Behavior of Blended Concrete Replacing Various Percentage of Glass Cullet with Coarse Aggregate Adding Geopolymer

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ABSTRACT

This study's goal is to investigate the characteristics of glass cullet-reinforced high-performance concrete (GCRHC), which is used to prepare high-performance trail mixes with 20% geo polymer (GP) replacements ranging from 10% to 40%. An ideal mixture is selected, which replicates cement at a constant 20 percent with geo polymer. Glass cullet are induced at 10 percent, 20 percent, 30 percent, and 40 percent by weight of coarse aggregate for that optimized mix along with geo polymer.

Cube moulds measuring 150x150x150 mm, cylinder moulds measuring 100x300 mm, and beam moulds measuring 100x100x500 mm are made, cured for 7 to 28 days, and then their hardened strength is assessed.

Keywords: Geo polymer, Glass-cullet reinforced high-performance concrete, Compressive strength, flexural strength, tensile strength, waste glass.

INTRODUCTION

Concrete is a structural material used in construction that is made up of aggregate, or hard, chemically inert particulate material (typically sand and gravel), which is then bound together by cement and water. Ordinary Portland Cement (OPC) is combined with additives like fly ash, slag, or silica fumes to create blended cement. These mineral admixtures produce cement that is currently regarded as being superior to regular cement. Two significant benefits of using blended concrete mix are technical and environmental. The minimum strength that concrete must have after 28 days of construction with proper quality control is known as the grade of concrete. Prefixing M to the desired strength in MPa designates the grade of concrete. For instance, a concrete grade with a 20 MPa strength would be identified as M20, where M stands for Mix. These concrete grades are transformed into different mix ratios. For M20 concrete, the cement, sand, and coarse aggregate mix ratio is 1:1.5:3.

Regular grades of concrete are M15, M20, M25 etc. For plain cement concrete works, generally M15 is used. For reinforced concrete construction minimum M20 grade of concrete are used.

Glass waste cullet can be used to replace up to 15% of the cement or sand in concrete. This can improve the concrete's sustainability without negatively affecting its compressive strength. Using glass waste in concrete can also contribute to sustainability in construction. Glass is abundant and non-biodegradable, so disposing of it in landfills can be costly and environmentally difficult. Recycling glass into concrete can reduce the consumption of resources and energy required to manufacture glass.

LITERATURE REVIEW

Manishankar S (2024) concrete industry is a major user of natural resources, which puts its sustainability in jeopardy. Considering this, this work explores how to partially replace fine aggregates in concrete production with waste glass cullets, thus addressing economic problems. With an emphasis on the M-20 mix, several weight percentages of leftover glass cullet—0%, 10%, 20%, and 30%—were used in place of fine aggregates. **Oksana and Serhii (2023)** is widely used construction material in the present industry. The concrete con-sists of cement, fine aggregates and coarse aggregates. Concrete is strong in compression and weak in tension. Also, the cement manufacturing industry on an average emits 7% of greenhouse gases to earth's atmosphere which leads to global warming. In order to address these environmental affects ex-tensive research is ongoing into the use of cement replacements, using many waste materials (like waste glass, plastics, fly ash, etc.) and industry's by-products. **Noor Md. Hasan et. al. (2023)** all of which lead to long term sustainable development. From this perspective, this experimental investigation was carried out to determine the cumulative influence of waste glass cullet and metakaolin (MK) as partial replacements for coarse aggregates and cement in an isolated and combined manner. This research demonstrated the influence of integrating glass aggregate and metakaolin wherein coarse aggregate was substituted by 10%, 15%, 20%, 25%, and 30% glass cullet (by weight), and cement was supplemented with 10% metakaolin. **A. S. Pasana et. al. (2023)** disposal of the huge volume of glass waste is one of the significant environmental issues that need to be addressed. One of the efficient ways to solve this problem is to incorporate ground glass waste in concrete mixtures. However, its inherent surface smoothness and microcracks within the glass particle harm the hardened properties of concrete.

OBJECTIVE OF THE STUDY

The main focus of this study, is the behavior of the glass cullet-reinforced high-performance concrete (GCRHC), which is used to prepare high-performance trail mixes with 20% geo polymer (GP).

