Analysis For Properties Of Utilizing Waste Glass For Eco-Friendly Ultra-High Performance Concrete For Sustainable Structures

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Abstract:-
Researchers have shown that many recycled materials can be used as partial replacement in concrete mixture in Ultra high performance concrete to result in ecofriendly and more sustainable structural material. Ultra-high performance glass concrete is latest UHPC for making sustainable concrete structures. Waste glass industry awards many harmful impacts to Environment. The utilization of waste glass in UHPC enhances Environmental Benefits. This paper present effects on fresh and mechanical properties of UHPC by crushed waste glass. With the addition of waste glass, the latest material ecofriendly ultra-high performance glass concrete which improving properties of fresh concrete and mechanical properties. Use of glass powder reduced amount of cement.

Key words:- UHPC, UHPGC, EFUHPC, Glass powder, Waste glass

Introduction:-

At present time latest concrete like high performance concrete (HPC), high strength concrete (HSC), ultra high performance concrete (UHPC), Eco-friendly ultra-high performance concrete (EFUHPC) have been developed for enhancing properties of concrete. Solid waste materials and recycled waste materials utilization increased in concrete production at present time which addresses environmental or ecological issues and save energy [1,2,3,5,9,11]. Many solid wastes like silica fume [1], fly ash [5], sugarcane bagasse ash [7], rice barn husk ash [7], marble waste [6,7], plastic waste [14,15], metakaoline [10], stone waste [16], building waste [4,5] and rock waste [11-13] were used as alternatives in concrete for their improvement or development features [3,6,17,18]. The Properties of concrete depends on W/C ratio, distribution of particle size and density [05]. UHPC more costly as compare to traditional concrete so for reducing cost prepared ecofriendly UHPC [32,33]. The UHPC possesses limited long term creep, elastic modulus up to 45000MPa, compressive strength up to 0.15GPa and flexural resistance up to 0.015GPa [2,3]. Many researchers indicate the significance of producing UHPC by using waste glass and this work have positive results on the environmental with enhancing properties of concrete [12-13].

From last many years, the WG has progressively enhanced due to the expanded of glass products. Waste glass poses a significant environmental challenge today, and is often recycled or used in landfills. Waste glass is also used in concrete, making it eco-friendly and enhancing its properties. WG material used in concrete in to form of small particle sizes an alternative of cement and ultra-fine filler which considered creative and sustainable [6,19]. According to previous study the range of particle size of glass material is 0.0075mm – 2.00mm and 0.0075mm size for expansions in concrete not harmful [20]. Finer than 75 μm donate the strength and durability of concrete and observed pozzolanic nature [10-12].
The chemical composition of glass mostly resolute by waste supplies and bulk of soda- lime glass is formed up of more than≥ 70% structure less SiO_2, ≥grater then 12% Na_2O & greater than ≥5% of CaO [3,4].

