An Experimental Study on Effective Utilisation of Glass Powder in Concrete

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Abstract - *Glass is used in many forms and for different purposes in day-to-day life. It has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses. Many efforts have been made to use waste glass in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. Its performance as a coarse aggregate replacement has been found to be non-satisfactory because of strength regression and expansion due to alkali-silica reaction. The research shows that there is strength loss due to fine aggregate substitution also.*

The aim of the present work was to use glass powder as a replacement of cement to assess the pozzolanic activity of fine glass powder in concrete and compare its performance with other pozzolanic materials like silica fume and fly ash. In this project we replace Cement by glass powder in the range 5% to 40% increment of 5% is studied. ItIs then tested for compressive strength and flexural strength at the age of 7, 28 and 90 days and compared with those of conventional concrete. Results are then studied for which proportion it gives higher strength.Also alkalinity test is done to find out resistance to errors.

Keywords : Glass powder, natural sand, compressive strength, flexural strength, water.

I. INTRODUCTION

Concrete is a blend of cement, sand, coarse aggregate and water. The key factor that adds value to concrete is that it can be designed to withstand harshest environments significant role. Today global warming and environmental devastation have become manifest harms in recent years, concern about environmental issues, and a changeover from the mass-waste, mass-consumption, mass-production society of the past to a zero-emanation society is now viewed as significant.

Normally glass does not harm the environment in any way because it does not give off pollutants, but it can harm humans as well as animals, if not dealt carefully and it is less friendly to environment because it is non-biodegradable. Thus, the development of new technologies has been required.The term glass contains several chemical diversities including soda-lime silicate glass, alkali-silicate glass and boro-silicate glass. To date, these types of glasses glass powder have been widely used in cement and aggregate mixture as pozzolana for civil works. The introduction of waste glass in cement will increase the alkali content in the cement. It also help in bricks and ceramic manufacture and it preserves raw materials, decreases energy consumption and volume of waste sent to landfill. As useful recycled materials, glasses and glass powder are mainly used in fields related to civil engineering, for example, in cement, as pozzolana(supplementary cementitious materials), and coarse aggregate. Their recycling ratio is close to 100%, and it is also used in concrete without adverse effects in concrete durability. Therefore, it is considered ideal for recycling Recently, Glasses and its powder has been used as a construction material to decrease environmental problems. The coarse and fine glass aggregates could cause ASR(alkali-silica

reaction) in concrete , but the glass powder could suppress their ASR tendency, an effect similar to supplementary cementations materials (SCMs). Therefore, glass is used as a replacement of supplementary cementitious materials.

II. LITERATURE REVIEW

Bhupendra Singh Shekhawat, Dr. Vanita Aggarwal[1],This paper present literature review on replacement of cement by waste glass powder which includes current andfuture trends of research on the use of crushed glass powder in Portland cement concrete From the above mentioned work of various researchers and our present experimental work, it is clear that glass can be used as a partial replacement of cement in concrete because of its increased workability, strength parameters like compressive strength, flexural strength and split tensile strength and also because of its increased durability measured by water absorption test and sorptivity test. As disposal of waste by-products problem is a major problem in today's world due to limited landfill space as well as its escalating prices for disposal, utilization of waste glass in concrete will not only provide economy, it will also help in reducing disposal problems. [1]

Ismail Ansari, Sheetal Sahare[2],Glass is an amorphous solid that has been found in various forms for thousands of years and has beenmanufactured for human use since 1200 BC. Glass is one the most versatile substances on Earth, used in many applicationsand in a wide variety of forms, from plain clears glass to tempered and tinted varieties, and so forth. After its usage it isgenerally dumped in landfills. Since glass is a non-biodegradable material, landfills do not provide a friendly environment. Many attempts were made to use waste glass in concrete industry as a replacement of coarse aggregate and fine aggregatebut the performance were unreliable because of strength regression. As glass powder with particle size less than 75 mpossess pozzolanic properties, past investigation reveals that glass powder can be effectively use as a partial replacement ofcement. Experimental Investigations shows a positive result by enhancing the compressive and tensile strength of concrete.Workability decreases with increment in glass powder content. A review on utilization of a glass powder as a partialreplacement of concrete and its effects on compressive and tensile strength of concrete is shown in this paper.[2]

