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BEHAVIOR OF RECYCLED GLASS AS FINE AGGREGATE WITH CONCRETE: A REVIEW

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Abstract—

Increase in population has lead to increase in infrastructure. Availability of sand is continuously being depleted due to the human overexploitation throughout the globe due to rapid urbanization and construction of other amenities, thus the demand of sand as fine aggregate have increased.Use of sand as fine aggregate has triggered lowering of water table,exploitation of natural resource ,erosion of river beds ,sinking of bridge piers ,etc. There is a huge potential to use the waste glass in concrete constructions.The chemical property of waste recycled glass is similar to that of cement due to the presence of SiO_2 , Al_2O_3 ,Fe_2O_3, Cao. When waste glass is used in concrete constructions production cost will get reduced .By using waste glass in the place of river sand it will be environmental friendly.It Helps in conserving the ecological balance. 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 which would help in saving energy. This paper deals with the use of waste glass as fine aggregate by replacing sand. A detailed study has been conducted on the variation of compressive strength in concrete due to waste glass used as partial replacement of fine aggregate by weight. This also deals with the effect on workability and ASR due to the presence of glass in concrete .Glass is found to be an ideal material because of its satisfactory performances and aesthetic property improvement. This will additionally solve the problem of overflowing landfills and give a complete new idea for sustainable building.

Keywords— workability,amenities ,ASR alkali-silica reaction,exploitation,waste glass,compressive strength ,ecological balance

I. INTRODUCTION

In sustainable building ,building materials are important element to ensure the quality of the infrastructure and for maximum positive environmental impact.Sustainable building materials are locally generated and involve recycled materials which are thermally efficient and require less energy. In the whole process to extract ,manufacture, transport and reuse or dispose they are eventually related for impact in wider ecological context.Human population have been increasing at a fast rate and so does the infrastructural demands ,which has lead to the increase in waste production at a large scale .As of 2005, the total global waste glass production estimate was 130 Mt, in which the European Union, China and USA produced approximately 33 Mt, 32 Mt and 20 Mt, respectively IEA(2007)[1]Rashed(2014)[2].

In the recent times, multiple industrial by-products have been used as Supplementary Cementitious Materials (SCMs) successfully which includes silica fume (SF), ground granulated blast furnace slag (GGBS) and fly ash Islam et al., (2011)[3]; Imbabi et al., (2012)[4]. The workability, early as well as long term strength, durability and economy can be maintained by these materials Detwiler et al., (1996)[5]. Similar to traditional SCMs, glass has a chemical composition and phaseRyou et al., (2006)[6]; Binici et al., (2007)[7]; Nassar and Soroushian (2012)[8]. Also Rashed (2014)[2] indicated waste glass has potential as SCM and also the interest of construction community in using waste or recycled materials in concrete is increasing because of emphasis placed on sustainable construction. The waste glass from in and around the small shops is packed as a waste materials which could be recycled and used many times without changing its chemical property Aimin Xu and Ahmad shayam (2004)[9]. Use of recycled waste glass particles can be used as a substitute for sand as fine aggregate.

II. SGNIFICANCE OF THE WORK

Sustainable construction practice means creation and responsible management of a healthy built environment considering resource efficiency and ecology Plessis(2007)[10].

Since the demand in the concrete manufacturing is increasing day by day, the utilization of natural resources is also increasing. Recent research findings have shown that concrete made with recycled glass aggregate are capable to yield better workability,which is one of the key feature of building construction.It has also been found that some % of fine aggregate when replaced by waste recycled glass increases the strength of concrete.Alkali and silicon dioxide is significantly found in waste glass.These chemical property of waste glass leads to the initiation of ASR and concrete cracking ,which is the main reason accounting for the early stagnation of research on the use of WG in concrete. Lots of research [11,12,13,14] indicates that WG may cause ASR expansion risk in concrete.

