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Study of Waste Glass Powder as Pozzolanic Material in Concrete

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Abstract: ***As concrete made possible to our every new construction and due to its discovery concrete changes world construction technology and speed up to the mark so that test of important properties of concrete like compressive strength has become so important. The main constitute of concrete is cement and production process of cement very long and not friendly to the environment and releases some greenhouse gases like CO2 etc and other pollutant but full replacement cement by any other substance could not possible so that work is going on the partial replacement of cement by some material like silica fume, fly ash, rice husk ash, etc. various research work have to be done to justify the replacement of cement by other pozzolanic material. Now in the present study we are replacing the cement by waste glass powder partially, main constituent of all type glass is silica (SiO_2) as the large size particle of glass used as the coarse and fine aggregates in concrete but in this process main problem is alkali-silica reaction (ASR) which is hazardous to concrete so that to mitigate the alkali-silica reaction glass is used in very fine powder form, the particle size of glass powder less than 100 µm so as to minimize alkali silica reaction.10%, 20% , 30% and 40% replacement of cement by glass powder have been done in this study and compressive strength of concrete at 7, 14 and 28 days are tested which shows that 30 % replacement of cement by glass powder is considerable.***

Key Words: *waste glass powder, cement concrete, alkali silica reaction etc.*

1. Introduction

Concrete is the mostly used man made construction material in the world and is second only to water as the most utilized substance on the planet. It is obtained by cementing material, water and aggregates and admixtures mixing together in required proportion. The mixture of all ingredients when placed in forms and allowed to cure it hardens into a rock like mass which is known as concrete. The hardened concrete may be considered as an artificial rock in which the voids of coarse aggregates (larger particles) are to be filled by fine aggregates (smaller particles) and the voids of fine aggregates are to be filled with cement. In a concrete mix the cementeous material and water make a paste which is called as cement-water paste, this also coats the surface of coarse and fine aggregates in addition to filling the voids of aggregates and binds the all aggregates as it cures and make a compact mass. The attractiveness of concrete is due to the truth that from the normal ingredient, the required properties of concrete are modified to meet the demand of different application. In last few decade incredible infrastructure development has taken place in over the country and making concrete of higher strengths M30, M60, M80, etc are common practice now a days. Due to globalization the practice in the making of high performance concrete (HPC) is taking place. In the current position India is the second largest producer of cement in the world after China as first. We knows that the concrete is very important and useful material in construction industry and discovery of concrete is very valuable in this field and used continuously from many years and various experiment and researches are done to know the change in important properties of concrete and replacement of its constituent. Concrete has become In construction industry the most important constitution to make concrete is cement and required in very large quantity the process of making concrete is hazardous to environment and a source of pollution. In the production process of concrete very large amount of CO2 and other greenhouse gases, from the previous experience production of one ton concrete produce about one ton CO2 and other greenhouse gases

1.1 Objective

As this study can done various ways with various parameter but according to next part some definite objective of this study are as follows:

- To evaluate the pozzolanic activity of waste glass powder as a partial replacement of cement and recyclability of waste glass powder.
- A comparative study of waste glass powdered cement mortar and conventional cement mortar.
- A comparative study of waste glass powdered concrete and conventional concrete.

1.2 literature review

Jitendra B. Jangid (2014) mulled over the glass powder incompletely supplanted at different rate between 0 to 40, at an interim of 5% .They tried its malleable, compressive, and flexural quality up to 60 days of age and contrasted it and ordinary cement. The general test outcomes

demonstrate that waste glass powder could be used in solid as a decent substitute of bond. Addition in quality was seen with expansion in rate with glass powder up to 20%.He got the higher quality when waste glass powder was supplanted by 20% concrete. The workability of solid abatements as rate of glass powder increments.

