iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38115

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

Experimental Analysis of Partial Replacement of Glass Powder and Fly Ash with Different-Different Percentages of Cement to Improve the Compressive and Flexural Strength of Concrete

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Abstract: ***The ordinary material for construction is concrete in India and its production causes some environmental effects during the production. There are many countries seeing deficiency of human dumping wastes or it's becoming very serious day by day for each nation. In order to deal with atmospheric impact related with cement manufacturing and so there is a requirement to produce an alternative binding material for preparing concrete. The development of concrete could reducing the utilization of naturally occurring sources or lesser the load of pollutants on atmosphere. In current scenario, no. of researchers have recognized the uses of additional cementing materials like silica fumes, fly ash, glass powder, rice husk ash, blast furnace slag etc. It could also change the different properties of hardened and freshen state of concrete, and also contributing the financial system in constructional cost. Efforts put on the concrete construction to mix fly ash and waste glass powder as half substitute with cement .Now a days Glass used in different way in day-to-day life. As glass is non-biodegradable, landfills don't provided an environmental eco-friendly resolution for dumping. Fly ash containing large amount of silica in comparison to cement. In current scenerio lots of industries producing more quantity of fly ash or its sold out very cheapest price in market. Glass is an inert material which could be recycled and used several times without altering its chemical property. Glass is an amorphous material which having high % of silica content. This property makes it probable pozzolanic property when its particles sizes is less than 75 mm. An important anxiety related to the uses of glass powder in concrete mix is that is chemical reaction happen among the alkali in pore solution and silica rich glass particle, which is called Alkali-Silicate. Reactions could be more harmful for the stability parameters of concrete, for this proper safety measure should be taken to reduce its effects. The addition of fly ash in glass concrete reducing the alkalies, silica reaction and improves the workability and durability of concrete. Unwanted glass powder is using for preparing concrete which leads environmental ecofriendly. The main purpose of this study is to find out effectiveness on durability of unwanted glass powder and fly ash based concrete. For analysis it was proposed that the uses of unwanted glass powder and fly ash as half substitution with cement in following proportion (10%, 20%, 30%, 40%) in concrete mix. Compressive strengthening of cubes and flexural strengthening of beams at the interval of 7th, 28th days were considered and compared with the conventional concrete. The results showing the probability of using unwanted glass powder and fly ash as half substitution with cement in concrete.***

Keywords: ***Silica fumes, Blast furnace, Rice husk, Glass powder, Fly ash, Compressive strengthening, Flexure strengthening***

I. INTRODUCTION

Million tonnes of glass cullet are used for land filled throughout the world in every year. In 2005, around 12.8 millions tonne of glass cullet was used in land filled in United States. When unwanted glass is collecting and various colour glasses is frequently added. Then Mixed colour glasses couldn't be recycled since of mixing colouring agent result in an changeable and uncontrollable colour in the new glass. Large glass pieces can be effectively sorted by colour using optical sensors; however, sorting small glass pieces is not cost effective, and much of this non-recyclable glass cullet is land filled. In the United Kingdom for example, 1.65 million tonnes of unwanted glasses are discarded per year due to their inability to be recycled. As far as the economic and environmental effects of landfills are concerned. One of the possible ways of reusing millions of tonnes of glass cullet each year as aggregate or supplementary cementitious material is in the concrete industry. The majority of crushed glass research has concentrated on its use as fine aggregates in concrete. However, the use of glass as a fine aggregate substitute in concrete has been restricted due to concerns about alkali-silica reaction (ASR).

Several studies shows that if ground finely enough, glass acts pozzolanically with a surface area of more than 300 m2/kg [4-9]. The pozzolanic reaction occurs when amorphous silica in the SCM reacts with calcium hydroxide (CH), which is produced as a by-product of the cement reaction, and water to form more calcium silicate hydrate. The majority of research on the impact of glass cullet on cementitious mixtures as SCM based on mechanical and chemical properties. Increases Long-term compressive strength, flexural strength, resistance to ASR and sulphate attack, and a reduction in water sorptivity of concrete containing finely ground glass powder have all been observed in concrete containing finely ground glass powder. Furthermore, some research found that finely ground glass powder had mechanical properties comparable to or slightly better than fly ash and slag at later ages, but much less than silica fume. Despite the aforementioned findings, few studies have attempted to link the microstructural properties of cementitious mixtures containing glass powder to the glass mixtures' performance characteristics. Federico investigated the effect of glass powder on the kinetic and performance properties of cementitious mixtures in depth. However, however, the impact of curing temperatures on various types of glass cullet reaction kinetics and efficiency has not been investigated. Temperature is one of the most important factors affecting the hydration of cement or cementitious materials. Weather, heat curing, and hydration heat can all affect the temperature of concrete.. Elevated temperatures will accelerate pozzolanic activity activation by increasing the rate of hydration, early strength gain, changing the hydration products produced, changing the density of the formed products, and changing the hydration products formed [15-16]. High temperatures, on the other hand, may reduce ultimate strength, increase permeability and drying shrinkage, and even cause delayed ettringite formation in some cases (DEF) and Concrete is a mixture of cement, sand, and water. Concrete's importance is enhanced by the fact that it can be built to withstand the harshest conditions. In recent years, concern about environmental issues has grown, and a shift from the past's mass-waste, mass-consumption, mass-production society to a zero-emanation society is now regarded as important. Glass does not normally damage the environment because it does not emit toxins, but it can harm humans and animals if not handled properly, and it is less environmentally friendly because it is non-biodegradable. As a result, new technology development has been needed. Glass refers to a variety of chemical compounds, including soda-lime silicate glass and alkali-silicate glass.. Until now, these types of glass powder have been commonly used as pozzolana in cement and aggregate mixtures for civil works. The addition of waste glass to cement raises the alkali content of the material. It also aids in the production of bricks and ceramics, protects raw materials, and reduces energy consumption and waste sent to landfills. Glass and glass powder are mostly used in civil engineering fields as useful recycled materials, such as cement, as pozzolana (supplementary cementitious materials), and coarse aggregate. Their recycling rate is close to 100%, and they can be used in concrete without compromising its toughness. As a result, it is thought to be suitable for recycling.

