# Evaluation of Strength Properties of Concrete Using Glass Granules as Pozzolana

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**Abstract—The paper focus on concrete using mineral admixtures like glass powder as pozzolana and also aim of this experimentation to study the durability properties of concrete containing waste glass powder as pozzolana.**

**The Main objective of this experimentation is to study the durability properties of concrete containing waste glass powder as pozzolana. Cement is replaced by glass powder in different percentages like 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40%.Strength properties of concrete such as compressive strength, tensile strength, flexural strength and impact strength are studied for M20 concrete. To find the percentage of waste glass powder to replaced cement in the concrete, to make concrete economical as well as to increase its compressive strength.**

**Index Terms—strength, concrete and glass granules.**

## I. INTRODUCTION

### 1.1 General

Cement concrete is a mixture of paste, composed of portland cement and water, coats the surface of the fine (small) and coarse (larger) aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete. As concrete, can build skyscrapers, bridges, sidewalks and superhighways, houses and dams to achieving a strong, durable concrete rests in the careful proportioning and mixing of the ingredients.

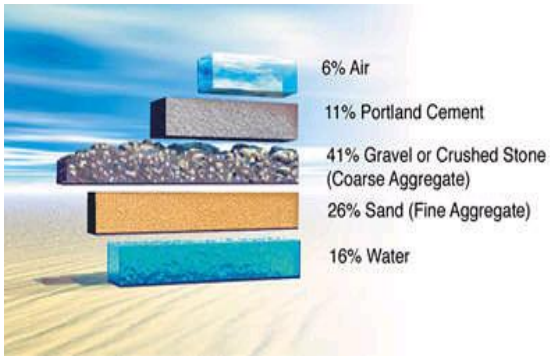


Figure 1: Basic Ingredients of Concrete

### 1.2 Waste Glass powder as pozzolana

Glass powder as pozzolana in concrete has the appropriate chemical composition to react with alkalis in cement and form cementitious products. Reducing carbon foot prints without compromising on desired characteristics and properties of concrete is one of the major aspects of sustainable development. The project is on concrete using mineral admixtures like glass powder as pozzolana is the aim of this experimentation to study the durability properties of concrete containing waste glass powder as pozzolana. Blending pozzolana portland cement with glass powder in different percentages is to be undertaken. Strength properties of concrete such as compressive strength, tensile strength, flexural strength and impact strength are to be studied.

Wastes are produced by the industries irrespective of the nature of their products. Disposal of wastes is a challenging task for industries. Industrial wastes like fly ash, silica fume, and blast furnace slag and other wastes like plastics, glass, and agricultural wastes are causing environmental pollution. Waste glass when ground to a very fine powder shows pozzolanic properties as it contains high $SiO_2$ and therefore to some extent can replace cement in concrete and contribute in strength development. This project, an attempt has been made to find out the effect of chloride and sulphate attack on the properties of concrete containing waste glass powder as pozzolana. The concrete industry has been making use of industrial mineral wastes like fly ash, silica fume and blast furnace slag as pozzolana by replacing a part of cement. While pozzolanic reaction adds to the strength of concrete and the utilization of these materials brings about economy in concrete manufacture. It has been estimated that several million tons of waste glasses are generated annually worldwide. The key sources of waste glasses are waste containers, window glasses, windscreen, medicinal bottles, liquor bottles, tube lights, bulbs, electronic equipments, etc. Only a part of this waste glass can be recycled. A majority of the waste glass remains unutilized.

The Main objective of this experimentation is to study the durability properties of concrete containing waste glass powder as pozzolana. Cement is replaced by glass powder in different percentages like 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40%. Strength properties of concrete such as compressive strength, tensile strength, flexural strength and impact strength are studied The following materials are used for experimentation to study durability properties of concrete containing waste glass powder as pozzolana with proper mix-design, carried out based on material properties.

The material to be used:

1 Cement: Portland Pozzolana cement

2 Fine aggregate: locally available sand with specific gravity of 2.62 falling under zone ii complying with IS: 383-1970 is to be used.

3 Coarse aggregate: locally available coarse aggregate with specific gravity of 2.93 complying with IS: 383-1970 is to be used.

4 Glass Powder: obtained by crushing the waste glass in a cone crusher mill and sieved through 600 micron sieve was used.

1.3 Origin of the research problem

In day-to-day life glass is used in many forms. It has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses. Many efforts have been made to use waste glass in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. This project is to study the durability properties of concrete containing waste glass powder as pozzolana.

1.4 Objectives & Significance of the study

To replace cement by glass powder in different percentages like 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40%. The strength properties of concrete such as compressive strength, tensile strength, flexural strength and impact strength are studied The following materials are used for experimentation to study durability properties of concrete containing waste glass powder as pozzolana with proper mix-design, carried out based on material properties.

