Utilization of Glass Powder And Fly Ash In Concrete Prodution

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Abstract--- The advancementof concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of fly ash and glass powder are generated in thermal and glass industries with an important impact on environment and humans. In recent years, many researchers have established that the use of supplementary cementitious materials (SCMs) like glass powder, fly ash (FA), blast furnace slag, silica fume, and rice husk ash (RHA), etc. can, not only improve the various properties of concrete - both in its fresh and hardened state, but also can contribute to economy in construction costs. This research work describes the feasibility of using such industrial waste in concrete production as partial replacement of cement. The use of glass powder and fly ash in concrete formulations as a supplementary cementatious material was tested as an alternative to traditional concrete. The cement has been replaced by glass powder and fly ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30% & 40% by weight of cement for M-25 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength up to 21 and 28 days. The aim of the present work was to replace cement by glass powder and fly ash as a admixture to assess the pozzolanic activity in concrete and compare its performance with plain concrete. It was found that compressive and tensile strength of the concretes increased as fineness increased. It was concluded that fineness of fly ash have positive impact on mechanical properties of concrete and cement motar.

Keyword:- fly ash,waste glass powder; concrete; strength; replacement

I. INTRODUCTION

Concrete is a versatile construction material that is widely used in virtually all structural works. It is a composite material comprising cement, aggregates, water and admixtures. Concrete is a blend of cement, sand, coarse aggregate and water.

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, and 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 by passing from 90 micron sieve. The introduction of waste glass in cement will increase the alkali content in the cement. It also helps 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.

Fly ash is an industrial waste and a material of pozzolanic characteristic occurring due to burning the pulverized coal in the thermal power plants. In the construction sector, the fly ash is used in the production of cement as an additive-material, in production of concrete instead of some of the cement or instead of some of the fine aggregate, as a base and sub-base material in highway construction, as a filling material in dams, in retaining walls, and for production of light construction material. Thus glass powder and fly ash as an admixture can be used in cement industries and construction technologies so as to reduce the cost of construction in civil projects

II. MATERIALS & CHEMICAL COMPOSITION

A. *Cement :*

Table. 1:

Compound	Formula
Calcium Oxide (Lime)	CaO
Silicon dioxide (Silica)	SiO2
Aluminum Oxide (Alumina)	Al2O3
Iron Oxide	Fe2O3
Water	H2O
Sulphate	SO3

The most common cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 43grade conforming to IS: 8112 was used.

B. *Glass Powder:*

The glass is a mixture of a number of metallic silicates, one of which is usually that of an alkali metal. It is an amorphous, transparent or translucent. It may also be considered as a solidified super cooled solution of various metallic silicates having infinite viscosity

Table. 2:

Composition (% by mass)	Glass powder
Silica (SiO2)	72.5
Alumina (Al2O3)	0.4
Iron oxide (Fe2O3)	0.2
Calcium oxide (CaO)	9.7
Magnesium oxide (MgO)	3.3
Sodium oxide (Na2O)	13.7
Potassium oxide (K2O)	0.1
Sulphur trioxide (SO3)	-
Loss of ignition	0.36
Fineness % passing (sieve size)	80 (45 µm)
Unit weight,Kg/m3	2579
Specific gravity	2.58

III. CLASSIFICATION OF GLASS POWDER:

- Soda lime glass
- Potash lime glass
- Potash lead glass
- Common glass

A. Fly Ash:

The fly ash used in the present work is supplied by RMC Plant Ujjain. Fly ash is largely made up of calcium oxide and silicon dioxide can be used as a substitute or as a supplant for Portland cement. Fly ash is also known as Green concrete. The sieve analysis of fly ash is given below.

