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PARTIAL REPLACEMENT OF CEMENT BY GLASS POWDER AND FINE AGGREGATION BY CHINA CLAY WASTE

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Abstract

The global warming is caused by the emission of greenhouse gases such as CO2 to the atmosphere. Among the greenhouse gases, CO_2 contribute about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. Consequently efforts have been made in the concrete industry to use waste material as partial replacement of coarse or the fine aggregate and cement. The problem arising from continuous technological industrial development is the disposal of waste material. If some of the waste materials are found suitable in concrete making not only cost of construction can be cut down, but also safe disposal of

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waste material can be achieved. In this study finely powdered glass are used as partially replacement of concrete as 5%,10%,15%,20%,25% and partially replacement of fine aggregate by china clay waste as 10%,20%,30%,40%,50% and tested for the compressive strength up to 28 days.

1. Introduction

Concrete is a composite construction material composed of aggregate, cement and water. There are many formulations that have various properties. The aggregate is generally coarse gravel or crushed rocks such as lime stone or granite, along with a fine aggregate such as sand.

1.2 CEMENT

Cement is a material with adhesive and cohesive properties which make it capable of bonding minerals fragments into a compact whole. For constructional purposes, the meaning of the term "cement" is restricted to the bonding materials used with stones, sand, bricks, building stones, etc.The cements of interest in the making of concrete have the property of setting and hardening under water by virtue of a chemical reaction with it and are, therefore, called hydraulic cement. The name "Portland cement" given originally due to the resemblance of the color and quality of the hardened cement to Portland stone – Portland island in England.

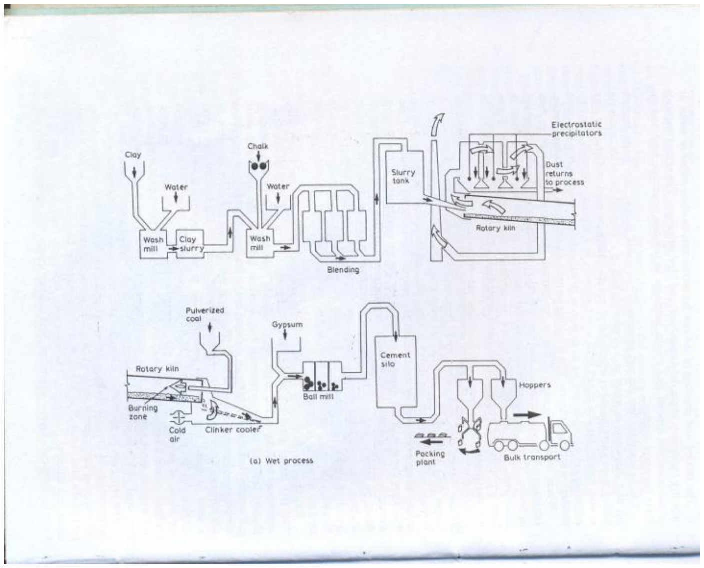
1.2.1 MANUFACTURE OF PORTLAND CEMENT

Raw Materials

- Calcareous material – such as limestone or chalk, as a source of lime (CaO).
- Clayey material – such as clay or shale (soft clayey stones), as a source of silica and alumina.

1.2.2 METHODS OF CEMENT MANUFACTURING

Wet Process



During the wet process, the raw mix is fed into the kiln in the form of slurry that may contain water up to 30 to 40%. In the wet process, the kiln is a very long tube in comparison to dry process, and the slurry that is easy to blend and homogenize due to the water, is directly being fed into the kiln. Wet process could be selected as manufacturing technology is when raw materials have natural high moisture content. The amount of moisture in mineral sometimes can be even more than 12%, as in case of chalk and in marlstone. The use of wet process is also essential when relatively poor grade limestone needs to be enriched through the beneficiation process. In this process, water is required as a process media. Until 1950, most of the cement processing kilns were wet kilns due to the ease of blending and homogenizing the components of the raw mix. In the wet process, the fuel consumption is in the range of 1300 to 1600 Kcal/Kg of clinker. Power consumption in manufacture process is about 110-115 kWh/ton of cement (Cement Industry, India, 2004).

