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TO STUDY THE POSSIBILITY OF USING WASTE GLASS POWDER AS POZZOLANIC MATERIAL IN CONCRETE

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ABSTRACT: Glass is used in many forms 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.
A series of tests were conducted to study the effect of 15% and 30% replacement of cement by silica fume, fly ash and glass powder on compressive strength and durability in the form of capillary absorption. The particle size effect was evaluated by using glass powder of size 150µm-100µm and glass powder of size less than 100µm.
The present study shows that waste glass, if ground finer than 100µm shows a pozzolanic behavior. It reacts with lime at early stage of hydration forming extra CSH gel thereby forming denser cement matrix. The early consumption of alkalis by glass paticles mitigate alkali-silica reaction hence increase durability of concrete.

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(supplem entary 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. METHODOLOGY

A nominal mix of concrete of proportion 1:2:4 was adopted for the present study. The first mix MC1 is control mix having only cement as binder. The MCF series had fly ash as replacement of cement. The MCS & MCG series had silica fume and glass powder as replacement of cement. The compressive strength test were conducted to monitor the strength development of concrte containing 15% & 30% of these pozzolana as cement replacement. The particle size effect of glass powder studied by using glass powder of size (150-100)µ and (50-100)µ. Capillary absorption test is conducted to study the effect of alkali aggregate reaction.
The EDS analysis and SEM analysis of the mixes were done to study the change in the morphological characteristics of concrete mixes

- The tests were conducted in two series.
- In first Series 30 % of pozzolana were used as partial replacement of cement.
- In second series 15% of pozzolana were used as partial replacement of cement.
- Eleven numbers of standard cubes (150x150x150 mm) were cast to measure the compressive strength after 28days and 52 days. Two cube were retained to measure

capillary absorption after 28 days and 52 days respectively.

- The EDS analysis and SEM analysis of the mixes were done after 28 days and 52 days to study the change in the morphological characteristics of concrete mixes.

To study the characteristics following tests were conducted:
Normal consistency
Normal consistency of different binder mixes determined by using the procedure referring to IS 4031: part 4 (1988):

• 300 gram of sample coarser than 150µ sieve is taken.
• Approximate percentage of water added to sample and mixed methodically for 2-3 minutes.

Fig

After applying oil to the surface of mould, paste was filled in the vicat's mould and was placed under the needle of vicat's apparatus.
• Release quickly the needle allowing it to sink in the paste and note down the penetration reading when the needle becomes stable.
• If the penetration reading is less than 5 to 7 mm, prepare the paste again with more water and repeat the above procedure until the needle penetrate to a depth of 5 to 7 mm.
• The percentage of the water with which the above situation is satisfied is called normal consistency.

Compressive Strength Test:

For each series five set were cast to determine compressive strength. Each set comprises of eleven standard cubes out of which nine cubes were cast to measure the compressive strength after 28days and 52 days. The size of the cube is as per the IS code 10086 – 1982.

Capillary absorption Test:

Out of eleven standard cubes two cubes were retained to measure capillary absorption coefficients after 28 days and 52 days curing respectively. This test is conducted to measure the capillary absorption which indirectly measures the durability.

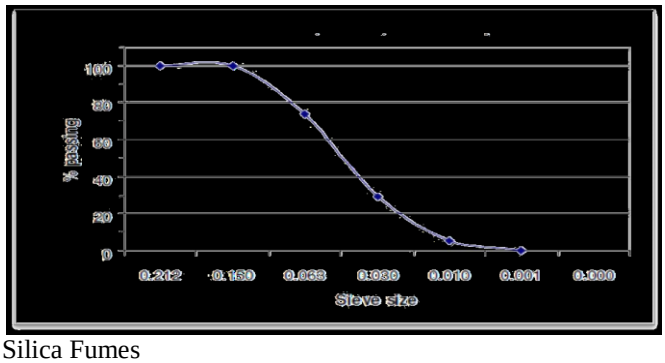
2.1Experimental Program

Materials

The materials used in this present work are glass powder, Ordinary Portland cement(43 grade), fly ash, silica fumes, coarse aggregates and fine aggregates.□

Glass Powder

The glass powder used in the present study is brought from Kolkata market. This material replaces the cement in mix proportion. Particle size distribution graph and XRD analysis of glass powder was done and shown in Fig.3.1 and Fig.3.2 respectively.



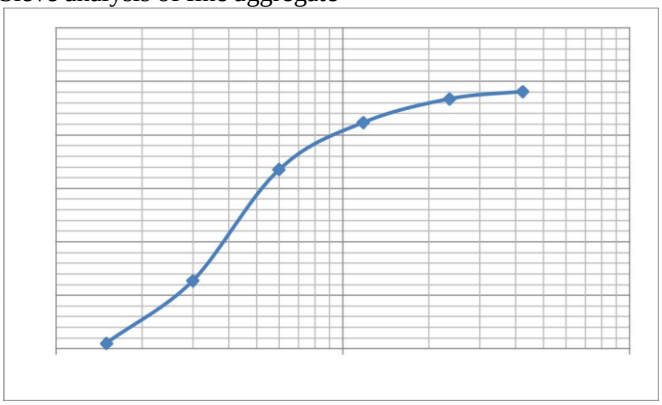
Silica Fumes

The silica fume used in the present work is supplied by Structural Laboratory of Department of Civil Engineering, NIT Rourkela. Silica fume is highly reactive pozzolanic material and is a by product from the production of silicon or ferro- silicon metal. It is composed from the flue gases from electric arc furnaces. Silica fume is very fine powder, with particles about 100th times minor than average cement grain. It is available in a water slurry form. It is used at 5% to 12% by mass of supplementary cementitious materials for concrete structures that requires high strength.

Fly Ash

The fly ash used in the present work is supplied by CPP2 of Rourkela steel plant. Fly ash is largely made up of calcium oxide and silicon dioxide can be used as a substitute or as a supplent for Portland cement. Fly ash is also known as Green concrete. .

Sieve analysis of fine aggregate



III. RESULTS AND DISCUSSIONS.

The results indicate that silica fume replacement produces higher strength than the glass powder and fly ash replacement. The strength development of concrete mix with glass powder of size <100µ is almost or more than the concrete mix with fly ash as cement replacement. This is confirmed from the results of both the series

IV. 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

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