II. MATERIALS

The materials used in concrete mix projects are cement, fine aggregate, coarse aggregate, Fly ash, Glass Powder as described in detail below:

1) *Concrete Composition:* The most important purpose of this research is to calculate the effect on the mechanical properties of concrete when OPC is partially replaced by 10%, 20%, 30% and 40% of glass powder, fly-ash and their combinations. Different material and experimental tests are performed to check the quality of concrete. The materials should be appropriate for future use in concrete or doesn't hold harmful ingredients in some amounts that can damage the quality or durability of the concrete.
2) *Cement:* Its one of the main imprtant component of concrete, since the binding medium for the distinct ingredients is created. Produced from naturally occurring raw materials and then mixing with toxic waste or underground. For the analysis, OPC 53 grades of Ordinary Portland Cement (OPC) conforming to IS12269-1987 were used. The mix configuration is made with ordinary Portland cement of grade 43. Concrete's most essential component is cement. The ability of cement to create improved microstructure in concrete is one of the most important criteria for cement selection. The hard Cement of Grade 43 was used in this analysis. Since it is an essential ingredient of concrete, mortar, stucco, and most non-specialty grout, Portland cement (often referred to as OPC, from ordinary Portland cement) is the most common form of cement in general use around the world.
3) *Fine Aggregate:* Aggregates that cover almost 70 to 75 % concrete volume are often used in more than one way as inert ingredients. This is well known now a day, however, that the (i) physical (ii) chemical (iii) thermal properties of aggregates drastically affect the property of 23 mm and concrete results. To extract all pebbles, fine aggregates (sand) use as fresh dry sand sewn in a 4.75 mm sieve. Clean river sand of maximum size 4.75 mm used such as fine aggregate.
4) *Coarse Aggregate:* For making concrete, coarse aggregate is used. They are generally in form of irregular broken stone, or gravel that naturally occurs. Coarse aggregates are called material that is wide to be held at 4.75 mm sieve size. Up to 20 mm may be its maximum span. And angular aggregate of size between 4.75mm to 20 mm is used as coarse aggregate.

5) *Water:* water plays an important role as it engages in a heat of hydration with cement. In concreting water is present in the form of gel which help to increase the concrete's strength. For mixing, portable water is usually considered satisfactory. The pH value of water shall not be lower than the maximum allowable values expressed in the following concentrations.

a) *Limits of Acidity:* Not more than 5 ml of 0.02 NaOH should be needed to neutralize a 100 ml solution of water using phenolphthalein as an indicator. The test details are as stated in IS 3025.

b) *Limits of Alkalinity:* Using a mixed indicator, neutralizing a 100 ml solution of water does not need more than 25 ml of 0.02 natural H2SO4. The specifics of the tests are as stated in IS 3025.

c) *Percentage of solids:* When measured in compliance with IS 3025, the maximum allowable limits of solids are as set out in IS 3025.

- The chemical and physical properties of groundwater shall be tested in conjunction with the soil investigation and if there is no water found to comply with the necessities of IS 456-2000, it shall be clearly specified in the tender documents that contractor has to organize for the construction of good quality water indicating the source.
- Water is to be found satisfactory for mixing as well as curing. For curing water shall not, however, create on the surface any undesirable stain or unsightly deposit.
- For mixing or curing, sea water must not be used.
- Water available for every source is to be tested before start any construction work and every three months thereafter until the end of work. In case of groundwater, different test can also be performed for a separate drawdown point.

6) *Fly Ash:* Fly ash is finely divided residue consequential from the combustion of pulverized coal and transported by the flue gases of boilers by pulverized coal. It was obtained from thermal power station, dried and used. In this experiment fly ash having particle sizes not more than 90 μ is used. Mineral admixtures like fly ash are generally adding in much more quantity in concrete to improve the workability of freshen concrete and also improving fire resistance in concrete by which thermal cracking doesn't occur, alkali-aggregate expansion, and sulphate attack; or to permit a reduction in cement content. F class fly ah is the highest classification. In this analysis, fly ash was obtained from the Century pulp and paper mill in Lalkuan, Uttarakhand. The specific gravity and fineness modulus of the fly ash were both poor, at 1.975 and 1.195, respectively.. Fly ash, otherwise called flue-ash, it may be noticeable among the residues created under combustion, and comprises those fine particles that rise with flue gases. Ash that doesn't rise is called bottom ash. In mechanical context, fly ash typically alludes with burning of coal. Fly ash is obtained by electrostatic precipitators and suction pumps before the gasses goes through coal-fired power plant's chimneys. Since, its depending on the source of the coal burning continuously and the contents for fly ash particles.

7) *Glass Powder:* Locally available glass is collected and converted into powder form. This material replace the cement in different % . Before adding glass powder in the concrete, it has to be powdered to required size. In this experiment glass powder particle sizes not more than 90 μ is used. Glass being transparent material produced by melting a mixture of silica, soda ash, and CaCO3 at temperature emulated by cooling during which hardening happens without crystallization. Glass products are normally used in our daily fabricated items. Since the increase of waste glass leads over the recent years and these waste glass pieces have been dumped and occasionally not in use. The waste glass fill areas are not in use since glass is less eco-friendly and is not biodegradable. The glass powder which is used in this analysis was purchased from a market in Kolkata. In the mix, this substance takes the place of cement. Glass is a completely recyclable material in theory; it can be recycled without losing its consistency. There are numerous examples of waste glass being successfully recycled: as cullet in glass making, as a raw material for the manufacture of abrasives, and so on, in sandblasting, as a pozzolanic additive, in road beds, pavement, and parking lots, as raw materials for making glass pellets or beads for highway reflective paint, to make fibre glass, and as fractionators for lighting matches and shooting ammunition

Glass is an amorphous (non-crystalline) substance that is essentially a supercooled liquid rather than a solid.

a) Glass can be manufactured in a range of shapes and sizes, from small fibres to meter-sized parts, with excellent homogeneity.
b) Glass is primarily composed of sand, soda ash, limestone, and other additives (Iron, Chromium, Alumina, Lead and Cobalt).
c) Glass has been used as an aggregate in road, house, and masonry construction.

i) Source of Glass

• Sand is circulated into three different size screens of various sizes.
• The best sand produces the best glass. The toughest glass is made from the largest sand.
• Glass is made by melting sand in a crucible.

ii) Sources of Waste Glass

- Glass food and beverage containers are a common source of waste glass, as are window repair shops.
- Decorative glass pieces
- Electric bulbs and old tube lights
- Glass polishing and manufacturing shop for glass windows and doors

- Application and properties of glass
- Glass is a uniform amorphous solid material that forms when a viscous molten material cools rapidly below its glass transition temperature without allowing enough time for a normal crystal attice to form.
- The most common type of glass is silica-based glass, which is used for windows, containers, and decorative items.

