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EXPERIMENTAL INVESTIGATION OF HIGH-PERFORMANCE CONCRETE BY USING GLASS POWDER AND IRON POWDER AS FINE AGGREGATE

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***Abstract**: High-performance concrete (HPC) plays an essential role in high thrust structures. General high-performance concrete is an engineered concrete that houses the most workable homes during gloss and solid concrete. Each component's overall performance and excellence are important to the HPC to exploit the compound's full capabilities. HPC has been developed through the use of unusual plasticizers, fine fillers, and various forms of fibers. HPC finishing is not the best now by reducing the water-to-cement ratio. And replacing cement and aggregates with some mineral additives such as silica fume, iron dust, glass dust, and ground granulated blast furnace slag (GGBS), methacholine, fly ash, etc., with chemical additives. From the literature's evaluation, it is understood that the satisfactory mixture, although partially altered through the glass powder, provides high compressive strength. But the surge in split electricity is not that great. And when the iron powder is partially changed, the mechanical concrete houses will be beautified with the increase in the proportion of concrete. The main objective of the company is to expand the overall production of extra concrete (M60) by replacing an exceptional mixture with the remaining 20% glass powder (fixed) and iron powder from 5% to 15% (variable). For HPC to achieve increased electrical values, you need a superplasticizer that reduces water. Workability controls should be implemented on fresh concrete. Strength tests (compressive strength, split tensile strength, bending power) and durability assessments should be performed on hardened concrete, and a contrast is made between high-performance concrete and conventional concrete.*

I. INTRODUCTION

High performance concrete is a concrete mix, which has excessive durability and high energy compared to conventional concrete. This concrete incorporates one or more of the cementations materials including fly ash, ground silica fume or granulated blast furnace slag, glass dust, iron slag, and typically an exceptional plasticizer. The term "over-performance" is quite pretentious because the critical function of this concrete is that its ingredients and proportions are mainly selected that will have housing especially suitable for the anticipated use of the high-power, low-permeability structure. Therefore, general high-performance concrete is not a special form of concrete. It incorporates substances identical to those of traditional cement concrete. The use of some mineral and chemical additives such as silica fume and super plasticizer improve the qualities of potency, solidity and workability at completely excessive volume.

High-performance concrete is cost effective, although its preliminary price is higher than that of conventional concrete because the use of high-performance concrete in construction improves the life of the supplier of the form and the structure suffers less damage, which could reduce basic loads. Concrete is a flexible and durable production fabric. It is not the most effective Strong, affordable and takes the way it is placed, but it is also aesthetically pleasing. However, experience has shown that concrete is at risk of deterioration, until precautionary measures are taken at some point in design and production. To do this we want to recognize the effect of components on concrete behaviour and produce a concrete mix within carefully managed tolerances.

Concrete is a mixture of cement, sand, coarse combination, and water. The key component that adds value to concrete is that it could be designed to play a huge role in the harshest environments. Today, global warming and environmental devastation have ended up causing damage in the current years, have generated environmental problems approximately, and the change of society from beyond massive waste, mass ingestion and mass production to a zero emanation society is now considered as an extended society. Normally, glass does not harm the environment in any way as it no longer supplies pollutants, however it could harm humans as well as animals, if not treated with caution and much less pleasant to the surroundings due to the fact that it is not biodegradable. Therefore, recent technology improvement has been required. The term glass incorporates numerous chemical diversities consisting of soda lime silicate glass, alkali silicate glass, and boron silicate glass.

