International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 01 | Jan - 2022 ISSN: 2582-3930

The Effect of Waste Glass Powder on Concrete Properties

Tanveer Ansari[1], Abhishek Mishra[2],

[1]MTech Scholar Civil engineering Department, IET Lucknow
[2]Assistant professor Civil engineering Department, IET Lucknow

---

Abstract

Concrete is made up of a variety of components such as coarse aggregate, fine aggregate, cement, and water, all of which are combined in different amounts to create a s pecified strength. The most significant element, cement, plays a vital part in the production of concrete. Cement manufacture creates a significant quantity of CO2, whic h is a greenhouse gas. Glass powder, like other waste pr oducts such as fly ash and Silica fume, is used as a partia l replacement for cement. Waste glass can be utilised as fine aggregate or as an alternative to cement.

Researchers discovered that because of the increased silica concentration in glass, it possesses pozzolana qualities, which means it may partially replace cement and improve the strength and durability of concrete. Various investigations have shown that leftover glass from doors and windows may be ground fine and reused. The reuse of leftover glass in the manufacturing of concrete can help to solve the problem of trash disposal while also lowering the cost of concrete. This study provides a review of the literature on the use of ground glass powder in Portland cement and in conjunction with other waste products, including current and future investigations.

Key Words: Glass fibre, Slump Test, Compressive strength, Concrete, Flexure strength

1.INTRODUCTION *(Size 11, Times New roman)*

A considerable volume of garbage is created daily as a result of many companies and enterprises. The disposal of garbage created by companies has become a significant problem. Solid waste management is one of the world's most pressing environmental issues [Bhupendra Singh &Dr.vanita, 2019]. Recycling and reusing garbage has emerged as the most viable solutions to their waste disposal issues. Reusing such garbage has a lower environmental impact and is more cost effective since the energy required to reuse recyclable materials is lower than that necessary to reuse virgin materials [J.M. Khatib et al, 2017]. Because of the vast number of building sites throughout the world, using these waste products in the construction business is the greatest alternative. The World Commission on Environment and Development (WCED) claims that Sustainability means “Meeting the needs of the present without compromising the ability of the future generations.

Concrete is the second most extensively used material; nevertheless, there are environmental concerns associated with its usage that must be addressed and cannot be overlooked [Ashutosh Sharma& Ashutosh Sangamnerkar, 2020]. For the manufacturing of one tone of cement, one tone of CO2 is released into the atmosphere, accounting for around 7% of the world's total annual CO2 output.

2. The Effect of Using Glass Powder

A. Compressive Strength

a. The strength of concrete containing glass powder when subjected to Sulphate attack was investigated by Bajad M.N. et al[2016], and the results concluded that the highest compressive strength is achieved with 20% cement replacement in both conditions, and the strength decreases with increases in percentage beyond 20%.
b. S.M. Chikhalikar and S.N. Tande [2017] investigated the impact of glass powder on fibre reinforced concrete when used as a partial replacement for cement and found that the compressive strength increased by 30% when compared to the control mix.
c. According to Dali J.S. and Tande S.N. [2017], the compressive strength of concrete rises when 20% of the cement is replaced with glass powder, whether exposed to alternate wetting and drying or not.
d. The use of glass powder in concrete manufacturing was investigated by Khatib J.M. et al [2017]. At a water cement ratio of 0.5 and a cement replacement of 10%, 20%, 30%, and 40%, the best compressive strength is attained at 10% partial replacement, and after 10% partial replacement, it declines & is less than the control mix.
e. The compressive strength of concrete rises as the size of glass powder decreases, according to Dhanraj Mohan Patil and Dr. KeshavK.Sangle [2018]. According to the findings, particle sizes between 90 and 150 micron have better compressive strength than particle sizes between 90 and 150 micron. He also came to the conclusion that the increase in compressive strength is initially lower at the 7th day, but it reaches the needed strength by the 28th day. In comparison to normal concrete, the results indicated that when 20% of the cement is replaced

with waste glass powder, the greatest strength is achieved.