III. LITERATURE REVIEW

Sand used as fine aggregate in concrete was replaced by weight with sheet glass powder{10%,20%,30%,40% and 50%} by Mageswari et.al(2010)[15] and had conducted few tests to find compressive strength, split tensile test and cylinder test .It was observed that the replacement of 20% of fine aggregate with crushed recycled glass increases the compressive strength upto 40 MPa in 28 days.Abdullah Saand et.al(2017)[16] concluded through his observation that there is a substantial increase in compressive strength of concrete upto 12% replacement of fine aggregate with WG. Whereas Vijay Sekhar Reddy et.al (2015)[17] studied experimentally and concluded that 20% of replacement gave 29.84 MPa strength in 28 days .On the contrary Tiwari Darshita et.al(2014)[18] disagrees with Mageswari[15] and Vijay sekhar reddy[17]and states through his observation that 15% replacement of fine aggregate with glass powder gave compressive strength of 31 MPa and reduces even at 20% of replacement. K..Aparna Srivastav(2016)[19] also concluded that compressive strength decreases when replacement percent of WGP with fine aggregate is more than 15%.

The flexural strength and compressive strength was found to vary with different types of glass on a research study by Aseel B.Al-zubaid et.al(2017)[20] .It was observed that different types of glass has different chemical property and different rate of increment in strength.

TABLE I

Comparison of Compressive strength in MPa

Percentage of WG replacement with fine aggregate	Mageswari et.al	Vijay Sekhar Reddy et.al	Tiwari Darshita et.al	Abdullah Saand et.al	K..Aparna Srivastav
0%	38	22.7	-	32	34.22
10%	39	25.88	30	35.5	37.15
20%	40	29.84	25	33	33.11
30%	35	24.66	22	26.5	-

Tiwari Darshita et.al (2014)[18] performed slump test according to IS 1199-1959 and found with increase of glass content, the slump value increases. Vijay Sekhar Reddy et.al (2015)[17] reported increase in slump value upto 20% replacement of glass powder with fine aggregate which further decreases in case of 30% replacement . When the crushed glass was used as coarse aggregate Christoper cheeseman et al. (2011)[21] stated due to its flat and elongated nature the wokability of concrete decreases . In the meantime, Roz-Ud-Din Nassar et al. (2011)[22] have highlighted that presence of waste glass milled into micro scale particle size improve the properties of concrete such as moisture absorption resistance and harmful transportation.

Silica gel is formed by the reaction between alkalis in Portland cement and silica in aggregate. The volume of the gel increases when it absorbs water. The swelling of ASR gel develops hydrostatic pressure under confinement by cement matrix and aggregate. Al-Amarieh M(2006)[23] stated if the internal pressure crosses the tensile strength, matrix cracks will be generated. However ground waste glass showed no reaction in concrete when used as fine aggregate. Shayan and Xu [9]reported that fine glass powder can incorporated into concrete up to 30% as a pozzolanic material in ASR. larger the particle size more is the probability of ASR occurrence. Hence proving the feasibility of the waste glass reuse as fine aggregate in concrete Shuhua Liu(2015) [24] reported that with the increase of fineness and content of WGP,the ASR expansion can be reduced. Meanwhile it will add no ASR expansion when WGP size is less than 209.2μm and it shows certain inhibitory effect on ASR expansion.