J.M. Khatib et al (2012) examined the execution of solid containing glass powder as halfway substitution of concrete. They supplanted the Ordinary Portland concrete (OPC) with 0-40% glass powder halfway. Testing incorporated the compressive quality test, ultrasonic heartbeat speed, and retention. The curing temperature of examples in water was 20°C. The outcomes imply that the most extreme quality of cement happens at around 10% glass powder. The quality of cement lessens past 10% glass powder

Dr. G. Vijayakumar et al (2013) considered that finely powdered waste glasses are utilized as a partial substitute of bond in concrete and contrasted it and conventional cement. This study inspects the likelihood of utilizing Glass powder as a fragmentary substitute of bond for new cement. bond was in part supplanted as 10%, 20%, 30% and 40% by glass powder and tried for its compressive, flexural and Tensile quality up to 60 days of period and were contrasted and those of conventional solid; results demonstrates that that waste glass powder can be utilized as concrete substitution material up to molecule size littler than 75µm to maintain a strategic distance from salt silica response. Inferred that supplanting of bond with glass powder by 20%, 30% and 40% upgrade the compressive quality by 19.6%, 25.3% and 33.7% correspondingly. substitution of glass powder in bond by 20%, 30% and 40% improve the flexural quality of cement by 83.07%, 99.07% and 100% correspondingly.

W P Prema Kumar et al (2014) mulled over that waste glass powder supplant the bond in solid in ventures of 5% from 0% to 40% by volume and impacts of this substitution on compressive quality, split elasticity, weight thickness and workability are figure out. This demonstrates that the compressive and split resistances of solid upgrade at first as the substitution rate of bond with glass powder builds and get to be most extreme at around 20% and after that abatements. The weight thickness and workability of solid lessening all the while as the substitution rate of concrete with waste glass powder increments. The substitution of bond up to around 30% with waste glass powder can be made with no diminishing in compressive quality of cement.

M. Iqbal Malik and Muzafar Bashir et al (2013) contemplated that fine totals were supplanted by waste glass powder as 10%, 20%, 30% and 40% by weight for M-25 blend. The solid examples were tried for compressive quality, part elasticity, sturdiness (water ingestion) and thickness at 28 days of age and the outcomes got were contrasted and those of ordinary cement. 20% substitution of fine totals by waste glass demonstrated 15% expansion in compressive quality at 7 days and 25% increment in compressive quality at 28 days. Fine totals can be supplanted by waste glass up to 30% by weight demonstrating 9.8% expansion in compressive quality at 28 days. With expansion in waste glass content, rate water ingestion diminishes. With expansion in waste glass substance, normal weight diminishes by 5% for blend with 40% waste glass content therefore making waste glass solid light weight. Workability of solid blend increments with expansion in waste glass content. Part elasticity diminishes with expansion in waste glass content.

2. Material and experimental study

2.1 material used

Ordinary Portland cement used for this experiment was Vikram Premium ordinary Portland cement of grade 43 conforming to IS: 12269-1987.

Coarse aggregate may be either gravel or crushed stone. Makes up 40%-45% of the mixture, comprised of particles greater than 1/4". Ordinary traditionally used gravel or commonly named as black metal was used for this experimental work. Numbers of test were conducted to check the suitability of the coarse aggregate in the concrete mix.

Fine aggregate normally called sand, this component can be natural sand or crushed stone, and represents particles smaller than 3/8". Generally accounts for 30%-35% of the mixture. Sand of zone 2 was used for this experimental work after performing the same test as on coarse aggregate.

Glass powder in this study flint glass powder is used. The particle size of powder is such s 99% passing with 150 micron and 95% with 90 micron IS sieve.

Table -1 Comparative physical properties of glass powder and cement

Physical properties	Glass powder (%)	Cement (%)
Specific gravity	2.66	3.15
Fineness	100	96

Table -2 Comparative chemical properties of glass powder and cement

Chemical properties	Glass powder (%)	Cement (%)
CaO	9.82	60-67
SiO_2	73.2	17-25

Al_2O_3	1.34	3-8
Fe_2O_3	0.65	0.5-6
MgO	3.50	0.1-4
SO_3	-	1.2-3
Alkali's (K_2O, Na_2O)	11.3	0.4-1.3

2.2 mix proportioning and testing of specimen

For this study M30 grade concrete mix have been designed according to the specification of IS: 10262-2009.the cement content in this mix is 410.42 kg/m^3 and water cement ratio is 0.48.the actual proportion of mix obtained is 1:1.80:2.71 and cement is replaced in range of 10, 20, 30 and 40 %. No admixture used in this work.

Total 30 numbers of cubes of size 150 mm x150 mm x150 mm are casted and tested in the standard compression testing machine at age of 7, 14 and 28 days of curing.