Dry process

Dry Process To reduce the moisture content of minerals below 1%, which is required for dry process, the raw materials are dried in a combined drying and grinding plant. This drying of materials is reached by using exhaust gases coming from the kiln. The raw ground mix is homogenized in large silos. Development of appropriate blending and homogenizing systems, in general, is crucial for making the dry process practicable. The blended and homogenized raw mix is then fed into dry kiln with air suspension preheater where partial calcination of the raw mix starts to take place. Dry process is mostly limited to the use of air suspension preheater. This provides maximum benefits since the heat consumption is an important issue. Development of the dry process, using air suspension preheaters, is being integrated with precalcinators. Pre-calcinators ensure complete calcination of the raw mix before its entry to the kiln. The advantage of this process is that the fuel consumption is lowest in the existing technologies. In the dry process, the fuel use in this process is in the range of 750-950 Kcal/Kg of clinker and the power consumption is in the range of 120-125 kWh/ton of cement (Cement Industry, India, 2004).

1.3 WASTE GLASS POWDER

Waste glass is one of the least recycled materials in the majority of countries as it requires relatively large amounts of energy to be consumed to melt the cullet The quantity of treated waste glass has risen by about 25% within the last 10 years due to an improved waste glass collecting system in Latvia, notwithstanding the glass waste recycling infrastructure still suffers from the lack of an adequate network of local recycling companies and alternative solutions are required to solve the problem of the stockpiled waste glass. Being amorphous and having relatively high silicon and calcium contents, glass is pozzolanic or even cementitious especially when the fineness of glass powder is much greater than that of Portland cement. substitution in conventional concrete because of potential alkali-aggregate reaction. But when the particle size of glass powder is less than 75 µm, silica may dissolve relatively quickly, reacting with free portlandite (Ca(OH)2) and acting as a pozzolanic material giving possible control over the alkali-silica reaction in concrete, therefore making this material a possible substitute for Portland cement

1.3.1 PHYSICAL PROPERTIES

The glass as natural sand replacement in concrete trials was a crushed product with a size distribution between 3mm ~ 0.3mm. The clear and green glass was very clean with no materials passing 150 and 75 micron fractions.

1.3.2 WORKABILITY

With the addition of glass powder, the slump loss with time is directly proportional to increase in the silica content due to the introduction of large surface area in the concrete mix by its addition. Although the slump decreases, the mix remains highly cohesive.

1.3.3SEGREGATION & BLEEDING

Glass powder reduces bleeding significantly because the free water is consumed in wetting of the large surface area of the glass powder and hence the free water left in mix for bleeding also decreases. Glass powder also blocks the pores in the fresh concrete, so water within the concrete is not allowed to come to the surface.

1.3.4 WASTE GLASS WORKING IN CONCRETE

The crushed glass powder contained contaminants in the form of traces of polymers, poly vinyl butylene (PVB) from the ELV glass content, traces of acrylic from the architectural glass content. Ninety percent of the contaminant material was considered to be PVB.

It was established that there was a small amount of organic material present in the crushed glass, but this was considered to be paper residue from the labels on the bottle glass. The moisture content of the glass as supplied was considered insignificant at 0.29%. The free lime content of crushed glass and glass powder is 1.22% and 0.26% respectively.

The powder glass used in this project had a grading that it would not qualify as a fine aggregate and would not be a Pozzolana either. However, it can possibly be used in concrete as a filler or “micro-aggregate”. This product is fine enough not to be susceptible to ASR even though it may not be fine enough to give much Pozzolana reaction.

1.3.5 MECHANISM OF ACTION OF WASTE GLASS POWDER

In general researchers try to explain the mechanism of action of waste glass from a particular characteristic of observed behavior in concrete. However the characteristics of both materials are differ each other. But the properties of glass play a predominant role.

Waste glass powder has a property that binds the aggregate together and gives concrete in strength. Due to their extreme fineness, the WGP particles occupy the voids between the cement grains, thus acting as a filler, reducing the porosity of bulk cement matrix and resulting in less permeable and durable concrete.

1.3.6 APPLICATION

1. Highly reactive Pozzolana used to improve motor and concrete.

2. Amorphous glass with high sio2 contains extremely small particle size and large surface area.

1.3.7 ADVANTAGE OF WGP

The advantages of adding WGP to concrete can be one or more of the following:

1. Reduced the cost of production.
2. Increased workability of the mix due to fineness of particles.
3. Reduced dosage of super plasticizer to achieve target workability.

Fig No : 1.3 Glass Powder

2. Existing Method

2.1.Utilization of waste glass in concrete

Ahamadshayam, volume-34, 81-89,2004

High performance concrete obtain by replacement of cement up to 20% glass powder leads to increase in compressive strength and flexutral strength on concrete. High performance concrete with glass powder can be effectively used in high rise building since high early strength is required with the reduced construction period.