f. When cement is substituted with 40% waste glass powder, the compressive strength at 28th and 60th days of curing is raised by 33.7 percent compared to ordinary concrete, according to Vijaykumar G. et al [2018].

g. Vandhiyan R. et al. [2018] looked at replacing cement with glass powder and found that there was a rise in early strength at 7 days, notably at 15% glass powder, which yielded a 29 percent gain in strength, while the control mix of cement mortar reduced to 23 percent after 28 days.

h. Kumarappan N. [2018] found that when 10% of the cement is substituted with glass powder, the compressive strength is higher than the control mix.

i. In their study, Vasudeuan Gunalaon and Kanapathy PillaySeri Ganis [2018] looked at the strength of concrete with partial cement substitution by glass powder at the 7th, 14th, and 28th levels. The results revealed that the compressive strength of the concrete mix at 20 percent glass powder mix is greater than that of the control mix at the 28th day for the grade of 30.

j. ShilpaRaju and Dr.P.R.Kumar found that when the amount of glass powder in concrete is raised up to 20%, the compressive strength of the concrete rises. When the proportion of glass powder is raised over 20%, the strength decreases.

k. For constant water content and constant water cement ratio, VeenaV.Bhat and N.BhavanishankarRao [2019] investigated the compressive strength when glass powder substitutes cement. The results indicated that when the water content is kept constant, compressive strength drops, however compressive strength improves when 20% of the cement is replaced with glass powder, and is around 27% higher than a typical concrete mix.

l. According to JangidJitendra B.&Saoji A.C.[2019], the maximum strength may be reached by replacing 20% of cement with glass powder. When compared to the control mix, the compressive strength has increased by around 30%.

m. According to Ashutosh Sharma and Ashutosh Sangamnerkar [2020], replacing 10% of cement with glass powder increases compressive strength by 52.6 percent in 3 days.

n. T. Bhagyasri et al [2021] evaluated the strength of concrete at 7th and 28th days of curing specimen for M2o grade with varied percentages of glass powder such as 10%, 20%, and 40% in their research. According to the findings, the highest compressive strength is attained at 20% partial replacement.

Above data summaries In the following table:-

Table -1: Compressive strength on 14th day

S. No.	*% of GLP*	*Author*	*CompressiveStrength (MPa)*	*Remarks*
1.	10%	Vandhiyan R. et al [2018]	33.03	-
2.	20%	VasudeuanGunalaon&Kanapat hyPillay Seri Ganis [2018]	29	-
3.	20%	Raghvendra K and Virendra kumara K. N.[2020]	50.55	Mix design-20% GLP + 40% Industrial Waste

Table 2 : Compressive strength on 3rd day

S. No.	*% Of GLP*	*Author*	*CompressiveStrength (MPA)*	*Remark*
1.	10%	Ashutosh Sharma and AshutoshSangamnerkar[2020]	12.643	Glass powder particle size 600-100 micron

S. No.	% Of GLP	Author	Compressive Strength (MPA)	Remark
1.	20%	Bajad M.N. et al [2016]	27.30	Without sulphate attack
2.	20%	Dhanraj Mohan Patil and Dr. Keshav K. Sangle [2018]	19.28	GLP particle size less than 90 microns
3.	10%	Vandhiyan R. et al [2018]	30.30	-
4.	20%	Vasudeuan Gunalao n& KanapathyP illay Seri ganis [2018]	20	-
5.	20%	ShilpaRaju and Dr. P.R. Kumar, [2019]	27.30	-
6.	20%	VeenaV.Bhat and N. Bhavanishankar Rao [2019]	29.92	At constant water cement ratio
7.	20%	Raghvendra K and Virendra kumara K. N. [2020]	36.51	Mix design- 20% GLP + 40% Industrial Waste
8.	20%	Bhagyasri T. et al [2021]	28.13	-
9.	20%	VeenaV.Bhat and N. BhavanishankarR ao [2019]	29.92	At constant water cement ratio
10	20%	Raghvendra K and Virendra kumara K. N. [2020]	36.51	Mix design- 20% GLP + 40% Industrial Waste
11	20%	Bhagyasri T. et al [2021]	28.13	-