Krati Gahoi1, R. Kansal[3],Concrete is the mixture of various materials coarse aggregate, fine aggregate, cement & water, each of them is mixed in various proportions to achieve specific strength. Cement being the most important material plays an important role in the manufacturing of concrete. The manufacturing process of cement produces a large amount Co2 gas which is a greenhouse gas. Just like other waste products like fly ash, Silica fume etc. glass powder is also used as a partial replacement of cement. Waste glass in the form of fine aggregate or as alternative cement can be used. Researchers has investigated that glass posses a pozzolana properties due to increase in silica content, so it can be replace cement to some degree and can improve the strength and also increase the durability of concrete. According to various studies, the waste glass from door & window can be grounded fine and can be reused. The reuse of waste glass in the production of concrete can reduce the disposal problem and it can decrease the cost of concrete. This paper is a literature review, which include present & future studies on using grounded glass powder in Portland cement and in combination withother waste product.[3]

Dhanaraj Mohan Patil, Dr. Keshav K. Sangle[4],Concrete is a construction material composed of cement, aggregates (fine and coarse aggregates) water and admixtures. Today many researches are ongoing into the use of Portland cement replacements, using many waste materials like pulverized fly ash (PFA) and ground granulated blast furnace slag (GGBS). Like PFA and GGBS a waste glass powder (GLP) is also used as a binder with partial replacement of cement which take some part of reaction at the time of hydration, also it is act as a filler material. In this study, waste glass powders have been used as replacements to the concrete ingredient i.e. cement and the mechanical properties like

compressive strength are measured. Also we were studied the size effect ofglass powder on strength of concrete. For checking strength effect of replacement of cement by glass powder, the cement is replaced at 10%, 20% and 30%. For study of size effect of glass powder the powder is divided in to two grades one is glass powder having size less than 90 micron and another is glass powder having particle size ranges from 90 micron to 150micron. It is found from study, Initial strength gain is very less due to addition of GLP on 7th day but it increases on the 28th day. It is found that 20% addition of GLP gives higher strength. And also GLP size less than 90 micron is very effective in enhancement of strength.[4]

Ashutosh Sharma[5],The research work is (was done to) determination of the effect of the use of 'Glass Powder' as a replacement of cement to assess the pozzolanic nature of fine glass powder when mixed in concrete and compare the difference in performance with other pozzolanic materials are mixed in concrete like silica fume and fly ash. The present study shows that waste glass, if ground finer than 600μm shows a pozzolanic behaviour. It reacts with lime at early stage of hydration forming extra CSH gel thereby forming denser cement matrix. Thus early consumption of alkalis by glass particles helps in the reduction of alkali-silica reaction hence enhancing the durability of concrete. Numbers of test were conducted to study the effect of 5%, 10%, 15%,20% and 25% replacement of cement by glass powder on compressive strength and durability. The particle size effect was evaluated by using glass powder of size 600μm-100μm.The results showed that the maximum increase in strength of concrete occurred when 20% replacement was done with glass powder.[5]

III. OBJECTIVE OF THE INVESTIGATION

Experiments were conducted on concrete prepared by partial replacement of cement by waste glass powder of particle size 600 micron and downwards. The main objective of this investigation was to evaluate the effect of waste glass powder on the compressive strength and the other properties of concrete and to evaluate the possibility of using glass powder in concrete without sacrificing the strength. The following were also considered.

- Partial substitute for the Portland Pozzolana cement
- To investigate the structural behaviour of such replaced concrete components
- To determine the percentage of glass powder which gives maximum strength when compared to control concrete.

IV. MATERIALS

The ingredients of concrete consist of Cement, fine aggregate and coarse aggregates, water. When the reaction of water with cement takes place hydration process is done and a hard material is formed. In this research we used waste glass powder as a partial replacement and filler material. The ingredients are used in proper proportion. Also the cement is replaced at 10%, 20%, and 30% by glass powder. They are described in details with their properties are as follows

A. Cement

Portland cement grade 43 is the most common type of cement in general usage. It is the basic ingredient of concrete, mortar and plaster.

B. Fine aggreagates and course aggreagates

Fine and coarse aggregate make up the bulk of concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose. For fine aggregates natural sand is provided with maximum size of 4.75 mm. Coarse aggregates are used with size between 20mm-4.75mm.