2.2. Production of sintered light weight aggregate using waste ash and other industrial residues

Christopher cheesemen, volume-2, 2011

It may be concluded that use of waste ash is a necessity in production of not only for high strength concrete but also for low/medium strength concrete as this material fesilitate the adaption of lower water cement ratio and better hydration of cement particles including strong bonding.

2.3. Waste glass as a supplementary cementuinous material in concrete-critical review of treatment methods

Federio.L.M, volume – 31,606-610 , 2001

Water retention for the concrete mixes incorporating self curingagent is higher compared to conventional concrete mixes, as found by the weight loss with time. Self-curing agent provides higher compressive , tensile strength than the strength of conventional mix.

2.4. Use of waste glass as powder and aggregate in cement based materials

Idir.R, Cyr.M-2009

The optimum use of glass powder for maximum strength was found to be 1% for M25 grade. As percentage of glass powder increased slump increased for M25 grade of concrete. From the workability test results, it was found the self-curing agent improved workability.

2.5. Properties of concrete with glass

Iikerbekirtopcu, volume-34,2004.

The best result were found by replacing glass powder 7.5% and fly ash 25% by weight of cement. Higher slump was found as an replacement of cement by glass powder and fly ash. Maximum compressive strength and split tensile strength was observed.

2.6. Effect of bottom ash as replacement of fine aggregate in concrete:

Aggarwal.P, S.M.Gupta, volume-8, pp 49-62,2007

Water retention for the concrete mixes incorporating self-curing agent is higher compared to conventional concrete mixes.As 7-days compressive strength of self-cured concrete gives mean strength 28.97 MPa which isalmost 10.1% greater than that of water cured concrete i.e. 26.07 MPa.

2.7. Effect of waste foundary sand as partial replacement of sand on the strength, ultra sonic pulse velocity and permeability of concrete

Gurpreetsingh, volume-26, pp 416 – 422, 2011

To ensure good workability of concrete at low water cement ratio plasticizers and foundary sand are used.these admixture reduce the water demand of concrete at comparable workability.for this reason and depend on their effectiveness,they are knownas water reducing agent.

2.8. Replacement of fine aggregate with foundary sand

John zachar,volume-3, pp 18 – 22,2007

As percentage of foundry sand gets increased slump as well as compaction factor also gets increased. Strength of self-curing concrete is relatively high when compared with conventional concrete. Self-curing concrete is the viable answer to many problems faced due to lack of proper curing. Self-curing concrete is an alternative to conventional concrete in desert regions where scarcity of water is a major problem.

2.9. Classification of recyle sand and their application as fine aggregate for concrete and bituminous mixtures Mahmodsolyman, volume-5, pp 1-196, 2006

The optimum replacement of cement with recycles sand 5% to 15% leads to increase in compressive strength whereas the percentage replacement of 20% leads to decrease in compressive strength. Variation of w/c ratio has an impact on compressive strength of concrete. With the increase in w/c ratio the compressive strength decreases and vice versa. **.**

3. Research Methodology

3.1 CONVENTIONAL MIX

3.1.1 Cube:

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375\times10^{-3}\ m^3$

No of cube = 3

= $\frac{3.375\times10^{-3}}{5.435}$

= 6.2×10^{-4}

= 6.2x10-4 x 1440

Quantity of cement = 0.892 x 1.5 x 3

= 3.99kg

Quantity of fine aggregate = 1.85x3.99

= 7.38kg

Quantity of coarse aggregate = 2.585x3.99

= 10.31kg

Water/cement = 0.45

Water = 0.45x3.99

Water = 1.79

3.1.2 Beam:

Size = 500x100x100mm

= 0.50x0.10x0.10

= 5x10-3 m^3

No of beam = 3

$= \frac{3.375x10\text{-}3}{5.435}$

= 9.19x10-4m^3

= 9.19x10-4 x 1440

Quantity of cement = 1.32kg

= 1.32 x 1.5 x 3

= 5.94kg

Quantity of fine aggregate= 1.85x5.94

= 10.98kg

Quantity of coarse aggregate =2.585x5.94

= 15.354kg

Water/cement = 0.45

Water = 0.45x5.94

Water = 2.673 L

3.2 Partial replacement of 5% of glass powder by cement and 10% of china clay waste by fine aggregate

3.2.1 Cube:(Glass powder)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

= $\frac{3.375x10^{-3}}{5.435}$ = 6.2x10-4 x 1440

Quantity of cement = 0.892 x 1.5 x 3

= 3.99kg

Glass powder = 3.99 x (5 ⁄ 100)