Table 3: Compressive strength on 7th day

B. Flexural Strength

a. Through an experiment, Bajad M.N. et al [2016] shown that 20 percent waste glass powder substitution is ideal in both sulphate-attacked concrete and non-sulphate-attacked concrete.

b. Dali J.S. and Tande S.N. [2017] investigated the various properties of mineral admixture-containing concrete after it was subjected to different wetting and drying, as well as high temperatures, and found that 20% cement replacement provides higher strength in both cases when the concrete is not subjected to different wetting and drying, and when the concrete is subjected to different wetting and drying.

c. In their study, Chikhalikar S.M. and Tande S.N. [2017] tested with flexural strength and found that a 20% dosage of waste glass powder is ideal for replacement cement.

d. When 40 percent cement is substituted with waste glass powder, flexural strength is enhanced, according to Vijayakumar G. et al [2018].

e. Vandhiyan R. et al. [2018] looked at replacing cement with waste glass powder and found that a 10% replacement of cement resulted in a significant increase in flexural strength.

f. ShilpaRaju and Dr. P.R.Kumar [2019] found that when the proportion of glass powder is increased up to 20% replacement, flexural strength increases, whereas strength decreases on the other side of 20% replacement.

g. In their investigations, JangidJitendra B. and Saoji A.C. [2019] predicted that when cement is substituted with up to 35 percent waste glass powder, flexural strength would rise, and the maximum gain is at 20 percent, on the other hand, it will decrease.

h. Bhagyasri T. et al. [2021] found that when cement is substituted with 20% glass powder, flexural strength is maximum at the 7th and 28th days.

Above data summaries In the following table:-

Table 4: Flexure Strength on 7th day

S.NO.	% of GLP	Author	Flexural Strength (N/mm^2)	Remarks
1.	20 %	Bajad M.N. et al[2016]	3.05	-
2.	20 %	ShilpaRaju and Dr.P.R. Kumar , [2019]	3.05	-
3.	20 %	Bhagyasri T. et al [2021]	3.35	-

Table 4: Flexure Strength on 28th day

S. No.	% of GLP	Author	Flexural Strength (N/mm^2)	Remarks
1.	20%	Bajad M.N. et al[2016]	4.17	-
2.	10%	Vijayakumar G. et al [2018]	6.5	-
3.	10%	Vandhiyan R. et al [2018]	4.8	-
4	20%	ShilpaRaju and Dr.P.R. Kumar, [2019]	4.17	-
5.	20%	JangidJitendra B. and Saoji A.C. [2019]	3.98	-
6.	20%	Bhagyasri T. et al [2021]	8.45	-

C. Split Tensile Strength

a. In their research on mineral admixtures in concrete at high temperatures, Dali J.S. and Tande S.N. [2017] found that 20 percent replacement is ideal when concrete isn't subjected to diverse wetting and drying, as well as when concrete is subjected to various wetting and drying.

b. In comparison to normal concrete, glass powder in concrete increased tensile strength effectively, according to Vijayakumar G. et al [2018].

c. According to Vandhiyan R. et al. [2018], there was just a little increase in tensile strength.

d. In their study, Raghvendra K and Virendra Kumara K. N. discovered that when cement is replaced with 20% waste glass powder an d 40% industrial waste (foundry sand), the s plit tensile strength is higher than normal co ncrete.

Above data summaries In the following table:-

Table 5: Tensile strength

S. No	% ofGLP	Author	Tensile Strength (N/mm^2)	Remarks
			5.25	Not subjected to alternatewettingand dryingafter60th day
			4.66	subjected to alternate wettingand drying after 60thday
2.	40%	Vijayakumar G.etal[2018]	3.55	At28thday
3.	20%	VandhiyanR. etal [2018]	3.11	At28thday
4.	20%	Raghvendra Kand Virendrakumara K. N.[2020]	3.73	At7thdayformix-20%GLP+40%Industrialwaste
			4.81	At14thdayformix-20%GLP+40%Industrialwaste
			5.86	At28thdayformix-20%GLP+40%Industrialwaste