Today, many recycling companies find that they make little or even a loss of profit from processing glass. The standard recycling process, which consists of accumulating, classifying, transporting, beneficiating and producing glass in bottles, is the most common form of glass recycling and has costs built into each step of the procedure. Glass is produced in many forms, including glass for containers, flat glass, bulb glass, and cathode ray tube glass. All types of glass have a restricted lifestyle within the way they are produced and want to be reused to avoid environmental problems. The undeniable glass dust can be recycled, however it is very luxurious to get rid of the stained glass color and recycle again. The glass waste became accumulated from warehouses with standard bottles. Cathode ray tube glass (TV screens, monitors, etc.) was not used in this study due to concerns about hazardous metal content. Glass container compositions from abundant raw materials are sand, soda ash, limestone, and waste glass. The percentage of raw materials is based primarily on availability, chemical and body consistency, size, purity, and price. The intention is to use the most top-notch and cheapest raw substances available. Glass packaging containers are generally made from a combination of various oxides or compounds based primarily on oxygen and are generally referred to as “soda lime” glass. The combination of raw materials creates glass containers that can be durable, sturdy, waterproof, effortless, and inexpensive. Some oxides form glass without including any other factors and are called network formers. The non-unusual maximum of these is silica (SiO^2). Disposing of waste cups is undesirable because they are no longer biodegradable, making them less environmentally friendly. There is a large capacity for the use of waste glass within the concrete construction zone. When the waste glass is reused in the manufacture of concrete goods, the cost of manufacturing the concrete will be reduced. Glass concrete merchandise can be classified as commodity merchandise and delivered value products. For simple commodities, the main goal is to use as much waste glass as possible.

II. LITERATURE SURVEY

Jostin.P.jose,et al. uses Of Glass Powder As Fine Aggregate In High Strength Concrete,.The boom of 9 % within the 28-day cube compressive strength of glass powder concrete when compared to Conventional concrete. Increase cylinder tensile power there's a boom of about 23% in 28 days of glass powder concrete while as compared to traditional concrete. There is an increase of seventy four % inside the 28-day flexural energy of glass powder concrete whilst compared to conventional concrete.

Jagriti Gupta, et alThe strength of concrete partially replace fine aggregate with glass powder,. The wasted glass is tried in different proportions so that the final product characteristics of the concrete mix are identical due to the handling mixture. Glassware waste was modified with addition with different probabilities of 2, 5, 7, and 10%. The reference concrete mixture was also made for comparison reasons. Test results indicated that in replacing 10% of glass cloth scrap in fine aggregate with M30 grade concrete, the observed compressive energy was greater than the target indicating the electrical pressure of normal M30 concrete.

Idir.Ret al. [2009] Used glass waste, which is cylindrical in shape, prevents the propagation of cracks in concrete systems. Their search conducted on scrap glass powders through the authors, found that scrap glass with a particle length of 1.18 to 2.36 mm produced the best growth in which low growth was observed in sizes of smaller particles.

Pereira et al. [2008] It was discovered that with a 30p replacement. From cement through 75µm particle size amber waste glass content material on the fly ash side, the compressive power of concrete growth is 25% at 7 days and 35% when tested for 28 days of electricity

Mageswariet al. [2010] this effect provides a benchmark that each waste glass fly ash and sand cane is used collectively to provide relatively high strength concretes without any adverse reaction. Particle sizes below that threshold had no effect on length variations. The waste glass powdered to a particle length of 300 microns. Or less, the alkaline silica response (ASR) caused by expansion can be reduced. In fact, the information published in the literature shows that if the waste glass is fine, below

75 microns. This impact no longer arises and the durability of the mortar rises.

Parkandet al.[2004] The tensile and flexural strength are adversely affectedly the addition on waste to replace the virgin aggregate, at replacement level of 30 % for the fine aggregate, the tensile strength decreased by 3%, in comparison to the control conventional concrete. The use of recycled waste glass as aggregate greatly enhances the aesthetic appeal of the concrete. Recent research findings have shown that concrete made with recycled waste glass aggregate have shown better long term strength and better thermal insulation due to its better thermal properties of the waste glass aggregates

Federioet al. [2001] when examining compressive strength values at 10%, 20p.C and 30%, replace with a high quality mix using residual glass with 75mic. -4.75 mm of particle length were three%, eight% and 5% above the value of traditional concrete. It has been concluded that 30 percent residual glass dust could be included as a cement alternative in concrete without unfavorable long-term results. Up to 50% of each large and coarse aggregate can also be replaced in 40 MPa energy grade concrete with desirable strength improvement houses by mixing the large plasticizer in it. Best results are achieved while the waste glass powder changes 30% or 40% of the sand with particle sizes ranging from 50 µm to 100 µm.

