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Eco-Sustainable Concrete: Utilization of Waste Glass Powder as A Partial Replacement for Fine Aggregates.

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ABSTRACT: *Concrete industry is one of the largest consumers of the natural resources due to which sustainability of concrete Industry is under threat. The environmental and economic concern is the biggest challenge concrete industry is facing. In this report, the issues of environmental and economic concerns are addressed by the use of waste glass powder as partial replacement for fine aggregates in concrete. Fine aggregates were replaced by waste glass powder as 0%, 10%, 15% and 20% by the weight of fine aggregates for M-20 mix. The concrete specimens were tested for compressive strength at 7 and 28 days of age and the results obtained were compared with those of normal concrete. The results conclude the permissibility of using waste glass powder as partial replacement for fine aggregates up to 15%.*

Key words: - Sustainability, waste glass powder, fine aggregates.

I. INTRODUCTION:

Concrete is most universally accepted man-made construction material with an increasing demand day by day. Using natural river sand causes exploitation of natural resources, lowering of water table, sinking of bridge piers and erosion of river bed. If fine aggregate gets replaced by waste glass powder by specific percentage and in specific range of sizes, it will decrease fine aggregate content. This will result in reduction of the ill effects of river dredging and thus making concrete manufacturing industry sustainable. The amount of waste glass has increased gradually over the recent years due to an ever-growing use of glass products. Most of the waste glass has and is being dumped into landfill sites. The land filling of waste glass is undesirable because waste glass is non-biodegradable which makes them less environmentally friendly. Utilization of this waste glass is the need of the hour. The concrete construction industry has a huge potential for using waste glass. The production cost of concrete will go down if waste glasses are reused in making concrete products. This would serve environment friendliness and also, the waste will be utilized in place of precious and relatively costlier natural resources.

Normally, glass does not harm the environment in any way because it does not give off any pollutants. But if it is not handled carefully, it can harm human beings as well as animals. Also, it is less environment friendly because it is non-biodegradable. Glass and its

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powder have been utilized as a construction material to decrease environmental problems. Due to its better thermal properties and better thermal insulation, glass aggregates contribute greater strength. The production cost of concrete will go down if waste glass is reused in making concrete products. For waste disposal and also for reducing environmental degradation, utilization of crushed glass material for the replacement of natural sand might play a vital role.

The glass used in this project is crushed waste glass being collected from the scrap. After collecting, all the unwanted materials, like labels, etc. are removed. Then it is washed and crushed into required sizes.

II. MATERIALS

Ordinary Portland cement of 53 grade is used confirming to IS: 8112-1989. Crushed granite metal (graded) with 20 mm to a proportion of 60% and 10 mm to a proportion of 40% is used as coarse aggregate which is tested according to IS: 2386-1963 Part 1 to VIII. River sand according to IS: 383-1970confirming to zone – II is used as fine aggregate. West glass powder.

Following tests are conducted for the ingredients i.e., cement and Aggregate.

I. Cement- Portland Pozzolona Cement (PPC) 53 Grade

II. Aggregate- 10mm and 20mm (locally available)

III. Properties of Fine aggregate (River sand)

Tests on Cement-

Sr. NO	DESCRIPTION	VALUE
1	Specific gravity	3.15
2	Fineness (by sieve analysis)	3.2%
3	Consistency	31%
4	Initial setting time	720 minutes Min 30 minutes
5	Final setting time	330 minutes Max 600 minutes
6	Compressive strength (3,7,28day)	27,39,55 MPa 27,37,53MPa

Table no 1- Test results of cement (Specifications as per IS 8112-1986)

Test coarse Aggregate-

SR NO	DESCRIPTION	VALUE
1	Specific gravity	2.65
2	Fineness modulus	3.3
3	Water absorption	2%
4	Surface moisture	0.08%
5	Aggregate impact value	24.40%

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6	Aggregate crushing value	21.40%
7	Bulk density	1642.50 kg/m^3

Table no 2- Test results of coarse aggregate

Test coarse Fine Aggregate

S. No	Property		Value
1		Grading of sand	Zone II as per IS383
2		Specific gravity	2.61
3	Bulk density	Loose state	1523.70kg/m^3
		Compacted state	1673.18kg/m3
4		Fineness modulus	2.49
5		Silt content	1%
6		Surface moisture	0.7%
7		Water absorption	1.52%

Table – 3 Properties of Fine aggregate (River sand)

III. MIX DESIGN

The concrete mix design is a process of selecting the suitable ingredients of concrete and determining their most optimum proportion which would produce, as economically and sustainable, concrete that satisfies a certain compressive strength and desired workability. The mix design is done according to IS: 10262-2009. The mix proportions adopted for M20 grade concrete with water/cement ratio of 0.45. A total of 4 mixes for each grade is adopted for M20 grade of concrete 0%, 10%, 15% and 20% adding of glass powder.