- Glass falls in the category of biologically inactive material that can be formed with very smooth and impervious surfaces.

Type	WGP
SiO2	72.61
Al2O3	1.38
Na2O	12.85
K2O	0.43
Cao	11.42
MgO	0.79

III. PROBLEM FORMULATION

In all parts of the world, natural resources are diminishing and waste from industries is rising at the same time. Eco-friendly and reliable building production includes the use of non-conventional and diverse waste materials and recycled this waste materials to minimize environmental pollution and to reduce uses of natural resources. The concrete mixture consists mostly of fly ash, which is also useful for preserving the heat of the concrete hydration temperature to save the cement. A mixture called concrete of water, aggregate, sand and cement is a complex material which is used in buildings and developments. We use Fly ash & waste glass powder as a partial substitute to minimize the use of cement, thereby minimizing uses of natural source in building, so that Fly ash & waste glass powder is used as one of the alternative materials in concrete. It is the waste product of iron or Glass production plants made from Iro and glass. The only sector where the safe uses of Fly ash & waste glass powder feasible is the building industry. When placed into concrete as a substitute material, it decreases the emissions of the atmosphere, the issue of space and therefore reduces the cost of concrete. When glass produced by the extraction process is produced in refining plants, Fly ash & waste glass powder is created in large quantities in the production of Boiler burning industries and glass powder industries.

IV. LITERATURE SURVEY

P. Meenaksh (2017) In this article, the half substitution of cement by barites and lime powder in concreting is investigated. The design mix of M30 concrete grade. The experimental work used cement as half substitution for barites and lime powder in proportions of 0%, 10%, 20%, and 30%. The substituted ingredients increased compressive strength in the early stages (7 days and 14 days), with the same outcomeIn 28 days, the concrete replacement did not display an improvement in compressive strength.

S.Sudha (2016) In this paper, the toughness and strength characteristics of concrete were analysed using lime sludge and fly ash as partial replacements for fine aggregate in the concrete mix. unwanted materials like fly ash and lime sludge are used in the building. These materials are inexpensive. Lime sludge is using with replacement of asphalt, and fly ash is using to replacing with first-class mixture. Lime sludge is present in various percentages: 0%, 5%, 10%, and 15%. Fly ash having percentage of 0 to 5%. At 7 and 28 days, the compressive strengthening, flexural strengthening, and split tensile strengthening were determined.

M. Narmatha and Dr. T. Felixkala It's been suggested that Metakaolin [MK] is a pozzolanic admixture with a variety of special properties. Metakaolin is a common admixture for use in concrete and cement. Metakaolin usually replaces 8 percent to 20 percent [by weight] of Portland cement. This type of concrete has excellent engineering properties. The specimen was cast in M60 concrete with 5%, 10%, 15%, and 20% substitutes, respectively. The compressive intensity ranged between 45 and 55 MPa after seven days. The compressive intensity after 28 days ranged from 61 to 73 MPa.

The split tensile strength for MK 10%, 15%, and 20% rises by 14.70%, 20.56%, and 11.76%, respectively. MK 10%, 15%, and 20% flexural intensity increases by 11.11 percent, 14.28 percent, and 7.94 percent, respectively. The result shows that metakaolin, which replaces 15% of the cement in the mix, outperforms all other mixes and is useful in achieving high efficiency. The addition of metakaolin increases compressive and break tensile strength by up to 15% as compared to cement replacement.

Dr. K. Srinivasu, M. L. N Krishna Sai, N. Venkata Kumar It should be noted that concrete is one of largely used building material, which depletes natural resources, causing environmental concerns in terms of raw material use and CO2 emissions during cement production. As The heat of hydration is reduced when cement is replaced with pozzolana. Fly ash, base ash, blast furnace slag are common industrial waste materials. Concrete is interested in elective cementation products such as metakaolin, silica fume, steel fibres, quarry dust, wood waste, limestone, and calcined clays. Heat of 6000°C to 8000°C causes dehydroxylation of the crystalline structure of kaolinite, resulting in metakaolin. Kaolinitic clay is commonly available in the earth crust. At 10% condensate silica fume, 5% MK, and 1.5 percent steel fibre material, high tensile strength was observed. In comparison to the blend, control concrete concrete with 8% MK and 1.5 percent steel fibre has an improving compressive strengthening 8.9%, tensile strength of 26.94 percent, flexural strengthening of 58.28 percent. The uses of metakaolin in concrete as a 25% substitute for cement resulted in excellent strength and durability improvements. The use of metakaolin has improved water permeability and absorption, results in increasing in concrete density. Metakaolin was used in the preparation of acid resistance concrete, which showed strong resulting in provisos of chloride permeability and sulphate resistance.

PragadaRambabu This mix's lime concrete, which has a higher degree of versatility than standard concrete, was obtained as strong base for load-bearing walls, columns, and lying under floors. This is unique waterproofing property which protect subsoil dampness in floors and walls.. Lime concrete can also be made simple and inexpensive while also offering a durablility of material which having resistance weathering and wear and tear. For M20 grade concrete, the substitution of cement by lime powder is performed in 10 percent increments from 0% to 30% in order to maintain a steady slump of 60mm. At room temperature, compressive strengthening of concrete cube aged 7th and 28th days is measured in 28th days and split tensile strengthening of concrete was measured. The overall both strengthening was only gained at 30 percent replacement, according to the test results. These mixtures, when used as a 30% substitute for Natural River sand, exhibit greater strength than control concrete.