The use of glass sheet powder as a replacement for fine aggregate in concrete, M. Mageswari1 and Dr.B.Vidivelli. The natural sand was partially replaced (10%, 20%, 30%, 40% and 50%) with SGP. Compressive electricity, tensile strength (cubes and cylinders) and bending energy were compared up to 180 days of age with those of concrete made with premium quality herbal aggregates. The fineness modulus, particular gravity, moisture content of the material, water absorption, apparent density,% voids,% porosity (free and compact) kingdom for sand (S) and SDA were also studied. The test results indicate that it is very feasible to manufacture concrete containing laminated glass powder (SGP) with characteristics very similar to those of natural sand mix concrete, provided that the proportion of SGP as a satisfactory combination is limited to 10-20 %, respectively.

Partial Replacement of Fine Aggregates with Waste Glass in Concrete With Respect To Conventional Concrete with Alccofine, Kamal Ranout *, PrachiVasistha. Fine aggregates replaced with the aid of glass with 3%, 6%, 9%, 12%, and 15% in M40 mix. In this research additionally alccofine 1203 used to offer extra power to concrete. Tests performed on these examples had been: compressive power, cut up tensile strength, flexural energy take a look at, SEM and XRD check. Findings: Strength will increase with the addition of glass debris to the concrete by partially replacing quality aggregates. Alccofine addition to glass as additive helps to improve the strength residences of glass concrete because of its micro length. Strength will increase as replacement of 5%, 7% to 9 % because of angular shape of glass molecules. Improvement: Size of the waste glass may be finer and extra Alccofine can be added.

SayisettiRajaiah et al. Experimental study on the use of residual glass dust as a partial replacement for cement and sand in concrete. In the preliminary LPG addition, the benefit price of electricity is low, but after 28 days it meets the required disposal energy. The addition of LPG will increase the energy of the concrete. To the extent of 20%, the cement substitute by using glass powder meets the maximum energy that is compared with that of normal concrete and another percentage of cement substitute. As the dimensions of the LPG particles decrease in the concrete, the power of the concrete will increase. From the results, thousands conclude that the particle size of less than 90 microns obtains greater resistance than that of the stages of particle length of ninety to 150 microns. The price of the creation in question within the company will be reduced and it will be affordable. A certain amount of environmental disturbances is reduced.

Shayan Ahmad [2002] it was concluded that 30% LPG can be integrated as a cement or as a blended alternative into concrete without long-term destructive results. Up to 50% of the satisfactory and coarse combination can also be replaced in 32 MPa electrical grade concrete with perfect energy development properties.

Chi sing lam, et al. [2007]. As the demand within the concrete manufacturing grows day by day, the use of river sand as a first-class mixture ends in the exploitation of herbal assets, lowering of the water table, collapse of the bridge piers, etc. Crushed glass has been attempted as an exceptional combination within the river sand alternative.

BassamTayehet al. Utilization of Waste Iron Powder as Fine Aggregate in Cement Mortar. The results of including 10%, 20%, 30% and 40% PI residues as a substitute for herbal litter have been evaluated and compared. Waste iron is of two types: IP iron, which shows a particle size distribution similar to that of the sand used to make the samples, and high-quality iron powder (FIP), which incorporates the best particles. The compression power decreased with the accelerated amount of IP delivered into the mixes, but rose with the addition of 10% FIP and decreased step by step with the degree of expanded FIP. Based on evaluation, flexural strength increased considerably with expanded FIP within the mixes. Recommendations are provided on recycling applications to preserve raw sources and substances and prevent environmental contaminants.

