive strength, tensile strength and flexural strength of concrete are decreasing by increasing waste glass in concrete. Replacement of waste glass by 30%, 50%, and 70% shows that 30% gives the admixture that is needed to obtain workability and air content. He talked about decreasing in slump test as the amount of waste glass was increasing. The reason which is some amount cement accumulates on the surface of the waste glass which results in a less fluidity in concrete. Also, the angular shape of glass provides less fluidity of concrete than that of sand.[10]

Shayan et al: Because of unstable of glass in the alkaline environment of concrete a large amount of glass which is deposed in a landfill are causing many problems as a deleterious alkali-silica reaction (ASR). In another case, those properties are giving some advantages by grinding the glasses into a powder which will give us the result as the fine aggregates; this fine aggregate will be able to replace 30% of cement in some concrete. Experimentally the dry shrinkage of the concrete which is containing fine glass powder is acceptable.
Air content increases at the ratio of 30% to 70% compared to concrete without waste glass this is due to the use of glass aggregate with the size of 0.6mm more than sand and its irregular shape having trapped more air on its surface area which results in a high air content in concrete
Compacting factor was tested on the ratio of 30%, 50%, and 70% and it yields1.1to 2%, 2.5% to 2.7%, 3.6% to 5.4% decrease in compactor factor were observed successively in comparison to normal concrete. It was caused by the irregular angle in the grain shape of waste glass which gives less fluidity in concrete.
Compressive strength test he used emerald green waste glass fine aggregate and mixing ratio of 30%, 50 %, 70%for 28 days which resulted in a decreased compressive strength 0.6%,9.8%,13.6% respectively. It is due to the small adhesive bond between the surface of waste glass aggregate and cement paste. also the decreasing of compacting factor as we increase the ratio of waste glass, Tensile strength decrease at 3.4 % the ratio of 30% of waste glass,9.2 for 50% and 15% for 70 %, and flexural strength at ratio of 30% it decrease 3.2% for 50% and 70% the reduction is 11.3% and 18.1% respectively compared to concrete without glass.[11]

Table 2 Physical properties of waste Glass

Property	GhassanNounu[8]	Mukesh [7]
Mean coefficient of linear expansion (20℃; 300℃)	$1.9{\cdot}10^{-6}$ K^{-1}	8.3 10^{-6} mm/mm.℃
Transformation temperature	2.525℃	
Temperature fixed points at a viscosity in dpa·s: 10^{13} upper annealing point	530℃	

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$10^{7.6}$ softening point 10^4 working point	720℃ 1040℃	548℃ 715℃
Density at 25℃	2.50 g·cm^{-3}	2500kg/m^3
Modulus of elasticity E (Young's modulus)	73·10^3 N·mm^{-2}	72 Gpa
Poisson's ratio	0.22	0.23
Thermal conductivity at 90℃	1.1 W·m^{-1}K^{-1}	0.937Wm/m^2.℃
The temperature for the specific electrical resistance of 10^8 cm	200℃	
The logarithm of the electric volume resistance: At 250℃ At 350℃	 7.1cm 5.7cm	
Dielectric properties(1 MHz, 25℃) Dielectric figure(permittivity) Dielectric loss factor (dissipation factor)	 7.2 70·10^{-4}	
Refractive index(=587.6nm)	1.514	1.523
Stress optical constant(DIN 52 314)K	2.7 10^{-6} mm^2 N^{-1}	

III. CONCLUSION

1. In previous experiment study of this topic, the problem of the alkaline reaction was observed in concrete, but in the same study, the compressive, flexural and tensile strength was increased by comparing to the normal concrete (concrete without glasses)
2. As we are improving this study and correct those issues of alkaline reaction, we will adopt a technique of using small sieved glass and less quantity, which will minimize that alkaline reaction in our experimental study.
3. After resolving this issue of alkaline reaction, the concrete with glass will be mostly economic because of using that waste glass, this will give us also a good strength of a concrete and a best-looking concrete.

REFERENCE

[1] Nasser Almesfer1 and Jason Ingham "Effect of Waste Glass on the Properties of Concrete" Amarican society of civil engineers, 2014
[2] Sadoon Abdallah, Mizi Fan "Characteristics of concrete with waste glass as a fine aggregate replacement" International journal of engineering and technology research volume-2,2014
[3] Sara de Castro, Jorge de Brito "Evaluation of the durability of concrete made with crushed glass aggregate "Journal of cleaner production 41(7-14), 2013
[4] S.P GatamVikasSrivastava and V.C Agarwal 'Use of glass wastes as fine aggregate in Concrete".J.acad .indus.res vol-1(6),2012
[5] Her-Yung Wang "A study of the effects of LCD glass sand on the properties of concrete "Waste management 29(335-341), 2009
[6] Zainab Z. Ismail, Enas A. Al-Hashmi "Recycling of waste glass as a partial replacement for fine aggregate in concrete". Waste management 29(655-659),2009
[7] Mukesh C Limbachiya "Bulk engineering and durability properties of washed glass sand concrete", construction and building materials volume 23 issue 2, 2009
[8] Bashar Taha and GhassanNounu,"Properties of concrete contains mixed color waste recycled glass as sand and cement replacement". construction and building material 22 (713-720), 2008
[9] Mohammad J Terro "Properties of concrete made with recycled crushed glass at elevated temperatures". Building and Environment 41(633-639), 2006
[10] Seung Bum Park*, Bong Chun Lee, Jeong Hwan Kim "Studies on mechanical properties of concrete containing waste glass aggregate". cement and concrete research 34(2181-2189), 2004
[11] Ahmad Shayan*, AiminXu "Value-added utilization of waste glass in concrete" Cement and concrete research 34(81-89), 2004
[12] IS 456 2000 Plain and reinforced concrete code of practice
[13] IS 10262:2009 Concrete mix proportioning -guidelines
[14] IS 383:1976 Specification for coarse and fine aggregates from natural sources for concrete
[15] IS 8112:1989 Code for Ordinary Portland cement
[16] IS 516:1959 Methods of test strength of concrete
[17] IS 5816:1959 Split tensile Strength of concrete
[18] Concrete technology: Theory and practice By M.S Shetty S.Chand Publications
[19] Concrete technology A.R. Santakumar Oxford University Press India Publications
[20] Concrete technology: Theory and practice By Murari Lal Gambhir, Tata McGraw-Hill Education Publications
[21] Concrete technology Neville Pearson Education India, Publications