Tarun R Naik and F.ASCE It was determined that replacing 15% to 20% of opc clinker with limestone filler with a Blainfineness value of 4000 to 4500 cm2/gm satisfying the compressive strengthening of ordinary in the early hours strengthening of 32.5 Mpa.

V. MATERIAL

The various materials which is used in this project for making concrete mixture are

A. Cement
B. Fine aggregate
C. Coarse aggregate
D. Fly Ash
E. Glass powder
F. water

It described in details below

1) *Cement:* it's one of the very important materials of concrete, because this creates binding intermediate with other ingredients. Prepare out of natural occur raw material, blended or inter-ground with industrial wastes. Cement which is used for this analysis was OPC 53 grades according to IS 10262.

Figure 5.1. Cement

The properties of cement used are shown in 3.1 Table.

Table 5.1 Properties of cement

Properties	Value
Grade of Cement	OPC (53 grade)
Sp. gravity of cement	3.15
Initial setting time	Not least than 30 min
Final setting time	Not least than 60 min
Normal Consistency	30.5%

2) *Fine Aggregate:* In any concrete mixture approximately 70 to 75 % volume of concrete having fine aggregates. Its sometime views as inert material in it. But, its attain various properties in it like physical, chemical and thermal properties. Significantly control the property and performance of concrete. It's generally used as clean or dry sand which were passes through the 4.75 mm size sieved to remove out all the pebbles and dirty particles from it.

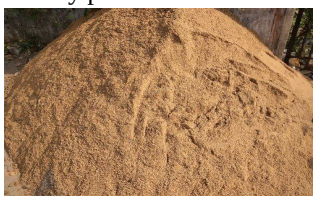


Figure 5.2 Fine Aggregate

The different Properties of F.A. are given below in table 3.2.

Table 5.2 Properties of F.A.

Properties	Value
Specific Gravity	2.68
Fineness Modulus	2.84
Water absorption	0.65%

3) *Coarse Aggregate:* Coarse aggregate is also use for preparing concrete. They generally found in broken form of irregular size stone or natural occurring gravel. A particle which does not pass through 4.75mm size sieve is known as coarse aggregates. Its minimum and maximum size is 9.75mm and 37.5mm.

Figure 5.3 Coarse aggregate

Properties of C.A. are given below in table 3.3.

Table 5.3 Properties of C.A.

Properties	Values
Specific Gravity	2.94
Size of Aggregate	20 mm
Fineness Modulus	7.06
Water absorption	0.217
Aggregate Impact value	15.6%
Aggregate Crushing value	22.9%

4) *Water:* water is very useful in the formation of concrete mixture because it participates in heat of hydration process with cement. With existence of water the gel is form which helps in increase the strengthening of concrete. Almost any naturally available water which is used for drinkable purpose and having no taste or odour should be used for mixing. Water available from lakes, ponds, and streams are containing marine life which is usually suitable for concrete mixture. Water which is used for mixing, preparing concrete or curing shall fresh or free from harmful substance of alkalis, salt, acids, organic matter, oils, sugar and any other matters which can be harmful to the life of other building materials like stones, bricks, concrete structure. Portable water is usually used for satisfactory addition.

PH value of constructional water should not be less than 6 to 8 for concrete construction if its value less than its permissible limit than it's harmful for other building materials and there are various concentration given below.

a) Limits of acidity: If water is highly acidic then its effect the concrete so to reduce the effect of acid take 100ml solution of water and used phenolphthalein as indicator and it shall not required more than 5ml of 0.02 normal NaOH and complete detail of this test is given in IS 3025.

b) Limit of alkalinity: If water is more alkaline so it's also effect the working of concrete so to neutralize it take 100ml solution of water and using mixed indicator. it doesn't required more than 25ml of 0.02 normal H_2SO_4 and complete detail of this test is given in IS 3025.

c) % of solid: Max. permitted limit of any solids when its tested should be classified under IS 3025.

Table 5.4 Maximum limits of solids in water

Types of solids	Limits
Organic solids	200 mg/litres
Inorganic solids	3000 mg/litres
Sulphates	400 mg/litres
Chlorides	2000 mg/litres for concrete not contain embed steel, and 500 mg/litres for R.C.C. works
	2000 mg/litres

The naturally available ground water should be tested along with soil investigation as well as physical and chemical properties. if water is not found up to requirements of IS 456 – 2000, the tender documents should obviously specify that the contractors have to arranged excellent quality of water which is suitable for construction and different source indicating the properties.

- Water is to be found suitable for mixing and curing. However, it is use for mixing and curing purpose should not be producing any unpleasant stains or unsightly particle deposition on the surface.
- Sea or marine water can't be useful for concrete mixing and curing.
- Water available from any source should be tested before starting any construction work and subsequently tested in every 3 months till the ending of construction work. In case of ground water, testing is generally done for various points of drawdown. Water available from any source should be tested in summer season before monsoon and again in summer season.

5) *Fly Ash:* it's obtained from the combustion of pulverized coal and transported by the flue gases of boilers by pulverized coal. It was obtained from thermal power station, dried and used. In this experiment fly ash having particle sizes not more than 90 μ is used. Mineral admixtures like fly ash are generally adding in much more quantity in concrete to improve the workability of freshen concrete and also improving fire resistance in concrete by which thermal cracking doesn't occur, alkali-aggregate expansion, and sulphate attack; or to permit a reduction in cement content.