III. MATERIALS USED

For this studied cement, fine aggregate, coarse aggregate, glass powder, iron powder and water used for making concrete & mortar.

a) Cement

Ordinary Portland cement (Brand-UltraTech) conforming to I.S.I standard is used in gift research. Portland cement is composed of calcium, aluminate, and aluminoferrite silicates. It is acquired by mixing predetermined proportions of limestone, clay and different minerals in small quantities that is pulverized and heated at a high temperature around 1500 degrees centigrade to produce "clinker". The clinker is then ground with small amounts of gypsum to provide a satisfactory powder known as ordinary Portland cement (OPC). When combined with water, sand, and stone, it slowly combines with water to form a strong mass called concrete. Cement is a hygroscopic cloth which means that it absorbs moisture. In the presence of moisture, it undergoes a chemical response called hydration. Therefore, the cement remains in the correct situation as long as it is no longer available in contact with moisture.

The Bureau of Indian Standards (BIS) has labeled Portland Everyday Cement (OPC) in three unique grades. The class is based especially mainly on the cement of compressive strength to a few parts of sand preferred by weight with a water-cement ratio obtained exactly. The ratings are

i. 33 grade (OPC)

ii. 43 grade (OPC)

iii. 53 grade (OPC)

The grade number indicates the minimum compressive strength of cement sand

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mortar in N/mm^2 at 28 days, as tested by above mentioned procedure.

Table.1 Physical Properties of Portland cement 53 Grade

S.NO	PROPERTY	TEST RESULTS
1	Normal consistency	31.5%
2	Specific gravity	3.14
3	Initial setting time Final setting time	50 min 160 min
4	Compressive strength of cement mortar cubes 7 days 28 days	 33 N/mm2 52 N/mm2

b) Coarse aggregate

The 20mm crushed granite stone which is used in the country was used. When the mixture is sieved through a 4.75mm screen, the retained aggregate is known as a coarse mixture. Gravel, cobblestone, and boulders fall under this category. The maximum aggregate size used can be set under a few conditions. In fashion, the 40mm size mix used for daily strengths and the 20mm size is used for excessive strength concrete. The size range of various coarse aggregates given below

Table.2 Properties of CA

Properties	results
Specific Gravity	2.95
Fineness Modulus	6.97
Bulk Density	1.63g/cc
Impact Value	25.37%

c) Fine aggregate

Clean and dry river sand satisfied to IS: 383:1970 locally available was used. When the aggregate is sieved through 4.75mm sieve, the aggregate passed through it called as fine aggregate. Natural sand is often used as a first-class mix; silt and clay are also included in this class. The smooth deposit that includes sand, silt, and clay is called marl. The cause of the first-class combination is to fill the voids within the coarse aggregate and behave as a workability agent.

Table.3 Properties of FA

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Properties	results
Specific Gravity	2.67
Fineness Modulus	5.17
zone	II

d) Glass Powder

Glass is an amorphous (not crystalline) that in essence, a chilled and not strong exquisite liquid. Glass can be manufactured with remarkable homogeneity in a selection of papers and sizes, from small fibers to pieces of metropolitan size. Mainly glass is made of sand, soda ash, limestone, and other additives (iron, chromium, alumina, lead, and cobalt). Glass has been used as an aggregate in the creation of materials for roads, construction, and masonry. Glass powders are useful fillers and extenders made of clean, post-business glass feedstocks. Glass calcium alumina silicate powders are absolutely amorphous and do not contain crystalline silica. The result of our product is relative chemical inertness, making the glass resistant to blooming and blistering in harsh environments.

Source of Waste Glass:

- Glass food and beverages container.
- Window repair shop
- Glass decorative items
- Old tube lights, electric bulbs
- Glass polishing and glass window and door manufacturing shop

Fig.1 Glass powder

Chemical properties of glass powder

1. PH - 10.25

2. Colour - Greyish white

Table. 4 Greyish white

Composition (%weight of mass)	Glass Powder
Silica(Sio2)	72.5
Alumina(Al2O3)	0.4
Iron oxide(Fe2O3)	0.2
Calcium oxide(Cao)	0.90
Magnesium oxide(Mgo)	3.3
Sodium oxide(Na2O)	13.7
Potassium oxide(K2O)	0.1
Sulphur trioxide(SO3)	-
Loss of ignition	0.36

e) Iron powder

Iron dust is formed as a whole from many other iron particles. Particle sizes vary anywhere from 20 to 200 µm. The properties of iron differ depending on the production method and the records of a specific iron powder. There are 3 types of iron powder classifications: reduced iron powder, atomized powder, and electrolytic iron powder. Each type is used in various packages depending on your homes. There could be very little difference within the visible appearances of reduced iron powder and atomized iron powder**.**