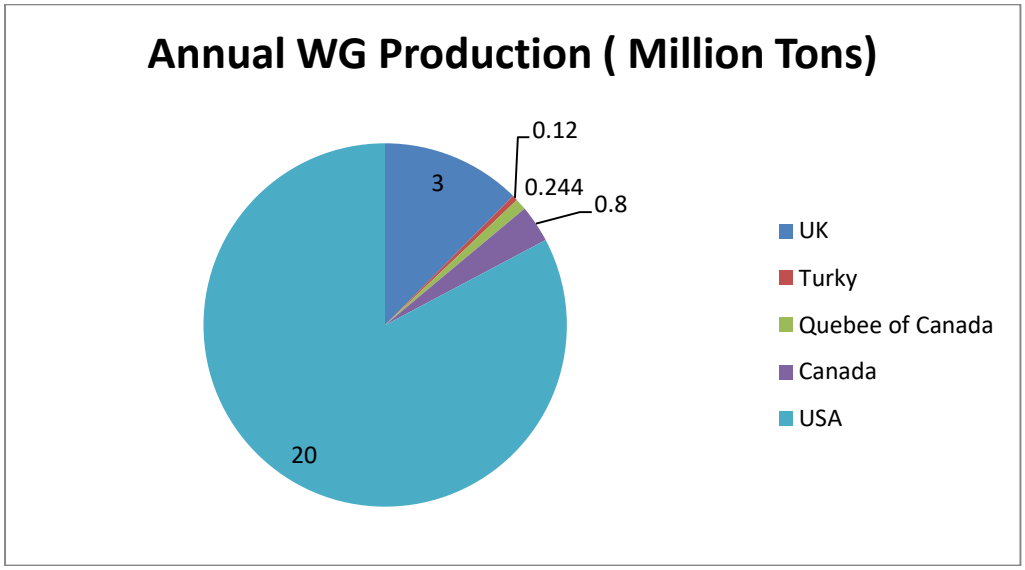

Figure 01: Annual WG production

Aim of study:-

In the above study showed many advantages of recycled of waste glass which impact on the environment and in this work studied about properties and sources of glass. In past studies many researchers showed performance of UHPC with use of waste glass replacement of cement or aggregates as ecofriendly replacement.

This work showed that use of WG influenced the aggregate content, size, finer filling materials, properties of fresh concrete and hardened concrete. This review is showed the previous work of the UHPGC at fresh and hardened both state of concrete.

Chemical Composition for Waste glass Powders

In previous studies many researchers found different chemical compositions. The chemical compositions of WG powder also affect the properties of UHPC. Some chemical compositions are given in table 01

Table 01: Chemical Composition

WGP	SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	Na_2O	K_2O	SO_3	TiO_3
CG[10,11,12]	72.42%	1.44%	11.5%	0.07%	0.32%	13.64%	0.35%	0.21%	0.035%
BG[10,12]	72.21%	1.37%	11.57%	0.26%	0.46%	13.75%	0.2%	0.1%	0.041%
GG[10,13,14]	72.38%	1.49%	11.26%	0.29%	0.54%	13.52%	0.27%	0.07%	0.04%
Cr. G[10,15,16]	72.61%	1.38%	11.7%	0.48%	0.56%	13.12%	0.38%	0.09%	
GP[10,17]	72.2%	1.54%	11.42%	0.48%	0.79%	12.85%	0.43%	0.09%	

Effect of WG on Fresh Properties of UHPC:-

Workability:-

Workability of concrete is important property of UHPC. The utilization of WG powder affect the workability of UHPC. The use of soda lime glass waste decreases the workability of UHPC and lime glass and glass sand increases the flow value of UHPC according to previous research given in table 02.

Table 02: Workability of UHPC with WG

Ref	Replacement	Glass Source	Effect
19	20%, 30%	Soda lime Glass	Decreasing Slump value
20	0%-30%	Lime Glass	Increasing Flow value
8	50%	Glass sand	Increase flow value

Air Content:-

By using more W/B and SP ratio, the air content of the EFUHPC mix will enhances. The used mixture process has valuable effect on overall air content [28]. According to 61etal air content in mixers with a higher blending speed in UHPC declared from 3to 5.4%. Similarly Amin et al measured, ring type mixture and decleared around 3.2 and 74 et al by vaccume accesary decleared less than 1% amount of air content.

Effect of WG on UHPC mechanical Properties

Compressive Strength:-

The compressive strength of UHPC with waste glass many factors like size, shape and content affected. Mosaberpanah et all replace 20% sand with waste glass and found upto 144Mpa compressive strength. Similarly Tahiwa et all found optimum result at 10% amount of WG and compressive strength 211Mpa. Amin et all attain 176.3Mpa compressive strength at 20% replacement of sand with WG and data shown in figure 02. According to all previous work 10 to 20% replacement of sand with WG enhance the compressive strength of UHPC and suitable for EFUHPC mix.