IV.COMPRESSIVE STRENGTH:

For compressive strength test, a homogenous mixture of concrete was produced by hand mixing different proportions of glass powder with cement, fine aggregates and coarse aggregates. The moulds were filled with 3 layers by giving 25 number of compaction blows for each layer for better compaction in cube specimens of size 150 x 150 x 150 mm and thereafter the moulds were kept on the vibrating table for final compaction. The specimens were casted for M-20 grade of concrete, considering w/c ratio of 0.45. After 24 hours, the specimens were demolded and were transferred to curing tank for a period of 7 and 28 days. Then these cubes were tested on compression testing machine as per I.S. 516-1959. The failure load was noted. The cubes were tested and their average test results were tabulated. For each batch of mixture, three specimens were tested and the failure load values were noted.

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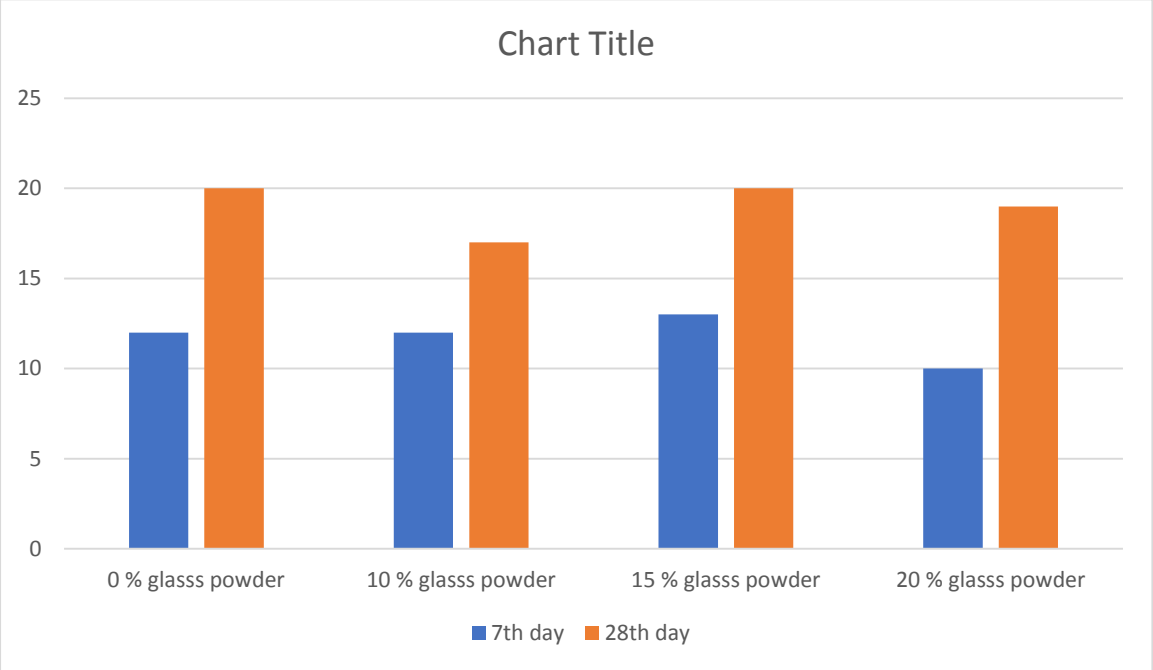
The formula used for compressive strength calculation is as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

V. RESULTS AND DISCUSSIONS

% Glass Powder	0%		10%		15%		20%	
Testing days	**7^{th} Day**	**28^{th} Day**	**7^{th} Day**	**28^{th} Day**	**7^{th} Day**	**28^{th} Day**	**7^{th} Day**	**28^{th} Day**
Maximum load carried by specimen.	270 KN	450 KN	270 KN	382.5 KN	292.5 KN	450 KN	225 KN	427.5 KN
Strength in N/mm^2.	12 N/mm2	20 N/mm2	12 N/mm^2	17 N/mm^2	13 N/mm^2	20 N/mm^2	10 N/mm^2	19 N/mm^2
Strength in %.	60%	100%	60%	85%	65%	100%	50%	95%



VI. CONCLUSION:

From the above research, the following conclusions may be made out:

1. While using waste glass powder as a partial replacement for fine aggregates, the strength of the concrete in which fine aggregates are replaced by the glass powder, is significantly similar to that of the traditional concrete with 0% glass powder replacement.

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2. A slight decrease in the strength is observed when aggregates are replaced by glass powder by 20% after the replacement by 15%.
3. Therefore, waste glass powder can be used as a partial replacement for fine aggregates.
4. The optimum quantity of the glass powder to be used as the replacement is observed to be **15%.**

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