= 200g

3.2.2 Beam:(Glass powder)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^{-3}

No of beam = 3

= $\frac{3.375x10^{-3}}{5.435}$

= 9.19x10-4 x 1440

Quantity of cement =1.32kg

= 1.32 x 1.5 x 3

= 5.94kg

Glass powder = 5.94 x (5 ⁄ 100)

= 297g

3.2.3 Cube:(China clay waste)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^{-3}

No of cube = 3

Quantity of fine aggregate = 1.85 x 3.99

= 7.38kg

China clay waste = 7.38 x (10 ⁄ 100)

= 738g

3.2.4 Beam: (China clay waste)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

Quantity of fine aggregate=1.85 x 5.94

= 10.98kg

Glass powder =10.98 x (10 ⁄ 100)

= 1.098kg

3.3 Partial replacement of 10% of glass powder by cement and 20% of china clay waste by fine aggregate

3.3.1 Cube:(Glass powder)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

= $\frac{3.375x10^{-3}}{5.435}$

= $6.2x10^{-4}$ x 1440

Quantity of cement = 0.892 x 1.5 x 3

= 3.99kg

Glass powder =3.99 x (10 ⁄ 100)

= 399g

3.3.2 Beam:(Glass powder)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

$= \frac{3.375x10^{-3}}{5.435}$

$= 9.19x10^{-4}$ x 1440

Quantity of cement= 1.32kg

= 1.32 x 1.5 x 3

= 5.94kg

Glass powder =5.94 x (10 ⁄ 100)

= 594g

3.3.3 Cube: (China clay waste)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

Quantity of fine aggregate= 1.85 x 3.99

= 7.38kg

China clay waste = 7.38 x (20 ⁄ 100)

= 1.476kg

3.3.4 Beam: (China clay waste)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

Quantity of fine aggregate = 1.85 x 5.94

= 10.98kg

Glass powder = 10.98 x (20 ⁄ 100)

= 2.196kg

3.4 Partial replacement of 15% of glass powder by cement and 30% of china

clay waste by fine aggregate

3.4.1 Cube:(Glass powder)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

= $\frac{3.375x10^{-3}}{5.435}$

= $6.2x10^{-4}$ x 1440

Quantity of cement = 0.892 x 1.5 x 3

= 3.99kg

Glass powder = 3.99 x (15 ⁄ 100)

= 598g

3.4.2 Beam:(Glass powder)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

= $\frac{3.375x10^{-3}}{5.435}$ = $9.19x10^{-4}$ x 1440

Quantity of cement= 1.32kg

= 1.32 x 1.5 x 3

= 5.94kg

Glass powder = 5.94 x (15 ⁄ 100)

= 891g

3.4.3 Cube: (China clay waste)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

Quantity of fine aggregate = 1.85 x 3.99

= 7.38kg

China clay waste = 7.38 x (30 ⁄ 100)

= 2.214kg

3.4.4 Beam: (China clay waste)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

Quantity of fine aggregate = 1.85 x 5.94

= 10.98kg

Glass powder =10.98 x (30 ⁄ 100)

= 3.294kg

3.5 Partial replacement of 20% of glass powder by cement and 40% of china clay waste by fine aggregate

3.5.1 Cube:(Glass powder)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

= $\frac{3.375x10^{-3}}{5.435}$ = $6.2x10^{-4}$ x 1440

Quantity of cement = 0.892 x 1.5 x 3

= 3.99kg

Glass powder =3.99 x (20 ⁄ 100)

= 798g

3.5.2 Beam:(Glass powder)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10\ m^3$

No of beam= 3

= $\underline{3.375x10^{-3}}$

5.435 = $9.19x10^{-4}$ x 1440

Quantity of cement = 1.32kg

= 1.32 x 1.5 x 3

= 5.94kg

Glass powder =5.94 x (20 ⁄ 100)

= 1.188kg

3.5.3 Cube: (China clay waste)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}\ m^3$

No of cube = 3

Quantity of fine aggregate = 1.85 x 3.99

= 7.38kg

China clay waste =7.38 x (40 ⁄ 100)

= 2.952kg

3.5.4 Beam: (China clay waste)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}\ m^3$

No of beam = 3

Quantity of fine aggregate = 1.85 x 5.94

= 10.98kg

Glass powder =10.98 x (40 ⁄ 100)