- To study the properties of the glass cullet-reinforced high-performance concrete (GCRHC), which is used to prepare high-performance trail mixes with 20% geo polymer (GP).
- To achieve durability of the glass cullet-reinforced high-performance concrete (GCRHC), which is used to prepare high-performance trail mixes with 20% geo polymer (GP).
- To achieve economy by selecting appropriate concrete ingredients.
- To study the workability of the glass cullet-reinforced high-performance concrete (GCRHC), which is used to prepare high-performance trail mixes with 20% geo polymer (GP).
- To study the compressive strength and tensile strength of the glass cullet-reinforced high-performance concrete (GCRHC), which is used to prepare high-performance trail mixes with 20% geo

polymer (GP).

METHODOLOGY

Following test were conducted on prepared samples and materials also as per relevant IS code of Practice:

1. Slump Cone Test
2. Compressive Strength Test

SLUMP CONE TEST

This is a test used extensively in site work all over the work. The slump test does not measure the workability of concrete although ACI 116R – 90 describes it as a measure of consistency, but the test is very useful in detecting variations in the uniformity of a mix of given nominal proportions. The slump test is prescribed by IS: 456 (2000), ASTM C 143 90A and BS 1881 Part 102:1983.

COMPRESSIVE STRENGTH TEST

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc. Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test. Out of test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not.

OBSERVATION AND RESULTS

COMPRESSIVE STRENGTH TEST

The compressive strength of concrete is one of the most important Properties of concrete in most structural application concrete is implied primarily to resist compressive stress. This test give us a thought regarding every one of the attributes of cement. With the assistance of this test we can watch that if Concreting has been done appropriately.

The compressive strength of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP)

Table: The compressive strength of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP) at 7 days

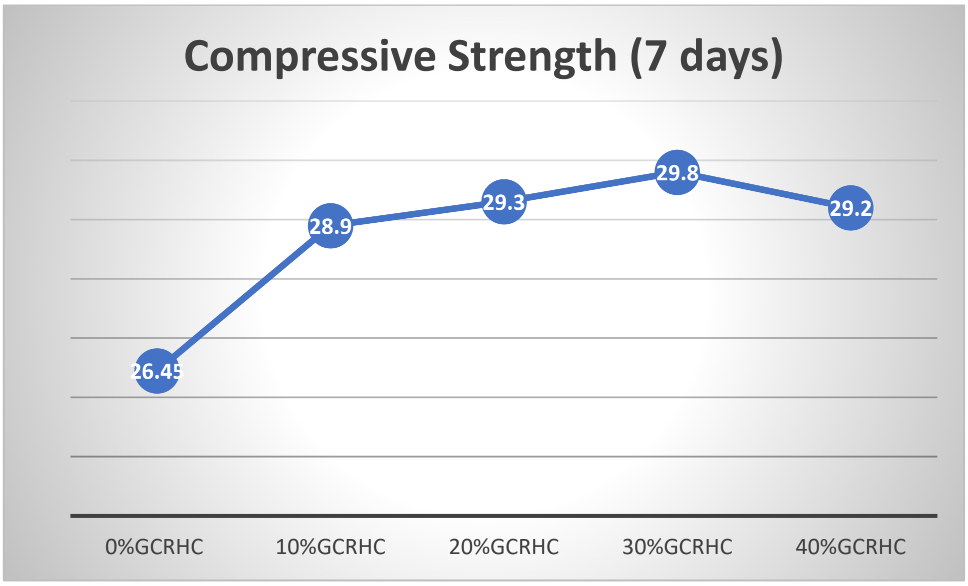
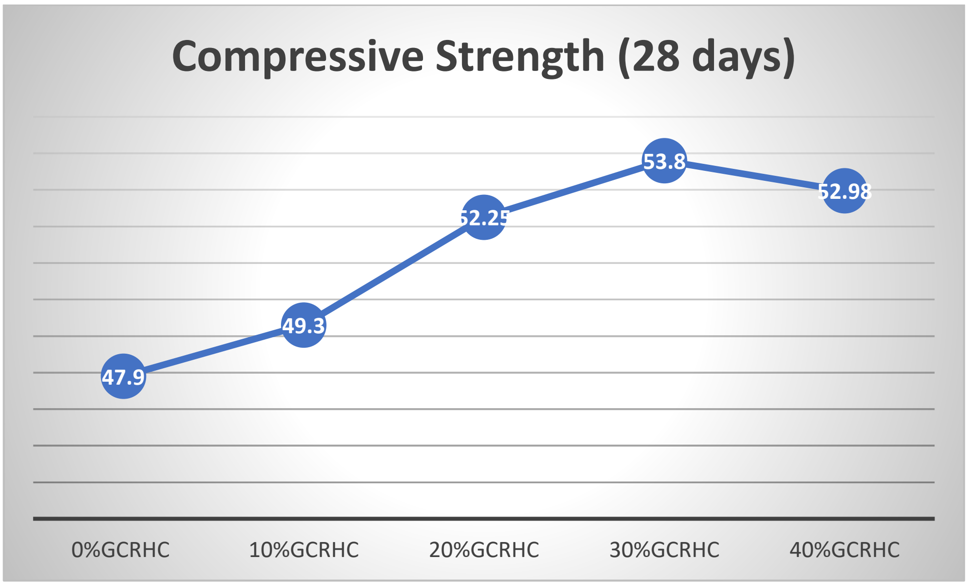