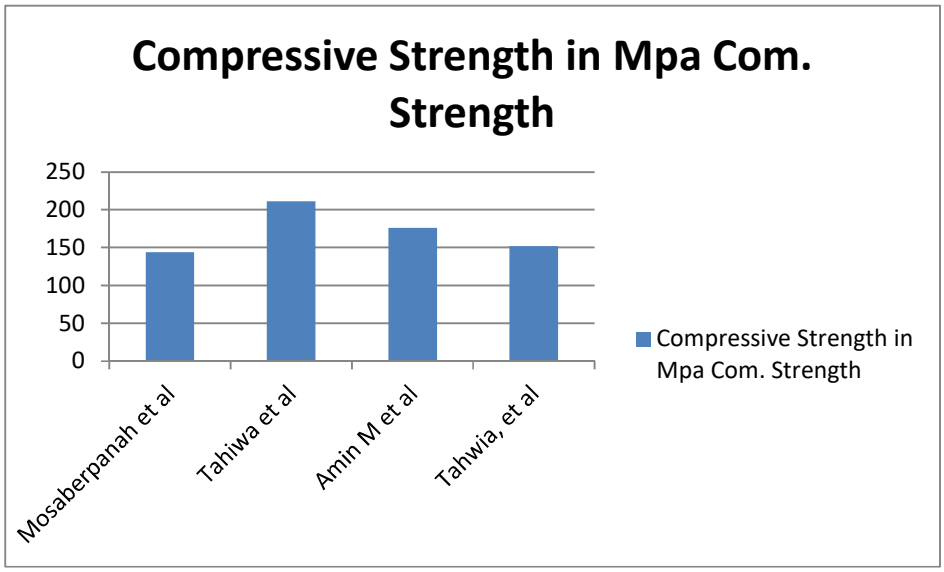

Figure 02: Compressive Strength

Flexural Strength :-

The flexural strength of UHPC with waste glass affected by many factors like, content, shape and size. According previous work Tahiwa et all gain 29.2 Mpa flexural strength at 10 % sand replacement with WG. Similarly Amin el all attain 25.7 Mpa at when WG used 20% .Similarly S. Chu et al and M a m Mohammad et al found at 17.1Mpa at 10%, and 27.88 Mpa at 20% amount of sand replaced with WG Al data shown in figure 03

According to all previous work analysis 10 to 20% amount of WG enhances the optimum flexural strength of UHPC and suitable for EFUHPC.

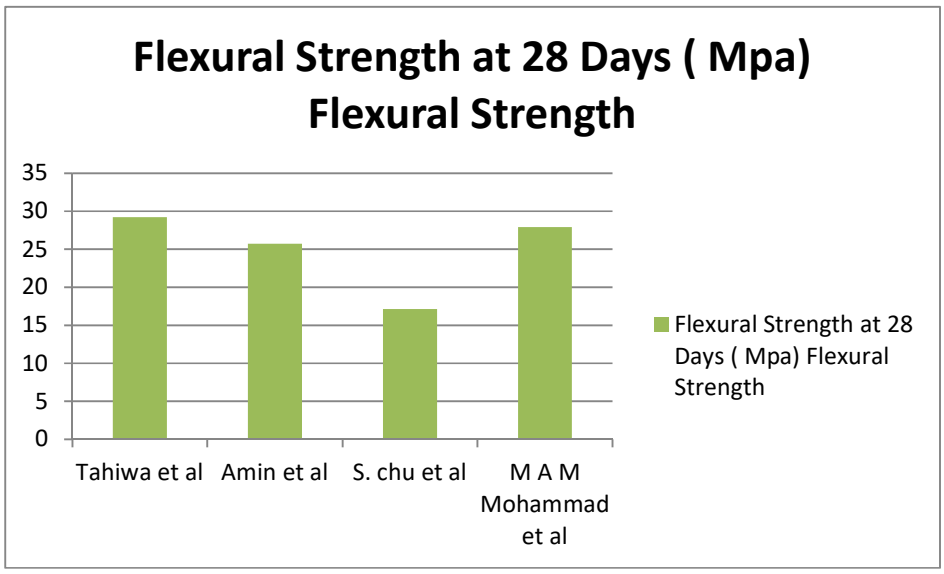

Figure 03: Flexural Strength

Splitting Tensile Strength:-

Splitting tensile strength is most usable property of UHPC. Utilization of waste glass enhances splitting tensile strength of UHPC. Amin et all found 18Mpa splitting tensile strength at 20% sand replacement with WG. 20% amount WG in UHPC mix suitable for enhancing splitting tensile strength and usable for EFUHPC making.

Water Absorption:-

Water absorption testing is most significant properties of UHPC which affet the properties of UHPC. The water absorption coefficient after use of WG as compare to ordinary concrete enhances up to five time [30]. The glass particle range lie between 25 to 75 µm and silica fume also useful for water absorption properties of UHPC[27,28]

Conclusions:-

The use of glass waste powder in UHPC affect the properties of UHPC and present time most suitable material for UHPC mix which enhances the properties of UHPC and making Eco-friendly UHPC mix.

10 to 20% replacement of sand with WG enhance the compressive strength of UHPC and suitable for EFUHPC mix.

10 to 20% amount of WG enhances the optimum flexural strength of UHPC and suitable for EFUHPC.

The Use of Waste Glass powder decreases the use of cement in UHPC mix.

Use of waste glass powder reduce cost and make sustainable structures.

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