Figure 5.3 FLY ASH

Table 5.5 Chemical properties of Fly ash

Chemical Component	% of chemical Component
SiO_2	64.58
Fe_2O_3	5.57
Al_2O_3	25.89
CaO	0.59
Na_2O	0.027
K_2O	0.041
MgO	0.26
SO_4	0.31
Loss on ignition	2.40
Specific Gravity	2.42

6) *Glass Powder:* Locally available glass is collected and converted into powder form. This material replace the cement in different % before adding glass powder in the concrete, it has to be powdered to required size. In this experiment glass powder particle sizes not more than 90 μ is used. Glass being transparent material produced by melting a mixture of silica, soda ash, and CaCO3 at temperature emulated by cooling during which hardening happens without crystallization. Glass products are normally used in our daily fabricated items. Since the increase of waste glass leads over the recent years and these waste glass pieces have been dumped and occasionally are not use. The waste glass fill areas are not in use since glass is less eco-friendly and is not biodegradable. The glass powder which is used in this analysis was purchased from a market in Kolkata. In the mix, this substance takes the place of cement. Glass is a completely recyclable material in theory; it could be recycle without losing its consistency. There are numerous examples of waste glass being successfully recycled: as cullet in glass making, as a raw material for the manufacture of abrasives, and so on, in sandblasting, as a pozzolanic additive, in road beds, pavement, and parking lots, as raw materials for making glass pellets or beads for highway reflective paint, to make fibre glass, and as fractionators for lighting matches and shooting ammunition

Figure 5.5 GLASS powder

Table 5.6 Chemical properties of Glass Powder

Chemical Component	% of chemical Component
SiO_2	72.61
Al_2O_3	1.38
CaO	11.42
Na_2O	12.85
K_2O	0.43
MgO	0.79

VI. METHODOLOGY

The motive of this study was to evaluate the property of concrete. And its contain Fine aggregates, coarse aggregate, cement, fly ash , unwanted glass powder. To analysis the different essential aspects like slump cone test, compaction factor test, compressive strengthening and Tensile strengthening of concrete for freshen as well as in harden state of concrete. In hardened state no. of Cubes preparing with the help of Concreting materials and replacing cement with different % of fly ash and glass powder. In freshen state the workability parameter like slump test and compaction factor test was study. The analysis was done for mix design of concrete-M30 grade. In this lesson, concrete cubes was casted for testing having dimensions of 150✕150✕150 mm and150mm × 300mm.
The study of this project is fully based on the experimental work. In this section of the dissertation, following steps are adopted during experimental work:

1) To build any structure first we need to build its base or foundations. Likewise first of all M30 grades of concrete are prepared according to the "INDIAN STANDARDS CODE" IS 10262:2009.
2) In the preparation of mix design for M30 grade of concrete having various physical properties of materials like specific gravity, nominal size, water holding capacity, fineness Modulus etc. are required, also some other aspect were involve like exposure condition of atmosphere sun and water, material mixing technique etc. are to be assumed in accordance with INDIAN STANDARD CODE IS 456:2000.
3) Later then analyze the working quality of various materials in a suitable proportion, and it's time for selection of the materials for concrete.
4) Always keeping in mind that according to "INDIAN STANDARDS" materials which is selected that is aggregate Conforming/fill the different parameters as per IS 383:1970 and 53 grade OPC according to IS 12269:1987 is taken.
5) Selected materials are mixed in a fixed proportion as per mix design to obtain the preferred strength. Sampling & analysis of concrete is carried out according to IS 1199:1959.
6) IS 2386 (Part 1): 1963 method is used for test of aggregate Especially for shape and size of aggregates.

Four main important experiment were perform on concrete are

- Slump cone test
- Compressive strength test
- Tensile Strength Test
- Compaction factor test

➢ Standard mould of 150 mm x 150 mm x 150 mm and 150mm×300mm sizes firstly cleaned and then oiled after this mixture is fill in this moulds.
➢ After 24 hours cubes are unbolted from the mould and placed into the curing tank which is filled with fresh water at 27 ± 2°C for 28 days.
➢ After 7 days, 14 days ,28th days of curing no. of cubes placed into compressive strength and Tensile Strength machine for final test who giving the actual strengthening of concrete i.e. test performed as per the guidance of "INDIAN STANDARD CODE" IS 516:1959.

A. Design Mix

To study the result of unwanted glass powder and fly ash with replacing some percent of cement to check the strength of cement mortars, mix was preparing with various % of unwanted glass powder and fly ash (by weight). Concrete mixtures with various percentage of glass powder and fly ash used as half-done or full replacement for cement were ready in order to study the result of glass powder and fly ash changes on the strengthening to normal concrete mixture. mixture was ready with various proportion of glass powder and fly ash. The proportion (by weight) of glass powder and fly ash were adding to the mixtures are giving as: 0%, 10%, 20%, 30% and 40%.The concrete mix decided for this analysis is M30 grade with water-cement ratio of 0.45. for this analysis total 45 no. of Cubes of usual sizes 150x150x150mm and 45 no. of 150×300mm sizes cylinder also prepared and then cured for 7th day, 14th , 28th days and testing done as per IS: 516-1959. The main purpose for observance the sample for large curing time of 28 and 56 day is to examine the harmful impact from uses of glass powder and fly ash as the place of cement and check compressive strengthening and tensile strengthening of concrete mixture. The mix proportion selected for analysis As per IS 10262-2009 is shown in 3.22 Table.

1) Mixed design of m30 grade of concrete acc. To is:10262(2009)& is 456(2000)

a)	Grade of Concrete:	M30
b)	Types of Cement :	OPC (Ultra -tech)
c)	Max. nominal sizes of aggregate	20 mm
d)	Minimum cement content	300 Kg/m³
e)	Max. water cement ratio	0.55
f)	Degree of Workability	25-50 mm (slump)
g)	Atmospheric situation	Mild