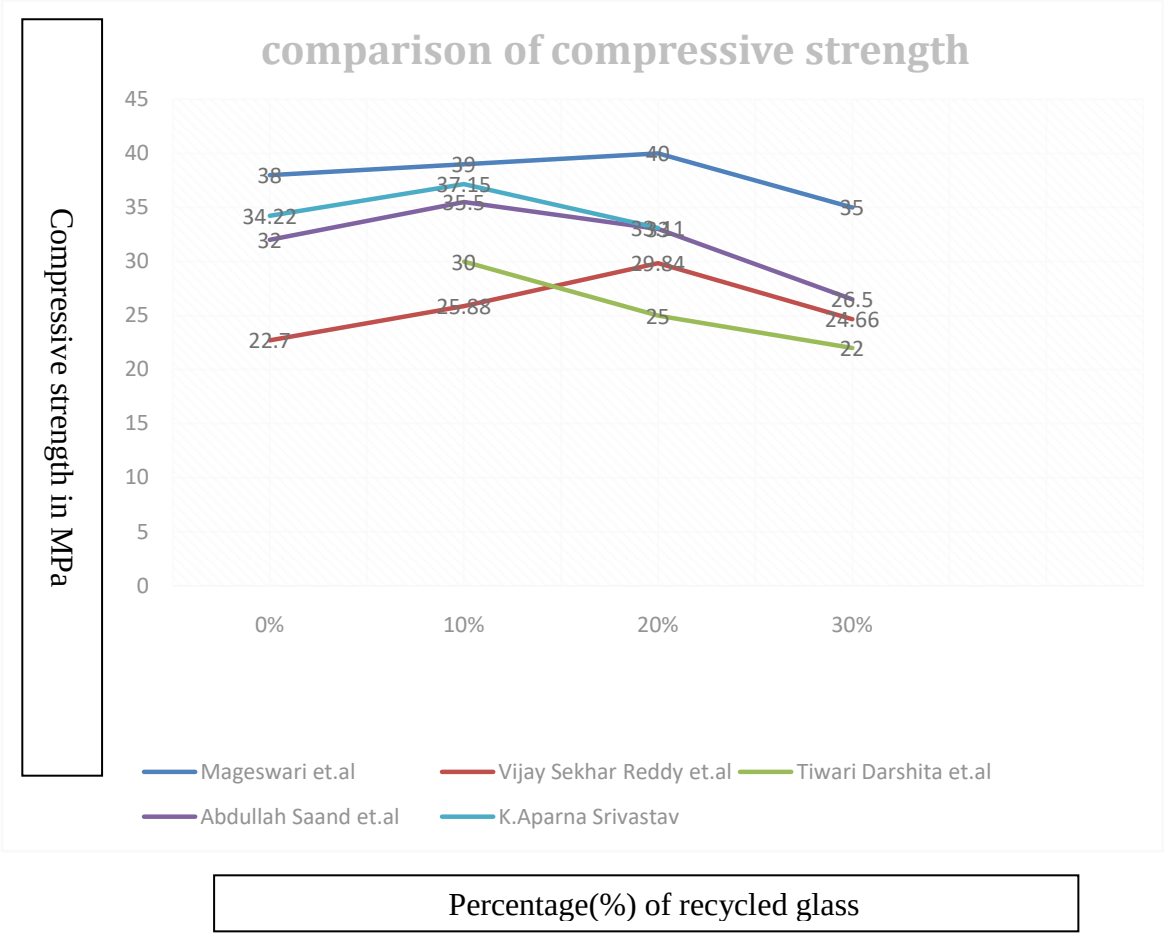

Fig 1. Comparison of compressive strength between different Authors when fine aggregate replaced by WG