Fig.2 Iron powder

f) Water

Water was used for mixing and curing is fresh portable water, which is under the prescribed limits.

e) Flyash

Fly ash, also known as "pulverised fuel ash" in the United Kingdom, is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

IV. RESULTS AND TEST DATA

Table.5 Compressive Strength Test Data for 7 days

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SPECIMEN	DIMENSION	AREA	FAILURE LOAD	COMPRESSIVE STRENGTH (N/MM2)	AVERAGE COMPRESSIVE STRENGTH
Glass powder concrete	150*150*150	22500	973.58	43.27	44.32
	150*150*150	22500	1026	45.6	
	150*150*150	22500	992.03	44.09	
5% IP	150*150*150	22500	1018.13	45.25	46.3
	150*150*150	22500	1070.55	47.58	
	150*150*150	22500	1036.58	46.07	
10% IP	150*150*150	22500	1098.68	48.83	49.88
	150*150*150	22500	1151.1	51.16	
	150*150*150	22500	1117.13	49.65	
15% IP	150*150*150	22500	1103.18	49.03	50.08
	150*150*150	22500	1155.6	51.36	
	150*150*150	22500	1121.63	49.85	

Table.6. Compressive Strength Test Data for 14days

SPECIMEN	DIMENSION	AREA	FAILURE LOAD	COMPRESSIVE STRENGTH (N/MM2)	AVERAGE COMPRESSIVE STRENGTH
Glass powder concrete	150*150*150	22500	1332	59.2	60.25
	150*150*150	22500	1384.43	61.53	
	150*150*150	22500	1350.45	60.02	
5% IP	150*150*150	22500	1428.53	63.49	64.54
	150*150*150	22500	1480.95	65.82	
	150*150*150	22500	1446.98	64.31	
10% IP	150*150*150	22500	1371.15	60.94	61.99
	150*150*150	22500	1423.58	63.27	
	150*150*150	22500	1389.6	61.76	
15% IP	150*150*150	22500	1397.03	62.09	63.14
	150*150*150	22500	1449.45	64.42	
	150*150*150	22500	1415.48	62.91	

Table.7 Compressive Strength Test Data for 28 days

SPECIMEN	DIMENSION	AREA	FAILURE LOAD	COMPRESSIVE STRENGTH (N/MM2)	AVERAGE COMPRESSIVE STRENGTH
Glass powder concrete	150*150*150	22500	1534.5	68.2	69.25
	150*150*150	22500	1586.93	70.53	
	150*150*150	22500	1552.95	69.02	
5% IP	150*150*150	22500	1554.75	69.1	70.15
	150*150*150	22500	1607.18	71.43	
	150*150*150	22500	1573.2	69.92	
10% IP	150*150*150	22500	1579.5	70.2	71.25
	150*150*150	22500	1631.93	72.53	
	150*150*150	22500	1597.95	71.02	
15% IP	150*150*150	22500	1609.43	71.53	72.58
	150*150*150	22500	1661.85	73.86	
	150*150*150	22500	1627.88	72.35	

Table.8 Compressive Strength Test Results for varying iron powder Content

	7 DAYS	14 DAYS	28 days
IRON POWDER	COMPRESSIVE STRENGTH (N/MM2)	COMPRESSIVE STRENGTH (N/MM2)	COMPRESSIVE STRENGTH (N/MM2)
Glass powder concrete	44.32	60.25	69.25
5% IP	46.3	64.54	70.15
10% IP	49.88	61.99	71.25
15% IP	50.08	63.14	72.58