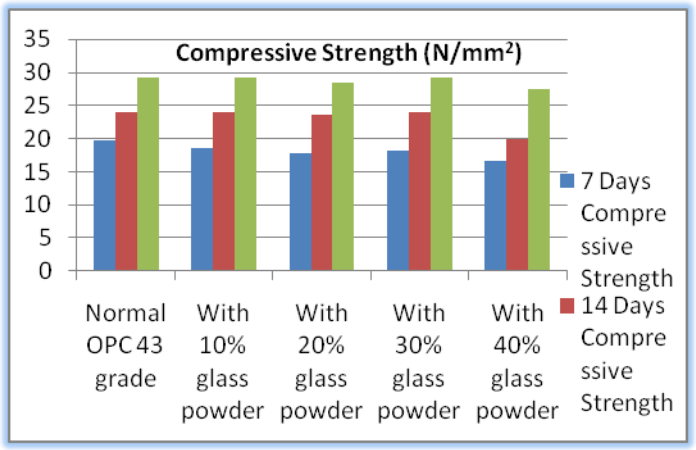

Chart -1: comparison of compressive strength of samples

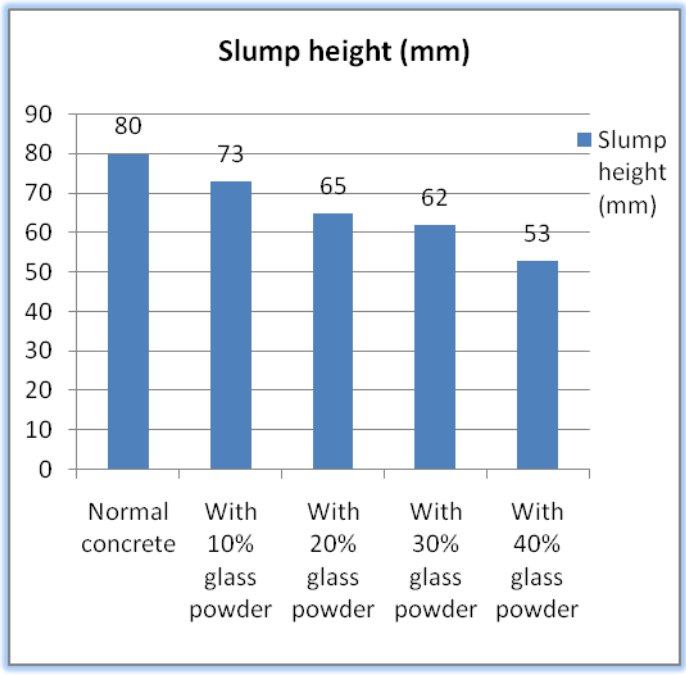

Chart -2: comparison of slump value of samples

Fig -1: compression testing machine

3. Results and discussion

From the test results it is clear that percentage reduction in the slump value is 8.7%, 18.7%, 25% and 33% for the 10, 20, 30 and 40 percent replacement of cement respectively. Which shows that water requirement of mix after adding glass powder is increases s the percentage of glass powder increases.

The test results of 7 days of concrete cubes are 84%, 76%, 79% and 70% of normal mix for the 10%, 20%, 30% and 40% replacement of cement in mix respectively and results of 14 days are 93%, 92%, 92.5% and 84% for the 10%, 20%, 30% and 40% replacement of cement which shows that glass powder have not been added early strength. Due to addition of glass powder strength at the

initial ages of concrete is not fully obtained. The test results of 28 days compressive strength are 99%, 98.70%, 99.60% and 95.5% of normal concrete mix for 10, 20, 30 and 40 percent replacement of cement with glass powder, it men at the later age glass powdered concrete gin the sufficient strength and 30% replacement of cement give approximately equal strength to the normal concrete mix so that 30% glass powder is effectively used in concrete mix as a replacement of cement.

4. Conclusion

From this study we made the following conclusions:

- The percentage reduction in the slump value is 8.7%, 18.7%, 25% and 33% for the 10, 20, 30 and 40 percent replacement of cement respectively.
- Initial strength of concrete is not fully achieved after addition of glass but at the later age full strength is obtained.
- 30% replacement of cement give approximately equal strength to the normal concrete mix so that 30% glass powder is effectively used in concrete mix as a replacement of cement.
- Water requirement of mix increase as the percentage of glass powder increase

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