= 4.392kg

3.6 Partial replacement of 25% of glass

powder by cement and 50% of china clay waste by fine aggregate

3.6.1 Cube:(Glass powder)

Size = 150x150x150

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m^3

No of cube = 3

= $\frac{3.375x10^{-3}}{5.435}$ = $6.2x10^{-4}$ x 1440

Quantity of cement = 0.892 x 1.5 x 3

= 3.99kg

Glass powder =3.99 x (25 ⁄ 100)

= 0.99g

3.6.2 Beam:(Glass powder)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

= $\frac{3.375x10^{-3}}{5.435}$

= $9.19x10^{-4}$ x 1440

Quantity of cement =1.32kg

= 1.32 x 1.5 x 3

= 5.94kg

Glass powder =5.94 x (25 ⁄ 100)

= 1.485kg

3.6.3 Cube: (China clay waste)

Size = 150x150x150mm

= 0.15x0.15x0.15

= $3.375x10^{-3}$ m3

No of cube = 3

Quantity of fine aggregate = 1.85 x 3.99

= 7.38kg

China clay waste = 7.38 x (50 ⁄ 100)

= 3.69kg

3.6.4 Beam: (China clay waste)

Size = 500x100x100mm

= 0.50x0.10x0.10

= $5x10^{-3}$ m^3

No of beam = 3

Quantity of fine aggregate =1.85 x 5.94

= 10.98kg

Glass powder = 10.98 x (50 ⁄ 100)

= 5.49kg

3.7 MIX PROPORTION:

Table No: 5.7 Mix Proportion

SL.NO	Mix Design	Cement	Glass Powder	Fine Aggregate	China Clay Waste	Coarse Aggregate
1	M0	100%	0%	100%	0%	100%
2	M1	95%	5%	90%	10%	100%
3	M2	90%	10%	80%	20%	100%
4	M3	85%	15%	70%	30%	100%
5	M4	80%	20%	60%	40%	100%
6	M5	75%	25%	50%	50%	100%

4. Result and Discussion

Result and Discussion

4.1 TESTS ON CEMENT

Tests are conducted to check the quality and to decide the suitability of cement for particular purpose. In order to test the quality of cement, the following tests are followed.

4.1.1 SPECIFIC GRAVITY TEST

Weight of empty container, w_1 = 0.030 kg

Weight of container + cement, w_2= 0.058 kg

Weight of container + cement + kerosene, w_3

= 0.089kg

Weight of container + kerosene, w_4 = 0.070 kg

$$\text{Specific Gravity} = \frac{(w_2-w_1)}{(w_2-w_1)-(w_3-w_4)}$$

$$= \frac{(0.058-0.030)}{(0.058-0.030)-(0.089-0.070)}$$

Specific gravity = 3.11

Range = 3.14 to 3.19

4.1.2 CONISTENCY TEST

Weight of cement = 300 g

Water = 34%

Consistency of cement = 5.5

Cement is an important constituent in concrete. The process of manufacture of cement consist of grinding the raw materials mixing them intimately in certain proportions and burning them in kiln at a temperature 13000C to 15000C. To determine the various properties of cement different tests are done. The tests done are

- Standard Consistency
- Initial Setting Time
- Final Setting Time
- Fineness of Cement

- Density of Cement
- Soundness of Cement

4.1.3 STANDARD CONSISTENCY

The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger of 10 mm diameter and 50 mm length to penetrate to a point 5 to 7 mm from the bottom of the Vicatmould FIG 3.1.1. The experiment was done as per IS 4031-Part IV.

Fig No : 4.1.3 Standard Consistency

4.1.4 INITIAL SETTING TIME

Initial setting time is regarded as the time elapsed between the moment that the water is added to the cement to the time that the paste starts losing its plasticity. Experiment was done as per IS -269:1989, clause 6.3

4.1.5 FINAL SETTING TIME

Final setting time is the time elapsed between the moment that the water is added to the cement and when the paste has completely lost its plasticity. Experiment was done as per IS -269:1989, clause 6.3.

4.1.6 FINENESS OF CEMENT

Fineness is a measure of total surface area of cement. For finer cements surface area will be more. Fineness influences the rate of hydration, rate of strength development, shrinkage and rate of evolution of heat. Experiment was done as per IS 4031-Part I-1996.

4.1.7 DENSITY OF CEMENT

Le Chatelier's flask is used to determine density of cement as shown in FIG 3.2. Kerosene which does not react with cement is used. Experiment is done in Le Chatelier'sflask


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Fig No : 4.1.7 Density of Cement

4.1.8 SOUNDNESS OF CEMENT

The testing of soundness of cement is to ensure that the cement does not show any applicable subsequent expansion. Unsoundness in cement is due to excess of lime, magnesia or excessive proportion of sulphates. Experiment is done by Le Chatelier method. And the value of soundness is 1mm.