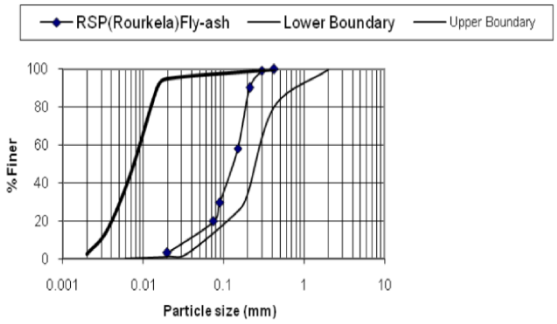

Fig. 1:

B. Grain Size Distribution Of Fly Ash: Two classes of fly ash are defined by ASTM International /ASTM C618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned (i.e., anthracite, bituminous coal/bituminous, and lignite).

C. Aggregate: Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Good grading implies that a sample fractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, lower shrinkage and greater durability.

D. Coarse Aggregate: The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are used. The Flakiness Index and Elongation Index were maintained well below 15%.

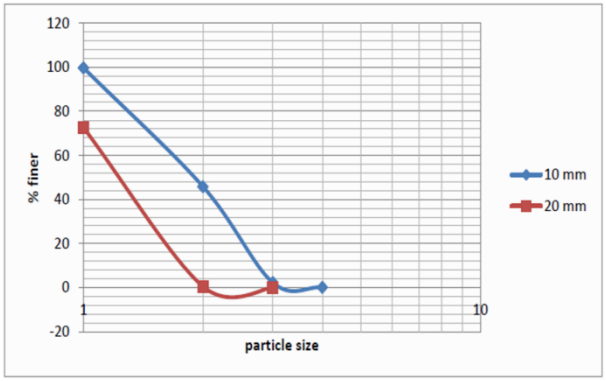

Fig. 2:Sieve Analysis Of Coarse Aggregate

E. Fine Aggregate: Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand and crushed sand is used in combination as fine aggregate conforming to the requirements of IS: 383. The river sand is washed and screened, to eliminate deleterious materials and over size particles.

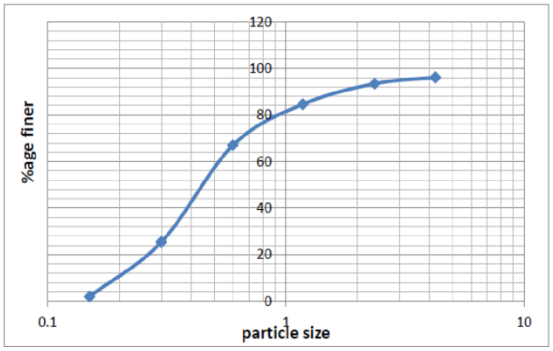

Fig. 3:Sieve Analysis Of Fine Aggregate

IV. EXPERIMENTAL WORK:

A nominal mix of concrete of proportion 1:1:2 was adopted for the present study. The first mix MC1 is control mix having only cement as binder. The MCF series had Glass powder and fly ash as replacement of cement. The compressive strength test was conducted to monitor the strength development of concrete containing 20% of this pozzolana as cement replacement.

The tests were conducted in two series.

- In first series fresh concrete cube is casted using M25 concrete.
- In second Series 20 % of Glass powder and fly ash were used as partial replacement of cement.
- Three numbers of standard cubes (150mmx150mmx150 mm) for each admixture were cast to measure the Compressive strength after 7, 21 & 28 days.
- Three no. of cubes (70.02mmX70.02mmX70.02mm) mortar cubes for this admixture were casted to check their compressive strength for 7, 21 and 28 days.

