

EXPERIMENTAL INVESTIGATION OF CONCRETE USING FLY ASH AND GLASS POWDER

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ABSTRACT

This study focuses on replacing some of the fine aggregate with glass powder and fly ash with cement. Glass is an inert substance that may be recycled and utilized repeatedly without undergoing any chemical changes. Glass has a high silica content and is an amorphous material, which makes it potentially pozzolanic when the particle size is smaller than 75 μm . The Alkali-Silicate reaction, which occurs when silica-rich glass particles react with the alkali in the concrete's pore solution, is a major cause for concern when using glass in concrete. If the right precautions aren't taken to reduce its effects, this reaction could seriously compromise the stability of the concrete. Glass powder and fly ash improve the workability and durability of concrete, lower the alkali silica reaction, and contribute to a greener environment during the concrete-making process. The use of fly ash as a partial substitute for cement in concrete and glass powder as a partial substitute for fine aggregate were suggested in this inquiry. Fly ash and glass powder were used to partially replace cement (10%, 20%, and 30%) and fine aggregate (10%). Cubes' compressive strengths after seven, fourteen, and twenty-eight days were examined and contrasted with regular concrete. The findings demonstrated that there is a significant increase in compressive strength and a decrease in tensile strength when utilizing glass powder and fly ash as a in concrete.

Keywords: Glass powder, Fly ash, Strength, Concrete properties, and environmentally friendly.

1. INTRODUCTION

Almost all structural works use concrete, a construction material that is widely used and flexible. It is a composite substance made up of water, admixtures, aggregates, and cement. Cement, sand, coarse aggregate, and water are combined to create concrete. Energy consumption reductions are becoming more important than ever because of global warming. Everyone on the earth has been affected by global warming, which is a widely acknowledged fact. Cement manufacture requires a lot of energy and produces a lot of carbon dioxide (CO₂), one of the main greenhouse gases. Over the previous 200 years, there has been an approximate 30% increase in atmospheric carbon dioxide levels. The cement sector contributes 7% of greenhouse gas emissions to the atmosphere. For every ton of cement produced in the industry, one ton of carbon dioxide (CO₂) is discharged into the environment. Alternative materials are being used in concrete to lower emissions. Alternatives abound and include glass powder, eggshells, fly ash, and rice husk ash. In terms of construction, an alternative should be affordable and accessible. In order to provide sustainable construction, construction companies are interested in utilizing recycled materials. There has been a growing push in recent years to reduce construction's negative environmental effects. Fly ash is a byproduct of burning pulverized coal in thermal power plants. It is an industrial waste with pozzolanic properties. Fly ash finds application in the construction industry as an additive in cement production, as a base and sub-base material in highway construction, as filler in dams and retaining walls, and as a lightweight construction material. It is also used in the production of concrete, either in place of some cement or in place of some fine aggregate. When mixed with Portland cement, the qualities of fly ash increase strength and improve durability. Because of the growing emphasis on sustainable construction, the construction industry is becoming more interested in employing waste or recycled materials in concrete. Glass garbage from small shops in the area is packed as waste and disposed of in landfills. Glass typically has no negative environmental effects because it doesn't release any pollutants, but if handled carelessly, it can hurt both people and animals. Additionally, because it doesn't biodegrade, glass is less environmentally friendly.

Glass encompasses a variety of chemical compositions, such as borosilicate, alkali-silicate, and soda-lime silicate glass. By passing through a 90 micron sieve, various kinds of glass powder are currently commonly employed as pozzolana in cement and aggregate mixtures for civil works. The addition of glass debris to cement will raise the cement's alkali content. Glass waste has a high silica (SiO₂) content—72%. When waste glass is ground into an extremely fine powder, it combines with the alkalis in cement to produce a cementitious product and pozzolanic reaction, which aids in the development of strength.

1.1 BENEFITS OF FA & GP

Sustainability of the Environment This helps in reducing greenhouse gas emissions and conserving natural resources.
Improved Durability:

The incorporation of fly ash and glass powder in concrete can enhance its durability and resistance to chemical attack, sulfate attack, and alkali-silica

Cost-Effectiveness: Fly ash and glass powder are frequently more affordable than cement, which makes them feasible substitutes for concrete manufacture.