4.2 TESTS ON FINE AGGREGATE

The quality of the materials which are prepared from aggregates are highly depends on the quality of aggregates and hence, it should be tested before using it.

4.2.1 SEIVE ANALYSIS TEST

The weight of soil taken for analysis, w = 1000 g

Table No : 4.2.1 Sieve Analysis

SIEVE SIZE (mm)	**WEIGHT RETAINED**	**CUMULATIVE %OF WEIGHT RETAINED**	**CUMULATIVE %OF WEIGHT RETAINED**	**PERCENTAGE N = (100-C)**
4.75	7	0.7	0.7	99.3
2.36	50	5.0	5.7	94.3
1.18	250	25.0	30.7	69.3
600 µ	337	33.7	64.4	35.6
300 µ	270	27.0	91.4	8.6
150 µ	77.5	7.75	99.15	0.85
75 µ	8.5	0.85	100	0
Pan	0	0	100	0

% of weight retained =

$$\frac{\text{Weight of soil retained x 100}}{\text{Total weight}}$$

$$= \frac{7 \text{ x}100}{1000}$$

% of weight retained = 0.7

4.2.2 SPECIFIC GRAVITY TEST

Weight of container, $w_{1=}$ 0.635 kg

Weight of container + aggregate, $w_{2\,=}$ 1.174 kg

Weight of container + aggregate + water, w_3 = 1.842 kg

Weight of container + water, $w_{4\,=}$1.507 kg

$$\text{Specific gravity} = \frac{(w_2 - w_1)}{(w_2 - w_1) - (w_3 - w_4)}$$

$$= \frac{(1.174 - 0.635)}{(1.174 - 0.635) - (1.842 - 1.507)}$$

Specific gravity = 2.50

Range = 2.63 to 2.67

4.2.3 WATER ABSORPTION TEST

Weight of sample, w_1=1000 g

Weight of saturated surface dry condition, w_2 = 1.026 g

$$\text{Water absorption} = \frac{(w_2 - w_1) \times 100}{w_1}$$

$$= \frac{(1.026 - 1.000)x\ 100}{1.000}$$

Water absorption = 2.6%

- Bulk density of fine aggregate
- Specific gravity of fine aggregate
- Sieve analysis of fine aggregate

4.2.4 BULK DENSITY OF FINE AGGREGATE

The bulk density is the weight of material in a given volume and it is measured in kilograms per litre. The bulk density of an aggregate is affected by several factors, including the amount of moisture present and the amount of effort introduced in filling the measure.

Bulk density shows how densely the aggregate is packed, when filled in a standard manner. It depends on the particle size distribution and shape of the particle. The experiment was carried out as per the procedure in IS 383

4.2.5 SPECIFIC GRAVITY OF FINE AGGREGATE

Specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Specific gravity is defined as the ratio of the weight of the fine aggregate to that of an equal volume of distilled water at that temperature and both the weights being taken in air. It is done using a pycnonmeter.

Fig No : 4.2.5 Apparatus for Specific Gravity

4.2.6 SIEVE ANALYSIS OF FINE AGGREGATE

Particle size distribution in a sample of aggregate is done by sieve analysis using a sieve shaker Fig 4.7. It is the operation of dividing a sample of aggregate into various fractions, each consisting of particles of same size. The standard sieves for sieve analysis of fine aggregates are 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ. Experiment was done as per IS 2386-Part I-1963,IS:383-1970 and the gradation curve was plotted.

Fig No : 4.2.6 Sieve shaker

4.3 TESTS ON COARSE AGGREGATE

The quality of the materials which are prepared from aggregates are highly depends on the quality of aggregates and hence, it should be tested before using it.

4.3.1 SPECIFIC GRAVITY TEST

Weight of container, $w_{1=}$0.635 kg

Weight of container + aggregate, w_2

= 1.265 kg

Weight of container + aggregate + water, w_3

= 1.900 kg

Weight of container + water, w_4

= 1.507 kg

Specific gravity

$$= \frac{(w_2 - w_1)}{(w_2 - w_1) - (w_3 - w_4)}$$

$$= \frac{(1.265 - 0.635)}{(1.265 - 0.635) - (1.900 - 1.507)}$$

Specific gravity = 2.85

Range = 2.6 to 2.85

4.3.2 WATER ABSORPTION TEST

Weight of sample, w_1 = 1000 g

Weight of saturated surface dry condition,

w_2 = 1.005 g

Water absorption

$$= \frac{(w_2 - w_1) \times 100}{w_1}$$

$$= \frac{(1.005 - 1.000)x100}{1.000}$$

Water absorption = 0.50 %

4.4 TESTS ON FRESH CONCRETE

Testing of fresh concrete is an important in concrete construction. The tests concerned with fresh concrete are to check the workability of concrete.