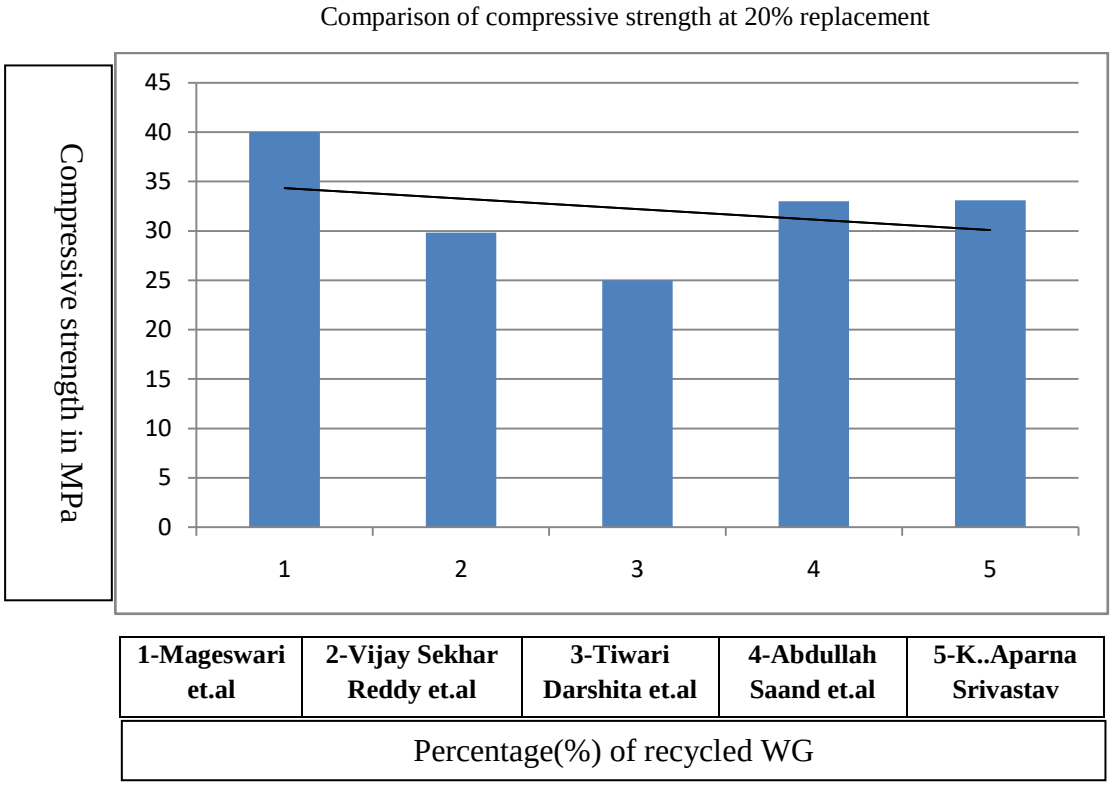

Fig 2. Comparision of compressive strength between different authors at 20% Of fine aggregate replaced by WG

IV.CONCLUSIONS

- Crushed glass could be preferably used as fine aggregate because its chemical property is similar to that of cement presence of SiO_2 , Al_2O_3 ,Fe_2O_3,Cao
- The maximum compressive strength is achieved by concrete on replacing around 20% of fine aggregate by weight with the recycled glass.
- The average compressive strength on 20% replacement was found to be in range of 30-35 MPa.
- The workabilty increases comparitively upto 20% replacement of fine aggregate with recycled glass by weight
- It will add no ASR expansion when WGP size is less than 209.2μm and it shows certain inhibitory effect on ASR expansion.
- WGP is more preferred as fine aggregate compared to coarse aggregate since its flat and elongated nature decreases the workability and increases the ASR expansion in concrete.

V.REFERENCES

[1] IEA, 2007. *Tracking Industrial Energy Efficiency and CO_2 Emissions*.OECD/IEA,1–321

[2] A.M. Rashed *Recycled waste glass as fine aggregate replacement in cementitious materials based on Portland cement* Constr. Build. Mater., 72 (2014), pp. 340-357

[3] Islam, G.M.S., Islam, M.M., Akter, A., Islam, M.S., 2011. *Green construction materials-Bangladesh perspective. In: Proceedings of the International Conference on Mechanical Engineering and Renewable Energy 2011*, (ICMERE2011) 22–24 December 2011, Chittagong, Bangladesh (ID-063)

[4]M.S. Imbabi, C. Carrigan, S. McKenna*Trends and developments in green cement and concrete technology*

[5] Detwiler, R., Bhatty, J.I., Bhattacharja, S., 1996. *Supplementary Cementing Materials for Use in Blended Cements. Research and Development Bulletin Rd112t, Portland Cement Association*, Skokie, Illinois, USA.