Table:

Mix-Type	**Mix ID**	**Compressive Strength 7 days**
0%GCRHC	Mix-CC	26.45
10%GCRHC	Mix-10%GCRHC	28.90
20%GCRHC	Mix-20%GCRHC	29.30
30%GCRHC	Mix-30%GCRHC	29.80
40%GCRHC	Mix-40%GCRHC	29.20

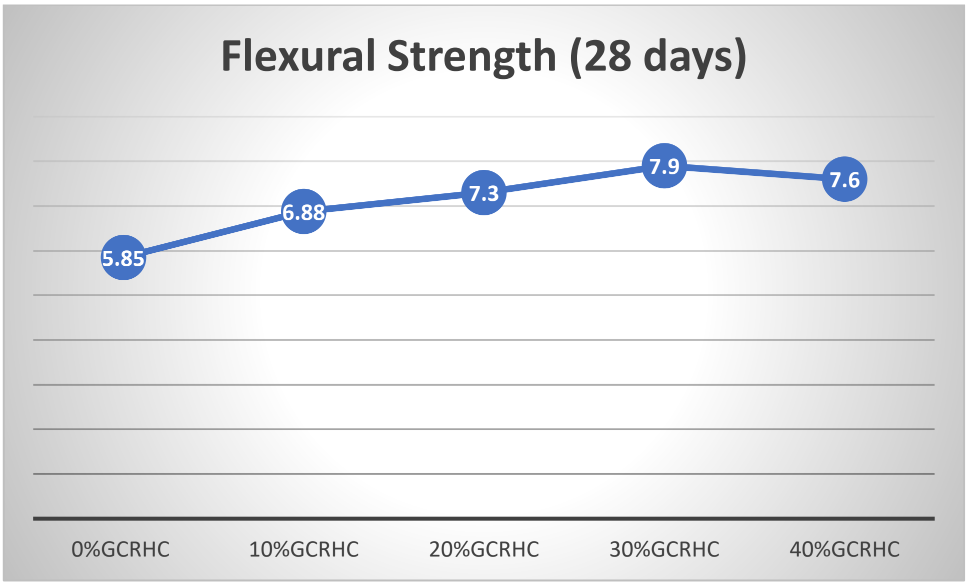
The compressive strength of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP) at 28 days



The Flexural strength of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP).

Mix-Type	Mix ID	Compressive Strength 28 days
0%GCRHC	Mix-CC	47.90
10%GCRHC	Mix-10%GCRHC	49.30
20%GCRHC	Mix-20%GCRHC	52.25
30%GCRHC	Mix-30%GCRHC	53.80
40%GCRHC	Mix-40%GCRHC	52.98

Table: The Flexural strength of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP) at 28 days



Mix-Type	Mix ID	Flexural Strength 28 days
0%GCRHC	Mix-CC	5.85
10%GCRHC	Mix-10%GCRHC	6.88
20%GCRHC	Mix-20%GCRHC	7.30
30%GCRHC	Mix-30%GCRHC	7.90
40%GCRHC	Mix-40%GCRHC	7.60

CONCLUSION

The following conclusions are made from the study:

1. Without reducing the water-cement ratio, the target mean strength of M40 grade concrete can be reached by using glass cullet-reinforced high-performance concrete (GCRHC) to partially replace aggregate.
2. 40 MPa is typically used for a variety of structural applications.

Compressive strength compares between normal mix concrete and Glass fiber mix concrete

Case 1;- The compressive strength of different percentages of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP) at 7 days.

Case 2;- The compressive strength of different percentages of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP) at 28 days.

Flexural strength compares between normal mix concrete and Glass fiber mix concrete.

Case 3;- The Flexural strength of different percentages of glass cullet-reinforced high-performance concrete (GCRHC) replaced with coarse aggregate in different % in concrete mix with 20% geo polymer (GP) at 28 days.

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