2) M-30 Concrete Mix Design

a) Design Stipulation

- Characteristic Compressive Strength — $30N/mm^2$

Required in field at 28 days

- Maximum size of aggregate — 20mm (angular)
- Degree of quality control — good
- Type of exposure — mild

b) Test Data For Materials

a.	Cement used Satisfaying the requirements	ordinary portland cement Of IS 269-1976
b.	Specific gravity of cement	3.15
c.	Specific gravity	
1.	Coarse aggregate	2.74
2.	Fine aggregate	2.63
d.	Water absorption	
1.	Coarse aggregate	0.50%
2.	Fine aggregate	1.00%
e.	Free surface moisture	
1.	Coarse aggregate	Nil
2.	Fine aggregate	2.0%

c) Target Mean Streangth Of Concrete

TMS — $30+12=42N/mm^2$ (As per most table 1700-5)

d) Selection of Water Cement Ratio

As per IS 10262 the free cement ratio required for the traget mean Strength $42N/mm^2$ is 0.44

e) Selection of Water And Sand Content

Form table 4 of IS 10262 for 20mm maximum size aggregate and sand Conforming to grading zone-I , water content per cubic meter of concrete 186 kg and sand content as percentage of total aggregate by absolute Volume= 35 percent

For change in volume in w/c ratio and belonging to zone –I the following adjustment is required
Therefore required sand content as percentage of total aggregate by absolute volume =35-0.1=34.90%
Required water content=186 lit/m^3

f) Determination of Cement Content

Water cement ratio = 0.44
Water = 186lit/m^3
Cement = 186/0.44
= 423 kg/m^3

g) Determination of coarse aggregate and fine aggregate content

From IS-10262 for the specified maximum size of aggregate of 20mm,the amount of entrapped air in wet concrete is 2%.

$$V = \left[W + \frac{C}{S_c} + \frac{1}{P} \cdot \frac{f_a}{S_{fa}}\right] \times \frac{1}{1000}$$

$$0.98 = \left[186 + \frac{423}{3.15} + \frac{1}{0.328} \times \frac{f_a}{2.63}\right] \times \frac{1}{1000}$$

Fa=569.1 kg

$$0.98 = \left[W + \frac{C}{S_c} + \frac{1}{1-P} \times \frac{C_a}{S_{ca}}\right] \times \frac{1}{1000}$$

$$0.98 = \left[186 + \frac{423}{3.15} + \frac{1}{0.672} \times \frac{C_a}{2.75}\right] \times \frac{1}{1000}$$

Ca=1214.71 kg

h) Adjustment of water & aggregate due to absorption of water .

Net quantity of coarse aggregate = 1214.71 −7.08= 1207.63kg =(say)1208kg
Net quantity of sand = 569.1 −3.48= 565.62kg=(say)566kg
Water to be added = 186+7.08+3.48 = 196.56 liter=(say)197litre

Water in liter/m^3	Cement in kg/m^3	F.A in kg/m^3	Coarese aggregate kg/m^3
197	423	566	1208

i) Mix proportions 1:1.34:2.85

j) Concrete Cube Strength 7 days 28.56 Mpa (Av)
28 days 45.80 Mpa (Av)

Table 3.22: Details of Concrete Mix Proportions

Percentage Glass powder & Fly Ash	Weight of Cement (kg/m^3)	Weight of Glass powder & fly ash (kg/m^3)	Weight of Water(kg/m^3)	Weight of C.A. (kg/m^3)	Weight of F.A. (kg/m^3)
W	423	0	197	1208	566
5% + 5%	380.7	42.3	197	1208	566
10% + 10%	338.4	84.6	197	1208	566
15% + 15%	296.1	126.9	197	1208	566
20% +20%	253.8	169.2	197	1208	566

B. Preparation Of Materials

All materials were bringing at normal temp. before commencing the results. The paste of cement was arriving to the lab, mix was prepare dry by hands to ensure maximum possibility of blending and uniformity done in the material, to eliminate harmful particles and proper care shall be done. Cement was store at dry place.

C. Slump Cone Test

This test is done for calculating workability of concrete. This test separately performs on fresh concrete and in concrete replaces cement in place of glass powder and fly ash to calculate the workability. The slump is most useful for detect variation in uniformity of mixed design of given nominal proportions; it's used to calculate the consistency of fresh concrete. This experiment is too conducted immediately after its made. Workability is an engineering property of newly blended concrete mixture, and it is the mixture of cement, sand, aggregate, water and admixtures. Because of this all engineering properties of cement concrete, whether it's in freshen or solidified state, its influenced by their proportions and ingredients. A good concrete mix is supposed to be more workable if its having some quality like easily transport, placing, compaction and finished without any segregation, bleeding. These test is utilized to focus the workability of new concrete. And this is done according to IS: 1199 – 1959. The various devices utilized for doing this test is Slump cone with top diameter 10cm, base dia.20 cm and a height of 30 cm or Tamping rod.

Procedure

- The inner face of the mould is altogether cleaned and a light layer of oil is applied.
- The mould is put on the flat, smooth, rigid and non-absorbent surface.
- After that the mould is filled into three different layers with newly blended concrete, each pretty nearly to one-third of the mould's height.
- Each layers is tempered by 25 times to round end of tamping bar (strokes are Appropriated equitably over the cross segment).
- After the upper film is rodded, concrete hits the place with trowel.
- Mould is excluded from the concrete promptly by bringing it gradually up in the Vertical course.
- The distinction in levels between the mould's height and the uppermost point of the died down concrete is measured.
- This distinction in height in 'mm'of concrete.

1) *Test Details:* In order to calculate the effects of half replacing of glass powder and fly ash with cement, is 5%-5% during the time of manufacturing of OPC as per IS 269-2013. The proportion is 1: 1.34: 2.85 concrete mixed is obtained with C.A. and F.A. Following mix is prepared with F.A. and C.A., gradually replacing glass powder and fly ash at 5%- 5% interval, by wt., up to 40%. The water cement ratio for test takes constant at 0.45 during the investigation. three numbers of 150mm x 150mm x 150 mm cube and 150×300mm cylinder is casting for every mix and put in water for significiant IS 10086- 1982. After this the no. of cubes are tested at 28th days of curing age, to calculate compressive strengthening and tensile strengthening. The optimal % of replacement is find for every replacement of glass powder and fly ash. To find out workability of freshen concrete, slump test and compaction factor is done, before preparing the cubes, according to IS 1199- 1959. Slump having mould base dia. of 200 mm,and small opening at top is 100 mm or 300 mm in height. Firstly cone is fill with different three layers, tamping every layer 25 times with 16 mm dia. rod to removing void from the specimen. And upper face of mix is levelled off. After that cone is removed, and ht. of slump is calculate. And compaction factor test also done for this concrete mix. Among different strengthening of concrete, compressive strengthening and tensile strengthening achieve more attention, for the reason that, in primarily stage concrete withstand to comp. stress. The method is applied as per IS 516- 1959.and the load is applying slowly slowly, when failure occur in the cube.