## II. LITERATURE REVIEW

Glass is used in many forms in day-to-day life, has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses. Many efforts have been made to use waste glass in concrete industry as a replacement of cement, fine aggregate and coarse aggregate. Its performance as a coarse aggregate replacement has been found to be non-satisfactory because of strength regression and expansion due to alkali-silica reaction. The research shows that there is strength loss due to fine aggregate substitution also. The aim of the present work was to use glass powder as a replacement of cement to assess the pozzolanic activity of fine glass powder in concrete and compare its performance with other pozzolanic materials like silica fume and fly ash.

**Thomas M. D. and M.H.Shehata et al.** (1999) have studied the ternary cementitious blends of Portland cement, silica fume, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement. Sandor Popovics have studied the Portland cement-fly ash - silica fume systems in concrete and concluded several beneficial effects of addition of silica fume to the fly ash cement mortar in terms of strength, workability and ultra sonic velocity test results.

**Mateusz Radlinski, Jan Olek and Tommy Nantung** (2008) in their experimental work entitled Effect of mixture composition and Initial curing conditions on the scaling resistance of ternary concrete have find out effect of different proportions of ingredients of ternary blend of binder mix on scaling resistance of concrete in low temperatures.

**Barbhuiya S.A., et al.** (2009) studied the properties of fly ash concrete modified with hydrated lime and silica fume concluded that addition of lime and silica fume improve the early days compressive strength and long term strength development and durability of concrete.

**Yogendran et al. (1987)** had focused to modify the properties of concrete with respect to its strength and other properties by using silica fume and chemical admixtures. They concluded that optimum replacement of cement by silica fume for high strength is found to be 15% for a water cementatious ratio of 0.34 at all age.

**Brooks et.al. (2000)** had studied the effect of silica fume, Metakaolin, fly ash and ground granulated blast furnace slag on setting times of high strength concrete, they concluded that there was increase in the retarding effect up to 10% replacement of cement by Metakaolin and as the percentage replacement is increased, the retarding effect is reduced.

## III. MATERIALS AND METHODOLOGY

The materials used in this present work are glass powder, Ordinary Portland cement (43 grade), coarse aggregates and fine aggregates.

Figure 2: Casting of Concrete Cubes

3.1 Methodology:

A nominal mix of concrete of proportion 1:2:4 was adopted for the present study. The compressive strength test was conducted to monitor the strength development of concrete containing 10%, 15% & 20% of these pozzolana as cement replacement. The particle size effect of glass powder studied by using glass powder of size (150-100)µ and (50-100)µ.

The tests were conducted in three series.

• In first Series 10 % of pozzolana were used as partial replacement of cement.

• In second series 15% of pozzolana were used as partial replacement of cement.

• In third series 20% of pozzolana were used as partial replacement of cement.

Eleven numbers of standard cubes (150x150x150 mm) were cast to measure the compressive strength after 28days.

After applying oil to the surface of mould, paste was filled in the vicat's mould and was placed under the needle of vicat's apparatus.

• Release quickly the needle allowing it to sink in the paste and note down the penetration reading when the needle becomes stable.

• If the penetration reading is less than 5 to 7 mm, prepare the paste again with more water and repeat the above procedure until the needle penetrate to a depth of 5 to 7 mm.

• The percentage of the water with which the above situation is satisfied is called normal consistency.

3.2 Compressive Strength

For each series five set were cast to determine compressive strength. Each set comprises of eleven standard cubes out of which nine cubes were cast to measure the compressive strength after 28days


Figure 3: Testing of Concrete Cubes

## IV. RESULT AND CONCLUSION

A. Replacement of Cement by Glass Powder Replacement of Cement by glass powder (10%)

| Cube No. | Load (w) KN | Compressive Strength N/mm$^2$ | Avg. Compressive Strength N/mm$^2$ |
|---|---|---|---|
| **1** | 506 | 22.48 | 20.60 |
| **2** | 375 | 16.67 | |
| **3** | 509 | 22.62 | |

Replacement of Cement by glass powder (15%)

| Cube No. | Load (w) KN | Compressive Strength N/mm$^2$ | Avg. Compressive Strength N/mm$^2$ |
|---|---|---|---|
| **1** | 572 | 25.42 | 23.47 |
| **2** | 539 | 23.95 | |
| **3** | 474 | 21.06 | |

Replacement of Cement by glass powder (20%)

| Cube No. | Load (w) KN | Compressive Strength N/mm$^2$ | Avg. Compressive Strength N/mm$^2$ |
|---|---|---|---|
| **1** | 286 | 12.71 | 15.12 |
| **2** | 320 | 14.22 | |
| **3** | 280 | 12.44 | |

B. Conclusion

As per above results when 10% glass powder for replacing cement in concrete by then strength will be increase @ 2-3 % of nominal strength of concrete M20. And also increase up to 15% , then our strength increases @16- 17 % of nominal strength of M20 concrete. Addition of glass powder by replacing of cement volume upto 20% then strength is reduced. To make concrete economical as well as to increase it's compressive strength we can replace 10% cement by waste glass powder in the concrete.

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