4.4.1 SLUMP TEST

Inner diameter of the slump = 10 cm

Outer diameter of the slump = 20 cm

Height of the slump = 30 cm

Volume of the slump cone = $\frac{\pi}{4}(b^2 - d^2)h$

= $\frac{\pi}{4}(0.20^2 - 0.10^2) \times 0.30$

Volume of the slump cone = 7.068 x 10 m^3

W/C ratio = 0.45

Slump value = 300-260

= 40 mm

Degree of workability = Medium

4.4.2 COMPACTION FACTOR TEST

Height of mould = 300 mm

Diameter of mould = 150 mm

Empty weight of cylinder = 7.10 kg

Volume of the cylinder = $\frac{\pi}{4} d^2 h$

= $\frac{\pi}{4} \times 0.15^2 \times 0.300$

Volume of the cylinder = $5.3 \times 10^{-3} m^3$

W/C ratio = 0.45

Weight of empty cylinder = 7.10 kg

Weight of partially compacted concrete= 17.73 kg

Weight of fully compacted concern = 19.393 kg

Compaction factor = 0.91

4.5 TEST ON HARDENED CONCRETE

Testing of fresh concrete is an important in concrete construction. The tests on hardened concrete are to find the strength, creep effects, durability etc.

4.5.1 COMPRESSIVE STRENGTH TEST

Compression strength of concrete with and without basalt was conducted. The compression test was conducted as per IS 5161- 959. The specimens were kept in water for curing for 7 days, 14 days and 28 days and on removal were tested in dry condition and grit present on the surface. The load was applied without shock and increased continuously at a rate of approximately

140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.

The maximum load applied to the specimen was then recorded and the appearance of the concrete for any unusual features in the type of failure was noted. Average of three values was taken as the representatives of the compressive strength of the sample as noted.

The compressive strength of concrete is three times greater than the normal concrete are specifications for concrete advocates that its water absorption should not be more than 12% (for class A) and 20% (for class A) of its weight? As per Penumbra and Melanin. A cement concrete brick should not absorb more water than 6% of its dry weight during 24 hours a water bath. A slightly higher value of water absorption%.

Dry weights were measured after atmospheric cooling and were immersed in clean water at room temperature (24-30ºC) for about 24hrs .The minimum compressive strength of concrete is 3.5 N/mm².So as the partial replacement of admixtures of concrete has compressive strength of 10-12 N/mm². It is be used for different works should not have compressive strength less than as mentioned above.

The universal testing machine is used for testing the compressive strength of concrete. After the curing period gets over concrete blocks are kept for testing. To test the specimens the blocks are placed in the calibrated compression testing machine of capacity 3000 ken applied a load uniform at the rate of 2.9 kN/min. A cement concrete concrete should not absorb more water than 6% of its dry weight during 24 hours a water bath. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that three numbers of bricks were tested for each mix proportion.

4.5.2 FLEXURAL STRNGTH TEST

Verify that the compression-testing machine is in working order and that it has been calibrated per FSEL operating procedure. The compression testing machine should be calibrated on an annual basis. It should also be noted that calibration of these machines is limited to 100,000 lb of compressive force due to the size of the compressive machine and the size of the calibration load cells available at FSEL. Prepare concrete samples for splitting tensile testing.

Verify that the samples do not have any significant defects that may affect the quality of the test results. Use a diamond end grinding machine as necessary to square off and flatten each of the sample ends.

Use a straight-edge and square to draw a line parallel to the sample axis on the circumferential face of the sample. Use a suitable device (e.g. combination and centering square) to draw diametral lines on each end of the sample connecting with the line. The diametral lines must be drawn within the same axial plane.

Use calipers or a ruler to determine the sample length (LL) by averaging a minimum of two length measurements taken in the plane containing the diametral lines. Use a pi tape to determine the sample diameter (DD) by averaging the following three diameter measurements: near the top of the sample, approximately at mid-height of the sample and near the bottom of the sample. Subsequently calculate the length-to-diameter ratio.