Better Workability and Pumpability: Adding fly ash and glass powder to concrete mixtures can improve their workability and pumpability, making them simpler to pour.

1.2 OBJECTIVE

To look into the viability and efficiency of substituting glass powder for fine aggregate and fly ash for cement in certain situations.

To determine the new characteristics of concrete

To determine the concrete's hardness

1.3 SCOPE

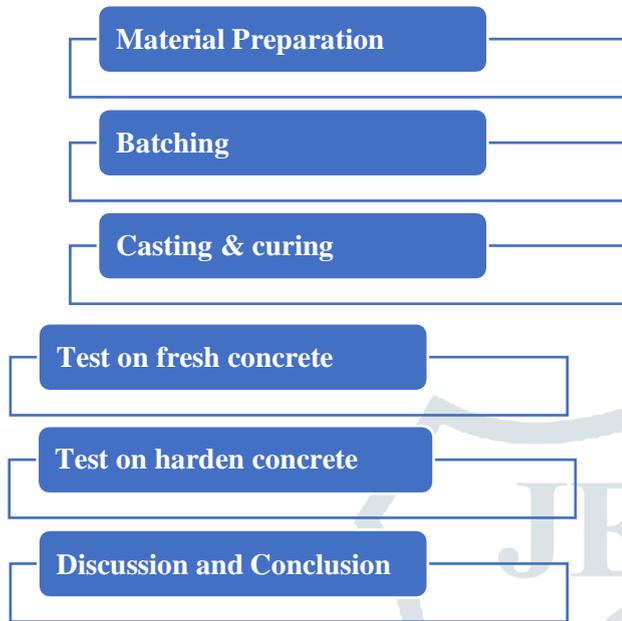
These days, this kind of concrete is widely employed in building all over the world. It may be used for many different things, such

Improving energy efficiency

Increasing the effectiveness of construction

- ❖ 3Reducing the influence on the environment
- ❖ Improving financial effectiveness

2. METHODOLOGY



3. MATERIAL USED:

The supplies utilized for this undertaking are

- Cement
- Fly ash
- Aggregates
- Fine aggregates
- Glass powder
- Coarse aggregate
- Water.

4.4.1 SIEVE ANALYSIS OF FA

Using a sieve shaker, sieve analysis is used to determine the particle size distribution in an aggregate sample. The aggregate sample is divided into multiple fractions throughout this process, each of which contains particles of the same size. Sieve examination of fine aggregates typically use conventional sieves with the following sizes: 4.74 mm, 2.36 mm, 1.18 mm, 600 μ, 300 μ, and 140 μ. The experiment was carried out in accordance with IS 2386-Part I- 1963 and IS:383-1970, and the gradation curve that resulted was plotted for the fine aggregate sieve analysis results.

TABLE 4.1

SIZE	Weight retained	% retained	Cumulative %	Pass %
4.25	25	1.25	1.25	98.75
2.35	715	35.75	37	53
1.18	1115	55.75	92.75	7.25
0.6	85	4.25	97	3
0.3	30	1.5	98.5	1.5
0.15	20	1	99.5	.5
0.09	10	0.5	100	0

Zone I as per IS 383-1970

MIX DESIGN

The process of choosing appropriate concrete materials and figuring out their relative amounts to produce concrete with a minimum amount of strength, durability, and workability in the most cost-effective manner is known as mix design. The fundamental idea behind mix design is to choose the right amount and ratio of ingredients to give the necessary strength and workability.

TABLE 4.2

VOLUME OF MATERIALS	
Cement	394 Kg/m ³
Fine aggregate	749 Kg/m ³
Coarse aggregate	1196 Kg/m ³

MIX RATIO

TABLE 4.3

Cement	FA	CA	W/C
1	1.6	3	0.5

CASTING AND CURING:

Typically, machines or physical labor are used to mix concrete, as shown Several elements are combined during the casting process, such as cement, water, fine and coarse aggregates, and additives. The final hardened concrete's qualities are largely determined by the proportions of these constituents. It is advised to measure these proportions by weight rather than volume for the best precision, while volume measurements might work for smaller tasks.,

After mixing the dry materials thoroughly, water is added little by little until the concrete has a workable consistency. Achieving the required workability may need changes, depending on the type of aggregate utilized. Finding the ideal balance is crucial to preventing the combination from being either too fluid or too stiff. While excessive fluidity may lead to water separating or leaking out of the mixture, excessive stiffness can impede the creation of high-quality test specimens.