V. RLT AND DISCUSSION1) COMPRESSIVE STRENGTH

A. Strength:

- Mortar Cubes
- Concrete Cubes

1) Compressive Strength For M25 Cement Mortar Cube At 7, 21 And 28 Days:

Grade of Concrete	Minimum compressive strength N/mm² at 7 days	Specified characteristic compressive strength (N/mm²) at 21 days	Specified characteristic compressive strength (N/mm²) at 28 days
M25	9	18	29
Cement – Glass powder	8.17	17.6	28.5
Cement – Fly ash	8.5	17.5	28.47

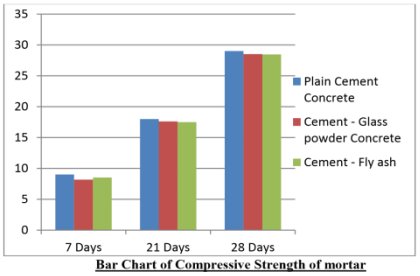

Fig. 4:

2) Compressive Strength Of M25 Grades Of Concrete At 7, 21 And 28 Days:

Table. 3:

Grade of	Minimum Strength at 7	Specified compress strenght (M/m2) 2 days	Specified characteristic compressive (M/m2) 2 days
M2	18	23	27
Ceme-Glass	17	22	26
Ceme-Fly	1	2	2

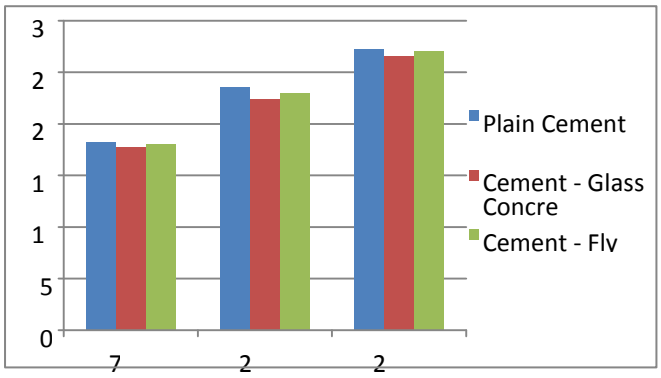

Fig. 5: Bar Chart of Compressive Strength of concrete

B. Normal Consistency Of Cement, Cement- Glass Powder And Cement – Fly Ash:

Descript	Consiste
Cem	3
Glass	4
Flv	4

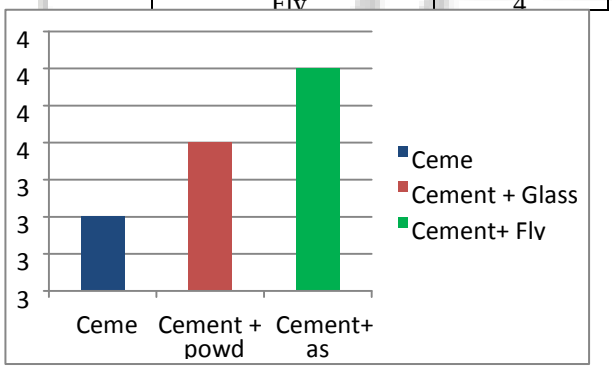

Fig. 6: Bar chart of consistency

C. Slump Cone Test: Slump cone test of Cement, Cement- Glass powder & Cement – Fly ash Concrete

Table. 4:

MIX	0.60%	0.70%	0.80%
M25	0 True	150 False	Collapse
Cement- Glass powder Concrete	0 True	220 False	Collapse
Cement- Fly ash Concrete	0 True	240 false	Collapse

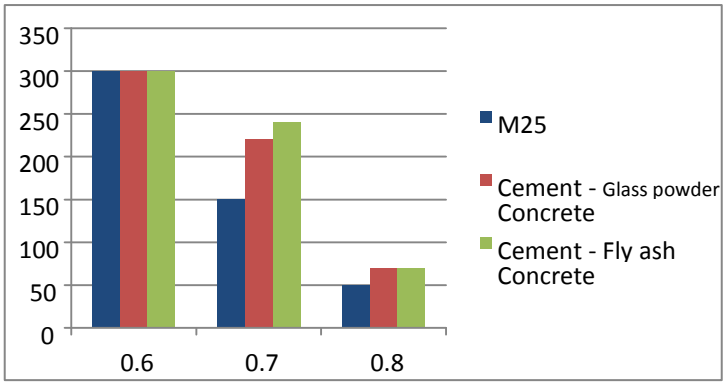

Fig.7 : Bar Chart of Slump Cone

D. Compaction Factor Test: Compaction factor test for cement, cement- Glass powder and cement – fly ash

Table. 5:

Material	Compaction Factor Value
Cement	0.85
Cement – Glass powder	0.86
Cement – Fly ash	0.92

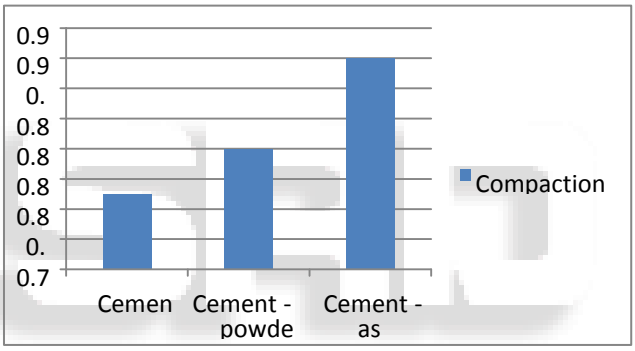

Fig. 8: Bar Chart of Compaction Value

E. Soundness Test: Soundness test value for cement, cement- Glass powder and cement – fly ash

Table. 6:

Material	Soundness Value
Cement	8
Cement – Glass powder	8
Cement – Fly ash	8.6

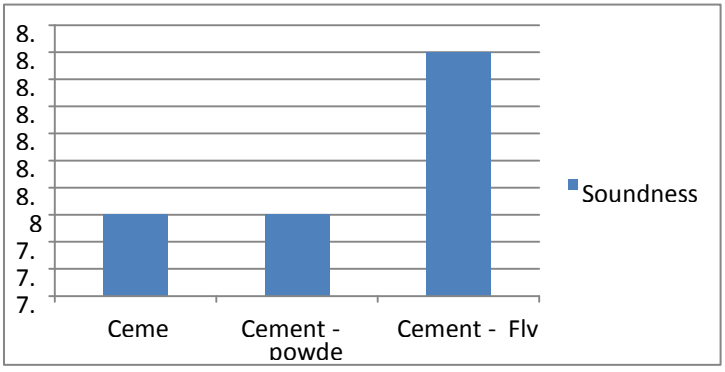

Fig. 9: Bar Chart of Soundness Value

VI. CONCLUSION

From the results of the various tests performed, the following conclusions can be drawn:-

- The data presented in this paper show that there is great potential for the utilization of waste glass in the form of glass powder.
- It is considered that the glass powder form would provide much greater opportunities for value adding and cost recovery, as it could be used as a replacement for expensive materials such as silica fume, fly as hand cement.
- Addition of Glass powder improved compressive strength of concrete. Compressive strength of concrete increases with increase in glass powder dosage up to 20% replacement to cement, then it starts decreasing. So the optimum percentage Glass powder found from experiment is 20%.
- 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.
- Concrete becomes more workable as the ash content increases. This means that fly ash concrete has lower water demand.
- The compressive strength generally increases with curing period and decreases with increasing fly ash content.
- Fly Ash is a suitable material for use as a pozzolana, since it satisfied the requirement for such a material by having a combined (SiO2 +Al2O3 +Fe2O3) of more than 70%. It is classified as a Class F fly ash.
- Replacing cement by fly ash has reduced the peak temperature by 8^0C.
- Replacing cement by fly ash has heat generation pattern which was more uniform and gradual.
- Compressive strength reduces when cement replaced fly ash. As fly ash percentage increases compressive strength and split strength decreases.
- Use of fly ash in concrete can save the coal & thermal industry disposal costs and produce a ‘greener’ concrete for construction.
- The cost analysis indicates that the reduced cement % decreases cost of concrete, but at the same time strength also decreases.
- This research concludes that fly ash can be innovative supplementary cementitious Construction Material but judicious decisions are to be taken by engineers.

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