D. Compaction Factor Test

It's a lab test but it could be use in field also. It is very accurate or susceptible than the slump test. It's mainly useful for concrete mix of very low workability and usually used when concrete is to be compacted by vibration. This procedure apply for plain and air-entrained concrete ,which is made with lightweight, normal weight or heavy aggregates having a nominal max. nominal sizes of 38 mm or less but not to aerated concrete or no-fines concrete.

1) *Procedure:* Mix of concrete to be tested should be placed in upper hopper, using the hand scoop. The hopper should be filled level with its brim or trap-door shall be opened so that the concrete falls into the lower hopper. After that concrete in rest position, and cylinder should be uncovered, trap-door of lower hopper opened, then concrete allowing to falling down to the cylinder. Surplus of concrete remain the upper level of the top of the cylinder then cut off by holding a trowel in each hand, with plane of horizontal, or move all together one from each side across the top of the cylinder. Outer surface of the cylinder should be clean well. This procedure at a place which is free from vibration or shock. Approx 10 g wt. of concrete should be calculated. This wt. should be the wt. of partially compacted concrete. After that cylinder should be refilled with concrete with similar layers approx 5 cm deep, each layer is completely rammer so its obtained in fully compacted state. Upper face of fully compacted concrete should be carefully struck off level with the top of the cylinder. And outer surface should be clearly wipe out.

E. Compressive Strength Test

The compressive strengthening on each 150×150×150mm Cubic specimen was determined in accordance with Compression testing machine. both tops of every specimen were ground before testing to make sure that constant loading occur during test. The diameter of each specimen was taken before compressive strengthening test. The testing was hydraulic controlled with max. capacity of 2000 KN. Load was applied gradually to the specimen at a constant loading rate of 0.5 N until complete failure occurred. The outputs of load from the testing machine were attached to data acquisition system, which records the data during the test. The maximum load is recorded and the compressive stress computed by dividing max. Load to the cross sectional area of sample. And type of fracture was also recorded. Figure 3.10 shows a cube in testing machine before test.

1) *Splitting Tensile Strength Of Concrete:* Tensile strength is an engineering property of concrete and structure load makes concrete more susceptible to cracking. Concrete have good compressive strengthening and less tensile strengthening. And it's approx about 10% of compressive strengthening. To determine the tensile strengthening we used Compression testing machine, it have 2 strips of plywood which have 30 cm long and 12 mm wide, tamping bar (steel bar of 16 mm diameter, 60 cm long), trowel, glass or metal plate and cylindrical mould. The tensile strengthening on each 300mm×150mm specimen was determined in accordance with Compression testing machine. both tops of every specimen were ground before testing to make sure that constant loading occur during test. The diameter of each specimen was taken before compressive strengthening test. The testing was hydraulic controlled with max. capacity of 2000 KN. Load was applied gradually to the specimen at a constant loading rate of 0.5 N until complete failure occurred. Calculation done according to 0.7*fck the tensile strengthening .And tensile strengthening of cylinder is calculated by 2p/piDL.

VII. RESULTS

A. Slump Cone Test

This test is done for calculating workability of concrete. This test separately performs on fresh concrete and in concrete replaces cement in place of glass powder and fly ash to calculate the workability. The slump is most useful for detect variation in uniformity of mixed design of given nominal proportions; it's used to calculate the consistency of fresh concrete. This experiment is too conducted immediately after its made. Workability is an engineering property of newly blended concrete mixture, and it is the mixture of cement, sand, aggregate, water and admixtures. Because of this all engineering properties of cement concrete, whether it's in freshen or solidified state, its influenced by their proportions and ingredients. A good concrete mix is supposed to be more workable if its having some quality like easily transport, placing, compaction and finished without any segregation, bleeding. These test is utilized to focus the workability of new concrete. And this is done on the basis of IS: 1199 – 1959. The various devices utilized for doing this test is Slump cone with top diameter 10cm, base dia.20 cm and ht.30 cm or Tamping rod.

Table 4.1: Slump value properties of different mix

Percentage Glass powder & Fly Ash	0%	5% +5%	10% + 10%	15% +15%	20% + 20%
Limiting Value of slump (0 – 150)	124	118	130	140	145

B. Compaction Factor Test

The compaction factor test is planned mainly for the use in lab. But it could also used in field. Its very accurate and susceptible than the slump test and this is especially useful for concrete mixes of very low workability or usually use when concrete is fully compacted by vibration. This procedure apply for simple, air-entrained concrete, those are made with light wt., normal wt. and heavy aggregate of nominal sizes of 38 mm or less but not to aerated concrete or no-fines concrete.

Table 4.2: Compaction factor test properties of different mix

Percentage Glass powder & Fly Ash	0%	5% +5%	10% + 10%	15% +15%	20% + 20%
Limiting Value of Compaction Factor (0.78 – 1.0)	0.91	0.89	0.87	0.92	0.87

C. Compressive Strength Test

Concrete is weaker in tensioning zone or strong in compression zone. Therefore it should be stronger enough to attain high compression. In this study for each mixed 3 different sample were examined and average strengthening is compared with nominal mix of M30 Mix. Compressive strength test finds out the high amount of compressive loading of a cube. That it could bear below facture limit. The results of compressive strengthening at the age 7th, 14th & 28th days are given in 4.3 no. tables.