C. Waste Glaas Powder:

Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and CaCO3 at high temperaturefollowed by cooling during which solidificationoccurs without crystallization. Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. The amount of waste glass is gradually increased over the recent years due to an ever-growing use of glass products. Most waste glasses have beendumped into landfill sites. The Land filling of wasteglasses is undesirable because they are not biodegradable,which makes them environmentally less friendly. So we use the waste glass in concrete to become the construction economical as well as eco-friendly.Composition of cement and Glass

Powder is as shown in Table I.

Sr.No.	**Properties**	**Waste Glass Powder (GLP)**	**Cement**
1	SiO2 (%)	70.22	23.71
2	CaO (%)	11.13	57.27
3	MgO (%)	-	3.85
4	Al2O3 (%)	1.64	4.51
5	Fe2O3 (%)	0.52	4.83
6	SO3 (%)	-	2.73
7	Na2O (%)	15.29	-
8	K2O (%)	-	0.37
9	Cl (%)	-	0.0068
10	Loss on ignition (%)	0.80	7.24

III METHODOLOGY

Material

Under this experimental investigation, following materials are using which are given as below:-

Material Selection:

1. Cement
2. Fine Aggregate
3. Coarse Aggregate
4. Glass Powder
5. Water

As above given material we trying the replace cement by Glass Powder as making mortar and check compressive strength ,water absorption test , slump test, Alkalinity test, Flexural test.

The procedure is as given:

- Preparation of Glass Powder- The entire glass sample collected is broken into pieces and converted into glass powder then it is sieved through 300 micron sieve and glass powder passing through the 600 micron sieve is considered for this test.
- Preparing mortar using different percentage of (glass powder) by replacing cement (i.e.by 0, 5,10,15,20,25 and 30).
- After curing the specimens are testing on Indian Standard testing machines.
- The concrete cubes were cast for compressive strength and flexural strength according to mix proportion and by replacing cement with glass powder(GP) in different proportion.
- Finally the results are compute and analyzing with varying percentages of Glass Powder comparing it with the conventional concrete.
- Similarly same procedure is carrying out for other proportions of concrete.

V. CONCLUSION:

1.Waste glass, if ground finer than 100μm shows a pozzolanic behavior.

2. The smaller particle size of the glass powder has higher activity with lime resulting in higher compressive strength in the concrete mix.

3. Compared to fly ash concrete, finer glass powder concrete had slightly higher early strength as well as late strength.

4. Micro structural examination shows that glass powder produces a denser matrix which improves the durability property of concrete.

5. The coefficient of capillary absorption test also indicates that incorporation of finer glass powder improves durability.

6. Glass powder of size 150μm - 100μm exhibit initiation of alkali aggregate reaction. The presence of ettringite confirms this.

7. The data presented in this study indicates that silica fume is best SCM. It gives highest compressive strength because of its smaller grain size and spherical shapes.

8. The results obtained from the present study shows that there is great potential for the utilization of best glass powder in concrete as replacement of cement.

9. The fine glass powder can be used as a replacement for expensive materials like silica fume and fly ash.

10. It can be concluded that 30% of glass powder of size less than 100μm could be included as cement replacement in concrete without any unfavorable effect.

REFERENCES:

[1]Bhupendra Singh Shekhawat1, Dr. Vanita Aggarwal (July 2014),” Utilisation of Waste Glass Powder in Concrete– A Literature Review”, International Journal of Innovative Research in Science, Engineering and Technology.

[2]ismail Ansari, sheetal Sahare," Utilization Of Glass Powder As A Partial Replacement Of Cement And Its Effect On Concrete Strength – A Review" Proceedings of 45th IRF International Conference.

[3] Krati Gahoi1, R. Kansal," Effect of Waste Glass Powder on Properties of Concrete: A Literature Review(2013)", International Journal of Science and Research (IJSR) ISSN.

[4] Dhanaraj Mohan Patil, Dr. Keshav K. Sangle(2013)", Experimental Investigation Of Waste Glass Powder As Partial Replacement Of Cement In Concrete" International Journal Of Advanced Technology In Civil Engineering.

[5] Ashutosh Sharma(February 2015),"Glass Powder – A Partial Replacement for Cement?" International Journal Of Core Engineering & Management (IJCEM).