After mixing the dry materials thoroughly, water is added little by little until the concrete has a workable consistency.

Fly ash is combined with coarse aggregate in proportions of 10%, 20%, and 30% in lieu of cement, and 10% in lieu of fine aggregate, until a homogenous consistency is attained. The slurry is then combined with coarse particles, and water is added gradually to avoid bleeding, which could weaken the concrete and cause surface water to rise. After compacting the mixture into molds, six cubes are ready for curing. We measure the compressive strength at 7, 14, and 28 days post-curing.

CURING

Concrete typically gains strength rapidly in the first two weeks after casting, with approximately 90% strength achieved within 14 days. By the end of 26 days, the concrete would have reached around 99%. Although the concrete continues to gain strength beyond this period, the rate of strength gain slows significantly compared to the other methods. The first method of curing involved "ponding," in which the cubes were fully immersed in water for the entire curing period. An average laboratory temperature of 26°C was maintained for the curing water to avoid thermal strains that could cause cracking. The second curing technique called for "sprinkling water" on the cubes.

4. Table 5 Mix description

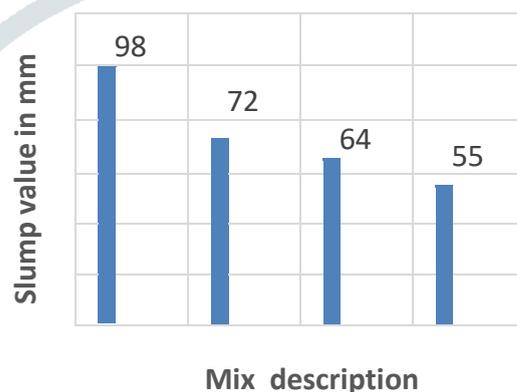
Mix	Cement	Fly ash	FA	Glass Powder
MIX 1	394	0	649	0
MIX 2	355.2	39.4	584	64.9
MIX 3	315.2	78.8	584	64.9
MIX 4	275.8	118.3	584	64.9

Table. 5 shows the quantity of materials which is used for making in this blocks.

7.1 SLUMP TEST

The slump test is the most widely used technique for determining the consistency of concrete, and it can be used in a laboratory or on a construction site. However, it is not a perfect representation of the concrete's placeability and does not measure all the factors that contribute to workability. You can learn more about the workability and quality of concrete by observing how the concrete slumps.

It is clear from the table analysis that MIX 3 with a 0.5 water-to-cement ratio was able to obtain the desired slump value. As a result, this ratio has been chosen as the design ratio. Thus, as fig. 7.1 illustrates, the addition of fly ash considerably decreased the slump value in this test. Trials 3 and 4, on the other hand, produced noticeably lower slump values. This could be related to either inadequate paste available for binding the mix or inappropriate mixing techniques.



5. TEST ON HARDEN CONCRETE:

The strength tests carried out on hardened concrete specimens are:

- Compression test.
- Water absorption.

Compressive strength:

To find out how well waste plastic, I-section paver blocks, and plastic brick pavers could support a weight under compression, tests of compression and compressive strength were performed on them. The test was carried out using a compressive testing machine (CTM).

The procedure was carried out in accordance with Indian Standard Code IS 3495: 1992 (Part D). Testing the plastic sample' compressive strength is essential. The specimens' weight and measurements need to be noted before testing. It is necessary to enter the test specimen into the machine such that the opposing sides of the cubes, not their top and bottom, receive the weight.

The load needs to be applied without shock and increased gradually at a rate of about until the specimen can no longer support the increasing load and no higher load can be sustained. Next, the specimen's maximum load, the look of the concrete, and any irregularities in the failure type must all be recorded.



