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# EXPERIMENTAL INVESTIGATION ON CONCRETE WITH GLASS POWDER AND CALCIUM CHLORIDE

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***ABSTRACT***

***Concrete is a widely used construction material, a composite of cement, aggregates (fine and coarse), and water. It is known for its versatility, strength, and durability. This study investigates the potential of enhancing concrete properties by incorporating industrial by-products and chemical admixtures. It focuses on the partial replacement of fine aggregate with glass powder and the partial replacement of cement with calcium chloride. Glass powder, an abundant waste material, has shown pozzolanic properties, contributing to improved strength and durability in concrete. Calcium chloride is a common accelerator, known to speed up cement hydration and early strength gain. To evaluate the combined effect of these replacements on the fresh and hardened properties of concrete. To determine the optimum replacement percentages for both glass powder and calcium chloride. The primary tests performed will be compressive strength and split tensile strength for 7 and 28 days.***

***KEYWORDS:**Glass Powder,Calcium Chloride, Pozzolanic ,Compressive strength and Split tensile strength*

## 1. INTRODUCTION

Concrete is a cornerstone of global construction, second only to water in consumption. It’s a composite material made from cement, aggregates like sand and gravel, and water. Through hydration, the cement and water react, forming a hardened paste that binds the aggregates into a durable, stone-like mass.This material's incredible versatility, strength, and durability make it the backbone of modern infrastructure. Concrete everywhere, from towering skyscrapers and vast road networks to intricate bridges, dams, and residential buildings. It provides essential structural integrity and long-term performance for all sorts of applications. Its ability to be molded into virtually any shape when fresh, combined with its resistance to heavy loads, fire, and harsh environmental conditions, is why it's so widely adopted.

Glass powder as a partial replacement for fine aggregate in concrete mixes. Glass waste, a globally abundant and environmentally persistent material, offers a unique opportunity to address both resource depletion and waste management challenges. By transforming discarded glass into a fine powder, it can exhibit pozzolanic properties, reacting with cement hydration products to enhance the concrete's strength and durability. This study aims to investigate the mechanical and durability characteristics of concrete incorporating various percentages of glass powder, paving the way for more eco-friendly and resource-efficient concrete production.

Calcium chloride (CaCl2) is a well-known chemical admixture in concrete, primarily recognized for its ability to accelerate cement hydration.When added to concrete, it significantly reduces both the initial and final setting times, leading to earlier strength development.This acceleration is particularly beneficial in cold weather concreting, allowing for faster form removal and earlier use of the structure. While typically used as an additive, exploring calcium chloride as a *partial replacement* for cement in certain applications warrants investigation. This approach aims to leverage its accelerating properties while potentially optimizing cement content, thereby impacting the overall cost and environmental footprint of concrete production.

## 2. OBJECTIVES

1. To investigate the fresh and hardened properties of concrete incorporating various percentages of glass powder as a partial replacement for fine aggregate.

2. To evaluate the influence of partially replacing cement with calcium chloride on the setting time and early-age strength development of concrete.

## 3. MATERIALS

**3.1 Cement: Cement** is a finely ground powder, typically made from limestone and clay, that acts as a crucial binding agent. When mixed with water, it undergoes **hydration**, a chemical reaction that forms a solid paste essential for bonding aggregates in concrete and mortar.

**3.2 Fineaggregate**:In civil engineering, **fine aggregate** refers to granular materials like sand, crushed stone, or crushed slag. Its particles generally pass through a 4.75 mm sieve but are retained on a 0.075 mm sieve.

**3.3 Coarse aggregate**: **Coarse aggregate** consists of larger granular materials, such as gravel or crushed stone, with particles primarily retained on a 4.75 mm sieve.

**3.4 Water: Water** is a critical component that contributes to concrete's volume, strength, and structural integrity. It serves two main purposes: it chemically reacts with cement through **hydration** to form a solid binding paste, and it acts as a lubricant, aiding in proper placement and finishing of the mix.

**3.5Glass Powder:** It synthetic, finely milled material derived from recycled or waste glass.

**3.6 Calcium Chloride:** While calcium chloride (CaCl2) is most commonly used as an admixture in concrete to accelerate setting time and early strength gain, its use as a partial cement replacement refers to a scenario where a small percentage of the cement in the concrete mix is directly substituted with calcium chloride.