[6] J. Ryou, S.P. Shah, M.S. *Konsta-GdoutosRecycling of cement industry wastes by grinding process*

[7] H. Binici, O. Aksogan, I.H. Cagatay, M. Tokyay, E. Emsen *The effect of particle size distribution on the properties of blended cements incorporating GGBFS and natural pozzolan (NP)*

[8] R.U.D. Nassar, P. Soroushian *Strength and durability of recycled aggregate concrete containing milled glass as partial replacement for cement Constr. Build. Mater., 29 (2012), pp. 368*

[9] Aimin Xu and Ahmad shayam *Value – added utilization of waste glass in concrete Cement and concrete research, vol.34,81- 89,2004.*

[10] C.D. Plessis *A strategic framework for sustainable construction in developing countriesConstr. Manage. Econ., 25 (1) (2007), pp. 67-76*

[11] Mukesh C. *Bulkengineering and durability properties of washed glass sand concrete. Constr. Build. Mater.* 2009;23:1078–1083.

[12] Schwarz N., Neithalath N. *Influence of a fine glass powder on cement hydration, Comparison to fly ash and modeling the degree of hydration. Cem.* Concr. Res. 2008;38:429–436. doi: 10.1016/j.cemconres.2007.12.001. [cross ref]

[13] Wang H.Y., Huang W.L. *Durability of self-consolidating concrete using waste LCD glass. Constr. Build. Mater.* 2010;24:1008–1013. doi: 10.1016/j.conbuildmat.2009.11.018. [cross ref]

[14] Lin K.L., Wang N.F., Shie L., Lee T.C., Lee C. *Elucidating the hydration properties of paste containing thin film transistor liquid crystal display waste glass.* J. Hazard. Mater. 2008;159:471–475. doi: 10.1016/j.jhazmat.2008.02.044. [cross ref]

[15] M. Mageswari and Dr. B. Vadevelli *The Use of Sheet Glass Powder as Fine Aggregate Replacement in Concrete* The open civil engineering Journal, 2010 volume.4

[16] Abdullah Saand , Manthar Ali keerio , Rabnawaz Juj , Salim Khoso , Daddan khan Bangwar Utilization of *Waste Glass as Partial Replacement of Fine Aggregate in Concrete* ENGINEERING SCIENCE AND TECHNOLOGY INTERNATIONAL RESEARCH JOURNAL, VOL.1, NO.1, APR, 2017

[17] Dr. M. Vijay Sekh ar Reddy,P. Sumalatha, M. Madhuri and K.Ashalatha *Incorporation of Waste Glass Powder as Partial Replacement of Fine Aggregate in Cement Concrete* InternationalJournal of Scientific & E Research, Engineering Volume -6, Issue 12, December-2015 ISSN 2229- 5518.

[18] Thiwari Darshitha and Patel *study of Strength and Workability of Different Grades of Concrete by Partial Replacement of Fine Aggregate by Crushed Brick and Recycled Glass Powder* International Journal of Science and Research (IJSR) volume 3 issue 6 June 2014.

[19] K..Aparna Srivastav *Partial Replacement of Fine Aggregates by using Waste Glass* International Journal of New Innovation in Engineering and Technology Volume 4 Issue 3 March 2016

[20] Christopher cheeseman, " Production of sintered light weight aggregate using waste ash and other industrial residues", Belgium,

[21] Roz UN, and Parviz S. Field Investigation of Concrete Incorporating Milled Waste Glass. Elsevier Journal, Construction and Building Materials 29, 2011:368–377.

[22] Aseel B. AL-Zubaida, Kadum Muttar Shabeeba, Aynoor Ibrahim Alia Study The Effect of Recycled Glass on The Mechanical Properties of Green Concrete International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES17, 21-24 April 2017, Beirut Lebanon

[23] Al-Amarieh M., *Improving the Physical and Thermal Properties of the Fire Clay Refractory Bricks Production from Bauxite 2006*

[24] Shuhua Liu,1,2,* Shu Wang,1,3 Wan Tang,1 Ningning Hu, 1 and Jianpeng Wei 1]*Inhibitory Effect of Waste Glass Powder on ASR Expansion Induced by Waste Glass Aggregate*.*Materials (Basel).* 2015 Oct; 8(10): 6849–6862.

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