Fig 5.2 Compressive strength

Compressive Strength: The results of the tests for compressive strength showed that the addition of glass powder and fly ash produced encouraging results. The greatest strength is found to be at 10% glass powder and 30% fly ash. The compressive strength of concrete has increased to match normal concrete with a fly ash content of 10% by cement weight. It was noted that, over this threshold, additional additions of fly ash and 10% glass powder content resulted in a little improvement in compressive strength.

Table 5 compressive strength

Mix	7days	14 days	28 days
Mix 1	2.24	2.46	2.55
Mix 2	2.16	2.15	2.32
Mix 3	1.98	2.06	2.25
Mix 4	1.98	1.99	2.15



fig 5.1 compressive strength

5.2 SPLIT TENSILE STRENGTH TEST

Concrete is strong in compression but weak in tension. The low tensile strength is caused by the existence of many micro fractures. These micro fissures propagate under load, resulting in inferior concrete strength. In this study, the tensile strength is determined using the splitting tensile test in line with IS 5816: 1999. Split tensile strength was measured using cylindrical specimens with a diameter of 150mm and a length of 300mm.

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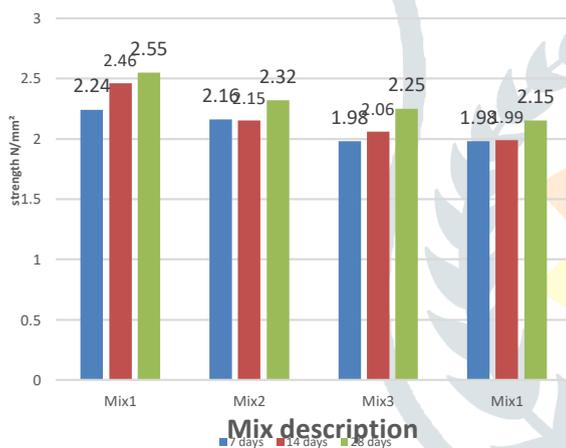


Fig 5.2 SPLIT TENSILE STRENGTH TEST

1. Tensile Strength: Adding fly ash and glass powder significantly improved tensile strength compared to normal concrete, especially at 10% glass powder and fly ash content. However, excessive glass powder concentration at the optimum level resulted in a loss in tensile strength as seen in fig 5.2, presumably due to fine powder with less friction.

RESULT

Several studies were conducted on this concrete. Studying a gap has shown a combined investigation of cement ingredient replacement. Using the reference section from the previous chapter, several scenarios are selected, and the performance of concrete with different mix proportions is examined. The compressive strength is investigated, and the tensile strength observations of the cases described are tabulated as shown in the following section of the results. Several observations are made to discover visible combinations of deemed a replacement.

Slump test: when the amount of fly ash in the mix increased, the slump value began to reduce dramatically. The result reveals that there is a 45% decrease in slump value when we add 30% of fly ash.

Compressive Strength: The compressive strength of concrete has been increasing relative to traditional concrete. However, additional increases in fly ash and 10% glass powder concentration above this threshold resulted in a minor gain in compressive strength.

Tensile Strength: As the amount of fly ash in concrete increases, the tensile strength decreases due to reduced friction in glass powder.

CONCLUSION:

Glass powder and fly ash, which are waste products, are quite viable as a reinforcement material in concrete. Furthermore, it is an efficient method of waste disposal, which will reduce the demand for additional waste disposal infrastructure and the load on existing landfills and incinerators. Utilization of waste materials, such as glass powder and fly ash, is also economic and environmentally friendly.

Concrete created by replacing 10, 20, and 30% of the cement with fly ash and 10% with glass powder for fine aggregate (GP+FA) produced satisfactory results and yielded the appropriate quality of concrete. Utilization of waste products such as glass powder and fly ash is both economical and environmentally friendly.

When the percentage of fly ash in the mix increased, the slump value began to reduce dramatically. The results reveal that adding 30% of fly ash results in a 45% decrease in slump value. So, it is advisable to utilize 30% of fly ash in this sort of concrete.

As the percentage of fly ash increases, the compressive strength of concrete also increases. The Fly Ash impact is more fruitful, together with Glass Powder at a lesser percentage. Concrete becomes more workable as the proportion of fly ash and glass powder increases.

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