## 4. EXPERIMENTAL RESULTS

### 4.1 Compressive strength

The compressive strength test measures the maximum load a material, like concrete, can withstand under compression before it fails or deforms. This is typically done by gradually applying force to a standardized specimen cube in a testing machine for 7 and 28 days.

**Table 1: Compressive strength results of concrete with Glass Powder used as a partial replacement of fine aggregate.**

| Sl.no | % of Glass powder | Compressive Strength Results, $N/mm^2$ | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1 | 0% | 26.48 | 39.07 |
| 2 | 5% | 33.24 | 48.54 |
| 3 | 10% | 35.05 | 50.88 |
| 4 | 15% | 37.42 | 53.54 |
| 5 | 20% | 35.71 | 52.16 |

**Table 2: Compressive strength results of concrete with Calcium Chloride used as a partial replacement of cement.**

| Sl.no | % of Calcium Chloride | Compressive Strength Results, $N/mm^2$ | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1 | 0% | 26.48 | 39.07 |
| 2 | 1% | 27.63 | 40.22 |
| 3 | 2% | 28.87 | 42.03 |
| 4 | 3% | 29.68 | 43.34 |

**Table 3: Combined Compressive strength results of concrete with 3% CC+15% GP**

| Sl.no | 7.5% of Glass powder | Compressive Strength Results, $N/mm^2$ | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1 | 0% | 26.48 | 39.07 |
| 2 | *3% CC+15% GP* | 39.56 | 60.12 |

### 4.2 Split tensile strength

The split tensile strength test is an indirect method used to determine the tensile strength of brittle materials like concrete. It involves placing a cylindrical specimen horizontally and applying a compressive load diametrically along its length, causing the cylinder to split along the loaded diameter due to induced tensile stresses.To cracking in concrete constructions for 7 and 28 days.

**Table 4: Split tensile strength results of concrete with Glass Powder used as a partial replacement of fine aggregate.**

| Sl.no | % of Glass powder | Split tensile Strength Results, $N/mm^2$ | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1 | 0% | 2.39 | 3.47 |
| 2 | 5% | 2.91 | 4.73 |
| 3 | 10% | 3.23 | 5.01 |
| 4 | 15% | 3.66 | 5.34 |
| 5 | 20% | 3.53 | 5.16 |

**Table 5: Split tensile strength results of concrete with Calcium Chloride used as a partial replacement of cement.**

| Sl.no | % of Calcium Chloride | Split tensile Strength Results, $N/mm^2$ | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1 | 0% | 2.39 | 3.47 |
| 2 | 1% | 2.63 | 3.91 |
| 3 | 2% | 2.78 | 4.13 |
| 4 | 3% | 2.94 | 4.29 |

**Table 6: Combined Split tensile strength results of concrete with 3% CC+15% GP**

| Sl.no | 7.5% of Glass powder | Split tensile Strength Results, $N/mm^2$ | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1 | 0% | 2.39 | 3.47 |
| 2 | *3% CC+15% GP* | 4.11 | 5.94 |

## 5. CONCLUSION

1. The normal concrete compressive strength results for 7 days and 28 days are 26.48 $N/mm^2$ and 39.07 $N/mm^2$.
2. At 15% partial replacement of fine aggregate with Glass powder which gives compressive strength result for 7 and 28 days is 37.42 and 53.54 $N/mm^2$.
3. At 3% partial replacement of cement with Calcium Chloride which gives compressive strength result for 7 and 28 days 29.68 and 43.34 $N/mm^2$.
4. Compressive strength result for combined replacement of 15% partial replacement of fine aggregate with Glass powder and 3% partial replacement of cement with Calcium Chloride which gives compressive strength result for 7 and 28 days is 39.56 and 60.12 $N/mm^2$.
5. The normal concrete split tensile strength results for 7 days and 28 days is 2.39 $N/mm^2$ and 3.47$N/mm^2$.
6. At 15% partial replacement of fine aggregate with Glass powder which gives split tensile strength result for 7 and 28 days is 3.66 and 5.34 $N/mm^2$.
7. At 3% partial replacement of cement with Calcium Chloride which gives split tensile strength result for 7 and 28 days is 2.94 and 4.29 $N/mm^2$.
8. Split tensile strength result for combined replacement of 15% partial replacement of fine aggregate with Glass powder and 3% partial replacement of cement with Calcium Chloride which gives compressive strength result for 7 and 28 days is 4.11 and 5.94 $N/mm^2$.

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