D. Water Adsorption Test

a. Water absorption decreases as the quantity of glass powder increases, according to Veena V Bhat and N. BhavanishankarRao [2019]. Water absorption was lowest when the glass content was 20%.

b. According to Raghvendra K and Virendra kumara K. N. [2020], the water absorption of concrete lowers as the amount of waste glass powder and industrial waste grows at 28 days, and it is least at 20% glass powder and 50% industrial waste that is foundry sand.

c. When cement is substituted with glass powder, water absorption during the 7th and 28th days is reduced, according to Bhagyasri T. et al [2021].

Above data summaries in the following table:-

Table 6: Water Adsorption Test

S. NO.	% ofGLP	Author	Water Absorption (%)	Remarks
1.	20 %	VeenaVBhat,N. BhavanishankarRao[2019]	0.516	At28thday
2.	20 %	Raghvendra K andVirendrakumaraK.N. [2020]	1.5	At28thdayMix – 20%GLP+50 % IndustrialWaste
			0.016	At7thday
			0.023	At28thday

E. Density

a. BajadM.N. et al. [2016] determined that the density of concrete including different amounts of glass powder is lower than that of conventional concrete, owing to the lower specific gravity of glass powder, 2.58, compared to 3.15 for cement.

b. In their study, J.M. Khatib et al [2017] discovered that when the amount of glass powder is raised, the density of the specimens decreases by 40%.The average density of all combinations was 2280kg/m3.

c. According to Kumarappan N. [2018], there is a slight change in the density of concrete as compared to conventional concrete as the glass powder content increases, with a dip at 40%.

d. VasudevanGunalaan and Pillay Seri GanisKanapathy [2018] discovered that

when the percentage of glass powder in the concrete increases, the concrete gets lighter. When compared to traditional concrete, when the amount of glass powder is raised, the average cube density decreases.

e. In their study, Veena V Bhat and N. BhavanishankarRao found that the density of constant water cement falls as the proportion of waste glass powder increases.

Above data summaries In the following table:-

Table 7: Density

S. NO.	*%OF GLP*	*Author*	*Density*	*Remarks*
1.	40%	BajadM.N. et al[2016]	2283kg/m^3	At28thday
	20%		2199N/mm^2	At7thday
	15%		2087N/mm^2	At14thday
	20%		2187N/mm^2	At28thday
3.	20%	Veena V Bhat, N.Bhavanishankar Rao [2019]	2361.48kg/m^3	At constantwatercement ratio

F. Slump Test

a. The workability of concrete reduces when cement is replaced by glass powder, according to Bajad M.N. et al [2016]. The drop is attributable to a decrease in the fineness modules of cementation materials, which reduces the amount of high-quality cement paste needed to provide ease per unit surface area of aggregate.

b. In their study, Vandhiyan R. et al. [2018] found that when glass powder is replaced with cement, the workability decreases. This decrease in workability is related to the angular form of glass powder particles, as well as the increased surface area of waste glass powder.

c. Slump value or workability of concrete mix with various amounts of glass powder is an alternative for cement, according to Kumarappan N. [2018]. In his experiment, the slump ranged from 40mm for a regular mix to 160mm for a 40 percent waste glass powder combination.

d. In their study, Vasudevan Gunalaan and KanapathyPillay Seri Ganis [2018] found that when the percentage of waste glass powder used as a partial replacement increases, the workability of concrete improves.

Above data summaries In the following table:-

Table 8: Slump Value of concrete mix

S.No.	*% of GlassPowder*	*Author*	*Slump Value(MM)*
1.	40%	BajadM.N. et al[2016]	66
2.	40%	KumarappanN.[2018]	160
3.	40%	ShilpaRaju,Dr.P.R.Kumar [2019]	67
4.	20%	VasudevanGunalaan&Kanapathy pillayseriganis[2018]	70

3. CONCLUSIONS

According to the above-mentioned research, glass is used as a partial replacement for cement in concrete due to its improved workability, strength parameters such as compressive strength, split tensile strength, and flexural strength, as well as its increased durability as measured by density and water absorption checks. Because disposal of waste by-products is a big concern in today's world due to limited landfill space and rising disposal prices, using waste glass concrete would not only save money, but will also assist in minimizing disposal difficulties.