If the length-to-diameter ratio ($LLDD/$) exceeds 2.1, shorten the sample through further grinding until the sample length is between 1.9 and times the diameter. If testing a cored sample, cap the contact areas of the sample with a thin layer of high-strength gypsum paste.

Record the sample identifier, average sample length (to the nearest 0.1 inches), sample diameter (to the nearest 0.01 inches), and length-to-diameter ratio for each sampled to be tested. Prepare the compression-testing machine.

Install bearing blocks and other test fixtures as necessary to successfully complete splitting tensile testing of the samples. Turn on the testing machine and allow the electronic and hydraulic systems to equalize for a minimum of 15 minutes.
Equalization of the electrical and hydraulic systems is necessary to ensure stable readings and repeatable results. Detailed instructions for operating the FX-250T test machine are provided in Appendix A and detailed instructions for operating the FX-500 test machine are provided it.

Test each concrete sample as soon as practicable after removal from its previous state of conditioning. Control of the load rate may be accomplished with an automatic compression-testing machine with a digital control system or through manual control. Wipe the concrete sample as necessary to remove any surface moisture

Place a wood strip along the length of each contact area. Ensure that each end of each plywood strip is aligned with the respective diametral line. The single-use wood strips should be about 1/8 inch thick , approximately 1 inch wide and as long as or slightly longer than the sample length. Typically, paint-stirring sticks are used for this purpose.

The wood strips may be held in place with a small amount of adhesive to facilitate alignment in the testing machine. Place the sample in the compression-testing machine. First center the sample along the length of the upper bearing block and then ensure that the projections of diametral lines are centered on the upper and lower bearing plates.

Verify that the top bearing block is parallel with the top surface of the sample and make adjustments as necessary. Zero the force readout of the compression-testing machine and ensure that the peak recording function is enabled.

Table No : 4.5.1 Compressive Strength

SLNO	Mix Design	COMPRESSIVE STRENGTH (N/ mm^2)		
		7 DAYS	14 DAYS	28 DAYS
1	M0	12.7	15.6	19.3
2	M1	13.5	17.1	21.3
3	M2	15.6	19.3	23.5
4	M3	17.1	20.4	25.3
5	M4	14.5	17.3	22.3
6	M5	12.9	15.9	21.1

Experimental Test Results at 7 Days,14 Days,28 Days curing

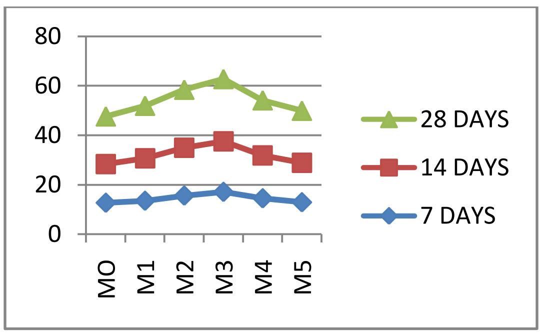
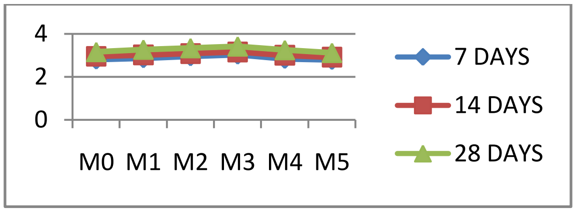


Table No: 4.5.2 Flexural Strength

SLNO	Mix Design	FLEXURAL STRENGTH (N/ mm^2)		
		7 DAYS	14 DAYS	28 DAYS
1	M0	2.80	2.95	3.15
2	M1	2.86	3.01	3.26
3	M2	2.95	3.08	3.33
4	M3	2.03	3.15	3.41
5	M4	2.83	3.00	3.24
6	M5	2.78	2.91	3.11

Experimental Test Results at 7 Days,14 Days,28 Days curing



5. CONCLUSION

From the results of experimental investigations conducted it is concluded that the glass powder can be used as replacement for cement and waste material from china clay industries can be used as a replacement for fine aggregate.

It is found that 15% replacement of cement by glass powder and 30% replacement of fine aggregate by industrial waste give maximum result in strength and quality aspects than the conventional concrete. The results proved that the replacement of 15% replacement of cement by glass powder and 30% of fine aggregate by the industrial waste induced higher compressive strength, higher split tensile strength and higher flexural strength.

Thus the environmental effects from industrial waste can be significantly reduced. Also the cost of cement and fine aggregate can be reduced a lot by the replacement of this glass powder and waste material from china clay industries.

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