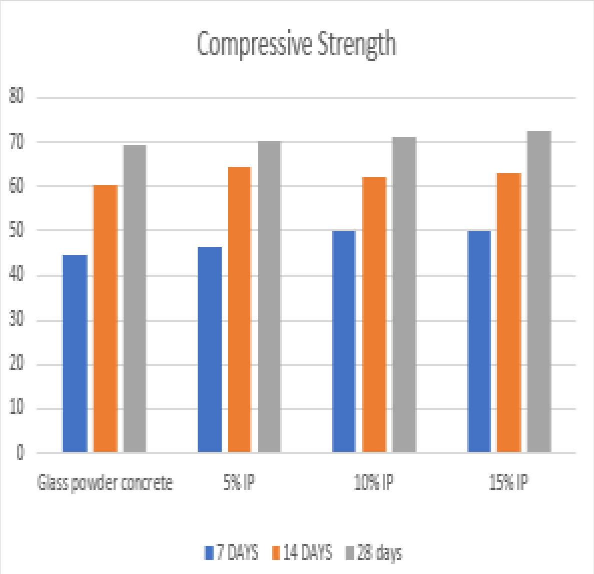

Fig. 3 Compressive Strength Test Results for varying iron powder Content

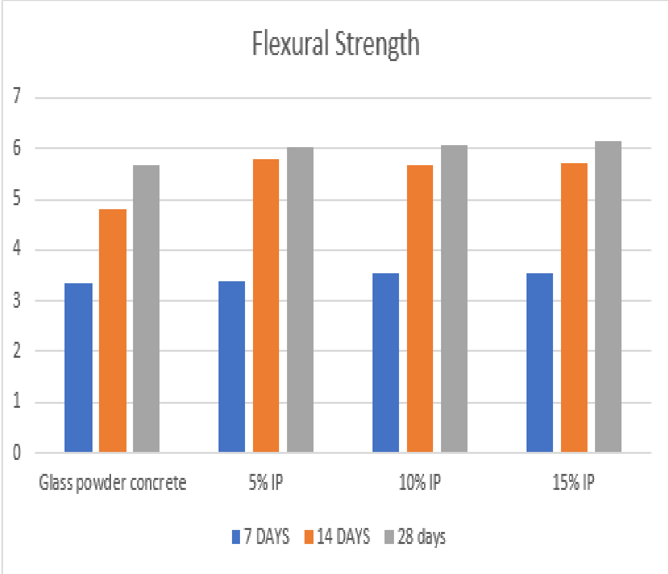

Fig.4 Flexural Strength Test Results for Varying iron powder Content

Flexural Strength test

Table.9 Flexural Strength Test Results for Varying iron powder Content

	7 DAYS	14 DAYS	28 days
IRON POWDER	FLEXURAL STRENGTH(N/MM2)	FLEXURAL STRENGTH(N/MM2)	FLEXURAL STRENGTH(N/MM2)
Glass powder concrete	3.33	4.81	5.66
5% IP	3.4	5.78	6.03
10% IP	3.53	5.67	6.08
15% IP	3.54	5.72	6.13

V. CONCLUSION

1. By increasing the proportion of iron powder and glass cohesive powder as a substitute for the best mixture, the group's electrostaticity is relatively improved.

2. Maximum compressive strength is achieved with iron powder of 15% and glass powder of 20% at 72.58 N / mm2 in 28 days of curing.

3. The maximum bending electrolyte is terminated with 15% iron powder and 20% glass powder at 6.13 N / mm2 at 28 days of curing.

4. Highest shear tensile strength made from iron powder at 15% and glass powder at 20% at 3.65 N / mm2 in 28 days of curing.

5. The fracture and bending stress is also raised due to the presence of iron powder, as the more effective presence of powdered glass now will not lead to increased bending stress and breaking electrostatic tension.

6. The operability control concludes that the mixture is semi-liquid in nature and can be used as pumpable concrete.

7. According to the Durability Research Round, the electricity is reduced by 20-25% for sulfuric acid by 5% in the total glass and iron powder.

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