REFERENCES

[1] BajadM.N. ,ModheraC.D.and Desai A.k.(2016) "Effect of Glass on Strength of Concrete Subjected to Sulphate Attack" International Journal of Civil Engineering Research and Development (IJCERD), ISSN 2228- 9428(Print) ISSN 2248 – 9436(Online), Volume 1, Number 2.

[2] BhatVeena V, Rao N. Bhavanishankar "Influence of Glass Powder On The Properties Of Concrete" International Journal of Engineering Trends andTechnology (IJETT), ISSN: 2319 – 8753, Volume16, Number-5, October 2021

[3] Chikhalikar S.M. and Tande S.N. (2017) "An Experimental Investigation On Characteristics Properties of Fibre Reinforced Concrete Containing Waste Glass Powder as Pozzolona" 37th Conference on Our World in Concrete and Structures, Singapore, August.

[4] Dali J.S. and Tande S.N. (2017) "Performance of Concrete Containing Mineral Admixtures Subjected to High Temperature" 37th Conference on Our World in Concrete and Structures, Singapore, August.

[5] JangidJitendra B. and Saoji A.C. (2019) "Experimental investigation of waste glass powder as the partial replacement of cement in concrete production" IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X [International Conference on Advances in Engineering and Technology –(ICAET-2019)]

[6] KRaghavendra, Virendra Kumara. K. N "Reusing Of Glass Powder And Industrial Waste Materials In Concrete" International Journal of Research in Engineering and Technology, eISSN: 2319-1163 | pISSN: 2321-7308, Volume: 04 Issue: 07 | July-2020)

[7] Khatib J.M., Sohl H.S., H.S. Sohl and Chileshe N. (2017) "Glass Powder Utilisation in Concrete Production" European Journal of Applied Sciences 4 (4): 173-176, 2017 ISSN 2079-2077 © IDOSI Publications.

[8] KumarappanN.(2018) "Partial Replacement Cement in Concrete Using Waste Glass" International Journal of Engineering Research and Technology (IJERT) Vol. 2 Issue 10, ISSN: 2278-0181.

[9] PatilDhanraj Mohan and Dr.SangleKeshav K (2018) "Experimental Investigation of Waste Glass Powder as Partial Replacement of Cement in Concrete". International Journal of Advanced Technology in Civil Engineering, ISSN: 2231 – 5721, Volume-2, Issue-1, 2018.

[10] RajuShilpa, Dr. Kumar P.R. "effect of using glass powder in concrete" International Journal of Innovative Research in Science, Engineering andTechnology, ISSN: 2319 –8753, Volume-3, Issue-5, July 2019.

[11] SharmaAshutosh and SangamnerkarAshutosh "Glass Powder – A Partial Replacement For Concrete" International Journal of Core Engineering and Management (ISSN 2348 9510, Volume 1, Issue 11, February 2020)

[12] Singh ShekawatBhupendra and Dr. AggrawalVanita "Utlisationof Waste Glass Powder in Concrete – A Literature Review" International Journal of Innovative Research in Science, Engineering andTechnology, ISSN: 2319 –8753, Volume-3, Issue-7, July 2018.

[13] T Bhagyasri, U Prabhavathi and NVidya "Role of Glass Powder in Mechanical Strength of concrete" Proceedings of 39th IRF International Conference, 27th March, 2021, ISBN: 978-93-85973-81-9.

[14] Vandhiyan R., Ramkumar K. and Ramya R.(2018)"Experimental Study On Replacement Of Cement By Glass Powder" International Journal ofEngineering Research and Technology (IJERT) Vol. 2 Issue 5, May, ISSN: 2278-0181

[15] VasudevanGunalaan and Pillay Seri GanisKanapathy "Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement" American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-12

[16] VijayakumarG., Vishaliny H. and Govindarajulu D. (2018) "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production" International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 2, February)