Table 4.3 Compressive Strength at various stage of curing (M 30)

Percentage Replacement of Fly ash & Waste glass Powder	Compressive Strength (N/mm²)		
	7 Days	14 Days	28 Days
0%	16.86	30.60	33.05
5% (G.p.) + 5% (F.a.)	17.96	27.02	29.84
10% (G.p.) + 10% (F.a.)	17.98	27.47	29.43
15% (G.p.) + 15% (F.a.)	18.68	28.82	32.08
20% (G.p.) + 20% (F.a.)	18.40	28.04	30.26

D. Splitting Tensile Strength of Concrete

Tensile strength is an engineering property of concrete and structure loading makes concrete more susceptible to cracking. Concrete have good compressive strengthening and less tensile strengthening. And it's approx about 10% of compressive strengthening. To determine the tensile strengthening we used Compression testing machine, it have 2 strips of plywood which have 30 cm long and 12 mm wide, tamping bar (steel bar of 16 mm diameter, 60 cm long), trowel, glass or metal plate and cylindrical mould.

Table 4.4 Splitting Tensile Strength at various stage of curing (M 30)

Percentage Replacement of Fly ash & Waste glass Powder	Splitting Tensile Strength (N/mm²)		
	7 Days	14 Days	28 Days
0%	1.54	1.85	4.25
5% (G.p.) + 5% (F.a.)	1.85	1.98	4.36
10% (G.p.) + 10% (F.a.)	2.34	2.76	4.92
15% (G.p.) + 15% (F.a.)	2.84	3.54	5.64
20% (G.p.) + 20% (F.a.)	3.11	1.84	5.67

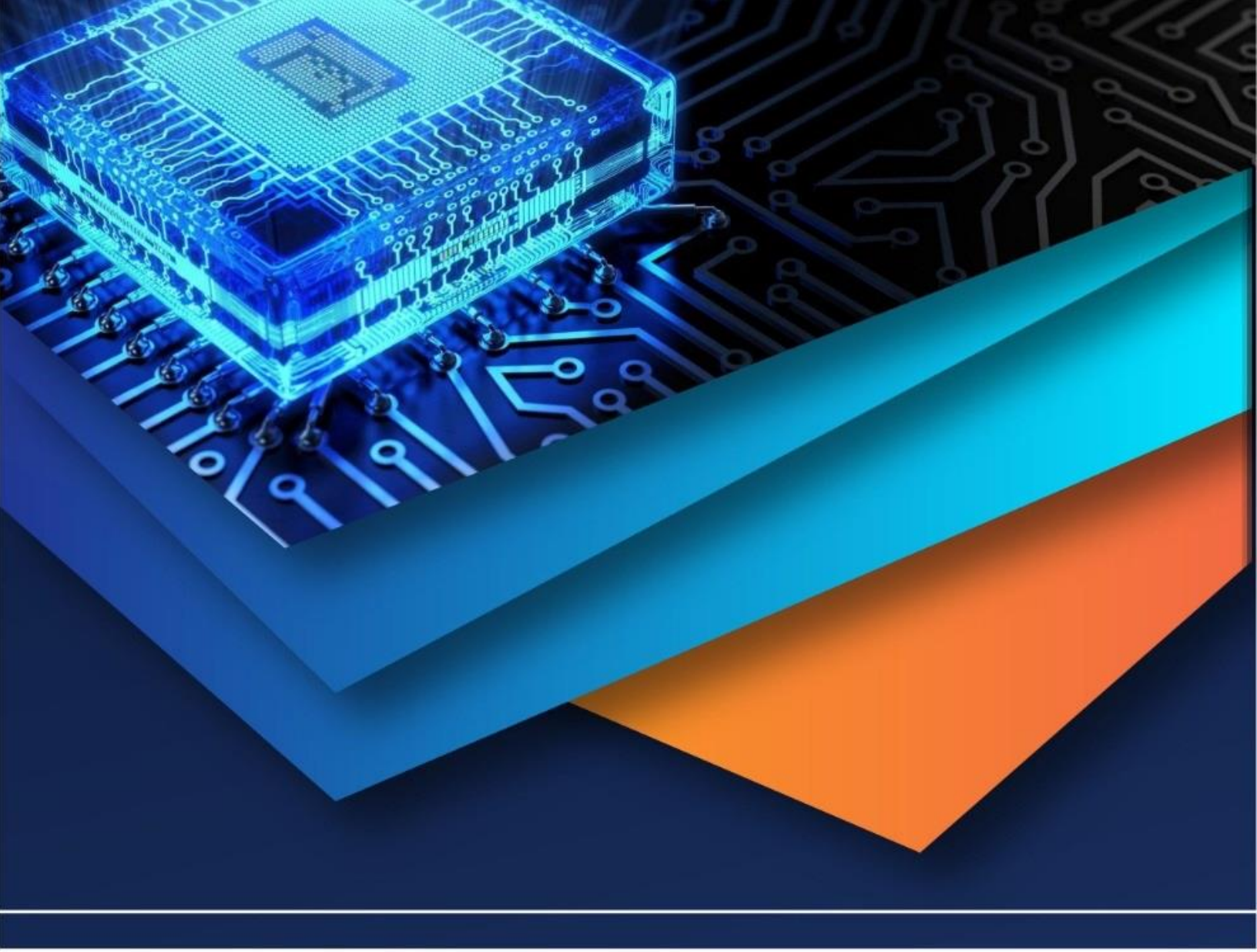
VIII. CONCLUSION

In this chapter will present a conclusion outlining the main findings as well as possible recommendation for additional research. This research has helps to identify factor causes of Fly ash & Glass Powder waste replacing with cement in concrete.

Following assumptions are to be taken for this analysis is as follows:

A. A Fly ash & Glass Powder waste is such type of waste used as a substitute to Cement in concrete.
B. From this analysis, fly ash & Glass Powder waste particles are used because it is low cost material which would help to resolve solid waste disposal problem or save atmosphere from pollution.
C. Concrete manufacturing cost reduces when in concreting cement replaced by Fly ash & Glass Powder waste.
D. More Amount of Fly ash & Glass Powder waste increasing the density of mix so its directly increase the Self-weight of mix.
E. The Compressive Strengthening of mix with half substitute of cement with Fly ash & Glass Powder waste up to 20% can be comparable with conventional Concrete.

Partial substitution of Fly ash & Glass Powder waste in mix shows good resistance against sulphate attack.



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